KEER2022 | Diversities

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The 9th International Conference on Kansei Engineering and Emotion Research (KEER2022) took place from 6th to 8th September 2022 (with an informal doctoral symposium the afternoon of 5th September).

The hosting city, Barcelona, is bathed by the Mediterranean Sea. Since ancient times, the Mediterranean has been a link between the East and the West, between the South and the North, and a way to share knowledge, technology and skills among very diverse peoples and cultures. Therefore, this edition of KEER revolved around the notion of diversities. Diversities of cultures, diversities of practices, diversities of perspectives, diversities of places, diversities of experiences. These diversities and their encounters are sources of richness. Understanding and experimenting with diversities in mind leads towards a greater comprehension of kansei. What we tried to do with the conference was encouraging discussion on the consideration of diversities as an encounter, bringing us together on the topic of kansei.

When the conference was initially planned, the restrictions due to COVID-19 were still very present all around the world, and uncertainty on how the conference could be done was high. For this reason, the conference was a bit of an experiment, as it had a hybrid format: some people attended face-to-face in Barcelona, while others were online. Sessions were developed during the morning in Europe, afternoon in Asia. For those present in Barcelona, afternoons were devoted to several activities.

What you will find in this book of proceedings are the papers presented in the contributed sessions of the conference. Enjoy!

SCIENTIFIC COMMITTEE (in alphabetical order of surname):

ORGANIZING COMMITTEE:

The KEER2022 International Conference in Barcelona was organized by
the Societies of the Kansei Engineering and Emotion Research (KEER):
the Japan Society of Kansei Engineering (JSKE),
the Taiwan Institute of Kansei (TIK),
the Malaysia Association of Kansei Engineering (MAKE),
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Papers

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A CONCEPTUAL MODEL FOR E-LEARNING SUPPORTING TOOLS DESIGN BASED ON CUE MODEL AND KANSEI ENGINEERING

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ABSTRACT

The Covid-19 pandemic has triggered changes in learning due to the practice of social distancing to curb the spread of the virus. E-learning platforms have become the main platform for learning throughout the pandemic. However, e-learning does have challenges when it comes to ensuring student's optimum participation throughout the learning experience that require extensive research about techniques and methods for an optimum e-learning experience. This includes various e-learning supporting tools that provides easy communication and immediate assistance to enhance user experience. The supporting tools or software usability and functionality design determined as imperative in enhancing the e-learning user experience. Thus, this research proposes a conceptual model for designing the e-learning supporting tools based on the CUE Model, integrated with Kansei Engineering for optimum user experience that can serve as a guideline for the e-learning supporting tools designer. The outcome of this research will create new research fields that incorporate multiple domains, including the e-learning domain, software and supporting tools design, emotions and user experience.

Keywords: *E-learning, user experience, chatbot, CUE model, Kansei engineering*

1 INTRODUCTION

With the emergence of the Covid-19 pandemic, a pressing need has emerged to adopt a new technique for optimising the hybrid learning approach by utilising the internet platform (Coman et al., 2020). E-learning enables students, trainers and instructors to obtain, enhance and maintain critical skills and knowledge using contemporary educational technologies (Hamidi et al., 2020). The e-learning technique has the potential to enhance the teaching and learning quality as it supports face-to-face instruction. It allows learners to study and acquire information through existing methods as well as from technology and the internet (Kimkong Heng & Koemhong Sol, 2020).

The rapid pace in technological change has a direct impact on the relationship between the instructor and students, as well as the design of e-learning supporting user interfaces tools (Mamani et al., 2019). For instance, students lose motivation during the teacher's efforts to deliver the planned activity since they are unable to "be present" when students may require assistance with learning (Coman et al., 2020). Students regularly experience feelings of confusion and loneliness due to the physical absence of their classmates and their inability to correctly answer the questions asked during lessons (Mitral et al., 2019). Multiple studies have shown that supporting tools or software are a significant advancement in the field of e-learning, emerging as the most innovative solution for bridging the gap between technology and education (Mamani et al., 2019; Mitral et al., 2019; Ramachandiran & Jomhari, 2015). Hadiana emphasised that the “usability” aspect must be the main key in designing an e-learning module and user interface. However, users desire persuasiveness more than usefulness and functional usability (Hadiana, 2015). Simultaneously, the research of (Redzuan, Mohd. Lokman, et al., 2011) and (Adnan & Redzuan, 2016) indicated that connecting the user emotion component with supporting tools capability is more effective for enhancing e-learning in terms of user experience (UX).

This study proposes a conceptual model to further enhance the design of E-learning supporting tools based on the CUE Model, integrated with Kansei Engineering (KE). The proposed conceptual model will be able to provide a guideline for the designers to design supporting tools that able to improve user experience or also known as UX. In this ongoing study, the e-learning supporting tool that we choose as the scope for discussion is the chatbot. The structure of this paper is as follows: Section 2 presents a brief overview along with the definition of UX and e-learning. This section also highlights other studies on the roles of chatbot as e-learning supporting tool, the CUE model and application of KE techniques in e-learning. Section 3 proposes a conceptual framework developed for the enhancement of UX in e-learning. Section 4 discusses the recommendations for future endeavours, and Section 5 presents the conclusion and future work of this paper.

2 BACKGROUND

E-learning is increasingly popular and widely employed in current education. Many higher learning institutions, such as universities, embrace e-learning platforms as younger students are more familiar with new technology and may be drawn to e-learning as an education platform. The term e-learning includes online learning, virtual learning or distributed learning (Arkorful & Abaidoo, 2015). It is conducted on the internet where students can access their learning materials online at any time or place (Kimkong Heng & Koemhong Sol, 2020). Moreover, students often access online learning materials such as recorded lectures, presentations, reading lists, activities and assignments through the offered platforms.

Several studies have demonstrated the benefits and advantages that may be gained through the use of e-learning technologies (Shahzad et al., 2021), (Wu et al., 2020). Other benefits mentioned in previous studies are students' perspectives regarding the reduced time spent on learning (Coman et al., 2020), the reduced energy needs for travelling to attend classes (Wu et al., 2020) and the ease in which students can monitor all activities conducted in the classroom and listen to teachers repeatedly as necessary (Arkorful & Abaidoo, 2015). However, e-learning has several drawbacks and limitations. According to Redzuan et al. (Redzuan, Mohd. Lokman, et al., 2011), the e-learning issue can be separated into three categories. The first is related to design, with emphasis on the e-learning design itself. The second is the course design and the third is the online learning material design. A study in (Kimkong Heng & Koemhong Sol, 2020) indicated that e-learning courses have not been well designed to address pedagogical issues. There is less interaction between users when it comes to applying the knowledge that students have learned. The applied practical skills are reduced, and the course materials are of lesser quality. According to a study, e-learning characteristics are essential information for instructional designers as they allow them to build and create personalised instructions for a target group (Suarta & Suwintana, 2015). Numerous user characteristics can be employed to measure individual differences, but the most explored research variable in e-learning is the learning style (Blakey et al., 2000). User characteristics such as the demographic factor (which includes the name, gender, language and age) have influenced different learning experiences. Educational data including years of study, name of college/university and skills have been examined to determine how user characteristics influence e-learning behaviour (Almahri et al., 2019).

2.1 Relationship between Emotion and User Experience (UX)

A comprehensive definition of emotion should encompass emotional experience or conscious feeling, brain and nervous system processes and visible emotional expression patterns (Adnan & Redzuan, 2016). E-learning also applies the use of emotional recognition. A learner's emotional state may indicate a change in presentation style and increased interaction to provide successful tutoring (Mehta et al., 2019). The aim is to make them feel part of a team, rather than just one individual. According to a study, positive emotions have been linked to enhanced e-learning experience (Adnan & Redzuan, 2016). To facilitate learning, the learner's attention must first be engaged and emotional responses utilised to positively 'trigger' the learner's attention (Adnan & Redzuan, 2016). Research by Redzuan identified emotions of enjoyment, pleasure, pride, satisfaction and engagement to be positively associated with e-learning (Redzuan, Lokman, et al., 2011). If a learner is enthusiastic and not stressed, learning will take place. If the surroundings are unfavourable and the learner lacks the feeling of security, learning will not occur. This is supported by a study that negative emotions such as anxiety, bewilderment, fear, anger, sadness, boredom and frustration have been frequently linked to negative feelings (Redzuan, Lokman, et al., 2011). Research on the physiological factor of the learner based on the traditional classroom face-to-face learning has been accomplished (Sandanayake & Madurapperuma, 2009). Meanwhile, UX is a modern concept that refers to people's perception of a product design including emotions, beliefs, preferences, cognitive impressions, physical and psychological reactions, behaviours as well as achievements before, during and after use (Minge et al., 2017). According to Hornbæk (Hornbæk & Hertzum, 2017), UX is concerned with how a product or service functions on the outside when an individual comes into contact with it. It is assumed that basic human needs are key drivers of product use and quality perception. UX is also defined as the feeling of satisfaction resulting from the usability experience. A blanket definition of UX is that it encompasses all of a user's experiences and reactions, whether assessed subjectively or objectively (Baumgartner et al., 2020). Hassenzahl (Zardari et al., 2021) define the term ‘appeal’ as the moment when a product may cause pleasing emotional reactions of attractiveness. The appeal was also defined as "the tangible side of the online environment which represents a website's appearance and feel of perceived beauty". Likewise, UX includes elements that can translate users' implicit emotions and needs into design schemes to support designs in terms of reaching a level of "pleasure" (Díaz-Oreiro et al., 2019). On the other hand, emotions have a significant impact on product and service design. If the user experiences pleasant emotions, they will more likely keep utilising the product or service. UX also can be represented in terms of separate components that interact with one another in a particular way. This interaction attempts to complete a given purpose which takes place in a certain setting and extends over a limited time (Yazid & Jantan, 2019). The instrumental qualities of the two categories are firmly linked to the usefulness and utility of a system. The non-instrumental qualities are the result of its appeal and attractiveness. Both qualities are significantly dependent on the third component, the emotions that accompany user engagement with the system (Minge & Thüring, 2018). Based on previous research, we can conclude that UX encompasses the effect on the emotions experienced, visual appeal, usability and function of a product. The importance of this study is to embed the UX effect, particularly for the use of chatbot, to enhance e-learning and enable a positive learning experience. Similar studies, such as in (Ramachandiran & Jomhari, 2015), have promoted positive engagement and connectivity for e-learners to prompt the desire to acquire knowledge and skills from a virtual learning environment. Thus, this study evaluates the usefulness of functions in the e-learning realm by considering emotions to determine an acceptable chatbot design. Emotions can enhance the UX of e-learning to be more attractive to learners, as emphasised in (Ismail & Lokman, 2020) and (Hamidi et al., 2020). When the user exhibits the attractiveness of learning, positive engagement or experience will then take place and learning will be much easier.

2.2 Component User Experience (CUE) Model

Thüring & Mahlke conducted a series of experiments to uncover the relationship between usability, aesthetics and emotion on the overall judgement that influences users' future decisions and behaviours (Yazid & Jantan, 2019). UX is associated with the interaction between humans and technology and has a significant impact on the user's evaluation of the system. UX can also be described as distinct components interacting with each other in a particular way. The CUE model illustrates three components of interaction: i) perception of instrumental characteristics; ii) perception of non-instrumental characteristics and iii) user emotional system response. Instrumental qualities involve the experienced level provided by the system, the ease-of-use attribute and the usefulness attribute concerning the practicality of the UX Model (Minge & Thüring, 2018). This category includes characteristics such as the effectiveness of system behaviour usability and functionality. Non-instrumental qualities include the system user’s interface address, the system's appearance and its feel, which correspond to hedonic features in the UX model (Minge & Thüring, 2018). This category includes design characteristics such as visual aesthetics and tactile quality. According to a study, both perception and emotion are likely to influence the interaction process. Emotion can be described as a subjective experience communicated through physiological responses and expressive behaviour (Yazid & Jantan, 2019). In the CUE model, the human interaction characteristic is represented by three factors: 1) system features such as functionality and interface design, 2) user characteristics such as knowledge or competence and 3) task/context. According to the author in (Minge & Thüring, 2018), the variable task/context includes the physical and social environment as well as the task which the user aims to accomplish.

2.3 Kansei Engineering (KE) for Design

"Kansei" is a Japanese philosophical term that refers to the psychological feelings and needs of humans (Redzuan et al., 2015). Kansei Engineering (KE) is a novel approach that offers a promising methodology for developing and constructing new appealing products and services with a strong focus on the human mind (Ismail & Lokman, 2020). According to (Afiza et al., 2021), KE was originally defined as the translation of consumer feelings with the product features and product image to some of the design aspects required to produce that product. The objective of KE is the development of new products in response to consumer feelings or emotions using the five human senses: vision, taste, smell, hearing and touch (Adnan & Redzuan, 2016). KE is a subset of artificial intelligence that is closely related to the design of systems and devices capable of recognising, interpreting and processing human emotions (Sandanayake & Madurapperuma, 2009). Although KE has been utilised in product development since the 1970s, the application of this methodology on education systems has arisen just recently, as seen in (Sandanayake & Madurapperuma, 2009), (Redzuan et al., 2015). For instance, in (Adnan & Redzuan, 2016), the semantic space for video-based e-learning materials for higher education will be used to drive the creation of video-based e-learning materials that incorporate targeted emotion. A model has been proposed based on student participation in e-learning, utilising KE to elicit design components associated with creating an emotionally engaging material to assist in encouraging pleasant learning experiences and fostering learning (Redzuan, Mohd. Lokman, et al., 2011). Thus, KE is one of the most effective ways for identifying emotion and correlating it with certain design elements in order to raise student interest in learning, motivating them to learn and enhance academic performance (Redzuan et al., 2015). Redzuan (Redzuan, Mohd. Lokman, et al., 2011) identified three components that influence pleasant emotional experiences in e-learning: interface design (UID), interaction design and content design. The design component of a chatbot can be applied as an artefact in our conceptual model using KE to enhance UX for e-learning. The KE methodology is typically conducted through a qualitative and quantitative approach using Semantic Differential (SD) to measure Kansei (Razali et al., 2020). In this context, SD is presented as Kansei Checklist (KC) to measure the relationship between e-learning chatbot and other component designs. KC is known as emotional descriptive words that consist of Kansei Word (KW). KW is related to user emotions and opinions represented as adjectives, nouns, verbs or sentences that are found in books, magazines and journals related to the domain (Ismail & Lokman, 2020). Thus, the KE methodology can identify emotions associated with a certain design in a chatbot, thereby the information can be used to improve user experience in e-learning.

3 PROPOSED MODEL

The purpose of this work is to present e-learning supporting tools design based on the CUE Model that we propose to integrate with Kansei Engineering to generate optimum user experience. We developed this model based on the extensive literature reviews discussed in the Section 2 to combine design influence and UX by taking emotion reaction into consideration. We employed the CUE model as a baseline model to construct a conceptual model that incorporates several different interaction property features, UX and system evaluations in the most significant components of human technology interaction. We design our study to implement KE as method to obtain emotion feedback toward the artefact that will be created in the next phase of our study. Our proposed conceptual model considers both teaching and learning aspects, as well as how e-learning supporting tools such as chatbots can enhance pedagogical transition processes in e-learning. Our proposed conceptual model is presented in Figure 1.

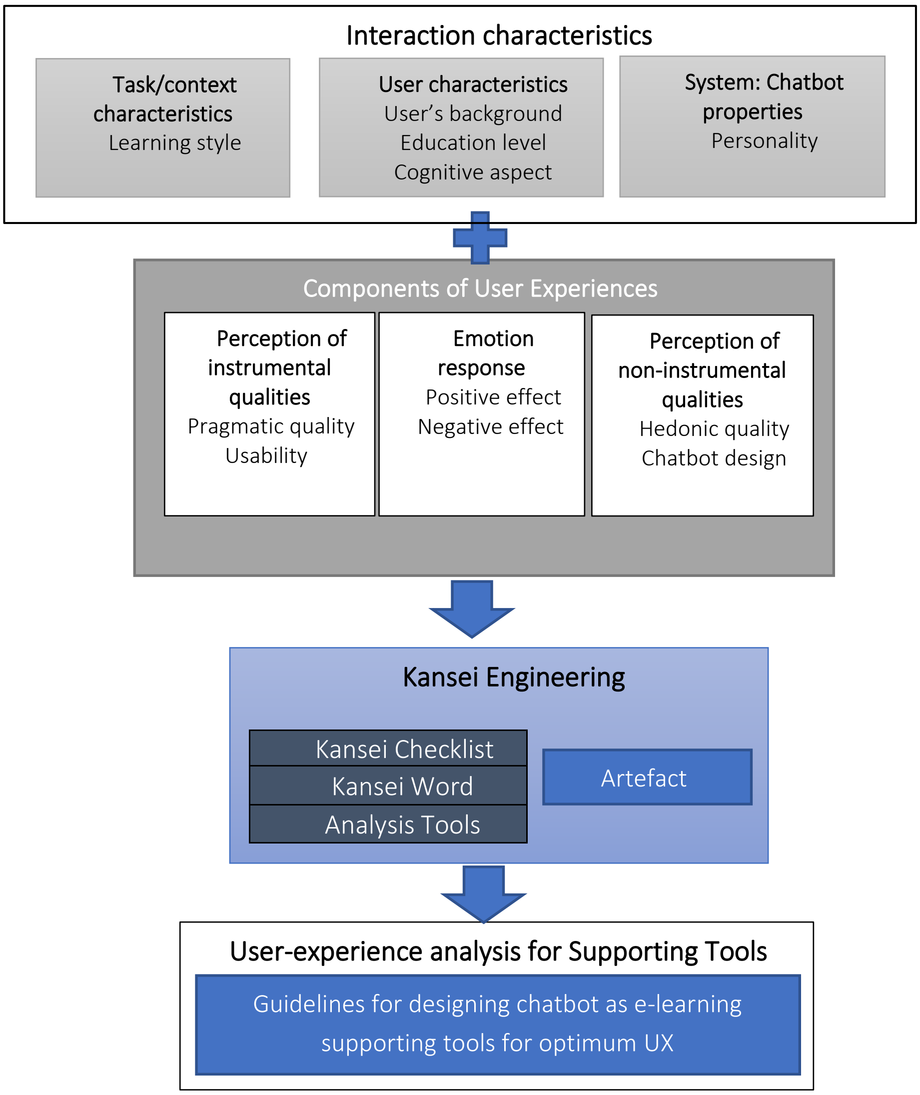

Figure 1: E-learning supporting Tools (Chatbots as scope) Design based on the CUE Model Integrated with Kansei Engineering for Optimum User Experience

The selection of variables for the model was guided by a review of models from the Human-Computer Interaction (HCI) literature, Hassenzahl's UX model and the KE approach for interpreting users' emotional responses and predicting UX outcomes such as system appraisal and intention to use (Minge & Thüring, 2018). Similar to the CUE model, our proposed model set variables into three categories: (a) interaction characteristic which has the task/context variables, user characteristic and chatbot characteristic; (b) component of UX that consist of perception of instrumental and non-instrumental qualities and KE approach for emotional response measurement; and (c) UX outcomes. Our proposed model will develop the early-stage process in designing e-learning that utilise chatbot and assess how UX influences positive emotions of users.

We assume that the interaction between a system and its users can be interpreted as qualities for interaction. There are two components in our model: interaction characteristic and user experiences that can be tested using Kansei Engineering. In our proposal, the interaction characteristics include task/context-related variables, user attributes and the system that can be tailored into personality. We propose that the level of learning adoption is diverse with a distinct demographic component, education level and cognitive aspect. These are included as the measuring variables encompassing the features of e-learning users. Our approach is based on the prediction that more efficient, effective and compelling educational materials can be designed and developed by taking learner characteristics into consideration. This model embraces personality to be implemented and in our conceptual model.

In this study, we are aiming to apply chatbot designs as an artefact to improve the educational experience because chatbots are used in numerous industries, such as in e-commerce, healthcare, service providers and business (Mamani et al., 2019), (Pricilla et al., 2018), (Chung et al., 2020). A chatbot constantly being defined as a virtual assistant that provides a group of questions and answers much quicker than a human representative would in a phone queue or an email exchange (Zumstein & Hundertmark, 2018). The designs serve as a teaching support for an instructor or as an automated teaching assistant capable of handling student doubts related to e-learning modules. A chatbot enables an interactive learning experience similar to the one-on-one interaction with the teacher, allowing enjoyable exchanges between users and virtual assistants via private messaging platforms and the use of chatbots is becoming increasingly popular among e-learners. In this proposed model, we emphasize the criticality to establish the bot's personality before the designing process of the chatbot started. We take into consideration that creating the appropriate personality for chatbot can improve the UX interaction between users and bots while communicating the demands of users (Ruane et al., 2021). Our proposal is based on the study that proven that utilising personality provides several advantages such as improving user understanding, delivering design requirements at an early stage and efficiently focusing on user goals, traits and requirements (Zumstein & Hundertmark, 2018). This is also based on the findings that personality has emphasised voice-based agents and making use of visual clues such as animated facial expressions or body language (Ruane et al., 2021). Interactive design has received significant attention (Nielsen et al., 2015), followed by user preference, age and gender. We apply these features in chatbot conversations to express personality on the side of the agent, as well as in our conceptual model to enhance the e-learning experience. We are focusing on chatbot as the measurement variable for the chatbot's properties and attributes. The component of interaction includes the consideration that learning styles are flexible due to underlying characteristics, cognitive structures, personality types, learning preferences, techniques and learning orientations. The emotional response in the model is also characterised into multiple components.

Based on the theory of the CUE model, the perception of instrumental qualities is related to pragmatic attributes to define the value of knowledge according to a tool's usefulness when users interact with a chatbot. In our proposed model, we define usability states according to five attributes: i) simple to learn, ii) efficient to use, iii) easy to remember, iv) few errors and v) pleasant to use as per the study in (Fan, 2020). Better e-learning environments stimulate learners to accomplish tasks enjoyably and efficiently. The approach known as non-instrumental qualities is related to hedonic attributes to fulfil the emotional and pleasure-related psychological demands of a user. Thus, in this research, we propose the chatbot design as a vital component to ensure the pleasure of entertainment that users will acquire to influence the behavioural intention of user application.

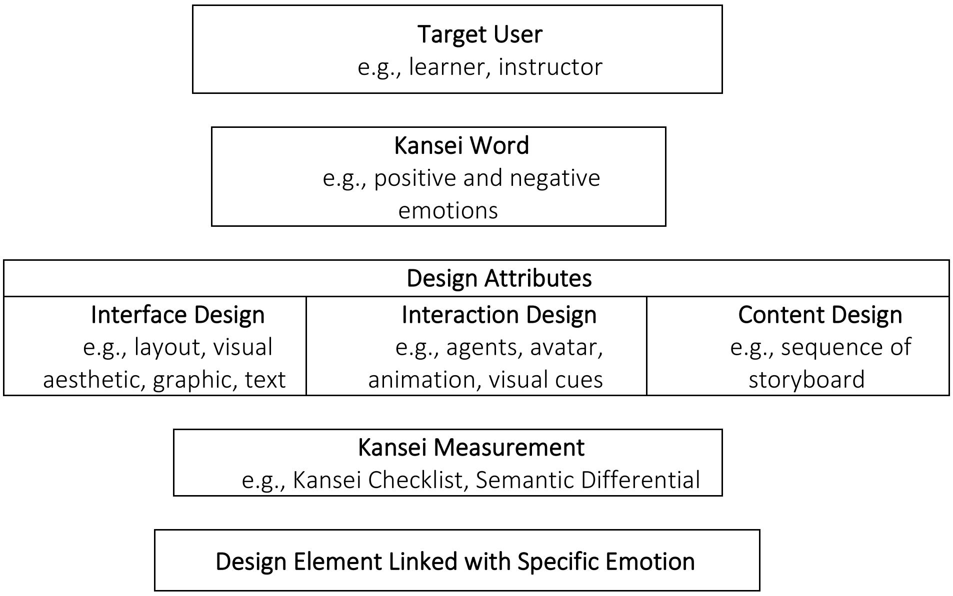

Figure 2: Research design to extract the combination of features by implementing KE approach via Kansei Checklist, Kansei Word and Analysis Tools

The model is further extended with the KE approach to extract the combination of features that emphasise the components of UX while utilising chatbot, exhibiting the effect of emotional experience in e-learning environments. KE is a recognised technique for extracting design features in numerous research areas. Figure 2 illustrates the research design of extracting the combination of features by implementing the KE approach via Kansei Checklist, Kansei Word and Analysis Tools. The output for this approach will set specific design elements linked to particular feelings or emotions. This will provide valuable information for developing chatbot based on the approach and predicting e-learning experience outcomes that include chatbot use intention, satisfaction and goodness.

4 CONCLUSION AND FUTURE WORKS

In conclusion, e-learning is electronic learning that involves the interaction between teachers and students that can be enhanced for better student learning experience using supporting tools including chatbots that we chose as our scope for this study. The use of chatbots proven to give several advantages in education due to the ability in promoting continuous learning, increases student motivation, improves student learning and listening abilities. Chatbots can be better utilized in giving better user experience in educating students on new concepts, facilitate self-guided learning and spark student interests in particular fields if the chatbot being design by taking various consideration during the design phase. Previous studies have stated that user feelings and e-learning have a significant relationship with positive learning experience. Most previous studies have claimed that emotion manipulation can enhance e-learning, making it more attractive to learners. Thus, this study discusses the important of designing the chatbot to better support the e-learning by taking emotion into our consideration.

The purpose of this study is to elicit emotional engagement in e-learning systems when the chatbots application are being used. We discuss how the CUE model and KE technique can be utilised as a potential baseline and mechanism to capture user emotions by enhancing UX. Designing and implementing e-learning supporting tools such as chatbots, however, is not as straightforward as it seems. Chatbot technology is evolving at breakneck pace, with several enhancements and new functionalities being launched on a regular basis. The development of chatbots as e-learning supporting tools should be carefully planned. Selecting the suitable platform tools is critical as it can contribute to the chatbot’s efficacy and efficiency. Thus, this study proposes a conceptual model to support the enhancement of user e-learning experience based on CUE Model and Kansei Engineering that will serve as a guideline for developing the design of e-learning supporting tools such as chatbots. In the conceptual model, we integrate CUE Model with Kansei Engineering as the methodology with aim to optimize the user experience by embedding the emotional aspect during the interaction. This paper reports the fundamental of our on-going study that will be further extended to obtained the result by performing activities that were explained in our research design. We intended to further explore chatbot design techniques and quantify the relationship its posses with e-learning approaches.

Future works are as follows: (1) conduct a study to evaluate and validate the conceptual model by experts, (2) develop instruments and artefacts for data collection and (3) analyse the collected data to understand the effectiveness of the proposed conceptual model. This study will contribute to a comprehensive analysis for e-learning supporting tools that focusing on chatbot interaction as our research scope. Based on the finding, we will develop functional and useful chatbots that will increase student engagement and UX.

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A STUDY ON EVALUATION OF A SENSE OF BEING ALIVE BY MOTION GRAPHIC

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ABSTRACT

Seimeikan, the sense of being alive might enhances motion graphics, makes it an effective communication tool, and affects human emotions. However, there is a lack of studies in terms of expressing a sense of being alive that focuses on human decision. The present study aimed to investigate the motion factors and find how motion affects the evaluation of sense of being alive. Two sets of motion graphics, artifacts and natural creature were used in the evaluation. The artifact set was composed of three levels of displacement (Linear), sine curve, and noise factors. The natural creature set was composed of data from fish locomotion. The findings of the study presented that (1) motion graphics based on natural creature were rated more positively than those that are based on artifact, (2) the motion graphics based on artifact showed the importance of noise factors, which highly correlated with expressing the sense of being alive compared to other factors. Moreover, it was found that high and low noise factors positively influenced the evaluation of the sense of being alive more than those without noise.

Keywords: *Motion Graphics, Sense of being alive, Artifacts*

1 INTRODUCTION

With the growth of science and new technology in recent decades, many man-made objects refers to artifacts in this study, have been produced to have realistic expressions similar to that of actual living being and are being utilized for various purposes. An example is Paro, a therapeutic robot which is used to provide emotional support to patients in environments such as hospitals, similar to that of animal therapy. They can communicate using an adorable voice, move their bodies and blink their eyes like a living baby seal (Takanori & Kazuyoshi, 2012). Recent observation

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shows the market of robot is growing and therefore there may be a possibility for a market of artifacts expressing a sense of being alive to grows in the future ("Robotics Growth Is about More than Technology", 2021). However, research related to a sense of being alive in the artifacts is minimal, including the lack of suggestions on how to make the artifacts express a sense of being alive.

What is the sense of being alive? How do humans feel a sense of being alive from the artifacts? The present study aimed to clarify these questions by looking at the Japanese word *Seimeikan*, which is closely related to the meaning of the sense of being alive. *Seimeikan* is a noun which is an integration of the two Japanese words: *Seimei* which means life and *Kan* which means feeling.

Seimeikan appears in various aspects, such as robots, art, medicine, psychology, etc. In the aspects of psychology, it is related to human perceptions of being, in which humanity does not exist only within the individual, but also connects with external factors such as family, society, and the nature of the universe (Koyasu et al., 2012). In terms of art, *Seimeikan* refers to the feelings of irregularity and asymmetry, which reminds us of natural forms. For example, when artists draw the form of mechanical artifacts such as bicycles, the shape of these artifacts can be separated into geometric shapes. In contrast, a horse, a natural creature, is symmetrically indivisible (Tachihara,1995). In addition, the Japanese art of arranging flowers, called *Ikebana*, brings out the feeling of naturalness and a sense of being alive to the spectator due to the flowers being arranged independently with different lengths and orientations (Averill, 1913; Korenaga & Hagiwara, 2004). Moreover, *Seimeikan* is also found to be related to a feeling of unpredictability, when humans see something change suddenly without expectation, for instance, when seeing a cockroach (Miura, 1996). These findings present multiple perspectives of *Seimeikan.* The present study proposes the implementation of *Seimeikan* as a scale to evaluate human judgment of objects or artifacts such as artworks or computer graphics, have lifelike expressions or are similar to living things in one way or another. This evaluation is based on a human feeling, recognition, or cognition about living things in their memory.

A previous research on expressing a sense of being alive with the focus on rhythms of flashing light, sound, and changing form presented the influenced factors related to expressing a sense of being alive (Witthayathada & Nishio, 2021). However, the previous research did not focus on human decisions. Therefore, this research focused on both human decisions and motion graphics factors based on artifacts and natural creatures. Then we aim to investigate factors affecting the evaluation on a sense of being alive regarding artifacts composed of motion graphics. In this study, *Kansei* engineering was employed as the analysis methodology. This method focuses on the consumer-oriented methodology for effective product development and is defined as a system which characterizes individual personalities depending on each individual, including lifestyle, age, gender, and the environment. *Kansei* refers to humans' aroused sensations, perceptions, feelings, and emotions that respond to stimuli. This methodology has played an essential role in numerous Japanese industries for over twenty years (Nagasawa, 2002; Kato, 2010; Nagamachi, 1995).

2 OBJECTIVE

The purpose of this study was to investigate how motion is influenced the evaluation of sense of being alive. The research objectives are as follows: (1) to find the influenced factors of expressing a sense of being alive of the motion graphics based on the artifact, (2) to understand the differentiation in evaluation between the participants' decision making, and (3) to compare between the motion graphic based on artifact and the motion graphics based on natural creature.

3 METHOD

3.1 Participants

23 native Japanese students (14 males and 9 females, mean age: 19.21) from Fukui University of Technology participated in the experiment.

3.2 Motion graphics stimuli

18 motion graphics stimuli divided into two sets of motion graphics simulations namely, artifacts (9 simulations) and natural creature (9 simulations) were prepared and used in the experiment.

3.2.1. Motion graphics based on the artifact

9 types of simulation of a 2D circle with three levels (without, low, high) of motion attributes such as displacement (Linear), sine curve and noise were prepared for the experiment. The design specifications of each attribute are as follows:

Motion = Displacement (Linear) + Sine curve + Noise

1) The displacement means the linear displacement was only set in the X-axis in a unit of time (1/60 seconds). Low values of the displacement make the circle move slowly, and high values of the displacement make the circle move fast. For the Y – axis, this displacement was set as constant displacement and speed . 2) Sine curve refers to a curve which caused by fluctuations and represents in the regular smooth repeating waveform, and 3) Noise employs the Perlin noise, which is a powerful algorithm used for creating virtual gaming environments with natural texture and model in animations (Lagae et al., 2010; Smelik et al., 2010). Each component consists of three different levels as low, high, and without the component (Table 1).

A total of nine experiments were carried out by using Taguchi's orthogonal array method L9 (9 tests, 3 variables, and 3 levels). This method used the process of decreasing the variation (Woolf, 2021). Figure 1 displays the simulations created by the processing software, and version 3.5.4 (MIT Media Laboratory, USA). The appearance of the simulations was designed in a white 2D circle with a size of 30 × 30 pixels (Width x height). The 2D circle appeared on a black background. The start points of the simulation were set at random and displayed in a size of 748 x 544 . The description of the attributes of each motion graphic is shown in Table 1.

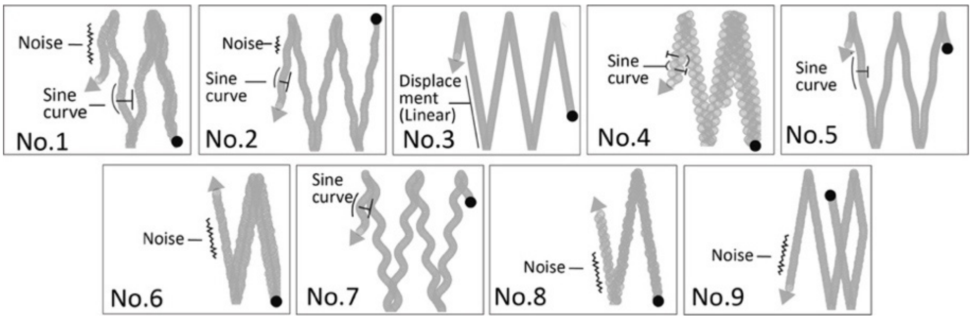


Figure 1.Example of the motion graphics based on the artifact with explanation of the motion attributes with the directional arrows

Table 1. The combination of attributes with different levels for making the motion graphics

No.	The attributes of the motion graphics		
	Displacement (Linear)	Sine curve	Noise
1	High	High	High
2	High	Low	Low
3	High	Without	Without
4	Low	High	Low
5	Low	Low	Without
6	Low	Without	High
7	Without	High	Without
8	Without	Low	High
9	Without	Without	Low

3.2.2. Motion graphics based on the natural creature

The motion graphics simulations for the natural creature set were created based on the data of fish locomotion (Figure2). In this study, the fish locomotion was selected because it is easier for the participants to observe the displacement, speed, and acceleration of motion of fishes compared to other living things. We used a camera to record the movement of Neon Tetra fish and used Image J (The National Institutes of Health, USA) to track the fish motion and export the two-dimensional (2-D) XY value to a .CSV file. Then, we used the processing software, which in version 3.5.4, to create nine samples of the motion. The appearance of motion graphics and the display size were produced the same as the simulation based on the artifact as described above in section 3.2.1 (The motion graphics based on the artifact). The path of motion graphics based on the natural creature showed that the dark color refers to slowly moving, and the light color refers to moving fast.

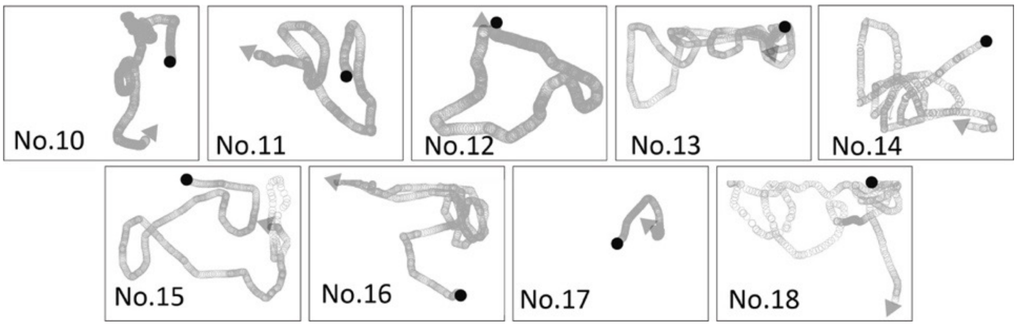


Figure 2. Example of the motion graphics based on natural creature with directional arrows

3.3 Procedure

The survey experiment was carried out for nine days from Oct 6th, 2021 to Oct 14th, 2021. This experiment performed the questionnaires to ask the participants to rate the score of how they feel a sense of being alive through motion, using the 5-point Linkert scale (From 1 = “Not alive” to 5 = “Alive”), as shown in Figure 3. Before the experiment started, we introduced the experiment’s purpose, explained the function of the survey interface, and told the participants that there was no limitation time for the evaluation. The participants were asked to sit at a distance of approximately 40 cm from a 15-inch monitor (MacBook Pro, Intel Core i7, 2.2 GHz, 16 GB) and then rate the score after watching the motion graphics. The questionnaire was designed by the processing software, and version 3.5.4 (MIT Media Laboratory, USA). Processing software was employed to collect the evaluation score and response time of the participants to each motion graphics simulation.

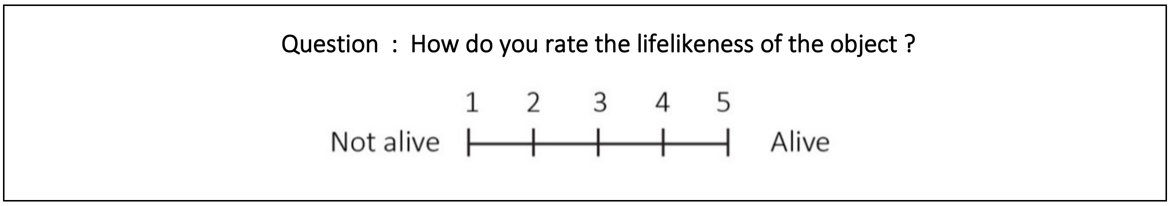


Figure 3. Questionnaire asking the participants to rate scores for 18 motion graphics

4 RESULTS

According to the objectives of this study, the experiment was performed to find how participants feel a sense of being alive in the motion graphics simulations. This study employed the analysis of variance (ANOVA) and a two-way ANOVA to investigate the evaluation of influential factors in expressing a sense of being alive. Then, the cluster analysis was employed to classify the motion graphic simulations into groups and to investigate the similarity and differentiation of the each group.

4.1 Data analysis results of the motion graphics simulations based on the artifact

For similarity in evaluation tendency, cluster analysis was used for grouping the motion graphics, and examining the similarity and differentiation of each cluster group. As a result, the 9 motion graphics simulations were classified into 3 clusters, which were A, B and C groups (Figure 4). The result showed group A consisted of the simulations with low and high noise. Group B consisted of the simulations without noise. Group C consisted of the simulations with low and without displacement (Linear). The mean of score in group A was highest among the clusters (Group A = 3.59, Group B = 2.37, and Group C = 2.77).

The difference between the highest and lowest scoring groups was discussed as follows: group A with the highest score consisted of the simulations with low and high noise. On the other hand, group B with lowest score consisted of the simulations without noise factor. Therefore, noise was noticed as an influential factor on participants' evaluation of a sense of being alive. Motion accompanied by noise might enable participants to feel a sense of being alive compared with motion without noise, such as motion in repeated patterns as seen in machine operation. Natural creatures expressed themselves in irregular motion, for example the movement of breathing rhythms in the human body (Jerath, 2020).

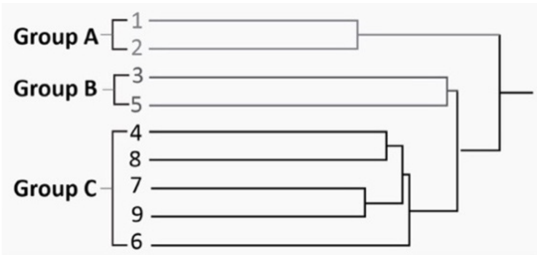


Figure 4. Result of the cluster analysis generated the motion graphics in three groups

For the difference in evaluation tendency, there are no significant differences between males and females with the feeling of expressing a sense of being alive regarding stimuli based on artifact (The left side of Figure 6, (i)). The mean of the evaluation score of the simulations and the standard deviation by gender were shown as follows: Male (2.97), and female (2.68).

For the three factors of the simulations (Displacement (Linear), Sine curve, and Noise), the result of the analysis of variance(ANOVA) showed that the significant differences were detected between without noise, low and high noise from the males ($p < 0.05$*), and females ($p < 0.05$*) as shown in Figure 6, (iv).The finding in both genders indicated that without noise factor was the lowest mean of score more than high and low. Moreover, the results showed that without noise have a lower variation than low and high noise in the both male and female group as follows: Male (Without noise: Mean = 2.57, SD = 1.1716, low noise: Mean = 3, SD = 1.3614, and high noise: Mean = 3.36, SD = 1.3937), and female (Without noise: Mean = 2.30, SD = 1.0675, low noise: Mean = 2.63, SD = 1.2136, and high noise: Mean = 3.11, SD = 1.1208).

For Interaction effect of noise levels and evaluation on evaluation tendency, Figure 5 presents a significant difference that can be seen between interaction effect of noise levels and evaluation. The result of two-way ANOVA indicated a main effect of noise ($p < 0.01$**) and no significant interaction effect between noise and gender, which was reported for the evaluation of the sense of being alive as can be seen in Figure 5. According to the obtained results, the high and low levels of noise positively correlated to the high evaluation score more than those without noise. Furthermore, there was no significant interaction between displacement (Linear) and sine curve factors with the evaluation of both genders From the finding, the noise factor was considered as positive affected to participants feeling a sense of being alive.

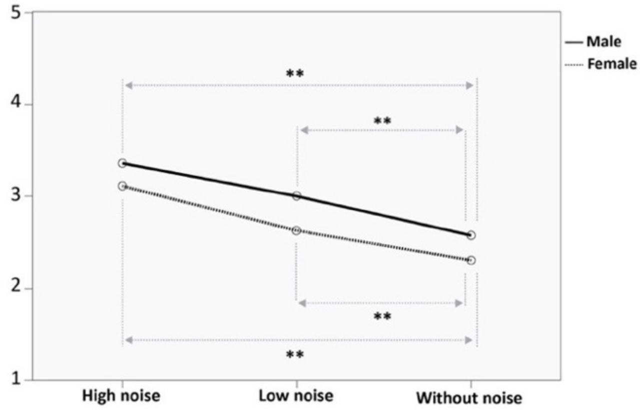
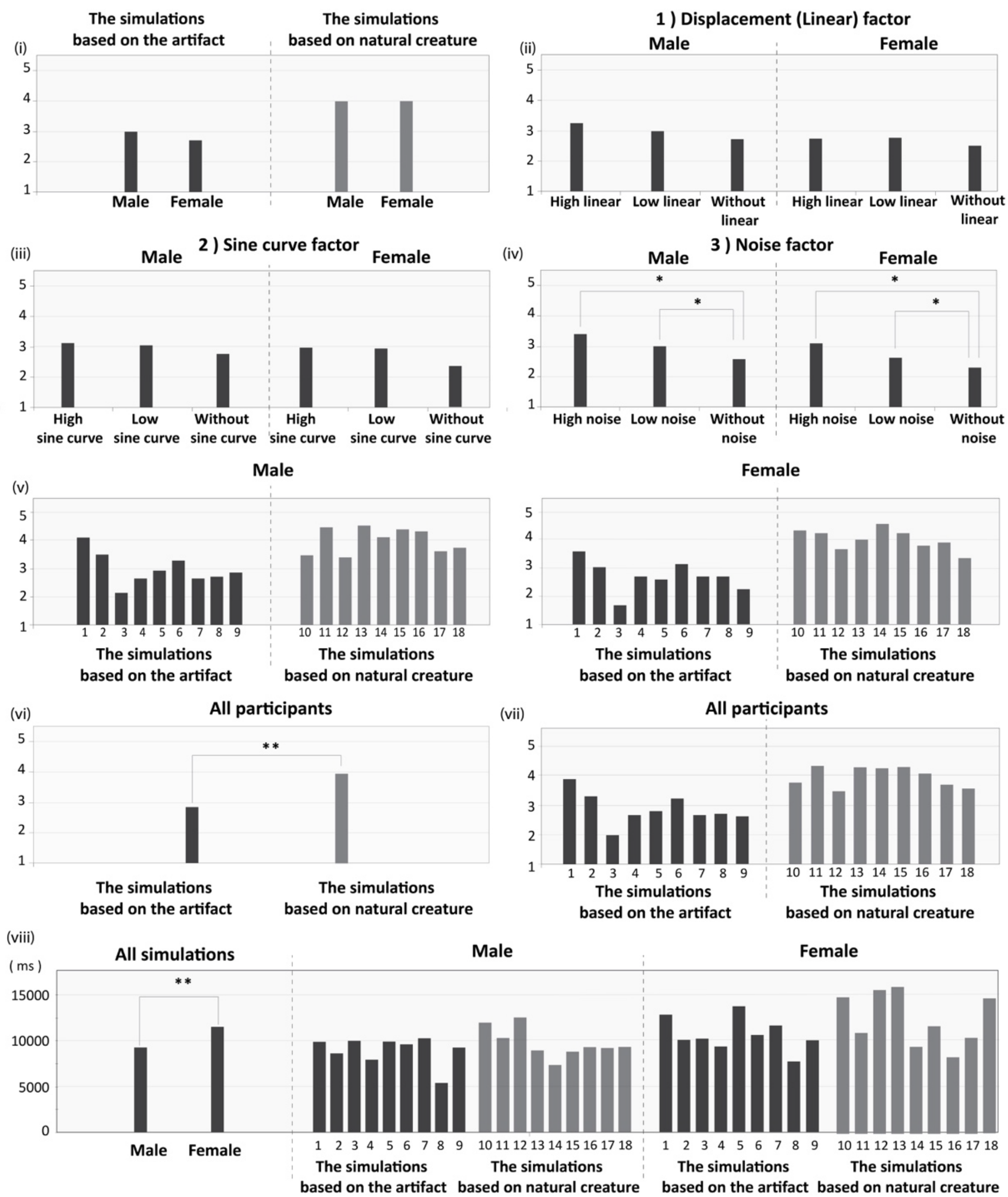


Figure 5. Two-way analysis of variance was used to analyze the three levels of noise and the evaluation scores for males and females. A significant difference was found as ** $p < 0.01$.



(i) Two set of motion graphics simulations and mean rating score of male and female
(ii-iv) Mean rating of male and female with three factors of motion graphics simulations based on the artifact
(v) Mean rating of male and female with two set of motion graphics simulations
(vi) Mean rating score of all participants with two set of motion graphics simulations
(vii) Mean rating score of all participants with the motion graphics simulations from no.1 to no.18
(viii) Mean response times of all participants, and male and female with two set of motion graphics simulations

Figure 6. Results of evaluation. A significant difference was found as * $p < 0.05$ and ** $p < 0.01$

4.2 Data analysis results of the motion graphics simulations based on the artifact and natural

For comparison between two sets of the simulations, the result of the analysis of variance(ANOVA) shows the significant difference between the artifacts simulations and the simulations based on natural creature ($p < 0.01$**) (Figure 6, (vi)). We considered that the motions of artifacts simulations were in repeated paths. On the contrary, the simulations based on nature were moved in irregular paths. The repeated path might be affected by the participant's ease of memorizing and predicting, but the irregular path might cause the participants to have unexpected feelings.

For difference in evaluation tendency, the finding shows no significant differences between males and females with the evaluation of motion graphics simulations based on the natural creature (The right side of Figure 6, (i)). The result of artifacts simulations shows that the average of male evaluation scores were higher than females (Male =2.97, and female =2.68). In contrast, male evaluation scores were lower than females in the simulations based on the natural creature. The mean for each gender and the simulations based on natural creature (Male =3.97, and female =4).

This study investigated the variation in participants' rating score, the finding of the simulations based on the artifact and natural creature was shown that differentiation of the variation between males and females. The finding showed that males 'evaluation was more varied than females as follows: The evaluation of simulations based on the artifact: Male (SD = 1.3414), and female (SD = 1.1707). In addition, the evaluation of simulation based on natural creature: Male (SD = 1.1861) ,and female (SD = 1.1067). This results indicated that the female evaluation score was more cohesive than males. It could be considered that male may be more confused in their decision-making than females.

For comparing between gender response times, females' response time to all simulations was longer than males ($p < 0.01$**) as can be seen in the left side of Figure 6, (viii). The results presented that female participants tend to take longer to rate than male participants. According to the obtained data, we looked at the differentiation between males and females and found that males do not think as complexly as females. Females are superior in carefulness and thoughtfulness more than male (Lewis, 2013; Mawaddah et al., 2018).

4.3 Cluster analysis of all motion graphics simulations

The cluster analysis was conducted. As a result, the 18 motion graphic simulations were divided into 2 clusters, A and B groups (Figure 7). The result indicated that group A mostly consisted of the simulations based on the natural creature. Two artifact simulations in this group were simulation no.1, and no.2. The attributes of simulation no.1 were high displacement (Linear), high sine curve and high noise. Simulation no.2 consisted of high displacement (Linear), low sine curve, and low noise. Group B contained only the simulations based on the artifact. The mean score in group A was higher than group B (Group A = 3.91, and Group B = 2.65).

From the finding of group A and group B, we discussed the differentiation between the high and low scoring groups. Group A with higher score mostly consisted of the simulations based on natural creature, and group B with lower score consisted only of the simulations based on artifact. According to the obtained result of group A, it is considered that simulations no. 1 and 2 were classified in this group because their attributes were similar to the simulations based on nature. Both simulations no. 1 and 2 consisted of low and high noise and this noise factor was found to positively affect participants feeling a sense of being alive. Therefore, it might be possible to make the artifact simulations express a sense of being alive similar to the simulations based on nature by employing the noise factor.

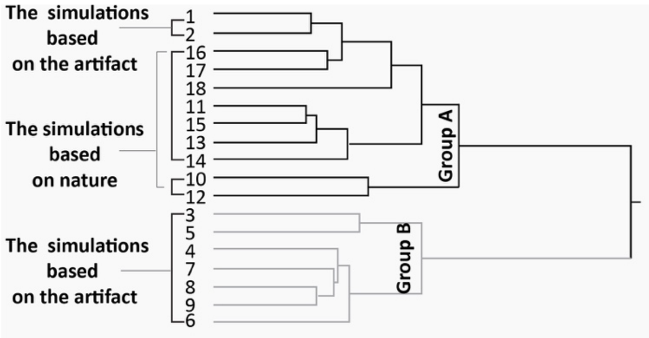


Figure 7. Result of the cluster analysis generated all motion graphics in two group

5 DISCUSSION AND CONCLUDING REMARKS

The present study aimed to investigate how motion is influenced the evaluation of sense of being alive. The findings of the study presented that the noise factor affected the feeling of a sense of being alive of participants according to the result of simulations based on artifacts (Figure 5). The simulations with low and high noise were significantly found to be different from those without noise (Figure 6, (iv)). High and low noise factors were found as correlated with the positive feeling of a sense of being alive. On the other hand, the motion without noise factor correlated to the negative evaluation scores. The importance of noise factors in expressing a sense of being alive is found in this study and may benefits future researches relating to a sense of being alive. Displacement(Linear) and sine curve factors had no influence on the participants' evaluation. Comparing between the simulations based on artifact and natural creature, there were significant differences between the two sets of simulations as can be seen in Figure 6, (vi). The simulations based on natural creature got the highest-rated scores more than the simulations based on the artifact. However, two artifact simulations were classified in the same group with the simulations based on natural creature from the cluster analysis (Figure 7). These two simulations consisted of low and high noise. For gender factors, there was no relationship between gender and expressing a sense of being alive in the artifacts. Furthermore, it was observed that female participants tend to take longer to rate than male participants (Figure 6, (viii)). Understanding the differentiation of participant background might impact developing the artifacts that can express a sense of being alive in the further study. Implementing *Seimeikan* ,the sense of being alive might give the audients get the new experiences of motion graphics.

6 LIMITATIONS AND FUTURE STUDY

1) Future study will examine the differentiation of the noise level effects on expressing a sense of being alive of motion and increasing the wide-ranging of the motion attributes. For example, we consider adding different noise levels in the more diverse motion, such as linear motion or circular motion with various kinds of noise, etc. In this current study, we produced the simulations based on the natural creature, which did not show the variables. The future study aims to produce all of the simulations with the variable for finding the differentiation and similarity of the each variable. 2) Performing the various simulations shape, such as the shape were in small, medium, and large size. 3) The size of the participants needs to increase. Moreover, we will consider balancing the numbers of male and female participants for efficiency in finding gender differences

in decision making. In addition, we plan to ask the participants from different backgrounds—for example, the participants who had any experience working in the design field compared to the participant who never had the experience, including asking the participants from different nationality backgrounds. 4) This study has only one evaluation asking whether the participants felt a sense of being alive or not. The future study will increase the number of evaluations and explore the words that have similar meanings with *Seimeikan* for considering more evaluations in the experiment. 5) Employing the Self-Assessment Manikin (SAM) to measure the participants' emotional state. This study is also supposed to ask participants from different nationalities due to the Self-Assessment Manikin is a non-verbal pictorial assessment technique (Bradley & Lang, 1994).

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A STUDY ON THE RELATIONSHIP BETWEEN CHILDREN'S DEVELOPMENTAL STAGES AND SENSE OF COLOR

ANALYSIS OF THE CHARACTERISTICS OF COLOR SCHEMES TO COLORING BOOK IMAGES BY IPAD

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ABSTRACT

It is well known that human sensitivity to color and expressive ability varies with age and gender. In addition, the perception, understanding, and comprehension of color vary according to developmental stage and color-related experiences. This study is one approach to research to clarify the relationship between such "sense of color" as above and the developmental stages of children.

In this study, the coloring behavior of teenage subjects; elementary school, junior high school, and university students, to coloring book images were investigated using iPads. The characteristics of coloring and color schemes used in the coloring books were analyzed to explore the relationship with the developmental stages of the children. The coloring book images, mandala-like patterns, used in the investigation were designed originally based on some preliminary investigations. In addition, the original palette of colors systematically arranged in hues and tones was specified to quantitatively analyze the characteristics of the colors used in the coloring book.

The results showed that the hues of colors used with high frequency in coloring books changed as the developmental stage progressed and that the range of tones by the combination of saturation and lightness widened.

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It was also found that the color schemes were simple and easy to understand at younger ages, while the complexity of the color schemes increased as the children grew older.

Keywords: developmental stages, color sense, color scheme, coloring book, color universal design

1 INTRODUCTION

In our recent studies, the methods have been examined to clarify the relationship between children's developmental stage, gender, and other factors and their "sense of color," taking into account their ability to understand and grasp colors, including color placement, as well as their experience and expressive ability (Muraki Asano et al., 2020). Based on the study, our research has been carried out to establish a school environment for "color universal design", taking into consideration that factors related to the formation of color vision in children include perceptual experiences during the growth process, color preferences due to psychological factors, and individual color vision characteristics (Atobe, 1992; Saito et al., 2010).

In this study, we carried out some surveys of elementary school students through university students to clarify the characteristics of color sense, color scheme, and design at each developmental stage, taking the following points into consideration. That is, these characteristics are probably tightly related to the sensory experiences (perceptual experiences) in the living environment. In this study, the same iPad coloring book method as in our recent study (Muraki Asano et al., 2020) was used.

The coloring books employed the design with as low concreteness as possible to avoid preconceptions in this study. Therefore, we analyzed the results as design characteristics, assuming that each image was intentionally constructed while arranging the colors. Furthermore, the purpose of this study was to use the findings of this research as an indicator that can be utilized to create a comfortable color environment for various life situations and spaces in the educational field.

2 METHOD

The method of this study was carried out in the following two phases.

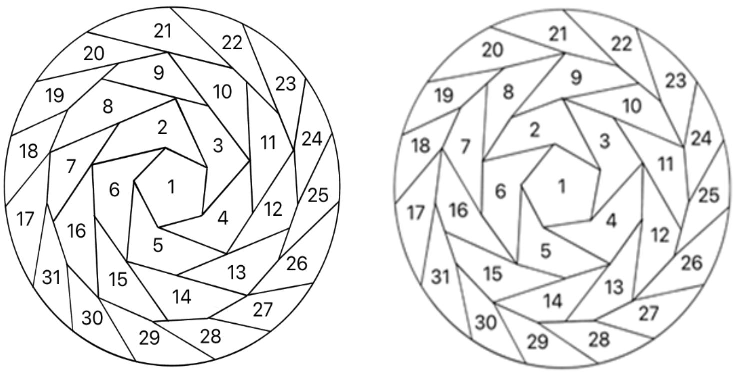
2.1 Preliminary examination

The first phase was intended to determine the design, the color palette to be used for coloring, and the amount of coloring time per child.

Based on the mandala-type design, which is a design with patterns within a circle, used in the previous study (Muraki Asano et al., 2020), four new designs were devised to elicit free ideas from the children in order to investigate their color sense, color scheme, and design. The four designs are: "a circle with curves all facing in one direction," "a circle with curves facing in opposite directions for each layer," "a circle with straight lines all facing in one direction," and "a circle with straight lines facing in opposite directions for each layer," respectively.

To select one of these designs to be used in the next phase; the main examination, we conducted a two-step preliminary survey of 20 respondents (university students) as follows:

First step: The respondents were presented with the above four designs and asked to answer a questionnaire concerning the names of objects and words that come to mind when they see the designs and the time required to fill in the forms. As a result, it became clear that straight lines are more abstract and geometric than curved lines, so we decided to use two types of straight lines (Figure 1) for the coloring pages in the preliminary survey (Design *a* and Design *b*).



Design *a* Design *b*

Figure 1. Two presented designs for coloring books focused on the preliminary examination.

Second step: A coloring investigation using iPads was carried out on the respondents. At the same time, we conducted a questionnaire about the coloring book. The color palette used consisted of the 113 colors proposed in the study as mentioned above, with color symbols attached. The actual colors of the color palette are shown in Figure 2. These colors were obtained by systematically varying the colorimetric values. (The application used for creation was ibis Paint X). The coloring time was limited to 2 minutes.

The results show that a higher percentage of the respondents answered that the image of Design *a* was more likely to precede the coloring of Design *b*. Therefore, Design *b* shown in Figure 1, was selected as the final design for this study. In addition, since no problems were found with the number of colors in the proposed color palette, it was decided to adopt it. However, the survey time was changed to 3 minutes based on the results of the questionnaire.

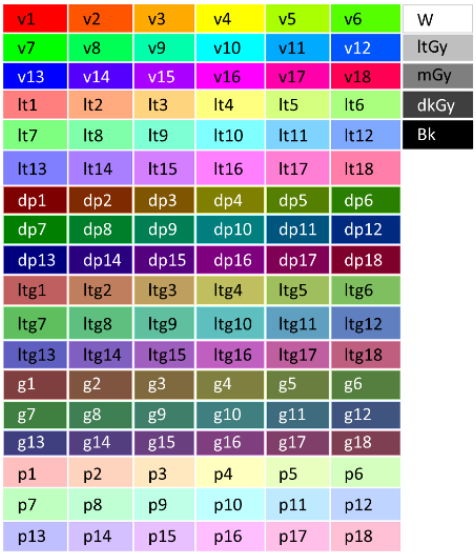


Figure 2. Suggested color palette.

2.2 Main examination

The respondents of the main examination were a total of 187 students (95 males, 92 females), including as follows: 63 fifth-grade students at Hakodate Elementary School attached to the Hokkaido University of Education, 103 third-grade students at Hakodate Junior High School attached to the Hokkaido University of Education, and 21 second-year students at the Hokkaido University of Education Sapporo. Survey period: October to December 2020. The designs used in this study, the color palette, and the amount of time spent coloring per student were as indicated in the preliminary survey described above.

In analyzing the results of this study, a total of 180 respondents (92 males and 88 females), excluding those who painted colors other than those in the specified palette, were considered valid responses and were included in the data analysis.

The results of the previous study, conducted at Sapporo Elementary and Junior High Schools affiliated with the Hokkaido University of Education, were used for comparison and discussion with the results of this study.

3 RESULT

Figures 3(1)-(3) show a summary of the number of respondents who used each color of the palette for coloring by developmental stage. From these results, the colors of the original palette in this study are represented by hues and tones that are close to each other on the PCCS color system and are summarized and analyzed as frequently occurring hues and tones by developmental stage in Figures 4(1)-4(3). This analysis shows that elementary school students frequently use cyan, yellow, and red hues, and that the most frequently used tones are mainly in the bright and clear color groups. The junior high school students showed the same hue frequency as the elementary school students, but their tones were more dispersed than those of the elementary school students, with the appearance of intermediate colors and dark purplish colors. The hues were more dispersed among university students, and the tone, p (pale), was less frequent than in the other developmental stages.

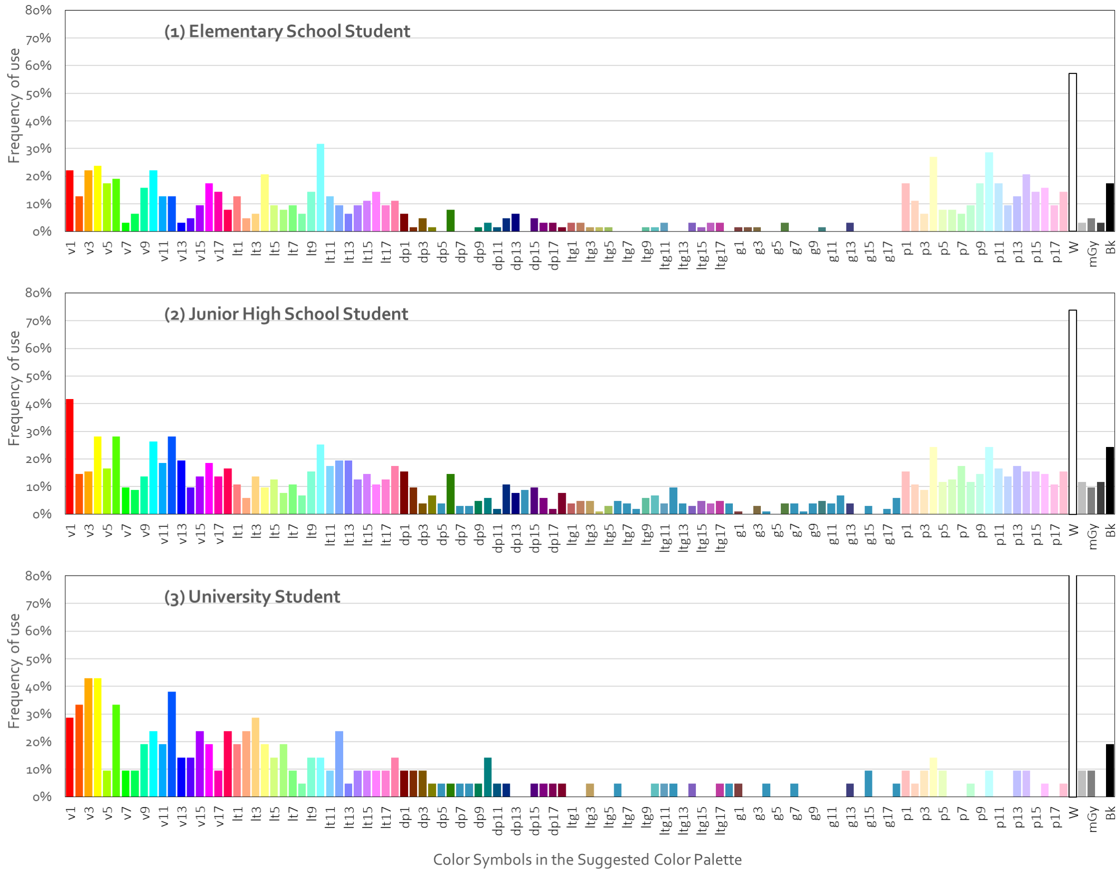


Figure 3. The number of respondents who used each color of the palette by developmental stage.

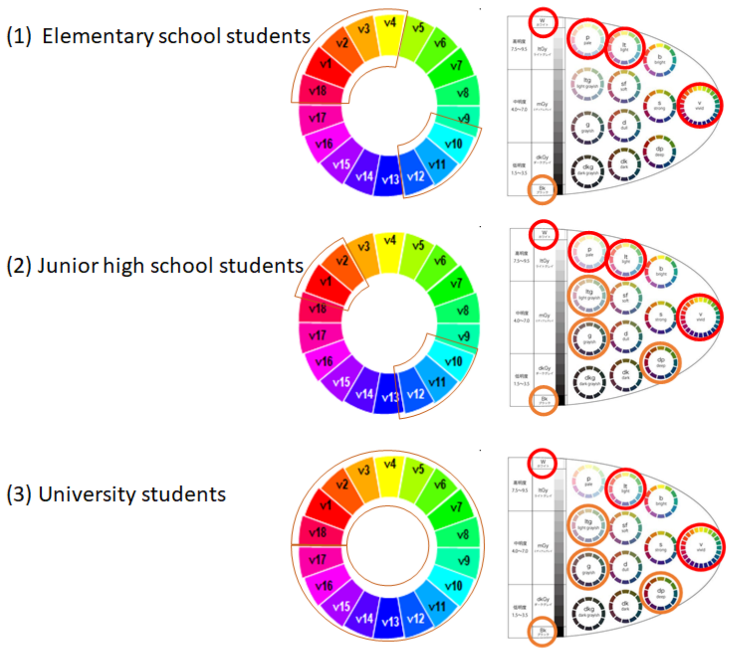


Figure 4. The number of respondents who used each color of the palette by developmental stage.

Hierarchical cluster analysis was conducted on the color position data and CIE L*a*b* values for the coloring book designs, applying the Ward method to the distance between the data. The results are shown in Figure 5 as a dendrogram.

Figure 6 shows the frequency of occurrence of each developmental stage in each of the eight clusters when divided by height=1000. The second cluster is the most common for all developmental stages, while elementary school students are in the fifth cluster, junior high school students in the third cluster, and college students in the first and second clusters. A comparison of the color scheme and design of the coloring books in each cluster revealed differences not only in hue and tone characteristics by developmental stage but also in color placement tendencies.

In various places and facilities in daily life, there are spaces and signs with color schemes that are difficult for children with a diverse color vision to identify (Mizunoya et.al, 2009). This is the same problem that remains even in today's schools, where "color universal design" has been taken into consideration, and it is pointed out that it hinders children's learning. These results indicate that there is a need to reduce these problems and to structure the color scheme and design of teaching materials, teaching tools, and displays so that all children can learn easily.

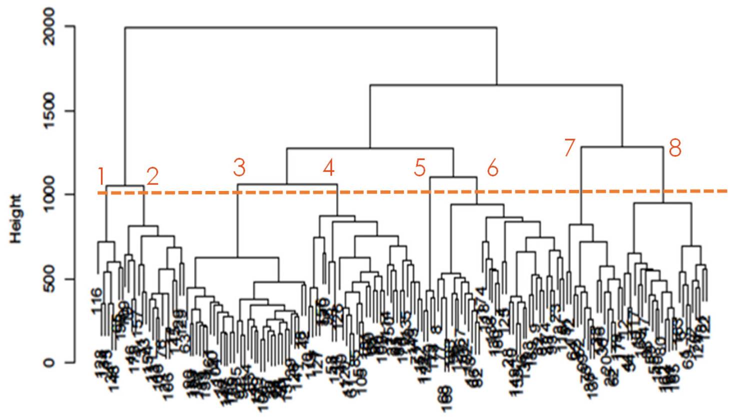


Figure 5. The dendrogram by the Hierarchical cluster analysis and Cluster No.

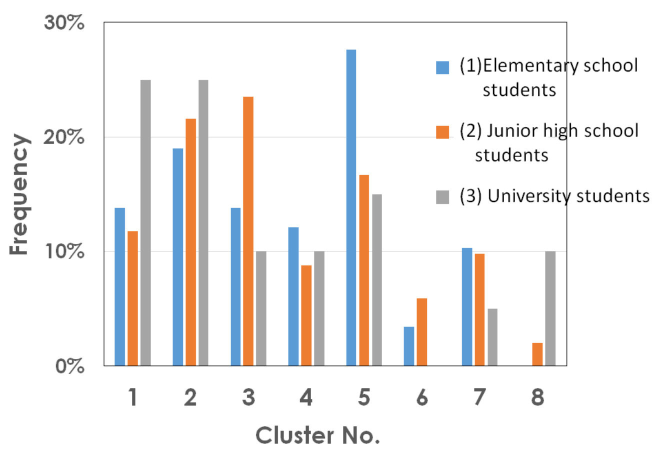


Figure 6. Frequency of each developmental stage in each cluster.

4 SUMMARY

This study shows that, in the elementary school age group, the influence of colors frequently seen in daily life was significant in the process of forming a sense of color. However, as the developmental stage increased, the range of interest in both hues and tones gradually diversified. Furthermore, elementary school students did not show any significant differences in coloring and design tendencies among individuals, and the results of all coloring pictures were similar in design. In contrast, junior high school students showed a great variety in design, which may be related to the fact that they begin to have their own sensitivities and preferences as they reach adolescence. College students tended to use a greater variety of colors, while there was less diversity in color patterns, and they tended to use gradations or some other regularity in the arrangement of colors.

Based on the results of this study, we are making suggestions for educational environments from the viewpoint of how colors used in daily life can be combined and designed to be more effective. For example, we propose the following as basic suggestions; for younger children, consider the diversity of color vision and avoid color schemes that are difficult to identify as much as possible, color schemes should take into account the unique aspect of preference or seasons of the regions they come into contact with on a daily basis; and for adolescents, while considering the diversity of sensibilities, keep in mind color schemes that have a clear purpose for puberty students, color schemes should be designed with a clear objective in mind, while taking into account the diversity of sensibilities.

ACKNOWLEDGEMENTS

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A STUDY ON THE RELATIONSHIP BETWEEN DECISION-MAKING SPEED AND KANSEI THROUGH DATA VISUALIZATION

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ABSTRACT

Data visualization is the processing of data, directed at a person, content, and purpose, to simplify decision-making for the person. In practice, does data visualization affect people's decision-making time? In this study, we formulate questions using tables and graphs for three data groups, with varying amounts of information. Twenty subjects are asked to answer the questions from least to most of information, and the time taken to answer them is measured. Following the experiment, the attributes of the subjects, including gender, age, occupation are obtained via a questionnaire. The experiment reveals that as information increases in the tabular format, the answering slows proportionally. In contrast, in the graph format, the responses do not slow down proportional to the increase in information. The relationship between the subjects' attributes and the speed of answering is determined and some significant differences are found. Six patterns of relationship between the answering time for the tables and graphs are obtained. Subsequently, the relationship between these attributes and "change of flow from data to action (hereinafter called "the decision-making process")" are examined in Kansei engineering, and the data visualization is found to be potentially effective at speeding up the decision-making process.

Keywords: *data visualization, decision-making, judgement, visualization*

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1 INTRODUCTION

In the past 20 years, the amount of information produced by humans has accelerated, and is believed to have increased 5,000 times (Japanese Ministry of Economy Trade and Industry, 2011). Companies that can analyze the information, decide based on that data, and quickly perform a plan-do-check-act (PDCA) cycle can advance further. Data visualization is used to represent information using computers to create appropriate and effective graphs and charts. It is designed to speed up the PDCA cycle by simplifying decision-making for viewers. It does so by becoming aware of people and purpose (Berinato, 2016). Particularly in business, data visualization is a powerful tool for decision-making. The purpose of this study was to determine how decision-making speed changed when using data visualization; how much it changed when more information was available. Also it aimed to verify whether the speed is related to attributes, such as gender, age, occupation, and academic background, etc. We used multivariate analysis of the data to arrive at conclusions (Blocher et al., 1986). Finally, we considered the influence of data visualization on human decision-making speed and sensitivity, according to the decision-making process (Shiizuka, 2011) proposed in Kansei Engineering.

2 LITERATURE REVIEW

Business intelligence (BI) has emerged as a system that collects data and makes them visible and understandable to people. Additionally, it is a system that creates support information for decision making for a variety of user applications (Jones, 2011). As an executive information system, the BI tool is a system wherein information is visualized for being easily understood by management (Lauer & O'Brien, 2020). It collects raw data and transforms it into valid information to drive enterprise business performance and provide strategic, tactical, and operational insights for decision-making. (O'Brien & Lauer, 2018). Applying data visualization to the output of BI tools in the form of tables and graphs, and to make them more understandable to subjects can have a significant impact on decisions (Moere et al., 2012). The format in which the graphs are displayed may be recognized to affect decision-making (Borkin et al., 2013; Dragicevic & Jansen, 2018; Lee et al., 2019). It has been shown that compared to plain text, graphs help make better use of obtained information and grant deeper insights (Iwatsuki, 1998). Graphs enable the construction of an adequate situation model and facilitates understanding text-comprehension (Iwatsuki, 2006). In addition, the visual embellishment of tables and figures has a significant and positive impact on the speed of memory recall as people judge when tables and figures are embellished (Borgo et al., 2012). In Kansei engineering, with respect to the decision-making process, it proceeds in the following sequence: data, information, knowledge, wisdom, and action. When the user receives consolidated information and integrates information in his or her mind and deeply understands the knowledge, the knowledge becomes wisdom, which results in the final action (Shiizuka, 2011). There are several studies on how people make decisions when purchasing products (Ishida et al., 2005), and what kind of images in advertisements motivate people to purchase goods (Tsuchiya et al., 2003). However, few experiment has quantitatively shown how graphs and charts affect the speed of human decision-making. Also studies on the relationship between decision-making speed and attributes of human have few performed.

3 METHODS

The experimental process is shown in Figure 1. Subjects were asked to answer questions containing tables and graphs. Herein, the questions with data visualization are referred to as graph format, and those without data visualization as tabular format. The primary data of the question had one column, the secondary data two columns, and the tertiary data three columns. As the number of columns increased, the amount of information increased, and so did the difficulty level (Figure 2). The durations to answer the questions were measured. There were 20 questions of the primary and the secondly and the tertiary were each 10 questions in all.

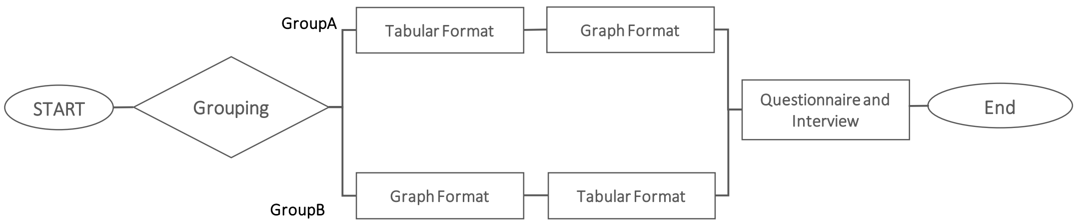
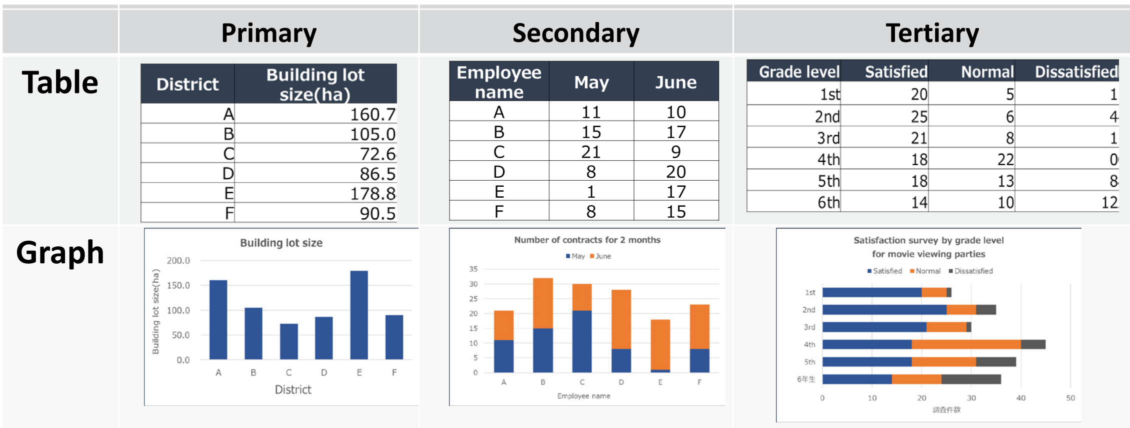


Figure1. Experimental process



District	Building lot size(ha)
A	160.7
B	105.0
C	72.6
D	86.5
E	178.8
F	90.5

Employee name	May	June
A	11	10
B	15	17
C	21	9
D	8	20
E	1	17
F	8	15

Grade level	Satisfied	Normal	Dissatisfied
1st	20	5	1
2nd	25	6	4
3rd	21	8	1
4th	18	22	0
5th	18	13	8
6th	14	10	12

Figure 2. Example of questions in tabular and graph format

The questions in the experiment were designed to be answered by those with arithmetic knowledge up to elementary-school level (according to the elementary-school curriculum guidelines set by the Ministry of Education, Culture, Sports, Science and Technology of Japan). An example question was provided at the beginning of the question text, so that all the subjects could answer. The subjects were divided into 2 groups. Group A answered the questions first in tabular format, and then in graph format. Group B answered the questions first in graph format, and then in tabular format. After the experiment, the subjects were presented with a questionnaire, and interviewed to analyze the relationship between the speed of answering duration and attributes. Twenty-two subjects participated in the experiment, but 2 subjects had incomplete experimental data. Therefore, data from 20 subjects were included in the study (Table 1).

Table 1. Subject list (*two subjects excluded due to inadequate data)

Group	No. of subject	Gender	Age	Occupation	Technical background	Final education
A	1	F	40s	Self-employed	n	Senior high school
A	2	M	40s	Executive	y	University
A	3	M	20s	Student	n	University
A	4	F	20s	Unemployed	n	University
A	5*	M	30s	Self-employed	n	University
A	6	M	30s	Office worker	n	College
A	7*	M	30s	Self-employed	n	Senior high school
A	8	F	30s	Office worker	n	University
A	9	M	30s	Public servant	n	University
A	10	M	30s	Office worker	y	University
B	11	M	40s	Office worker	y	Graduate school
B	12	M	30s	Office worker	n	University
B	13	M	20s	Office worker	n	Graduate school
B	14	M	30s	Self-employed	n	University
B	15	M	30s	Self-employed	n	Senior high school
B	16	F	30s	Office worker	n	Vocational school
B	17	M	50s	Self-employed	n	Senior high school
B	18	F	30s	Office worker	n	University
B	19	M	30s	Free lance	n	University
A	20	M	40s	Office worker	y	Graduate school
A	21	M	50s	Office worker	n	Graduate school
B	22	M	20s	Office worker	n	Graduate school

4 RESULTS

Each subject's average duration of answering were summarized.

4.1 Speed results for answering

As described in the experimental process, we considered the counterbalance for the 2 groups that affects the answering time. Subsequently, non-parametric tests were conducted to analyze the 2 groups and answering durations. The results revealed that the asymptotic significance probability (two-sided) was 0.254, which implied that the order of answering the questions did not affect the answering duration. This confirmed the validity of the experimental method. (Tables 2 and 3). The speed of answering was categorized according to the amount of information and the format, such as the primary table and primary graph, etc. The changes in the average duration of answering are presented in Table 4 and Figure 3. As the amount of information increased from primary, to secondary to tertiary, the difference in answering durations increased between tabular and graph formats.

Table 2. Changes in average time to answer per question for the 2 groups (Table = T, Graph = G)

Format	Primary (T)	Primary (G)	Secondary (T)	Secondary (G)	Tertiary (T)	Tertiary (G)
Average time to answer of group A	4.7	3.8	13.2	6.4	19.2	7.5
Average time to answer of group B	4.2	3.4	10.2	6.2	15.4	6.7

Table 3. Test statistic as related to two group and response time

Test statistic	Average time taken to answer
the asymptotic significance	0.254

a. Grouping variables: Experiment order

Table 4. Changes in average time to answer per question (Table=T, Graph=G)

	T	G
Primary	4.7	3.8
Secondary	12.2	6.6
Tertiary	18.1	7.4

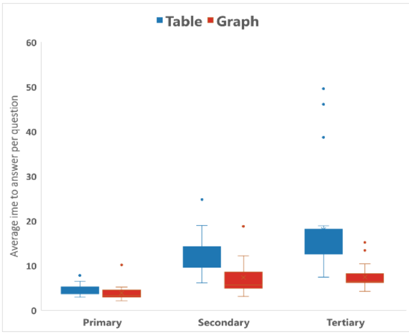


Figure 3. Changes in average answering time

4.2 Results of questionnaire and interview

A total of 13 questions were presented, including gender, age, occupation, type of business, type of work, previous work experience, final education, background is technical or not, whether they had studied how to create graphs and charts in the past, whether they used graphs and charts in their daily lives, which ones they often used, and their feelings about the experiment. Subsequently, the factors influencing the speed or duration of answering was investigated. First, non-parametric tests were conducted to analyze factors, such as gender, age, occupation, and answering time. The result was not significantly different from the answering time, except for the level of difficulty and question format (Table 5). No significant difference was found for occupation, but there was a significant trend. Next, a two-way analysis of variance (ANOVA) was conducted to examine the interaction between the significant differences in answering duration. As shown in the non-parametric test, significant differences were found between difficulty, method, and interaction (Table 6). However, as we observed a large change in answering time between company-executive, self-employed, and other occupations, we decided to create a new column called “Occupation 2” and perform the test again. In Occupation 2, all occupations except company-executive and self-employed were classified as other. The results exhibited a weak correlation (Table 7).

Table 5. Non-parametric test analysis of questionnaire items

Factor	p value
Gender	p = 0.626
Age	p = 0.129
Technical	p = 0.970
Final education	p = 0.202
Occupation	p = 0.67
Difficulty	p = 0.000
Format	p = 0.000

Table 6. Two-way ANOVA results for the interaction difficulty with formality and job type

Factor	p value
Difficulty	p = 0.000
Format	p = 0.000
Occupation	-
Difficulty*Occupation	p = 0.662
Difficulty*Format	p = 0.000

Table 7. Two-way ANOVA results for question difficulty for occupation 2

Factor	p value
Difficulty	p = 0.000
Occupation 2	p = 0.526
Difficulty*Occupation 2	p = 0.083

Although this is only a trend, as the amount of information in the tabular format increased, the response duration increased proportionally. However, in the graph format, the duration did not increase proportionally with increase in the amount of information. With such an increase and compared to others, company-executive and self-employed subjects showed greater differences in response durations between tabular and graph formats. In a follow-up interview, the company executive and the self-employed person were asked why it took them longer to answer the questions in tabular format than in graph format. The self-employed said, “Because I keep accounting books, I dared to be calm and took my time with the numbers in the tabular format.” and the company executive said, “In the case of the tabular format, I looked at all the lines to avoid answering the questions incorrectly.”

4.3 Question format and response-time patterns

The answering durations of the 20 subjects were analyzed according to the question format and difficulty level. The results showed 6 patterns (Table 8, Figure 4).

Table 8. A-E grouping factors and applicable subjects

Pattern	Format	Time to answer from Primary to Secondary	Time to answer from Secondary to Tertiary	Applicable subject number
A-1	Table	Become longer	Become longer	9, 15, 17, 21, 22
	Graph	Become longer	Become longer	
A-2	Table	Become longer	Become longer	11, 18, 19, 20
	Graph	Become longer	Become longer	
B	Table	Become longer	Become longer	1, 6, 12, 13, 14
	Graph	Become longer	Become shorter	
C	Table	Become longer	Become longer	2, 8, 10
	Graph	Become shorter	Become longer	
D	Table	Become longer	Become shorter	3, 4
	Graph	Become longer	Become longer	
E	Table	Become longer	Become shorter	16
	Graph	Become shorter	Become longer	

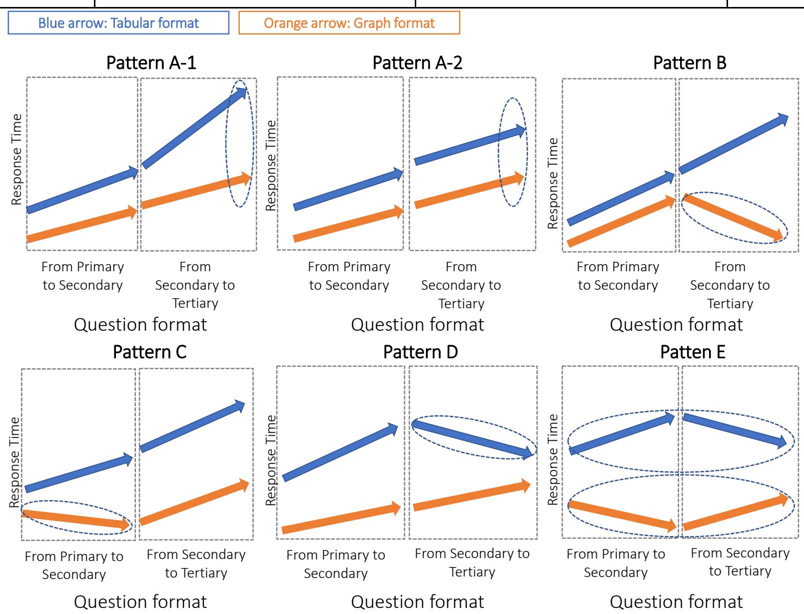


Figure 4. Variation of the answering time for groups A-E according to question format and difficulty level

First, Pattern A revealed that as the amount of information increased, answering duration increased steadily in both, tabular and graph formats. In Pattern A-1, the difference in the duration from secondary to tertiary between the tabular and graph formats was larger than from primary to secondary. Five subjects belonged to this group. Pattern A-2 also exhibited a steadily increasing response duration, but its difference from secondary to tertiary order of tabular formats was smaller. It included 4 subjects. In Pattern B, the duration increased steadily in the tabular format, but in graph one, it decreased as the information increased from secondary to tertiary. This included 5 subjects. Pattern C revealed an increasing duration in the tabular format, but a decreasing one in graph one, only for the first- and second-order questions. This included 3 subjects. Pattern D involved a tabular format, in which the answering duration shortened with increase in information amount from secondary to tertiary. However, in the graph format, the duration increased for both, primary-to-secondary and secondary-to-tertiary, as the time increases steadily. This included 2 subjects. In Pattern E, including 1 subject, the answering duration shortened with increase in information, from secondary-to-tertiary order in tabular format. However, in graph format, the response slowed from secondary-to-tertiary order. Non-parametric tests were conducted to analyze the relationship between attributes of subjects and 6 patterns. There was significant difference in graphing experience only in pattern A-2. In others, the difference was not significant in terms of the p-values for attributes (Table 9).

Table 9. Significant differences for Patten A-E group *Pattern E is excluded because of one subject

Pattern	Gender	Age	Occupation	Technical	Education Background	Graphing experience
A-1	-	-	0.39	0.59	0.39	-
A-2	0.83	-	0.059	0.056	-	0.04
B	0.63	-	0.289	-	0.472	0.982
C	0.63	0.86	0.86	0.63	-	0.188
D	0.83	-	-	0.83	-	0.83

5 DISCUSSION

The results of the experiment indicate that the decision-making speed, when looking at data in tabular and graph formats, may be related to occupation. Six patterns of response duration of 20 subjects were analyzed according to the question format and difficulty level. Next, we discuss the relationship between data visualization and the decision-making process (Shiizuka, 2011). Data change into information when they are organized into a meaningful form, presented in an appropriate method, and transmitted within their surrounding context. Data is delivered to a receiver by a sender, through visual information with graphs as a meaningful form. That establishes communication by explicit knowledge. Data visualization shortens the interpreting duration, thus potentially speeding up the transition from knowledge/wisdom to action and enabling decisions. This is represented using the decision-making process, where the x-axis is the Subjective and the y-axis is the Objective (Shiizuka, 2011). In addition, the z-axis is the rate of progress to decision-making. The length of the line is the time taken. The green line indicates the movement with data visualization, and the red line indicates the movement without it (Figure 5). When data visualization is utilized, the progress from data to information is linear, as opposed to the progress without data visualization. When entering the non-verbal area from information, it takes much time to understand the information if there is little visual information, such as in a tabular format. However, the graph format processed by data visualization facilitates decision-making by stimulating the five senses that make knowledge and wisdom function. It suggests that subjects' take less decision-making time when they see graphs processed by data visualization. Thus, data visualization effectively speeds up the decision-making process. For example, a company's management must make optimal decisions considering various factors with knowledge and wisdom. Therefore, to make data actionable quicker, despite the recent enormity of information, we believe that visual stimulation will be effective (Figure 6). Subsequently, we examined the relationship between each flow and data visualization on the receiver side in the non-verbal area. In this study, since the subjects were only allowed to choose their answers from the questions, there was no difference in the action. Therefore, change in response duration was defined as the action. We confirmed 6 patterns of Kansei among the 20 subjects. When analyzing their answering times in tabular and graph formats, with increasing amount of information, we could not find significant differences among the 6 patterns. As Shiizuka states, this could be because knowledge and wisdom are acquired by each individual before proceeding to action and they overlap as a spectrum (Shiizuka, 2011). Therefore, it was difficult to isolate and identify a single component

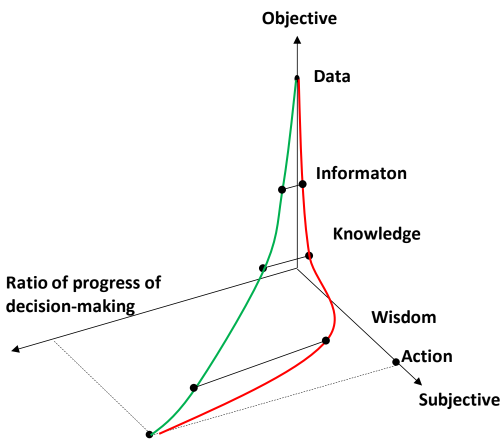


Figure 5. Change flow from data to action (decision-making) with the rate of progress of decision-making added as the z-axis

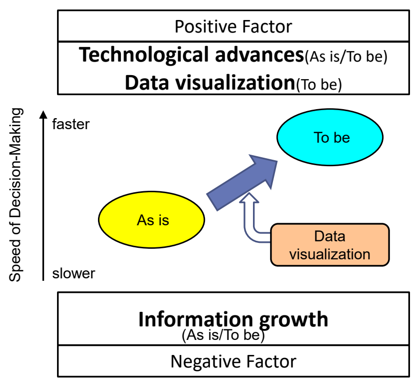


Figure 6. Data visualization driving speed of decision-making

6 CONCLUSION

In this study on the relationship between data visualization and answering time, the following conclusions were drawn. As the amount of information in the graph format increases, the answering time does not increase proportionally. The relationship between the decision-making process and data visualization revealed that: the graph format with data visualization shortened answering duration towards "information" directly; the rate of progress of decision-making, from "knowledge" to "action", was accelerated by data visualization; and 6 patterns of durations emerged. The patterns were defined as Action and analyzed. It revealed no significant difference between subjects attributes and the 6 patterns due to the spectrum. In future, we can increase the sample size, ask each subjects to repeatedly answer different questions, and examine the attributes in more detail.

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A STUDY ON THE SOCIAL AND CULTURAL CONTEXT OF TOYS FOR PRIMARY SCHOOL CHILDREN

COMPARATIVE STUDY OF TRANSNATIONAL TRANSFER STUDENTS AND LOCAL STUDENTS

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ABSTRACT

In response to the post-epidemic relationship and other factors, the number of students who transfer from abroad is increasing daily. The timing and reasons such children return to their hometown to study nowadays are extremely diverse, often appearing in the floating population, emergencies, and individual cases.

At present, more and more "international transfer students" appear in the education system of their hometown and home country, and they are facing great difficulties in academic and interpersonal relationships. Because of their lack of language skills, such children cannot successfully integrate into the education system after returning to their hometowns. In order to protect students' learning rights and avoid becoming "guests in the classroom," this study starts from the social and cultural context of toys among elementary school children; Analyzed and explored their cultural background through evaluation constructs, user journey maps, questionnaires, and applied grounded theory in qualitative research, as well as their emotional ups and downs during the game. Explore objects' meaning and relationships represented in the social culture of children to explore the emotional motivation of school children and the preferences of product modeling. It aims to understand the relationship between personal emotional fluctuations, environmental and behavior of use, hoping to create more possibilities for future curriculum development and toy design. This study adopts between-subjects design to investigate the acceptance level and psychological experience process of 120 elementary school children in the process of experiencing the interactive integration of toys into learning. Among them, 60 students are Eastern Asians and 60 are Western foreign students. Interview and record analysis. And from the popular toys on the e-commerce platform on the market, 20 items were screened out one by one for the classification of interactive toys and experience , integrated into the research and investigation of these 120 elementary school children, observed and recorded through questionnaires and interviews.

Keywords: international transfer students, Evaluation constructs, Experiential Value, Grounded theory, Children's DISC Behavioral Patterns Test Form

1 INTRODUCTION

Due to the post-epidemic and other factors, more and more children of new residents in Taiwan have flowed into the education systems of Taiwan and other countries due to family factors. Because of their lack of Chinese language ability, these children of new residents have to deal with schoolwork and interpersonal skills when they return to Taiwan. Relationships are greatly challenged.

These students are usually demoted or entered into tutoring classes because their Chinese proficiency cannot keep up with the students of the same grade. However, in Taiwan's teacher training system, there is a lack of teaching training specifically for teaching students whose native language is non-Chinese. Therefore, for teachers, communication problems often lead to a sense of helplessness in teaching; For students, the unfamiliarity and communication barriers brought by Chinese often make them anxious about learning Chinese. The purpose of this study is to explore the communication strategies, cultural contexts, and the factors that affect the interaction patterns and backgrounds of primary school children from international backgrounds when interacting with local primary school children in toy games.

This study adopts between-subjects design to investigate the acceptance level and psychological experience process of 120 elementary school children in the process of experiencing the interactive integration of toys into learning. Among them, 60 students are Eastern Asians and 60 are Western foreign students. Interview and record analysis. And from the popular toys on the e-commerce platform on the market, 20 items were screened out one by one for the classification of interactive toys and experience toys, and integrated into the research and investigation of these 120 elementary school children, observed and recorded through questionnaires and interviews. The type of curriculum that can be designed in the future, and how to use what type of toys to integrate the learning process of East Asian students and Western cross-cultural students.

Figure 1. Classification of interactive toys and experiential toys

1.1 Research background and purpose

With the wave of globalization and the rise of regional economy, transnational population migration has become a common trend and phenomenon in all countries, and Taiwan is no exception. The trend of population migration also appears.

According to the statistics of the Taiwan Immigration Department of the Ministry of the Interior, the number of foreign residents in Taiwan in 1981 was only 44,441, and in 2010 it had reached 671,375. In this wave of international migration, in addition to the introduction of foreign workers, China has also launched an era of frequent cross-border and cross-strait intermarriage. According to statistics from the Immigration Department of the Ministry of the Interior, as of the end of 2010, there were 521,136 new residents. The number of second-generation children has exceeded 380,000, and the number of new resident families in Taiwan is considerable, which shows that Taiwan has transformed into a multicultural immigrant society.

In recent years, although the phenomenon of marriage immigration in Taiwan has retreated slightly, but after a long period of accumulation, the number of new residents has reached a certain proportion in the total population of our country.

These transnational students lack informal social support networks from their native families, relatives and friends, coupled with language and cultural barriers, which limit the satisfaction of their needs and social activities among their classmates.

However, these new residents are discriminated and treated unequally in the formal social system, or due to lack of information and legal gaps, making the process of seeking help bumpy, and even hitting walls everywhere.

In addition, with the evolution of the marriage immigration process in Taiwan, the rights and interests of the new resident students in Taiwan and the difficulties they face will take on different appearances. However, whether the relevant government policies, laws, systems and measures can be timely and systematically responded to. It is worthy of in-depth study to make the new residents smoothly integrate into Taiwan society.

Zhong Zhen-Cheng (2017) defines students who have received education abroad for a certain period of time in the non-Taiwan state education system, or who have been transferred to Taiwan state education and other education systems several times, as "transnational transfer students".

1.2 Research object

Most of the children in this study are between the ages of seven and twelve, are currently enrolled in the third to sixth grades of a public elementary school in Taiwan; A few cases are middle and lower grade students. Because the 7-12-year-old schoolchildren are middle and senior grades students, their comprehension and expression abilities are relatively clear and thorough, so these four grades are the main research objects.

2 LITERATURE REVIEW

2.1 International transfer students

According to the operational definition of Zhong Zhen-Cheng (2017), the transnational transfer students defined in this study refer to “students who have received education for a certain period of time in a foreign non-Taiwan state education system, or who have been transferred several times in Students of Taiwan's state education and other education systems.

"The subjects of the study may be born in Taiwan or elsewhere and go to school in other places, and then return to Taiwan to continue their bridging education. The research subjects of this study all went to primary school abroad, and then returned to Taiwan to receive education, but the living environment was mainly Chinese.

Zhong Zhen-Cheng (2015) believes that mother tongue, first language, and second language have a dynamic relationship, and its causes include: field, learning sequence, thinking and cognition, policy and planning, interpersonal, self-determination, ethnic group Identity, ability, and frequency of use are nine factors, and these nine factors also reflect the language development process of these transfer students. From Chinese language learning in childhood to primary school, these nine factors also follow the transfer students’ internationalization. The flow between them brings out its transfer needs in the nine major factors.

2.2 Social culture

According to a study published in the American Journal of Public Health, preschoolers who know how to share, collaborate and help others are more likely to earn a college degree and full time job 20 years later than children who lack these social skills. Children who get along well with others are also less likely to drink excessively and break the law. The study followed nearly 800 students over 20 years.

The results suggest that certain social-emotional abilities in children may be strong predictors of future life outcomes. "These social-emotional competencies may be reflected in their ability to perform well in school, pay attention and adapt to their surroundings," said Damon Jones, a research assistant professor at Penn State.

"The research doesn't show that willingness to share makes life better, but refusing to share makes life worse for kids. But schoolchildren who interact well with others are more likely to make friends and receive positive feedback from teachers, so they enjoy school and learn more. Jones shows that in early education, when they are still willing to change behavior, identify children's social weaknesses early and help children.

Through life, work, and getting along with friends, people spend time and energy engaged in various social activities, carry out various personal and social interactions. In other words, people look for various activities and purposes in social situations: make friends, know others, and be recognized by others. Appreciating, controlling and relying on others, giving support and helping others, etc., because people seek their own purpose in social situations, and constitute a dense and complex social behavior and organization. According to current social theoretical knowledge, social behavior is eight different products of drives, which can be defined as a persistent tendency to seek a purpose, is a source of energy.

Exploring social and cultural contexts and interactions can understand the development of interpersonal relationships between students from different nationalities and backgrounds because of toy objects, such as incorporating toy objects into the content of daily chats, or making friends because of playing with toys, using objects to build or expand One's own interpersonal relationships, whether they are hobbies for entertainment or knowledge learning, can establish emotional exchanges, inspire will, stimulate life's joy, and promote learning interaction and mental health. Therefore, establishing a social support network for transnational school children is to maintain psychological optimism. One of the important conditions related to learning motivation.

The social ability and behavior of schoolchildren is a social support network way for individuals to gain self-affirmation in interacting with others. While obtaining the affirmation, it is also the negative pressure of personal emotions, such as anxiety, anxiety, tension, negativity, etc. An effective way to relieve stress. On the contrary, in the process of stress relief, after all kinds of negative emotions disappear, a state of psychological balance can be established, and the quality of social skills and behaviors can be further improved, and then a psychological balance can be obtained. Therefore, personal social skills and behaviors are closely related. Mental balance and health are mutually causal.

2.3 Communication strategy

Communication strategy (CS) was first proposed by Selinker (1972), but he did not define the term communication strategy in detail, and then Tarone (1977) first defined the term "communication strategy", which refers to the use of a language by individuals. In order to overcome the method used when the language structure is insufficient to convey its semantic connotation, Tarone and Yule added communication strategy into one of the projects of language competence in 1989, and more and more scholars began to focus on communication strategy. Definition and classification research, such as: Faerch and Kasper (1983b), Dörnyei and Scott (1995) and others, and even some scholars believe that communication strategies are also part of learning strategies, such as: O'Mally and Chamot (1990), Oxford (1990).

Among them, in the classification and definition of communication strategies, Dörnyei and Scott are the masters who divide communication strategies into two main dimensions. One is the dimension of problem-orientedness, which refers to the dimension of CS Occurs mainly when people have a conversation in order to solve the problem of communicating in a second language; Second, the dimension of consciously adopting strategies (Consiousness) refers to the emergence of CS as a method for the interlocutor to organize his limited language through thinking and output.

Dörnyei and Scott also analyzed previous research on communication strategies and found that scholars generally limit communication strategies to "negotiating" semantic information, but they believe that the interpretation of communication strategies should involve all language-related issues. Methods that can solve language communication problems should be included in the definition of communication strategy. Dörnyei and Scott extended the classification method of communication strategies, and the classification methods of the three items they proposed also have clear corpus definitions, so the researcher adopts Dörnyei and Scott's communication strategy definitions and methods as the classification of this study. in accordance with.

The communication strategies used by students are also a manifestation of learning. However, in the current academic research in Taiwan, most of the literature related to communication skills takes leaders or the general public as the main research objects, and the research direction of communication strategies in Taiwan is Most of it lies in the leaders and educators of the enterprise itself.

There are few studies on communication strategies by Taiwanese scholars on the learners' own CSL, and most of the few studies on communication strategies focus on foreign language learning. Research and summarize the phenomena observed in the teaching activities of bilingual communication strategies and the advantages brought by the training of communication strategies.

Zeng Rongyu (2015) and Pan Aima (2015) both studied college students and above. Zeng Rongyu believed that a culture with low context and a small power gap would affect the display of their communication strategies, while Pan Aima believed that language Students with higher levels of anxiety use more communication strategies.

In foreign research, English as a second language communication strategy research is mainly, such as Tarone (1977), Faerch and Kasper (1983a, 1983b), Bialystok (1983), Dörnyei and Scott (1995).

This study aims to explore the communication strategies of primary school children in Taiwan where Chinese is their second language. It is hoped that the research results can be used as a reference for the language learning of international transfer students in the future.

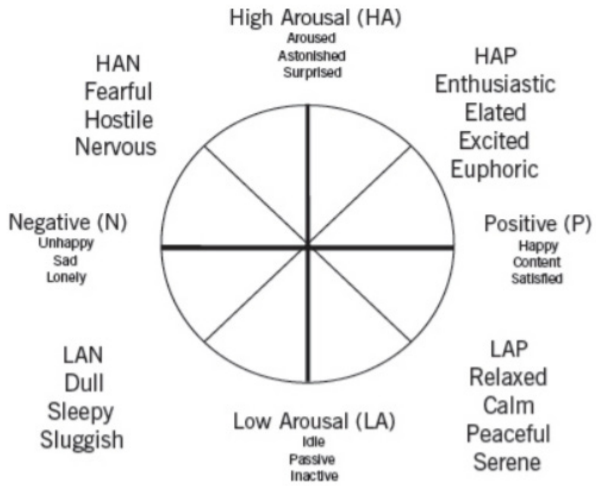

Figure 2. Two-dimensional model of affect. (HAP, high arousal positive states ; LAP, low arousal positive states; HAN, high arousal negative states; LAN, low arousal negative sates.)

2.4 Experiential Value

Through the results of subjective and objective comparison, judgment and deliberation, people express their beliefs and ideas, that is, people's values. Experience originates from the events that occurred and the mental state at that time is actively formed. It is a response to stimuli and creates a special consumption response. Value is the influence of long-term experience on consumer behavior, which will be converted into a concept and viewpoint of consumers. Value is interpreted from the perspective of experience, and value can also be defined as an interactive, relative and preferred experience (Holbrook, 1996; 1999), and experience value is the value creation after experience.Consumer perceived value is composed of three core driving factors, namely product value, service value and experience value.

The experience of products or services provided by consumers from stores or enterprises is the value derived from inner feelings, that is, experience value. The core of consumer value lies in experience, not the products or services they buy, and the experience they feel during the experience. Tangible product value or service transcends value with intangible emotional value, immersing consumers in the context of consumption, and leaving a deep impression on consumers. The consumer experience itself is also rich in value.

It is a sublimation of service value, a kind of spiritual satisfaction from the heart, and will form a deep memory or produce a good aftertaste. Zhou Congyou and others believe that experience value promotes products and services through experience, so that consumers have a sense of identity and value, and then affect consumers' consumption behavior.

Consumers interact with products and services directly or through a distance, and this interaction provides the generation of experience value perceptions and the basis of provider preferences; However, Mathwick, Malhotra and Rigdon believe that experiential value is the cognition and relative preference for product attributes or service performance. The interactive process can enhance the experiential value, but the interaction may help or hinder the achievement of consumers' goals.

In other words, the value feeling generated by consumers in the interactive experience of products or services is the experience value. At the same time, the experience value refers to whether the purchase of the product is consistent with the self or the group they admire after purchasing the product. feeling. Therefore, the value concept of consumers is a multi-dimensional multi-dimensional structure, and how to present the value of goods is worth paying attention to. Holbrook summarizes the experience value into three aspects, including external value and internal value; self-oriented value and other-oriented value; active value Value and passive value The traditional experience value is divided into intrinsic and extrinsic value; the intrinsic value of the spiritual level is composed of the pleasure obtained in the process, while the extrinsic value of the material level comes from the completion of the task or work.

Holbrook adds "self-direction" and "other-direction" to the traditional classification of experiential values of intrinsic and extrinsic values, where self-direction refers to influence on oneself, and other-direction refers to influence on others other than oneself; and activities Dimension, including passive and active value points, believes that passive value comes from consumers' understanding, evaluation and response to consumption goals, and active value comes from the cooperation between consumers and marketing entities to form a three-dimensional experience value matrix including efficiency, fun , excellence, aesthetics, status, ethics, respect and spirituality.

Mathwick, Malhotra and Rigdon define experiential value as promoting consumers to achieve their consumption goals or intentions, their feelings towards products and their preferences caused by interaction during the consumption process; and they propose an experiential value scale to measure experiential value. The structure of experience value type, that is, internal, external value and active and passive value are developed into four dimensions of experience value measurement, namely consumer investment remuneration, service superiority aesthetics and fun. Because it is difficult to distinguish active and passive value, There are some difficulties in practical application, so Holbrook once again proposed the two-matrix experience value measurement in 2006, including external value and internal value; self-oriented value and other-oriented value, developed into four dimensions: economic value, hedonic value Value, social value and altruistic value are described below and shown in Table 1.

Table 1. Two-dimensional experience value

	Extrinsic value	Intrinsic Value
Self-directed value	Economic Value	Hedonic value
Other-Oriented Values	Social value	Altruistic value

1. Economic value: refers to the product or consumer experience as a means to achieve the consumer's own goals, such as whether the product is worth the money or is of good quality.

2. Hedonic value: It refers to the pleasure that consumers get from the consumption process, or the aesthetic enjoyment they can feel from it, such as getting pleasure from consumption or appreciating beautiful things in the consumption process.

3. Social value: Refers to personal consumption behavior as a means to shape the reaction of others, in short, to obtain the reaction or influence of others, for example, this consumption strengthens others' goodwill towards me and has self-confidence.

4. Altruistic value: refers to how personal consumption behavior has a positive impact on others, related to morality or some kind of spiritual ecstasy.

This study adopts the two-dimensional experience value proposed by Holbrook in 2006 as the experience value after the interaction of toys for elementary school children of different nationalities. And put forward a research: What is the current situation of the experience value of toys after interaction?

3 RESEARCH DESIGN AND METHODS

This chapter is divided into three parts, which are the evaluation construction method, the grounded theory and the DISC child behavior scale, and the others are the design of interviews and questionnaires, which are described as follows:

The "evaluation structure method" mainly conducts interviews with highly involved groups, and sorts out authentic and credible evaluations and opinions from actual behavior cases through paired comparisons of various characteristics; Even the correspondence between abstract feelings and specific conditions, which is often difficult to capture, can be collected through this method. The study introduces the evaluation structure method of Charm Engineering and the "two-dimensional scale" of the Kano quality model, and clarifies the correlation between the integration of different toys into teaching design attributes and the learner's experience satisfaction and learning effect, and determines the quality classification of each toy design attribute. , in order to summarize the attractive experience and learning factors of toy design integrated into elementary school teaching, which can help teachers and designers or learners to create more effective teaching effects.

This research starts from the toy social culture context of 120 elementary school children; Through evaluation construction method, questionnaire survey and application of grounded theory in qualitative research to analyze and explore their cultural background, and conduct in-depth interviews with students on their learning and interaction patterns, as well as their emotional changes during the game, to explore the social culture of objects in elementary school children The meaning and relationship represented by the following, and reflect the intangible information and resource exchange in social cultural activities from the objects, and then review and verify the explanation of the social cultural behavior of toys; To understand the relationship between personal and environmental factors and toy use behavior.

4 ANALYSIS AND CONCLUSION

This study takes the social and cultural context of toys of primary school children in the East and the West as an example to explore the differences in the experience and communication cognitive evaluation of primary school children's experience of integrating toys into curriculum design, and to clarify the benefits, advantages and disadvantages of different types of designs in message communication and experience creation ; It also discusses the learning motivation of elementary school children, and discusses the learning benefits of different types of toys integrated into the curriculum design for different types of knowledge, so as to effectively enhance the educational function.

Table 2. Summary table of t-tests for different gender variables and experiential values (N=120)

structure	Item	Gender	Number	Average	Standard deviation	t	two-tailed test (p=0.05 level)
Economic Value	I think this game interaction has the opportunity to try different toys is worth it.	boy	68	4.16	0.776	2.734	**0.007****
		girl	52	3.90	0.793		
	I would like to spend time on toys to interact with my classmates.	boy	68	4.12	0.782	1.685	0.093
		girl	52	3.96	0.838		
Hedonic value	I find it enjoyable to interact with my classmates with toys.	boy	68	4.28	0.767	2.575	**0.010****
		girl	52	4.05	0.781		
	I think toy interaction gives me spiritual support.	boy	68	3.97	0.839	1.585	0.114
		girl	52	3.81	0.892		
	I think toy interaction makes life full of hope.	boy	68	4.01	0.870	1.451	0.148
		girl	52	3.86	0.898		
Social value	I think the interactive integration of toys into learning gives me a sense of accomplishment.	boy	68	3.99	0.818	1.557	0.120
		girl	52	3.84	0.815		
	I think playing with toys can gain relevant knowledge about learning.	boy	68	3.93	0.882	3.606	**0.000*****
		girl	52	3.55	0.917		
Altruistic value	I think playing with toys can help me learn to get along better with my classmates.	boy	68	4.14	0.768	3.652	**0.000*****
		girl	52	3.79	0.876		
	I think this can promote my thinking on issues related to disciplinary knowledge.	boy	68	3.94	0.858	2.945	**0.004****
		girl	52	3.63	0.930		
	I think this can facilitate my action to learn subject knowledge.	boy	68	3.85	0.847	2.632	**0.009****
		girl	52	3.58	0.892		

*$p<0.05$ **$p<0.01$ ***$p<0.001$

As shown in Table 2., different gender variables have significant differences in the four dimensions of experiential value, and boys are more agreeable than girls. In economic value, boys are more likely to agree such expenses are worthwhile, and boy respondents in hedonic value feel more pleasant than agreeing to interact with their classmates with toys; In the part of social value, boy respondents agreed that they could gain subject-related knowledge, and in altruistic value, boys felt that they could learn to get along better with their classmates, and promote their own thinking and actions on issues related to learning subject knowledge.

Table 3. Summary table of t-test of variables and experience value of students of different nationalities (N=120)

Structure	Item	Nationality variable	Number	Average	Standard deviation	t	two-tailed test (p=0.05 level)
Economic Value	I think this game interaction has the opportunity to try different toys is worth it.	Foreign students	48	4.17	0.761	2.098	**0.037***
		Asian students	72	3.95	0.799		
	I would like to spend time on toys to interact with my classmates.	Foreign students	48	4.13	0.760	1.268	0.206
		Asian students	72	3.99	0.836		
Hedonic value	I find it enjoyable to interact with my classmates with toys.	Foreign students	48	4.29	0.705	1.806	0.072
		Asian students	72	4.09	0.800		
	I think toy interaction gives me spiritual support.	Foreign students	48	3.99	0.860	1.233	0.219
		Asian students	72	3.84	0.878		
	I think toy interaction makes life full of hope.	Foreign students	48	4.11	0.910	2.154	**0.032***
		Asian students	72	3.86	0.877		
Social value	I think the interactive integration of toys into learning gives me a sense of accomplishment.	Foreign student	48	4.11	0.808	2.535	**0.012***
		Asian students	72	3.84	0.812		
	I think playing with toys can gain relevant knowledge about learning.	Foreign students	48	4.11	0.790	4.867	**0.000*****
		Asian students	72	3.57	0.921		
Altruistic value	I think playing with toys can help me learn to get along better with my classmates.	Foreign students	48	4.14	0.785	2.500	**0.013***
		Asian students	72	3.86	0.862		
	I think this can promote my thinking on issues related to disciplinary knowledge.	Foreign students	48	4.07	0.786	3.748	**0.000*****
		Asian students	72	3.65	0.929		
	I think this can facilitate my action to learn subject knowledge.	Foreign students	48	3.99	0.807	3.472	**0.001****
		Asian students	72	3.60	0.887		

*$p<0.05$ **$p<0.01$ ***$p<0.001$

As shown in Table 3., transnational transfer students and Western immigrant students are combined into "foreign students", and students from other Asian countries who return to Taiwan to study with Taiwanese students are combined into "Asian students", a total of two groups are conducted independently Sample t-test. From the research results, it can be found that there are significant differences in the four dimensions of experiential value, and all respondents from Western foreign students are more agreeable than those from Eastern Asian primary school students. In terms of economic value , Transnational transfer foreign students feel that this kind of expense is worthwhile, from the perspective of hedonic value, Western foreign students think that life is full of hope after interacting with toys; The part of social value is that foreign students feel more fulfilled and can learn relevant knowledge of subject content; From the perspective of altruistic value, foreign students feel that they can learn to get along better with their classmates, and promote their thinking and actions on issues related to subject knowledge. This part may also be related to their less frequent contact with relevant information and knowledge. Using different types of toys interacting with classmates of different cultures can also learn some information, so they feel that the cost is worthwhile, and have a sense of hope and achievement.

The following are the results of this research:

1. Integrate the results of the three-phase interviews in this study to clarify the planning procedures, experience, and design thinking aspects of the integration of different types of toy cultures into instructional design, and to clarify the relationship between the emotional attributes of the charming experience and the attributes of instructional design through a visual hierarchy diagram, to understand the preference trend of elementary school children.
2. Through the comparison of the differences in students' experience evaluation, learning theme information communication and satisfaction through the integration of different toys into teaching modes, the advantages, and disadvantages of different concept types for the creation of learning experience are clarified, which can be used as a reference for future teaching design.
3. For elementary school children after learning and designing different types of toy communication contexts and cultures, compare the learning effects of the curriculum topics, clarify the applicability of different types of concepts to the learning of different knowledge types, and summarize the results of comparison and analysis to guide future teaching design. Reference basis for teachers' teaching material design.
4. The Kano quality model is used to clarify the correlation between different curriculum design attributes and learner experience satisfaction and learning effectiveness, and to determine the quality classification of various types of toy culture integrated into the teaching curriculum design attributes, so as to summarize the attractive experience and learning factors, which can help curriculum designers or educators and policy makers are more successful in creating effective teaching.
5. Through quantitative analysis, we can clarify the numerical relationship between the design attributes of different toy types and the experience preference and learning effect, and the feelings can be described numerically, which can be more accurately used as future design development and prototype inference.
6. This research integrates the qualitative and quantitative results, and summarizes the correlation between the experience evaluation and learning benefit, curriculum design experience evaluation and learning satisfaction, and learning satisfaction and learning benefit of the integration of different types of toy cultures in the East and the West into instructional design. , and sorted out the principles of attractive experience curriculum design, which will help educators and curriculum designers to effectively build a teaching design that has experience fun, educational functions, and enhances the satisfaction of learning outcome.

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ACHIEVING CUSTOMER ACCEPTANCE OF NOVEL PRODUCT FEATURES BY OFFERING CUSTOMER DELIGHT

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ABSTRACT

Today's markets often offer different product solutions to the same customer need. In particular, new products offer new features requiring new customer behavior. This is typically driven by technology push, environmental concerns, or legal requirements. Due to inconvenience users do not easily change their behavior and thereby reject novel products unless they offer an obvious delight in the eyes of the user. Product developers need to take this in account when designing products. Tools such as UX, Kansei Engineering and Kano model are amongst those supporting product practitioners. This is exemplified by the affective evaluation of computer mice over three generations. It can be seen that in particular women have different affective needs in comparison to men related to auditive properties of mice. Hence it is important to adjust the user panel composition in accordance with the expected effect in order to avoid biases due to lacking diversity.

Keywords: *Biases in UX, Affective Product development, computer peripherals, computer mice, Kano Model*

1 AIM

This paper aims to identify promoters and inhibitors for user acceptance and suggest tools for achieving customer acceptance and delight as well as listing general biases from affective engineering methods emerging from lack of panel diversity. While the panel size, as well as its composition in terms of age and gender is commonly reported in publications, there are other limitations that introduce inherent biases in the study outcome. This paper lists and identifies some of the most common biases potentially limiting UX studies and narrowing the scope of inputs for product design activities. These are either found in publications emerging from academia and its collaborations with different industries, as well as recognized limitations within the industry. This section aims at opening the discussion but mostly raising awareness of how easily multiple bias can limit the scope of product design and compromise the success of products and their successors. While UX studies, paired with all sorts of data analysis, including advanced and novel statistical methods, have been shown as historically proven promoters of product success, the source of their data is still the (always limited) panel of users made available to researchers. Established methods may lead product designers to meet captured user needs and address the Voice of the Customer (VoC), but design outcome might be based solely on a whisper.

Adopting new features that extend from functionality and performance towards a more experiential and user captured needs, essentially in the form of a better perceived UX, is a driver for future product success. In a simple but applied example, evolution of features within a specific product line, a high-end computer mouse and 3 of its consecutive generations, is visualized through a Kano Model. The goal is to understand how both performance and UX delighters features shift across the plot, from novel and delighter experiences to requirements across the evolution of the product itself. Moreover, how new attributes are introduced between generations as new product features or shifts in solely experiential requirements. These shifts are sourced from user-driven studies and by capturing the VoC in parallel with the design of the product itself. The Kano Model, in this example, should allow to visualize the emergence of new market trends, as well as temporal shifts in relevance and importance of specific product features.

2 INTRODUCTION

In times of environmental change, technology push, and increasing customer demands, products evolve fast. New features appear bringing with the novel functionalities and improving performance. Customers need to constantly adapt and change lifestyles and behaviour to accommodate products in their daily routines. This creates a constant emotional pressure of change which can be averse to the introduction of new features to the market. Customer satisfaction research traditionally focuses on functional needs only missing to address those emotional, affective aspects (Tontini, 2007).

Many product developers, therefore, feel they have no or little influence on the market perception of those novel products. In literature, these aspects are generally referred to as “illdefined requirements”(Cheng & Atlee, 2009; Gaspar, 2013; Valverde et al., 2019). Being able to outline those requirements, analyse and integrate with the physical product design is a key factor for successful product creation.

Industries such as automotive, hardware, consumer electronics, food, and software, among many others, see product development engineering activities closely supported by User Experience (UX) studies. User Experience emerges anywhere along the product development cycle: vision stages, where product requirements emerge by capturing Voice of Customer (VoC) and user feedback through benchmarking; product validation, such as prototypes and demonstrators, iterations closer to the final product; and capturing product performance, including through the promotion of emotional attachment and brand sense with its user base, when afforded to the market and throughout the whole of its lifecycle. While user experience inputs, from subjective feedback to objective and quantified data are analysed internally by the design actors, a lot of its source content is also readily available to the public in general. This is available via feedback given through large online retailers, social media content, tech reviews, and inherent discussions, amongst other media. Specific product usage can be captured through shared analytics, and embedded features capable of measuring product usage, e.g. battery cycle in an electronic device. Additionally, online data gathering algorithms capturing PUX feedback from online sources allow further expanding the information available to the design team.

Yet user experience studies still rely heavily on evaluation panels, segments of the population that aim to address target users at any level. From a selection of industry experts, typically those directly involved in the product development, to target users and naïve customers, UX panels can be formed and selected to specifically address different stages of the design cycle.

UX studies are very resource-intensive, both in time and cost, and their ability to capture holistic experiences is always limited and bounded by the panel itself, the source of information to the analysts. Bigger industries, such as the automotive may have resources to engage in larger UX studies and have permanently dedicated teams to do so (Enigk et al., 2008; Mauter & Katzki, 2003; Mittermeier et al., 2010), while also benefiting from long product development cycles. But such is not the case for most industries, either facing faster design to market cycles, as in the case of consumer electronics, and smaller companies that lack resources or face specialized markets. Many companies, including start-ups, launch their envisioned products based on a belief of market acceptance and in the hope of iterating the next generation aftermarket exposure – and fail.

In essence, products designed from UX data captured by a very particular panel will not address the overall market needs. And while it’s not expectable that the same product fits everyone, the underlying missing data is the ability to capture a larger share of the market or simply design better products, both key to success for any company. This was further constrained by the recent pandemic situation, leading to slower development cycles and an overall inability to directly access users for the most basic form of capturing UX: a live interview.

3 COMMON BIASES EMERGING FROM UX DUE TO LACK OF PANEL DIVERSITY

It is common to push UX studies towards research centers, universities and institutions, and market analyses specialized companies. Available funding for shared Research and Development (R&D) activities fosters this mutually beneficial engagement, including by bringing industry and academia together and promoting knowledge transfer among parties. But it's also here that UX studies find their scope inherently limited, particularly in the panel composition. In an always limited resource context, finding panellists within the same environment as the researchers is common practice, being within a company or a university. Many biases or the inhibition of achieving a holistic understanding of the market aren’t inherently introduced.

UX studies formed within a university immediately find themselves bonded to an age bias, typically centered on a younger population, students between ages 18-25 as these are those more easily available and willing to participate in such studies. Another underlying bias is education, as such studies are done among people of higher(est) levels of schooling. Research groups are also found within a specific school, e.g., design school, so a further narrowing of the population is forced upon the study if an active effort is not employed to seek out participants in other contexts (e.g. other departments). It is, important to note, however, that the design of a product directly aiming at these populations their target users can greatly benefit from such narrow scope. But certainly, this is not the general case.

Engineering activities immediately see a design bias introduced towards gender. STEM fields, particularly in mechatronics and surrounding knowledge areas, are well known to be heavily male populated. UX input is given mostly by males, biasing the design towards a male preference. In extreme, gender differences can be found in ergonomic assessments for designing a product. A well-known case is Swedish and German car seats, usually designed for the 90% percentile of the male body (Gjengedal, 2019), but with the bias further extended to the extreme as the local population is recognized by the highest average of human height. Beyond overall comfort, serious safety, and health issues have long been recognized (Hell et al., 2002; Mordaka & Gentle, 2003; Viano, 2003). Similarly, in the context of computer peripherals, computer mice were found to be designed for male hands, i.e. too big for the average female hand, being particularly relevant in Asian markets. A very particular example still in this context is left-handed people, as most are forced to use right-handed mice or, at best, symmetrical mice due to the lack of market options or equally good alternatives to their sought product. While biometrics and ergonomics provide clear examples, less evident and more subjective biases can be found in product aesthetics, functionalities, and features. From distinct aesthetic features such as choice of colours or shapes to even subtle features such as afforded haptics and acoustics, gender biases will result in differences from PUX response among users.

Some industries can have external groups of people that they resort to, representative of intended target users. In consumer electronics, early access to products is then given to these users for feedback but such usually occurs immediately before production or at its early stages where, by then, only minor updates or reviews of the product are possible. But these groups are usually composed of expert users, such as athletes, including esports (gaming), well-known tech reviewers, social media influencers, and other already well-recognized individuals within a specific field. Yet, it's not easy to find a correlation between individual-specific feedback and a better product design. Expert users are a niche and they do not voice the overall larger audience of target users, albeit being quite capable of influencing the market and setting market trends. Here, bias can also be introduced from sponsoring, even if just due to have provided a free sample, leading to naturally more positive feedback from these users.

Industries can also resort to market study companies, which provide services in the design of UX methods and engaging with wider audiences of target users. Found to be costly, they are beneficial, particularly due to outsourcing non-available resources. However, this adds a new layer in-between the design team and their market: the partner company itself. However extensive the UX study might be, the final output is a report. As detailed as it might be, the design team still needs to analyse the provided data. And how much of the Voice of their Customer (VoC) and specific very valuable feedback is lost in plots, charts and statistical analysis will remain unknown. The UX panel is chosen, albeit predefined by the contracting company, is not necessarily an accurate representation of intended target users, just larger than what could have been done internally.

A larger bias can be found in the inability from capturing multi-cultural effects, especially in a global market. Products are now designed to be sold worldwide and internet-based stores allow easy access to foreign markets – and for people around the World to source such products. But it's here that a greater bias can be found in language differences (Fenko et al., 2010; Harzing et al., 2009; Spence & Zampini, 2006), such as the original language used to design the UX study, including in the formulation of questions or surveys to acquire data; to a different interpretation of the same UX descriptor for different cultures. The same experience adjective can be seen positively for a specific culture; while negatively for another, hence either not addressing specific market needs or resulting in a negative PUX in such markets. The food industry is a foremost example of the difficulty of understanding a different market for its products, even just by the struggle with the acceptance of a single simple design parameter: level of added salt.

4 ACHIEVING CUSTOMER ACCEPTANCE THROUGH POSITIVE CUSTOMER EXPERIENCE

Environmental restraints, legal requirements, technology push, or customer demands mean that new products more often feature new functions, modes of operation, appearance or features (Norman, 1988). This of course also affects the outline of products to accommodate those novelties. On the downside, customers can feel hesitant of using the products because it creates insecurity, unfamiliarity or just inconvenience. Those inhibitors for a quick adaptation to the new product can be critical to the product's success (Norman, 1988).

Often even small deviations from a familiar layout such as a different texture, colour, sound or smell can make buyers choosing the more traditional (a technically inferior) product over the new one. Hence, product developers try to design products in a way that they resemble older versions of the product by e.g. giving them the same design cues on all products of the same brand or at least allowing the use of accustomed mental functionality model for the new product (e.g. MS Windows desktop is simulating a manual work desk.) (Cornelius, 1996). Here, companies also aim at retaining their specific brand sense, a set of perceivable and distinct behaviour in their products that is associated with the brand's identity (Lindstrom, 2005), it aims at establishing itself as a unique experience. Again, it is not fulfilling the needs that are in cause or performance or feature offerings over competitors, it's the physical form by how this performance is delivered and, ultimately, perceived by the users. It is this form that distinguishes the experience from other brands.

Hagtvedt and Patrick (2009) claimed that luxury brands have a greater extendibility, in the sense of longer lasting as market players than value brands by virtue of their hedonic potential and promise of pleasure. These authors demonstrated that trade-offs between luxury and merely utilitarian products, such as increased cost vs. less social affirmation respectively, affects the desire to re-experience a brand. The ability to delight and the promise of pleasure in experiencing a luxury product promotes hedonic potential and favours affection towards the brand, favouring its extendibility. In contrast, even at a lesser cost, satisfying consumer's needs by means of full performant and utilitarian product which fulfil needs but is not felt as desirable as luxury leads to a restriction in its company extendibility (Hagtvedt & Patrick, 2009). One significant outcome of these authors' work is the importance of brand consistency, being product performance, sensorial cues, hedonic potential, and its ability to continuously delight.

However, when radically changing the products working principle, as in the case of the introduction of electric propulsion in Tesla's cars, the latter guidelines cannot be met. In this case, customers will unquestionably react hesitantly toward accepting the product since changing their routine behaviour of finding a charging station every time they park the vehicle is required. The goal of a product developer in those cases must then be to create strong delight aspects to convince users of the product's superiority. In the case of Tesla this will certainly be novel design features, excellent acceleration and performance attributes while promoting a sense of environmental friendliness. Inherently, driven from disruptive innovation, a new emotional experience emerges, along with a new brand sense, driving change in a very conservative industry such as the automotive.

Several product development tools can facilitate the optimal choice of concepts. In the further text a few are presented and discussed.

UX in product development

Engineering requirements are means to define intention and constraints of a design and are considered necessary inputs to the design process (Almefelt et al., 2006; Falk et al., 2014). Conceptually, design and requirements are related and interdependent (Lyytinen, 2009). Precisely defining the design problem is the aim of Requirements Engineering. Cheng and Atlee have listed (2009) generic and inherent difficulties in achieving a set of engineering requirements. From such list, emerges the notion of ill-defined requirements: ideas of what the design is supposed to achieve but remain imperfectly defined, without a clear outline, and sometimes conflicting within themselves or other requirements. However, these "must progress towards a single coherent, detailed, technical specification for the system" (Cheng & Atlee, 2009).

Hence any design process is started by a set of well-defined and ill-defined requirements, supported by technical specifications. These later are defined by engineering parameters, which are both inputs to the design process in the form of design variables, which are a final outcome of the product performance. However, product performance, by itself, cannot be entirely described by engineering parameters. To numerical product properties, it is necessary to consider non-parametric sensorial cues and emotional or satisfaction qualities. There isn't a common or shared taxonomy in the literature for these properties (Gaspar, 2013; Valverde et al., 2019). These authors revised the literature and found that formal design properties can be considered as: design parameters (Demirtas et al., 2009), design attributes (Bahn et al., 2009), design features (Han & Hong, 2003), design elements (Hsu et al., 2000), design features (Hsiao & Chen, 2006)(Hsiao & Chen, 2006), physical measures (X. Chen et al., 2009), engineering parameters

(Choi & Jun, 2007), and numerical features (H.-Y. Chen & Chang, 2009; S. C. Chen et al., 2009).

According to Gaspar(2013), there is a distinction between parameters and attributes: the first are directly related to physical properties and can be described through numerical values, while the latter involve some form of human perception. Perceived properties may be non-numerical and can be described through adjectives and descriptors (e.g. through Kansei words (Nagamachi, 1989).

The process of addressing ill-defined requirements finds value in UX studies. User experience research and its plethora of methods available to capture VoC and other subjective data, paired with proper statistical analysis, can better define such requirements and emerge with useful quantified data and even concrete specifications to drive design processes.

Kansei Engineering and affective design

Kansei Engineering and affective product design are obviously suitable tools for the integration of subjective, emotional customer demands into product design. One drawback of those development tools has been, that good emotional response can only be derived from products, customers are well accustomed to. In turn, this means, that novel product features need to be experienced well enough in order to be appreciated fully. With the latter discussed customer hesitation about new features means that evaluation of those on affective evaluation scales can only be done reliably if the users have access to prototypes allowing them sufficient time and interaction to build experience and thereby a solid opinion. If this is the case, it is possible to use Kansei Engineering in order to select relevant product features (Nagamachi, 1989; Schütte et al., 2004).

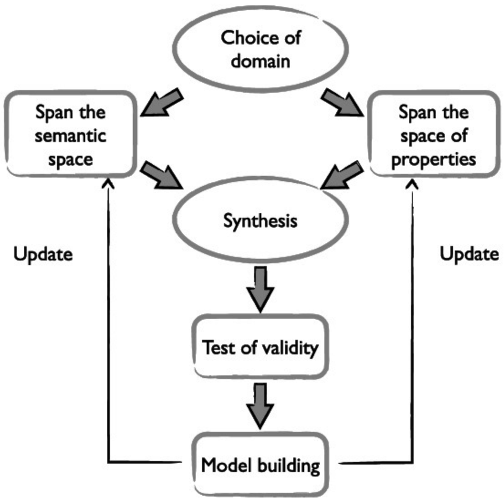

Figure 1: Kansei Engineering model (Schütte et al., 2004)

This in turn enables the product creator to select product concepts with the best combination of product features to evoke the least amount of inconvenience and at the same time create a positive attitude and in the best case a desire for the product.

Kano Model

Emerged within TQM and QFD, Kano's model is a tool that allows positioning a product by its product requirements and features regarding potential user satisfaction and achieved expectations (Kano et al., 1984). It distinguishes 3 types of product requirements:

- Must-be (or basic) requirements are those that the user expects them to be present, are inherent to the product main functionalities and are taken for granted. While these do not lead to satisfaction, they do lead to extreme dissatisfaction if unfulfilled.
- One-dimensional (or performance) requirements are those that will influence, usually proportionally, user-satisfaction. They are the product qualities characteristics that raise it above competition (comparison standards) and fulfil expectations.
- Attractive (or excitement) requirements are those that have the greatest influence in user-satisfaction, although they are not expressed or expected by the customer. They are the elements of surprise or delight in product experience. However, they do not elicit dissatisfaction if the expected functionalities are met.

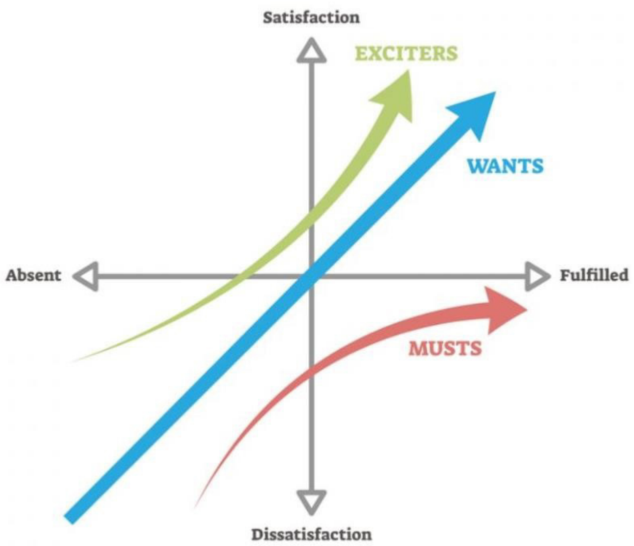

Figure 2 Kano model (Kano et al., 1984).

By using the Kano model product developers can identify potential delighters that are connected to novel product features that requires customer acceptance and subsequent user behavioral change. By emphasizing those delight factors by intuitive design, communication or even marketing, the user will be more likely to accept the new unfamiliar user patterns.

5 EXAMPLE OF KANO MODEL EVOLUTION ALONG THREE GENERATIONS OF THE HIGH-END MICE PRODUCT

Visualizing an example of the historical evolution of product features, both towards performance and UX delighters, a Kano Model is applied to a specific product line. In this case, logitech's flagship mouse MxMaster, and three of its latest generations. This product, as well the UX studies herein reported, are focused on high-end users in a professional context, such as creatives, designers, architects, engineers, programmers, accountants, and office workers in general. Focusing on the model's first quadrant only, a Kano Model is provided representing feature evolutions from MxMaster 2 to MxMaster 3 and Mx Master3S in figure Y. Along this Kano Model analysis, product features are split into four categories: features related with software used with the device and how it interacts with other devices and applications, interactions available from mouse inputs such as wheels and buttons, performance and technical specifications, and UX specific attributes. Some features are shared across multiple categories. Mouse models are depicted by different colours for each of the feature categories. Standalone labels represent either new design requirements or shifts from product to product, while overlayed labels represent features that were kept unchanged throughout the generations.

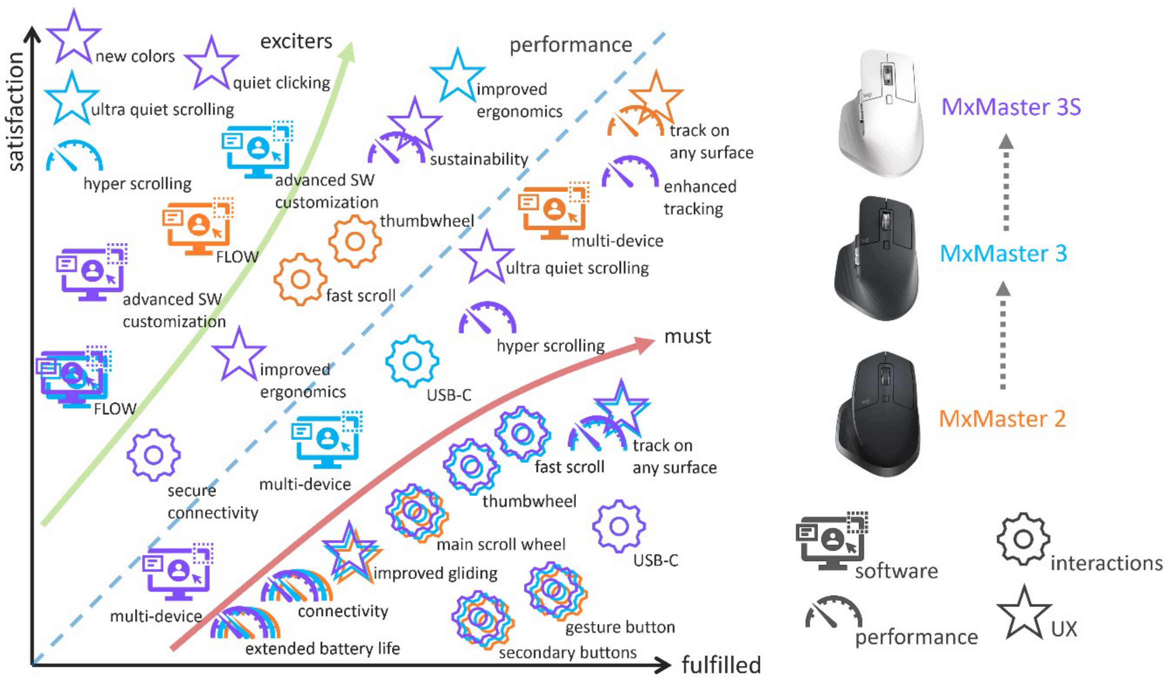

Figure 3 - Kano Model evolution from MxMaster 2 (2015) to MxMaster 3 (2019) and to MxMaster 3S (2022).

Observing the plot, new added requirements, even if related to more technical aspects in the device, can be regard as exciters when newly presented but tend to progress towards must have requirements when previously fulfilled. The novel aspect of these features justifies the increased affective response when presented in product, while it naturally evolves to an already accepted feature that users cannot do without, while no longer having an intense affective response to it. However, the removal of such feature in a new generation would potentially lead to a very negative response. This justifies why, in time, the already fulfilled features also clutter under the must have region of the model.

Focusing solely on the UX related category, Mx Master 2 saw less design entries than following generations. In fact, the number of UX related requirements has increased from generation to generation, hinting a greater influence of capturing the VoC along time. While technological progress was kept through engineering activities in improving overall product performance, product design was further complemented with more inputs from UX studies.

For the latest generation, sustainability requirements and a new quiet click for the main keys were key drivers for innovation. In the former, its relevant to mention that sustainability is not only regarded as a performance requirement, lessening the environmental impact from the company, but also an exciting UX feature valued by the users. In the latter, several specific UX studies were conducted, internally in logitech as well as externally. These not only identified a relevant market need for quieter mice but also that introducing this feature would rate very high in excitement and overall affective response for the users.

There is, however, an inherent performance aspect to mouse clicking UX, as no loss of performance, i.e., speed of clicking and accuracy can be accepted as well has no decrease in product longevity. While some adaptation to reduced audible feedback was observed, the studies showed no initial impact on user performance for quieter clicks if the haptic feedback was of a higher quality. This hints on sensorial cross-modal effects, where the lack of audible feedback can be compensated by more intense haptics, the tactile perceived mouse clicks, to form a holistic impression of feedback quality. Interesting findings were also reported about gender biases in main click haptic and audible feedback preference, with quieter and lower input user force favoured by women. In the overall, only a fringe of the population, less than 1/10 users, still preferred the more traditional and very audible click from previous generations. Data hints on an age bias towards this outcome, as these users belonged to the panellists' higher age group.

6 CONCLUSIONS

Satisfaction models are methods and tools which aim at achieving quantifiable translation of customer's needs and VoC into satisfaction related performance product requirements. In a way, they bring "the voice of the customer and the voice of the engineer closer together. While a lot of emphasis made to address user-satisfaction and, later, customer delight in product design as any company's goals, "there is a distinct lack of literature supporting the assumptions these strategies make" (Burns & Evans, 2000). Furthermore, any of these models is as good as the methodologies used to capture VoC, create its inputs and translating them (Burns & Evans, 2000). Acquiring VoC, by means of traditional surveys and inquiries, places the customer outside of real product experience. Moreover, customers may not be entirely aware of their needs or, even, adequately express themselves (Falk et al., 2014). Product designers also usually deal with more negative information (e.g. failures in previous products) and user expressions usually reaches them by numerically translated models and summarized VoC reports and tables (Burns & Evans, 2000).

Novel products feature new properties which in turn require altered customer behaviour. To make customers adapt to those products they need to agree on changed functionality. This requires a good understanding from the users' side and proper communication from the product provider's side.

This paper evaluated an evolution of such features, through a Kano Model visualization, within a specific product line. Here, amongst other performance attributes, a specific experiential requirement has emerged from UX studies specifically designed and employed within the brand to address a specific feedback cue: the feedback afforded from the mouse main keys. The outcome of recognizing, both from these studies as well as from publicly available user feedback (e.g., tech reviews and user comments on social media) was an equally performant mouse clicks but now with noticeable different feedback, one that can be described by a series of affective descriptors such as a “quiet”, “professional”, “comfortable”, “precise” and “robust” amongst others.

However, understanding new features and the necessity of their existence does not in the first place lead to customer acceptance. In order to ensure customer acceptance, each change must be accompanied by a “delight” aspect. Concretely this means that the computer mice’s quiet click in the study certainly constitute a change in how the click feedback is delivered to the user in comparison to conventional mice and therefore necessitate change of user behaviour, but at the same time the quiet work environment serves a delight factor making it worth to the user.

The theory works fine in the example stated, but there are risks involved. If the novelty is not well enough communicated by the provider or understood by the user; or if the products are “too” innovative with a highly complex novelty, users do not experience the delight aspect and hence reject the product.

As a vehicle to achieve customer delight, several tools can potentially be used. In this paper KANO model is used in the study and Kansei Engineering and UX-methodology is suggested as suitable approaches. In this context it is important to remark that evaluation of subjective impressions is possible but can be seriously hampered by a lack of panel diversity. In the UX studies performed to develop new mice, both gender and age have found to have a measurable effect on the subjective experience of clicking sound of computer mice. The importance of selecting a proper and extended panel, even if within the specific scope of a niche market (highend professional mouse users), shows how different UX outcomes can emerge from the lack of diversity in the panel itself. And if UX studies outcomes are gaining greater influence as design inputs, further care must be taken to drive product success by addressing the VoC. Not a niche VoC but a holistic VoC that expresses its target market needs, as well its continuous shifts and trends.

The authors also recognize that current context may have played a major role here, even to the point of overwhelming previously identified gender differences in the outcomes of the UX analysis for case-study given. As the design activities have taken place in the recent pandemic, where many people saw their home merging with their main workplace, a space also now continuously shared with their relatives, audible feedback cues, i.e. repetitive and frequent loud mouse clicks, may have created and, at least, enhanced the global market need for quieter computer peripherals. The global market has voiced loudly that it needed a whisper from mice clicks and the UX methods employed have properly captured it.

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AN EYE-TRACKING STUDY TO ASSESS THE PERCEPTION OF USABILITY AFFORDANCES OF ASSISTIVE DEVICES
AN APPLICATION TO JAR OPENERS

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ABSTRACT

Some assistive devices (ADs) aim to ease elders performing daily activities by changing postural and strength requirements. Elders usually have cognitive lacks too, making AD usability perception an important issue. Usability perceptions arise from the affordances conveyed by the AD: design features should act as signifiers transmitting opportunities of how to use the AD. This study assesses the perception of jar openers usability. Eye-tracking (ET) data from 56 subjects were used. Rendered images of 6 ADs were shown, in 2 versions: with and without rubber on the grip area. Each slide showed the 6 ADs, each AD image being an area of interest (AoI) to be tracked. The participants ranked the ADs in the next usability affordances: comfort, effort level, easiness to grip, easiness to use, lid slippery and robustness. For each affordance, they were eye-tracked while deciding the best AD, and afterwards they ranked the other ADs. The ranks were transformed into scores, and their correlation with ET parameters (decision time and number of fixations on each AoI) were studied, along with the effect of the rubber on the scores. Heat maps were also analyzed to identify the signifiers of the ADs that attract attention on usability. The results showed the potentiality of ET to study the perception of ADs usability affordances, and that the addition of rubber on the grip area of the jar openers or the material and shape of the lid area have an effect on their understanding and use.

Keywords: *assistive devices, eye-tracking, usability affordances, signifiers, product design*

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1 INTRODUCTION

The grasping and manipulation capacity of the human hand is key for the development of activities of daily living (ADL), both in personal and work contexts (Bullock et al., 2013). This ability is diminished in old people, and is aggravated by pathologies with high prevalence, such as hand osteoarthritis (HOA). Household management tasks, especially those requiring high grip force combined with twisting movements, have been identified as the ones generating more functional problems in HOA patients (Kjeken et al., 2005). In particular, the jar opening task is one of the most limiting activities for old people (Weeks-Levy et al., 2020).

In this home context, assistive devices (ADs) may improve the quality of life of the elderly by increasing their autonomy. ADs facilitate the execution of certain tasks, protecting the structures of the hand against deterioration (Duruöz, 2014). ADs are designed to compensate the loss of strength and/or dexterity (Shipman & Pitout, 2003), improving the functional capacities of people with hand pathologies, such as range of motion, muscle strength, resistance and manual dexterity (Kjeken et al., 2011; Rogers & Holm, 1992).

However, ADs are often rejected because of several reasons, most times due to problems that can be solved with an appropriate design. E.g., many ADs require too high physical demands of strength and/or dexterity (de Boer et al., 2009) or even cognitive ones, since at certain ages it gets harder to understand the operation of new devices (Yusif, Soar, & Hafeez-Baig, 2016). In order to achieve its objective, among other requirements, an AD must be effective and safe, easy to use and accepted by the user. In addition, in the emotional field, it is essential that the AD transmits positive emotions in order to guarantee its use. Positive emotions are associated with greater security and independence, while negative emotions can lead to frustration, stigma, and disinterest in the use of ADs (Chen, 2020). Both the meaning of the product and the transmitted emotions must be taken into account when the product preferences are established, considering the user's criteria from the beginning of the development process (Agost & Vergara, 2014). In conclusion, it is essential that the person accepts to use the product and feels natural and comfortable using it, and this is something that is not fulfilled by most ADs for manipulation.

Furthermore, the user should be able to understand correctly how a product works, for which the information transmitted by the AD must be clear. Usability perceptions arise from affordances, which can be anything that it is possible to do with a product, making the desired action possible. Moreover, if the affordances are not intuitive, signifiers (design elements capable of transmitting opportunities of how to use the product) should be used to indicate them. Adding signifiers is the best way to discover the affordances and make sure that the feedback is clearly understood by the user (Norman, 2013).

Affordances of some ADs have been assessed in recent studies. A study (Lucaites & Pagano, 2018) evaluated walking ADs used by old people, and showed that the user experience is a fundamental factor to ensure that users better understand the functioning of the AD and use it appropriately. Several studies have used Eye-Tracker (ET) technology for the assessment of affordances. In Burlamaqui and Dong's study (2017), a series of subjects observed a product for a certain time and then tried to explain, through a questionnaire, its functioning. They found a strong correlation between the perception of affordances and the explanation of the product's function from the questionnaire results. Number of fixations, time to first fixation in AoI, and first fixations in AoI ET metrics were analyzed, but none of them seemed to successfully identify the intended affordance. Regarding the most representative design aspects, Berni et al. (2020) found, through the use of ET, that the most creative characteristics and most original elements of the products are essential to capture the design intentions by the users. Although the jar opening task is recognized as a very limiting activity for old people, jar openers usability affordances have not been investigated yet, which might be key to improve their design and promote their use.

This study aims to analyze the usability perceptions of the affordances conveyed by jar openers: comfort, effort level, easiness to grip, easiness to use, lid slippery and robustness. ET technology is tested to assess the jar opener signifiers, with the final goal of developing general tools to improve the quality of life of the elderly and facilitate performing ADL.

2 METHODOLOGY

The study analyzes the perception of usability affordances of 6 different models of jar openers and suggest the design features that can act as signifiers, transmitting information about how to use the AD, with special emphasis on the use of rubber in the gripping area.

2.1 Participants

Sixty-three candidates were recruited for an ET experiment, most of them (about 80 %) students and staff of the Universitat Jaume I, Castelló, Spain. Candidates with an ET registration data percentage below 75 % (3) or with inconsistent answers (4) were discarded. Finally, data from 56 participants (26 women and 30 men) were used for the analysis. The participants had a representative coverage in age: 16 subjects under 35 years, 21 over 45.

The participants were not allowed to manipulate the ADs. At the end of the experiment, they were asked whether they were familiar with the jar opener models: 33.9 % claimed not to know any of the models assessed, 37.5 % knew one of the models, and the rest knew two or more.

All of them had normal or correct-to-normal vision. The ET device (Tobii Pro X2-60) was placed below a 24-inch computer monitor. The participants sat in front of the screen, at an approximate distance of 60 cm. All participants were calibrated at the beginning of the test.

2.2 Stimuli and procedure

Six models of jar openers in two different versions, without and with rubber on the grip area (Figure 1), were chosen for the study. The jar opener models were selected so as to be varied in grip and type of effort used in the opening action.

Two ET projects (A and B) were designed, so that each subject assessed the 6 models but in only one of the versions: Project A had models 2, 4 and 6 with rubber, and models 1, 3 and 5 without rubber, and Project B with the opposite version of the 6 models. The participants were randomly allocated to the projects. Due to the exclusion criteria, subjects per project were slightly different: project A with 27 subjects, and project B with 29.

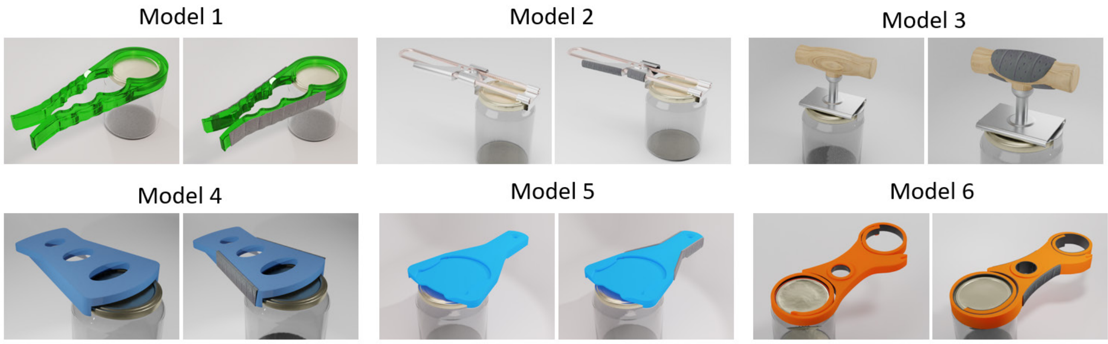

Figure 1. The 6 jar openers models with their two versions: without rubber (left) and with rubber (right)

To assess the functionality, each subject ranked the jar openers in 6 different usability affordances: comfort, effort level to use it, easiness to grip, easiness to use, lid slippery and robustness. The 6 models were shown simultaneously in a stimulus as in Figure 2, for each affordance. The jar openers were shown in their working position (placed over the lid jar), except for 'lid slippery' affordance, to show properly the AD area that contacts the lid. The models were located in a different position in the screen for each question, to avoid its effect on the results.

Figure 2. Examples of the stimulus used (Spanish version) for the affordances 'easiness to use' (left) and 'lid slippery' (right) in Project A

In order to rank the jar openers for each affordance, the same stimulus was shown 4 times, so that each time the subject was asked to select (in this order): the best jar opener model, the second best, the worst and the second worst. Each affordance appeared randomly for each subject. As a result, a total of 24 images (6 affordances x 4 questions per affordance) for each project were generated, which represented the stimulus set. The subjects could read the question at the bottom of the screen (Figure 2), and answered by clicking on the selected model.

2.3 Data analysis

The image of each of the 6 jar openers in each stimulus was defined as an Area of Interest (AoI), i.e., participants' attention was tracked in each of the 6 rectangles containing each model. Several metrics from these AoIs were obtained from the subjects' eye movement only during the first question posed for each affordance: TFD (Total Fixation Duration in seconds in each AoI); FC (Fixation Count, number of fixations in each AoI); and Click Count, to identify the AoI selected.

For each affordance, a score was assigned to each jar opener from the Click Count metric of the 4 ranking questions posed to the participants: +2 for the best, +1 for the second best, –2 for the worst, –1 for the second worst, and 0 for the non-selected models.

The results were analyzed with SPSS statistical software (IBM SPSS Statistics 27). Descriptive statistics of TFD and FC metrics per affordance and scores are shown. First, with the scores, error bars graphs were obtained for 95% confident intervals for means. T-student tests were performed, one per each affordance and model, to investigate whether the rubber (independent variable) has a significant effect on the scores (dependent variable). ANOVAs were performed, one per affordance, also with the scores as dependent variable, and the model as the independent one, to check whether the scores are significantly different between models in each affordance. Thirdly, Spearman's correlations were computed, in order to measure the association between the scores and ET parameters (TFD and FC metrics) for all the affordances altogether.

Finally, heat maps for the stimulus shown when selecting the best model for each affordance were analyzed to understand which parts of the jar opener attract the participants' attention on usability. Heat maps illustrated the mean number of fixations for all subjects with a color scale. The effect of the rubber was assessed from a qualitative analysis of the heat maps.

3 RESULTS

Table 1 shows the descriptive statistics of TFD and FC per each affordance and score. Last row shows the statistics of all the data.

Table 1. Statistics of TFD (seconds) and FC (number of fixations) per affordance (comfort, CM; effort level, EL; easiness to grip, EG; easiness to use, EU; lid slippery, LS; robustness, RO), score and globally

		TFD (s)			FC		
		Median	P5	P95	Median	P5	P95
Affordances	CM	0.65	0	3.17	4	0	14
	EL	0.85	0.12	3.80	4	1	19
	EG	0.58	0	2.75	3	0	12
	EU	0.64	0.06	3.17	3	1	15
	LS	0.78	0.12	3.77	4	1	16
	RO	0.57	0	3.41	3	0	13
Scores	-2	0.46	0	1.77	3	0	10
	-1	0.48	0	1.68	3	0	9
	0	0.55	0	2.32	3	0	11
	+1	0.80	0.10	3.80	4	1	16
	+2	1.79	0.57	5.52	8	3	26
Global data		0.67	0	3.41	4	0	15

Figure 3 shows the error graphs of the scores of each affordance for each jar opener. Models with significant differences in the scores (ANOVAs) depending on the presence of rubber are marked with an asterisk. In general terms, the assessment depends on the affordance, and the rubber added on the grip area was positively assessed in most models and in all of the affordances. Model 1 seems to be the most affected by the rubber. In addition, significant differences ($p<0.001$) in the scores were found between models in all the affordances.

The Spearman's correlations were significant (at 0.01 level) between scores and the ET metrics (correlation coefficient with TFD was 0.423, and with FC was 0.394).

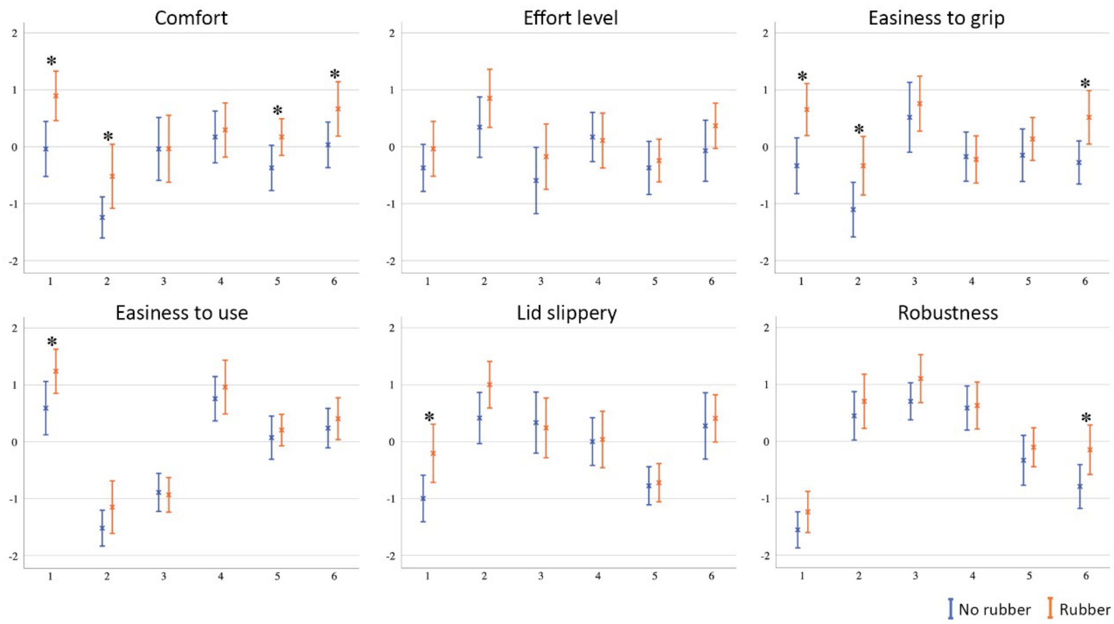

Figure 3. Confidence intervals (95 %) for mean of the scores. Models with significant differences ($p<0.05$) in the scores depending on the presence of rubber are marked with an asterisk.

Finally, figure 4 shows heat maps for each affordance, in Project A and B. Figure 5 summarizes the results of the heat maps for the 6 models, per affordance, distinguishing per AD zones: grip area, the jar area that is in contact with the lid, and rubber (for rubber model version).

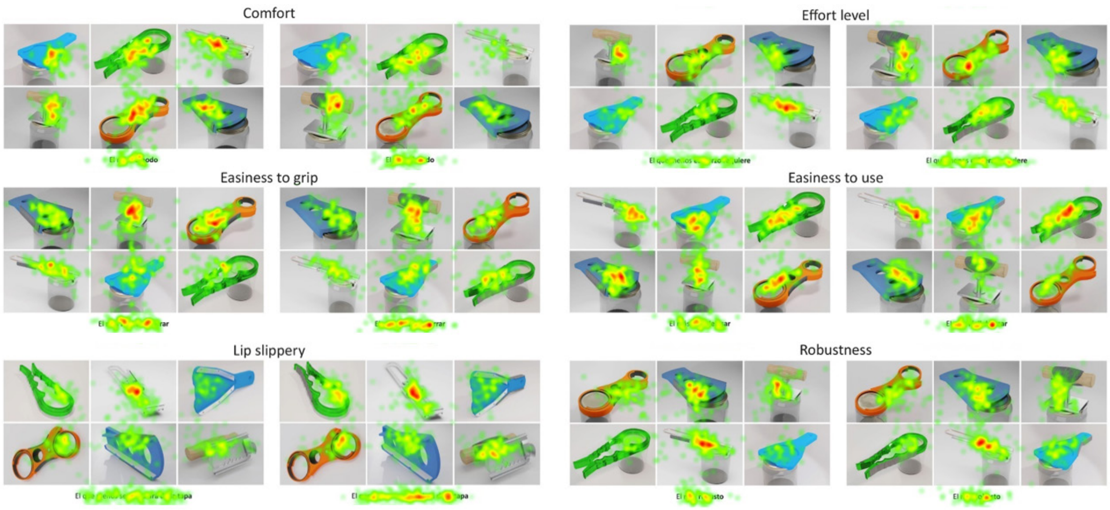

Figure 4. Heat maps of Project A (on the left of each affordance) and Project B (on the right). Red color means higher attention.

In general terms, the attention in the established areas depends on the affordance assessed. The lid area was paid high attention in both versions. On the other hand, the intensity on the grip area depends on the model version, being higher in the rubber version. The rubber was more observed in 'comfort' and 'effort level' affordances.

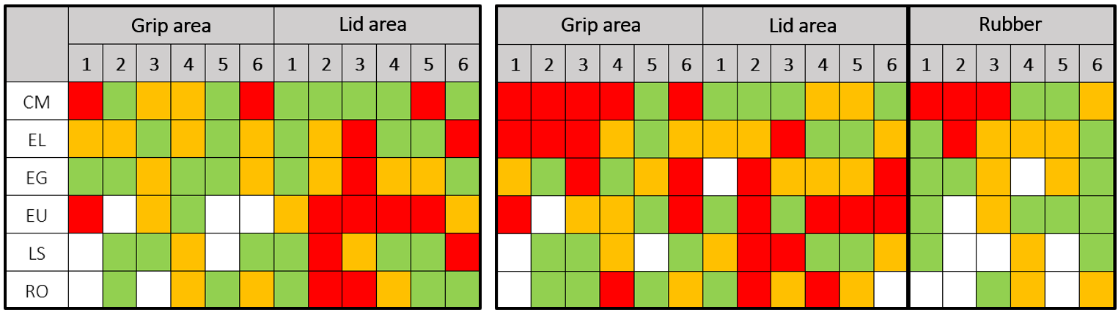

Figure 5. Summary of heat maps for the 6 models without rubber (left), and with rubber (right), per affordance (comfort, CM; effort level, EL; easiness to grip, EG; easiness to use, EU; lid slippery, LS; robustness, RO). Red-yellow-green color for higher to lower attention, white color for no attention

4 DISCUSSION

This study aims to analyze the ADs usability affordances of 6 models of jar openers and their 6 modified versions (adding rubber on the gripping area) through ET technology. Although getting familiar with the product favors to understand its functioning and proper use (Lucaites & Pagano, 2018), in no case the participants manipulated the ADs, so that all the information came through visual stimuli, because the goal was to assess how the design features of the ADs affected the perception of the affordances at first glance.

The usability affordances of the different models were assessed based on the scores assigned from the Click count metric from the ET, highest scores meaning greater perceived affordances. These results can help in the design of ADs with a high affordance transmission, in order to promote their acquisition and use. In addition, heat maps can help to identify the ADs signifiers that attract the subjects' attention for each usability affordance. Here are the features that seem to favor higher affordance transmission for the different affordances:

- Comfort: Shape, rubber and material seem to have an important role. Models 1 and 6 with rubber obtained the best scores. Both models are long, with a large gripping area, and made of plastic. In contrast, model 2, made of steel, was considered the worst. The grip area received high visual attention, especially in model 2, which could be attributable to its complex design, which become into a signifier difficult to be understood. The rubber acted as an important signifier in models 1, 2 and 3, with higher attention on the grip area for the rubber versions.
- Effort level: Shape and material seem again to be key. Model 2 is the best scored, especially the rubber version. This model is metallic and has a lever shape, which can be clearly seen as a signifier of reduction of the effort required. However, models 1 and 6, with a similar lever shape, had lower scores, maybe because their material (plastic) acted as a negative signifier. Highest attention was paid to model 2, that had the best scores, especially to the grip area and the rubber. However, model 4, also with high scores, had less attention,

probably attributable to the simplicity of model 4 against model 2, so that it helped to understand its affordances, and subjects needed less attention time to assess it.

- Easiness to grip: Models 1 and 6 in their rubber versions are high scored, together with model 3, in its two versions. The grip area of these models has attracted high attention. The design of the handle in model 3 might have acted as a familiar signifier to grip. In the rubber versions, the rubber was observed with more attention, thus the rubber helped to understand the affordance. In contrast, model 1 and 6 without rubber have received low attention: their grip shape acted as a better signifier to understand the easiness to grip. I.e. rubber and shape seem to act as signifiers in this affordance.
- Easiness to use: Simplicity of the mechanisms seems to make the difference. Models 1 and 4 in both versions had the best scores, in contrast to models 2 and 3, whose mechanisms become into complex signifiers to be understood. Besides, all the scores are similar for both versions and all the models present similar attention paid, being the lid area the most observed. This may point that to evaluate the easiness to use, it is more important to know how the jar opener works (how it grabs the lid to turn it) than how has to be grasped. Therefore, in this affordance, the rubber is not a signifier.
- Lid slippery: Material and shape of the region that has to be in contact with the lid might have been key. Models 1 and 5 were assessed as the most slippery because they are made of non-texturized hard plastic (model 1) or metal thin edge (model 5) signifiers in the area to grip the lid (Figure 6). These two models attracted low attention, probably because these signifiers were strongly related to slippery. Models 2 and 3, assessed as the least slippery, were also metallic in the lid area, but in this case with a protruding flange that has probably acted as a positive signifier against slippery (Figure 6). Again, these models were the most observed, probably because the complexity of the mechanism made the participants to doubt. Models 4 and 6 are also high scored, although with medium attention, and they have a soft material (rubber appearance) in the region to be in contact with the lid.

Figure 6. Material and shape details of models 1, 2, 3 and 5

- Robustness: The material might have been the reason to assess models 2 and 3 (made of steel) with high scores. The most observed models in this affordance were the best scored, especially the lid area, steel probably acting as a positive signifier of robustness. Model 4 was also assessed as robust, maybe because it is made out of just one piece, without moving elements, and with a higher thickness of the material, although being plastic. In contrast, model 1 was assessed as the worst, probably because the product seems to be made of fragile plastic. It was also the least observed.

In general terms, regarding the scores obtained, the rubber improved the assessment of the affordances in most of models. In particular, model 1 was the most affected by the rubber, increasing significantly its scores in comfort, easiness to grip, easiness to use and lid slippery, so that we can conclude that rubber acts as a signifier that improves its perceived usability affordance. Shape and material, in special material of the region of the openers in contact with the lid, can be acting also as signifiers for the perception of several usability affordances.

AoIs have been used to obtain quantitative data through ET metrics. Contrarily to Burlamaqui & Dong (2017), we have been able to find metrics that help to assess the affordances. A significant correlation has been found between the TFD and FC metrics with the scores, showing that the total time spent observing the product and the number of fixations in each AoI is related to the usability perceptions, i.e. the models that best show the affordances are given more attention. However, this can be affected by the way in which we have performed the study, as we have used the ET metrics when the participants were looking at the best model for each affordance. Effort level, easiness to use and lid slippery affordances seem to be more complex to assess according to the higher values of TFD and FC metrics, and they might need clearer signifiers.

Future work could look for additional ET metrics to address the study of ADs affordances, and could consider more specific AoIs to obtain a more detailed effect of different signifiers. Old people, or even people with pathologies that affect hand function, could be considered to participate in a future ET study in order to obtain results that could have a real impact on the quality of life of the elderly.

5 CONCLUSION

This work has analyzed the usability affordances of jar openers to identify the relevant signifiers affecting the perception of the affordances. ET technology has been checked to be a potential useful tool for the study of ADs signifiers. Jar opener models can be improved by adding the identified features that make easier their understanding and use, such as the addition of rubber on the grip area of the jar openers or the material and shape of part in contact with the lid.

ACKNOWLEDGMENTS

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ANALYSIS OF FUZZY TEA LEAF IMAGES TO PREDICT A QUALITY BY DCGAN

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ABSTRACT

Purpose of our research is to classify tea image at each shooting time.The flavor and quality of tea leaves change greatly depending on the time of picking.The more Umami ingredient “theanine”, the higher the quality.The more Astringent ingredient “catechin”, the lower the quality.Therefore, it is important to pick the tea at the timing when the theanine content is maximized.In an actual farm, the timing of picking is decided at the leaf opening stage, not at the component analysis.The leaf opening period consists of 8 stages, from the germination period until the 7th leafopening period.As a rule of thumb, the highest quality is achieved at the 5th leaf opening stage.Skilled technique is required to determine the leaf stage.We shoot a tea plantation with a large drone and analyze the shot image by deep learning.Analyzing each leaf opening stage leads to quality prediction.And I've been thinking about how to predict quality.In order to determine the leaf opening stage, we tried to classify the images using a well-known method, Luminance histogram,Spectrum analysis by FFT and AKAZE.However, none of the conventional methods were able to classify well.The cause is that it is difficult to extract the features due to the fuzzy of the tea image.Therefore, we devised a classification method using deep learning.We use DCGAN, SAE, LSTM and CWD.The originality of this research lies in the fact that these analyzes are not performed individually but continuously.

Keywords: Image Analysis, Tea Quality, Apps iPhone

1 INTRODUCTION

In cultivation, harvesting and consumption of tea, there are many aspects to be evaluated by the usual engineering approaches. The purpose of this study is to predict the optimum tea quality by the another unique methods we improve. The quality varies greatly depending on the amino

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acid value contained in the tea leaves, and it depends on theanine in particular. High-quality tea can be obtained by plucking the tea with the maximum content of theanine, which is an umami ingredient. However, theanine is transformed into catechin, which is an astringent ingredient, in the sunlight. Leads to a decline. Tea leaves are divided into first tea, second tea, third tea, and autumn -winter bancha, and each period is called the plucking time, and the optimum picking timing at the plucking time is called the optimal time.

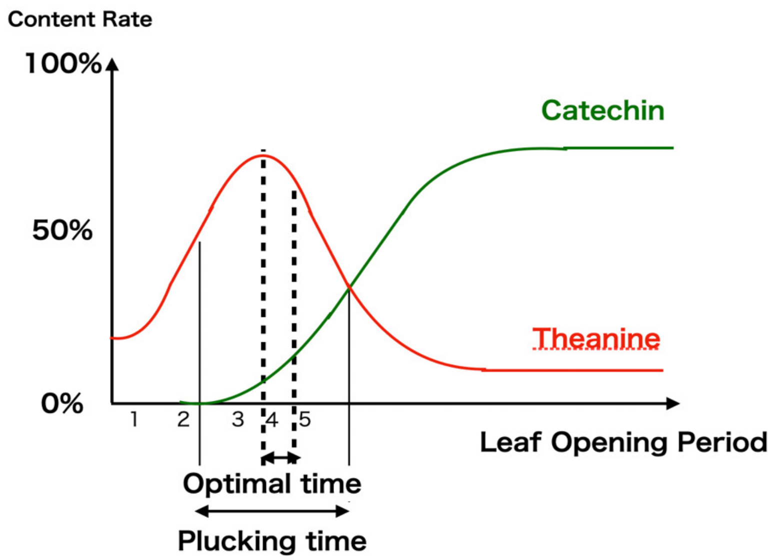

Figure 1. Optimal time and Plucking time

Tea industry officials use the leaf-opening period as a criterion for determining the optimal time for plucking. The sprout of tea leaves opens at a rate of about once every 5 days on average, and is divided into 6 to 7 stages of leaf opening depending on the leaf opening state. The highest quality period when theanine is maximized is the 5th leaf opening period. Tea industry personnel comprehensively judge the tree vigor from the growth status of tea leaves, branch elongation, adult leaf size, color, etc., and judge the leaf opening period, but accurate judgment requires skillful skills.

$$P = \frac{K}{1+\frac{Ke^{-rt}}{N_0-1}} \qquad Q = 1-\frac{K}{1+\frac{Ke^{-rt}}{N_0-1}}-R$$

Formula1. Amino acid content of theanine and catechin

Our research is to judge the opening stage of tea leaves from the viewpoint of image analysis. We collected the images with a large industrial drone. So far, we have tried to compare the image features at each leaf opening stage by performing brightness histgram, spectrum analysis, AKAZE feature point extraction, and three-dimensionalization of the image. However, it is difficult to say that any has achieved sufficient results. To attempt more serious classification, this study classified tea leaf images by deep learning. Image analysis was performed using the Continuous Wavelet Decomposition (CWD) and deep learning DCGAN, PCA, SAE, and LSTM as methods. The advantage of combining many methods is that it makes it easier to classify images that are difficult to classify accurately with just a single method. Based on these, we considered the development of an application to be proposed to a large-scale agricultural corporation.

2 DATA COLLECTION

With the cooperation of Kagoshima Horiguchi Seicha, we took a picture with a drone. The drone is Aerosense's AEROBO AS-MC3-T and RGB cameras used the UMC-R10C from SONY, and the multispectral camera used the Altum from Michaelsence. From October 2020 to August 2021, the photographs were taken in 11 periods.

It was taken in each period after the first tea, the second tea, the third tea, and the autumn-winter bancha.

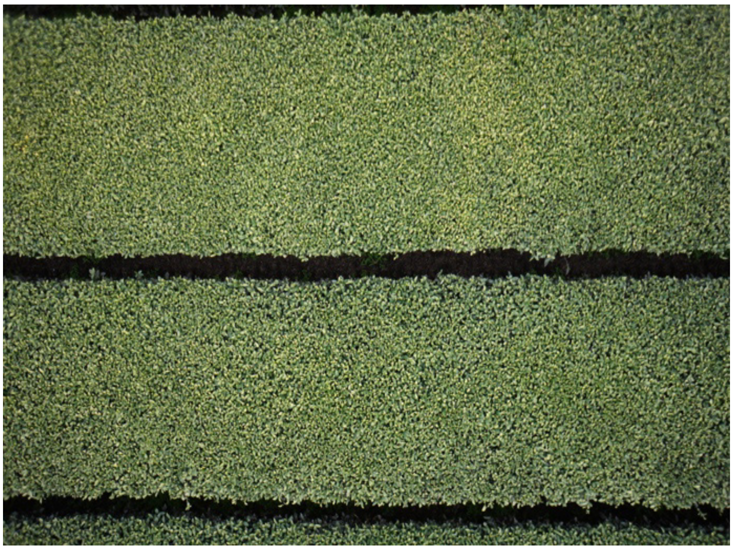

Figure 2. RGB image of tea leaves

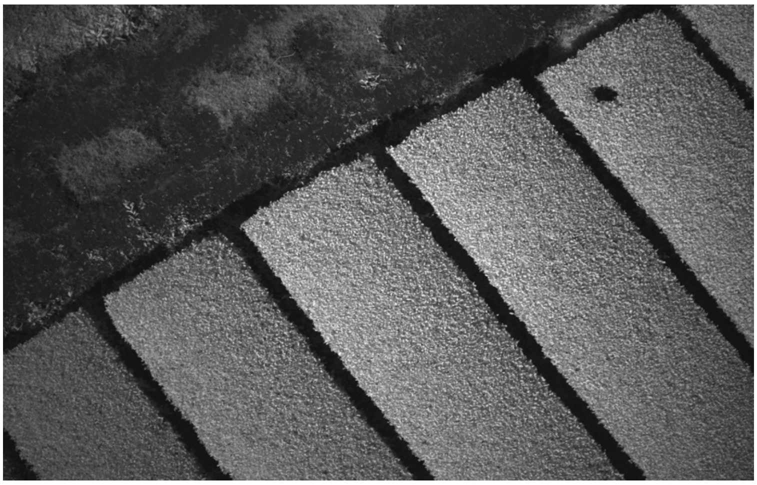

Figure 3. Multispectral images of tea leaves

The total number of data acquired is over 120,000, and the minimum shooting altitude is 5m. All images were taken from directly above the field and are not angled. All captured images are 5456 x 3632 pixels.

3 DATA PREPROCESSING

An attempt was made to extract the features of the image using a commonly used method. First, 200 images were extracted for each of the first, second, and third teas, and represented by a brightness histogram. The brightness in the range of 100 pixels to 150 pixels is easy to see with the human eye, but no noticeable change was seen in that range. This suggests that it is difficult to distinguish tea leaves with the naked eye.

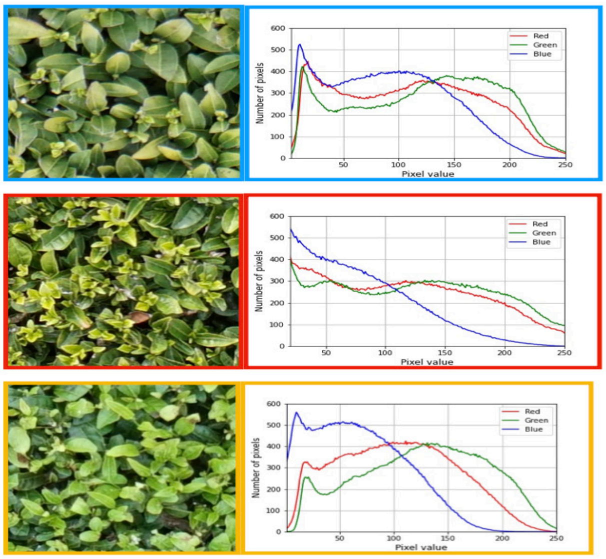

Figure 4. image brightness histogram

Second, the frequency of the image was analyzed by the fast Fourier transform, and compared with the original image using a high-pass filter and a low-pass filter.The image with only the low frequency band was almost the same as the original image, and the image with only the high frequency band could hardly be feature-extracted.

$$\sum_{i=0}^{n-1} c_i x^i = \sum_{i=0}^{\frac{n}{2}-1} c_{2i} x^{2i} + x \sum_{i=0}^{\frac{n}{2}-1} c_{2i+1} x^{2i}$$

Formula2. Fast Fourier transform(FFT)

In other words, the features of the tea leaf image are concentrated in the low frequency band, which also suggests the difficulty of extracting the features of the tea leaf image.Therefore, it is extremely difficult to properly classify tea leaf images using a general image analysis method.

In this study, multiple deep learnings were used in succession in order to successfully extract features. As a prototype, 800 images of 256 x 256 pixels were cut out from the image taken on October 30, 2020, and we made a data set of the input image.

This dataset is very important in linking our research with the tea leaf expert's perspective. Normally, tea industry personnel do not take a bird's eye view of the entire tea plantation. Instead, they focus on a part of the tea plantation and see how it grows.Then, it is judged whether or not it is picked. Therefore, in order to get the same perspective as the tea leaf expert, it is necessary to cut out a part of the acquired data and use it as a data set.

4 CONTINUOUS WAVELET DECOMPOSITION AND DCGAN

Deep Convolutional Generative Adversarial Networks is a type of GAN, which is a deep learning method characterized by having two learning devices, a generator and a discriminator.DCGAN is especially easy to automatically generate images. When DCGAN learns the input image, DCGAN generates a fake image that imitates the input image. While the learning accuracy is low, the classifier immediately determines that the fake image is fake.However, as the learning accuracy of the generator increases, the image that looks exactly like the real thing is generated so that the discriminator makes a mistake in the classification.By extracting the features from the fake images generated with low learning accuracy, it is possible to extract information that could not be captured by the analysis of the tea leaf image itself. In this study, as a preprocessing of DCGAN data, the Continuous Wavelet Decomposition (CWD) of images was performed on 800 data sets. CWD is a method of extracting feature quantities by dividing a time-series signal into a plurality of wavelets, and a one-dimensional wavelet is used for an audio signal and a two-dimensional wavelet is used for image processing. The Daubechies CWD used in this study is an advanced version of the multi-resolution analysis proposed by Mallat (1989a).

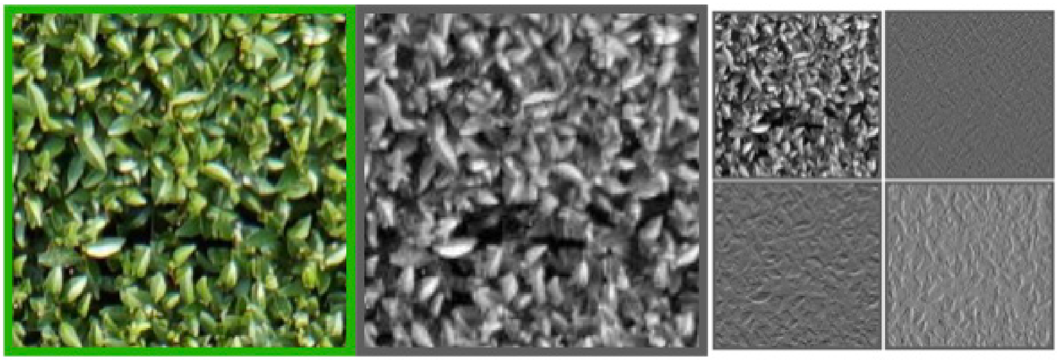

Figure 5. Daubechies the Continuous Wavelet Decomposition

$$\varphi(x) = \sum_{k=0}^{N-1} h_k \varphi\,(2x-k) \quad \psi(x) = \sum_{k=0}^{N-1} g_k \varphi\,(2x-k)$$

Formula3. Mother wavelet and Scaling function of Continuous Wavelet Decomposition

First the dataset was grayscaled, then Daubechies WD resulted in 4 pairs of images. Here, of the 4 output results, the upper left image is an identity map, which is the same map as the original image.800 images per pair, 128 x 128 pixels, were generated. We treat the 4 output groups as separate data sets. That is, we treat a total of 3200 images. Each of 800 images, we treat 600 images as training data, and we treat 200 images as test data. The learning results are currently being verified, and validation data needs to be prepared to improve accuracy.

Second, We ran DCGAN about 4 training data each as the input layer. The probability distribution of DCGAN-generated images that have been learned from images taken at the same date and time represents the range of characteristics of tea leaf images at a certain shooting time.

As a heuristic, the loss function of the generator and discriminator was used. It can be seen that there is a large difference in the number of epochs until the loss function converges to a certain value between the case where the preprocessing by CWD is performed and the case where the preprocessing is not performed. It was also found that it can be used to judge that the learning accuracy is sufficiently improved by the convergence of the loss function

$$u_{ij} = \sum_{k=1}^{N} \left[\sum_{(p,q)\in\rho_{ij}} x_{pqk} w_{p-i,q-j,k} \right] + b_k$$

Formula4. Convolution layer of deep convolutional generative adversarial networks (DCGAN)

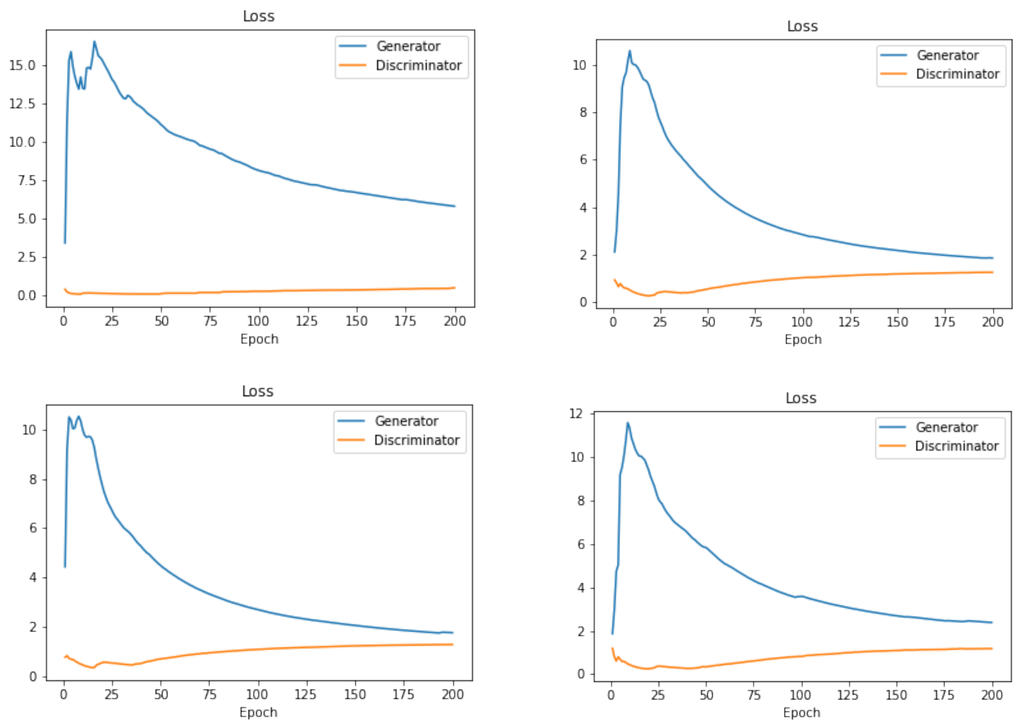

Figure 6. DCGAN Loss Functions

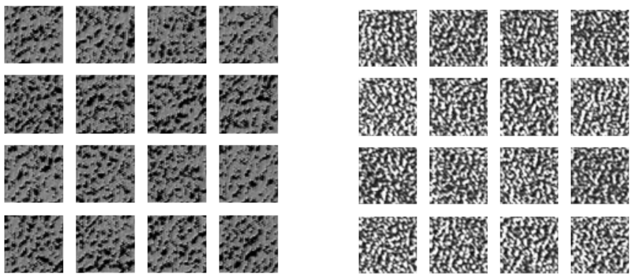

Figure 7. DCGAN Automatic image generation

The first loss function is that of the identity map, and the other three are the result of CWD in each direction. From this comparison, it can be said that the loss function is more likely to converge when DCGAN is performed after CWD than when DCGAN is performed without CWD.

5 SAE AND PRINCIPAL COMPONENT ANALYSIS

The generated hidden layer of the second layer is used as the input layer of the third layer. The characteristic of SAE is that the number of nodes is reduced by extracting hidden layers one after another. Pretreatment by principal component analysis (PCA) was performed to use SAE. PCA is one of the linear dimension reduction methods. First, the direction in which the data variance is maximized (first principal component) is determined, and then the basis orthogonal to the determined direction (second principal component) is determined. Through this, it is possible to reduce the feature amount of the image.

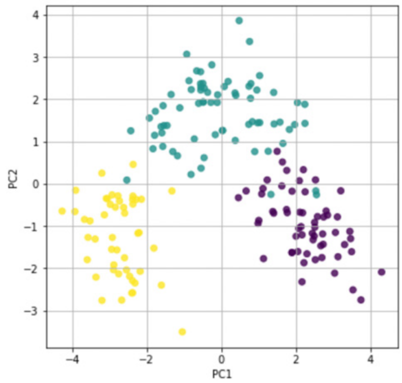

Figure 8. Principal Component Analysis

6 LSTM AND PREDICTION OF OPTIMAL TIME

Long short-term memory (LSTM) is a type of recursive neural network characterized by having a forgetting layer gate in addition to the input layer and output layer. Images automatically generated via WD and DCGAN are time-series data via SAE. By predicting time-series data for each shooting time through LSTM, the difference becomes explicit. In addition, LSTMs have a loss function, so both DCGAN and LSTM are available.

$$z_{t,j} = \sigma((W_{out}x_t)_j + (R_{out}z_{t-1})_j)f(c_{t,j})$$

$$c_{t,j} = \sigma((W_{in}x_t)_j + (R_{in}z_{t-1})_j)f(((W_c x_t)_j + (R_c z_{t-1})_j) + \sigma((W_{for}x_t)_j + (R_{for}z_{t-1})_j)c_{t-1,j}$$

Formula5. Long short-term memory

Therefore, the LSTM completes an analysis engine that can predict the optimum plucking time while having a certain width. Since LSTM is time-series data, other time-series data such as temperature, humidity, and amount of solar radiation can be used as data for prediction.

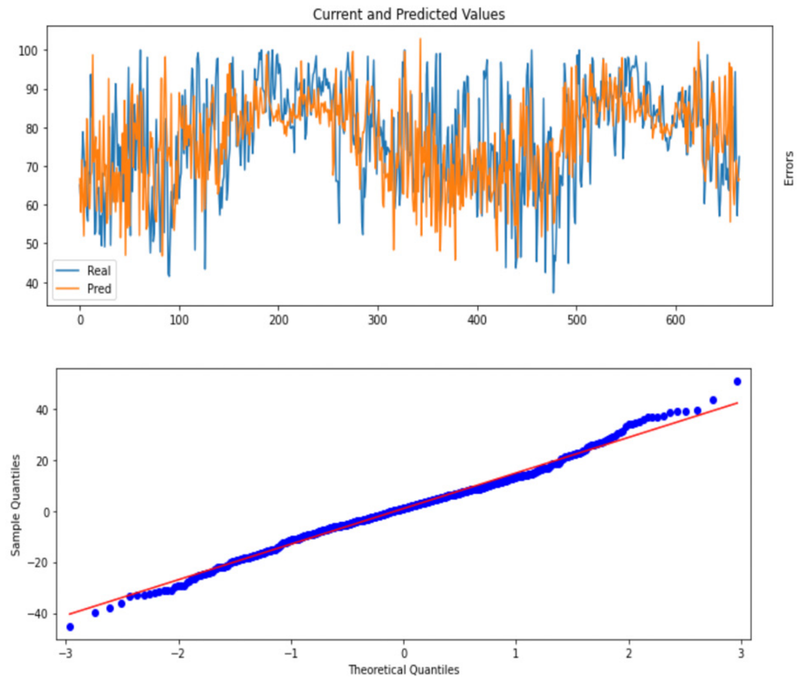

Figure 9. LSTM Prediction

7 APPLICATION DEVELOPMENT

Tea quality predictions obtained through multiple deep learning.The results are managed by a server on the cloud. Meanwhile, an iPhone application is under development for a large-scale agricultural corporation. Agricultural personnel take a tea leaf image with an iPhone in the field. At that time, environmental information such as GPS information of the shooting location and wind speed is also acquired. The acquired data is sent to the cloud, and it is determined which environment is similar to the image of which shooting day at which place.

From the judgment result, the period until the optimum time for plucking is predicted. The predicted period is sent to the iPhone terminal with a certain width. In other words, it is an application that feeds back the optimum time for plucking when shooting with an iPhone in the field. We would like to contribute to improving the quality of tea with this application.

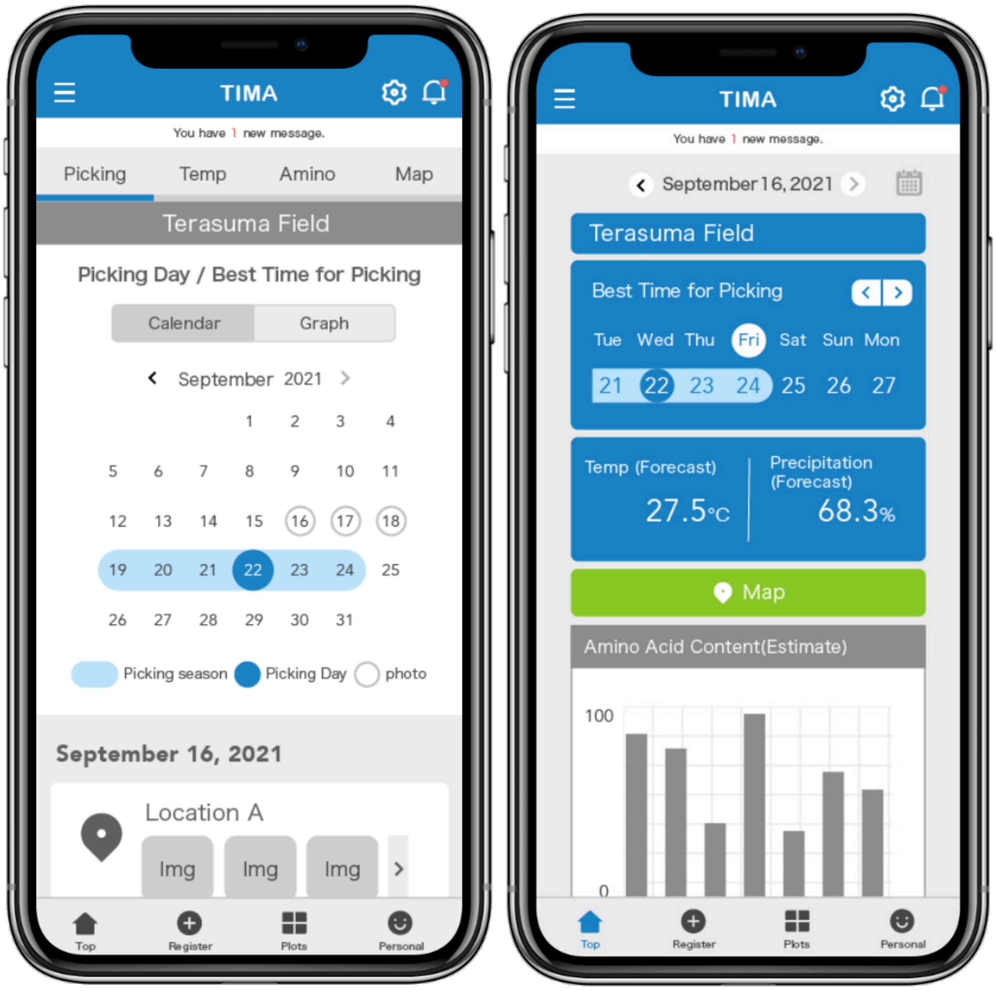

Figure 10. Development for iPhone Apps (screen under development)

8 CONCLUSION

In this study, the tea quality will predict usesig our unique method the combination of WD, DCGAN, SAE, and LSTM. However, it does not accurately describe how effective our analysis method is compared to existing image analysis methods. And how to compare the evaluation of DCGAN and LSTM. Also the selection of necessary field data exactly are our future tasks. In addition, our study accumulate differences in the amount of features for each tea type and shooting date especially. Moreover we determine an approach on the leaf opening period more clearly.

9 IMPLICATION

Finally, we think the relationship between our research and Kansei engineering. From the perspective of Kansei engineering, our research can be said to be the pursuit of the deliciousness of tea. Generally, the higher the quality of tea, the better it is. So what does it mean that tea leaves are of high quality? Chemically, as already discussed, "*Umami*" depends on the amino acid content. Tea leaves are plucked at the appropriate content.

If the picking time can be determined only from the images of tea leaf, we think it may be an index of deliciousness different from the amino acid content. We hope that this research will give you an opportunity to think about what "*Umami*" is.

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ANALYSIS OF PERCEPTIONS OF SUSTAINABLE LABELING ACCORDING TO PRODUCT TYPE

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ABSTRACT

Sustainability labeling is commonly applied to consumer products. It is usual to find labels related to different sustainability aspects, such as environment, health or fair trade. Consumers with sustainability awareness will base their choices on how the product aligns with their values. However, consumer preferences about sustainability traits may depend on the specific type of product.

To determine if perceptions on labeling about sustainable aspects differ based on product type, a study was carried out in which 73 participants chose between three versions of a same product, each version containing a sustainable label (environmental, social or related to health). Three different products for daily use were chosen: food (a milk carton), clothing (a T-shirt) and a personal hygiene product (a bottle of shampoo). For each product and aspect of sustainability, the labels were chosen among the best known. Choices had to be made around various perceptions: quality, price, sustainability, trust, willingness to pay and general choice (preference).

The results show that, for some questions, the choice of the preferred sustainability aspect depends on the product. Therefore, it is concluded that the evaluation and decision criteria of sustainable labeling may vary, depending on the type of product to which it is applied.

Keywords: *product labeling, sustainability, perceptions, choice, type of product*

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1 INTRODUCTION

Consumers are increasingly aware of the environmental repercussions that their actions and purchase decisions have on the environment. This environmental awareness has been evolving and becomes a motivating and valued component in the purchase decision (Borin, Cerf, & Krishnan, 2011). Some authors have analyzed and evaluated the factors related to the environmental responsibility of consumers, highlighting aspects such as knowledge in this area and their awareness of the environment, attitude, ecological values, emotional affinity towards nature or their willingness to act in an environmentally friendly way (Taufique, Chamhuri, Talib, & Chamhuri, 2014). However, apart from the environmental aspects, the information related to the repercussions on their own health, or social conditions and local commerce, is increasingly valued by consumers and even decisive in the purchase decision, while it has been scarcely analyzed in the literature. According to Carvalho, Salgueiro, and Rita (2015), these global indicators constitute what they call sustainable consumer awareness, which increases as access to information does.

Although product information can be presented in different ways (packaging, instructions manuals, billboards, etc.) and formats (images, phrases, symbols, etc.), labels seem to be the most appropriate means of providing the information required by the consumer, generating greater transparency and confidence (Carvalho et al. 2015). According to Lamb, Hair, and McDaniel (2011), an informative label is understood as the symbols or text designed to help consumers properly select products by reducing their cognitive dissonance, unlike persuasive labels, whose main objective is focused on promotional aspects, where consumer information is secondary.

Regarding environmental considerations, the effectiveness of environmental product labeling has been widely used by companies to differentiate their products from others without environmental considerations (D'Souz, 2000). However, the information transmitted by these eco-labels is not always clear to the individual, and there are numerous studies available in the literature focused on analyzing their effectiveness in different products, such as clothing (Koszewska, 2011), food (Van Amstel et al., 2008), vehicles (Noblet, Teisl, & Rubin, 2006) or washing machines (Pérez-Belis, Bovea, Vergara, & Mondragón, 2015). Other aspects analyzed in the literature are related to the perception of labels related to product quality (Grunert & Aachmann, 2016) or those related to fair trade (Rousseau, 2015).

To ensure complete understanding, the information on product labels should be clear, reliable and understandable, allowing consumers to detect, read and understand this information, on which they base their purchase decision (Thøgersen, 2000; Leire, & Thidel, 2005). But beyond the information provided by these labeling systems or the consumer’s understanding, it is necessary to know the way in which these types of labels are emotionally perceived, since according to Janssen and Hamm (2012) consumer’s perception is of a subjective nature, not basing their purchase decision, in most cases, on objective knowledge. According to Brécard (2014), although consumers understand, for example, that an ecolabel is a symbol of environmental quality, most of them opt for one product or another, depending on what that symbol, information or label conveys to them, more than by the technical or environmental qualities that it communicates. That is why it is essential that labeling systems connect with the emotional part of consumers, in the same way that big brands do (Berger & Hari, 2012). However, to gain insight about the connection between labels and the subjective impressions generated, more studies are needed. For example, it is essential to know if the same labels cause the same perceptions, depending on the type of product that displays them.

Within this approach, a study has been carried out with the aim of analyzing the influence of the type of product and the sustainability dimension on certain meanings, emotions and preferences generated by the product.

2 METHODOLOGY

The study aims to analyze the assessment of some labels related to different sustainability dimensions (environment, health and social respect), in various perceptions or subjective impressions that they generate (meanings, emotions and product preference), depending on the type of product in which the sustainable labeling is shown.

2.1 Participants

Seventy-three individuals (32 women and 41 men) participated in the experiment. Most of them (94.5%) were students, while the remaining 5.5% was made up of University staff. Regarding age ranges, 86.3% were under 25 years old, 6.8% belonged to the group from 26 to 35 years, 5.5% from 36 to 45 years, and 1.4% from 46 to 55 years. None of them had specific knowledge about sustainability labels.

2.2 Stimuli

The selection of product types and labels has been made based on a previous review and classification. Preference has been given to those labels related to sustainability dimensions that are applicable to various types of product, and that may be familiar to consumers because they are frequently used. The types of product have also been chosen from among those commonly used. The chosen products are a food product (a milk carton), a textile product (a T-shirt), and a basic cosmetic product (a bottle of shampoo).

Regarding labels, efforts have been made whenever possible for products to share the same label for a given sustainability dimension, although this has not always been achieved. Next, the chosen labels are explained and summarized in Table 1.

Sustainability dimension of environmental respect

- FSC: The Forest Stewardship Council label shows a certification about products that come from well-managed forests, responsible sources or recycled materials (FSC, 2018).
- Ecolabel: This label from the European Union shows environmental excellence in products and services that meet high environmental standards throughout their life cycle (UE-E , 2020).

Sustainability dimension of health respect

- EU organic label: This label provides a visual identity for organic products that meet strict conditions of production, transformation, transport and storage (EU-OL, 2010).
- OEKO-TEX: This certification system promotes the development of sustainable products in the textile and leather industry, following quality controls and standards (OT, 2022).
- Eco-Cert: This certification guarantees, among others, ecological and healthy production, responsible use of natural resources, absence of certain ingredients and recyclable packaging. (EC, 2022).

Sustainability dimension of social respect

- Fairtrade: The Fairtrade labels are a guarantee that the products are independently audited according to rigorous standards (FT, 2022).

Thus, the Fairtrade label (social respect) is shared for the three products, and the Ecolabel label (environmental respect) for two of them.

Table 1. Label selected for each sustainability dimension

Sustainability dimension	Cosmetic (Shampoo)	Food (Milk Carton)	Textile (T-Shirt)
Environment respect	EU Ecolabel	FSC	EU Ecolabel
Health respect	ECO CERT		CONFIDENCE IN TEXTILES Tested for harmful substances according to Oeko-Tex Standard 100
Social respect	FAIRTRADE	FAIRTRADE	FAIRTRADE

2.3 Procedure

Six perceptions or subjective impressions (SIs) were selected for the analysis of their elicitation, based on the labels. Next, the SIs are shown, followed by the specific question required to participants:

- Sustainability: Select the most sustainable product.
- Trust: Select the product that generates more trust.
- Quality: Select the highest quality product.
- Willingness to pay: Select the product for which you would be willing to pay a higher price.
- Price: Select the most expensive product.
- Choose: Select the product you would choose first.

None of the SIs assessed is directly related to the specific meaning of the labels; that is, the level of knowledge or understanding of labeling is not being evaluated. Instead, emphasis is placed on the impressions achieved with each of the labels, which will be analyzed according to the sustainability dimension, and the type of product.

Images of each type of product were created, and slides were prepared showing a product, repeated 4 times: one with each of the labels (3 sustainability dimensions), and also another image with the product without any label, representing an 'Indifferent' option. The order in which the labels appeared was randomized. For each type of product, 6 slides were made (Figure 1). In each one, participants were asked to select the version of the product considered to best meet one of the subjective impressions. It was also said that, in the event that there was no particular preference, the 'Indifferent' option should be indicated, although this choice was requested to be avoided as much as possible.

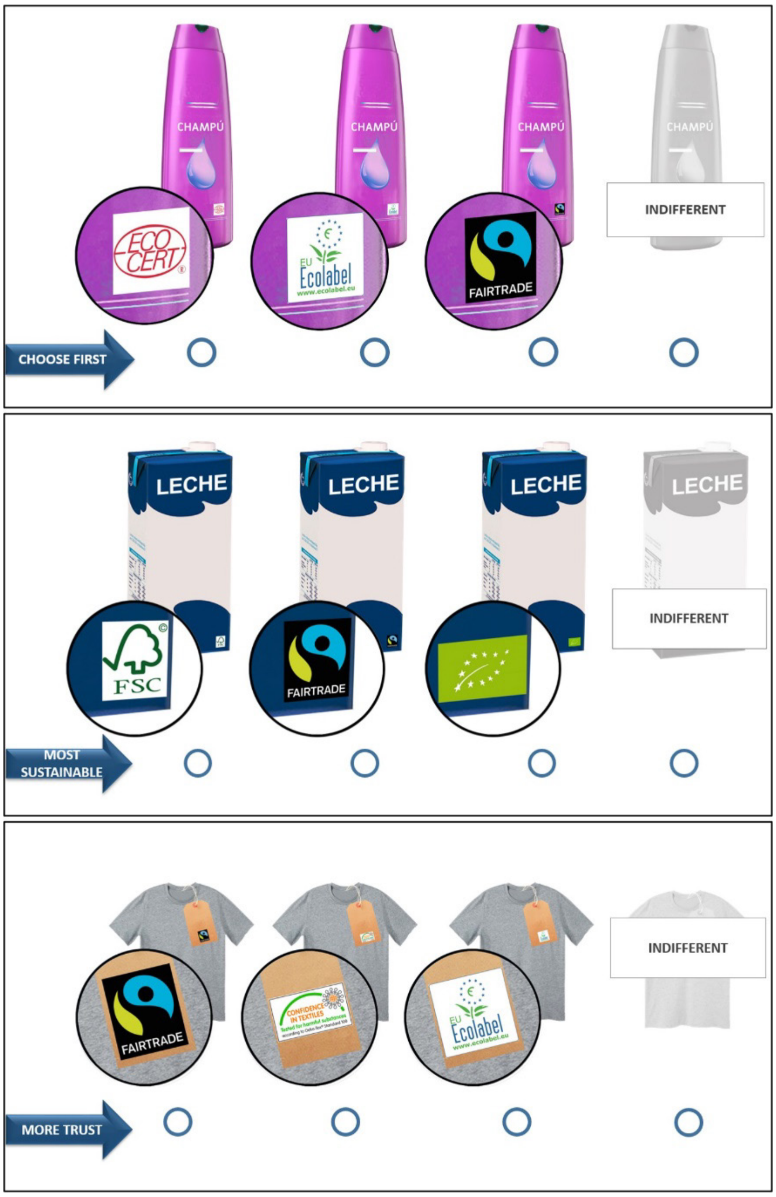

Figure 1. Three examples of the slides, one for each type of product, from among the 18 considered in the study (6 assessments per product).

3 RESULTS

Figure 2 shows, for each subjective impression, the times (percentage) that each of the 3 sustainability dimensions of products has been selected: health, environment and social. In most cases, the environmental label is the most chosen, especially for the question about sustainability. For this question, the percentage of cases in which the environmental label is chosen, is much higher than in the rest of the labels: 87.67% for the bottle of shampoo, and 71.23% both for the milk carton and the T-shirt. Thus, the concept of sustainability is mostly associated with the environmental dimension, for the 3 types of product analyzed.

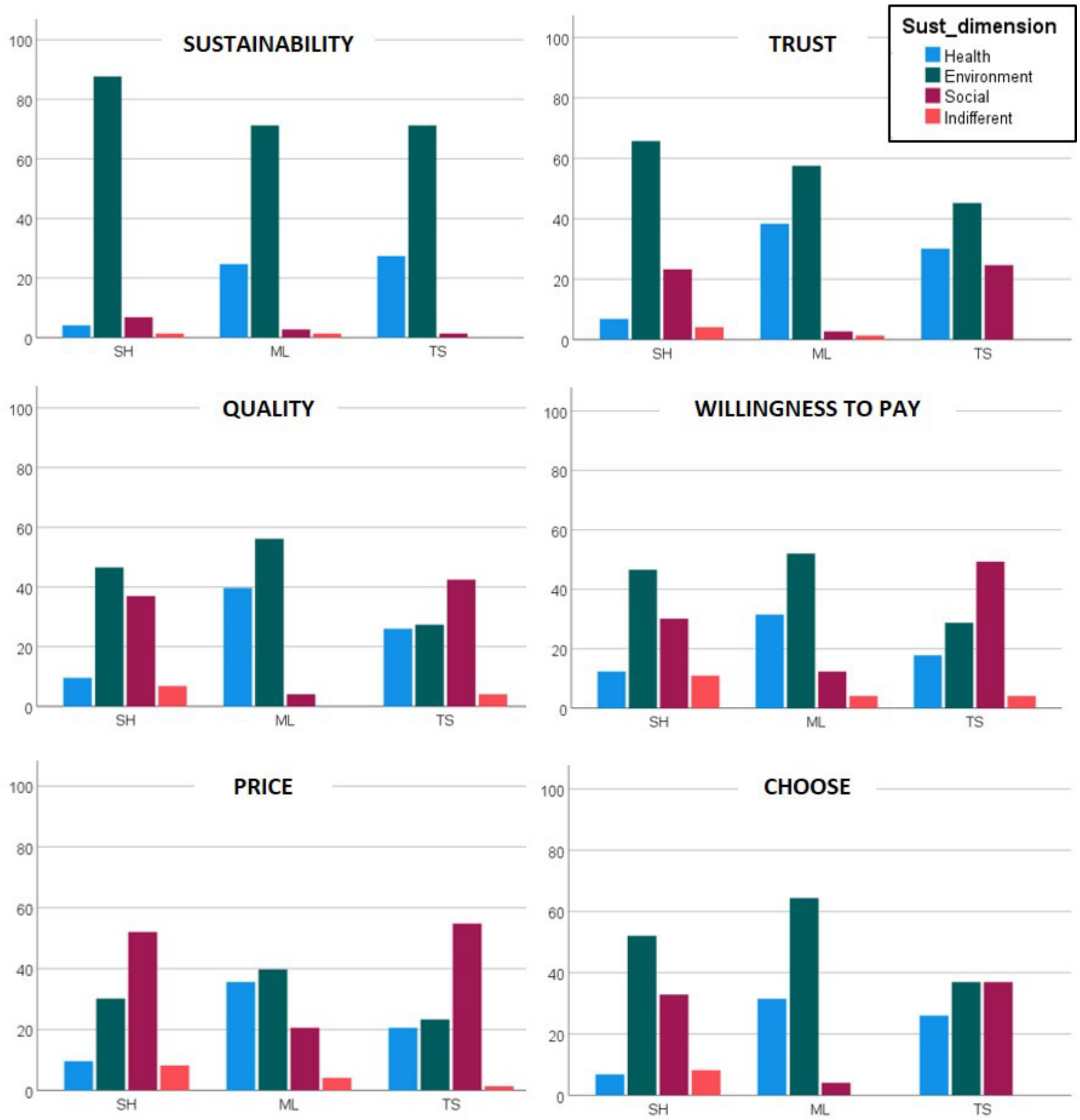

Figure 2. Selection percentage for each product (SH: bottle of shampoo; ML: milk carton; TS: T-shirt) and sustainability dimension, by subjective impression.

Also, in the question about the trust generated by the product, the environmental label was chosen first for the three products, although in this case the percentages are not so high (65.75%, 57.53% and 45.21%, for the bottle of shampoo, the milk carton and the T-shirt, respectively). For the milk carton, the health label is chosen a much higher percentage of times (38.36%) than the social one (2.74%). However, in the case of the T-shirt, the difference between both labels is not high (30.17% and 24.66%, respectively). The health label also maintains in other questions a high relative percentage of answers for the milk carton, probably because the milk carton is a food product, and health is prioritized to a greater extent, while in the T-shirt or the bottle of shampoo, more value is given to social aspects.

Regarding the perception of quality, for the bottle of shampoo, this is fundamentally transmitted by the environmental label (46.58%), although closely followed by the social one (36.99%), while for the milk carton, quality is represented by the environmental label (56.16%), followed by the health one (39.72%). In the case of the T-shirt, the social label is the most representative of quality (42.47%), while the environmental and health labels maintain very similar percentages. These proportions are similar to those obtained for the question about willingness to pay, which may mean that the participants associate more the willingness to pay for products that they perceive to be of higher quality, above other subjective impressions, such as sustainability.

However the results of willingness to pay does not match with its assumed price, especially for the bottle of shampoo, for which the social label is chosen first (52.05%) as the most expensive version, despite participants had said they would pay more for the environmental one. The social dimension is also the most identified with price for the T-shirt, even with a higher percentage (54.79%), while for the milk carton it is the third dimension, below environmental and health labels.

Finally, the question 'Select the product you would choose first' denotes the general preference of the product. In this case, the environmental label is the most chosen for the bottle of shampoo (52.05%) and the milk carton (64.38%), while for the T-shirt, it is selected by the same percentage of participants than the social label (36.99% each). Following the pattern seen previously in other questions, the health label for the milk carton is chosen by a higher percentage of participants than for the other products, although as the second option, after the sustainability label.

4 DISCUSSION AND CONCLUSION

The results show that, in general, consumer's final decision related to sustainability factors is mainly guided by information from environmental issues, which agrees with the most studied type of sustainable consumer responsibility (Taufique et al, 2014). Probably this result is because sustainable labeling on environmental aspects has been widely used in products (D'Souz, 2000). In fact, the question about sustainability is the one where the results are more focused on this label: for the products with the lowest choice of the environmental label (the milk carton and the T-shirt), this dimension represents the 71.23% of the total selection. Thus, it can be concluded that the environment is the sustainable dimension that consumers most identify with the global concept of sustainability.

For the T-shirt the preference is shared equally between the environmental and social labels. Besides, reviewing the rest of the questions, it can be seen that, except for the question about sustainability and the one about trust, the social label is always the first option in the "T-shirt" product. This result is consistent with the fact that clothing is a type of product for which much has been said about the need to recover a sustainable system, in which excessively cheap labor and poor social conditions are not used.

Also for the bottle of shampoo, the social label is more selected than the health dimension. However, in the case of the milk carton, the health dimension is always the second option, after the environmental one, and above the social label. Considering that the questions are not directly related to the specific meaning of the labels (no question refers to care of health, environment or social conditions), this shows that the type of product considered is capable of modifying the relative meaning of the sustainable labeling. Thus, a T-shirt with social labeling has achieved a greater impression of quality than another one including health labeling. On the contrary, the carton of milk is considered to have more quality in its version with healthy labeling than with the social one.

As previously mentioned, for each product and dimension, the label considered best known by the participants has been included in the study, and this has led to use the same label in some cases (social or environmental aspect, as seen in Table 1). However, different results are obtained between products for the social dimension, which shares labeling in all of them. Differences have also been found for the bottle of shampoo and the T-shirt, between the social and environmental dimensions, even though they share representative labels. For example, for the questions about quality, willingness to pay and choose, the bottle of shampoo with the environmental label (*Ecolabel*) is considered more representative than the social one (*Fairtrade*), and just the opposite occurs with the same labels for the T-shirt. This shows that the differences found are due to the sustainability dimension, and not to the specific label used in each case. Brécard (2014) indicated that consumers are affected by the perceptions that a label conveys to them, more than by real information communicated by the label.

The results of this study allow enriching previous statements, as it can be concluded that perceptions and decision criteria of sustainable labeling may vary, depending on the type of product to which it is applied. Future work could consider the study of the consumers’ behavior, based on specific labels of each sustainable dimension.

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ANALYZING DIRECTIONALITY OF INFLUENCE AMONG ENSEMBLE MUSICIANS USING GRANGER CAUSALITY

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ABSTRACT

In small musical groups, performers can seem to coordinate their movements almost effortlessly in remarkable exhibits of joint action and entrainment. To achieve a common musical goal, co-performers interact and communicate using non-verbal means such as upper-body movements, and particularly head motion. Studying these phenomena in naturalistic contexts can be challenging since most techniques make use of motion capture technologies that can be intrusive and costly. To investigate an alternative method, we analyze video recordings of a professional instrumental ensemble by extracting trajectory information using pose estimation algorithms. We examine Kansei perspectives such as the analysis of non-verbal expression conveyed by bodily movements and gestures, and test for causal relationships and directed influence between performers using the Granger Causality method. We compute weighted probabilities representing the likelihood that each performer Granger Causes co-performers' movements. Effects of different aspects of musical textures were examined and results indicated stronger directionality for homophonic textures (clear melodic leader) than polyphonic (ambiguous leadership).

Keywords: *Kansei information processing, Social interaction, Entrainment, Granger causality, Joint actions.*

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1 INTRODUCTION

Temporal data now appear everywhere, and this statement is getting increasingly true with the availability of new modalities, recording devices, and innovations. With recent advancements, studying joint human activities is becoming increasingly accessible, and thus helps with investigating perception and actions among individual and small group setups.

Coordinating tasks is an essential aspect of our lives, and we tend to demonstrate remarkable examples of cognitive and movement-related synchrony to achieve shared task objectives. Humans have a presumably innate capability to entrain their movements, and this is particularly seen in artistic activities such as music and dance where we tend to exhibit intrapersonal and interpersonal entrainment (Clayton et al., 2005; Miyata et al., 2017). The evolutionary process has rendered humans to indulge in social interactions where we may use different communicative capabilities such as voice tonal quality, facial expressions, and bodily gestures, along with cognitive capabilities of perceptual sensitivity and heightened attention to achieve common goals in joint actions (Knoblich & Sebanz, 2006; Tomasello & Vaish, 2013).

In social situations, it is but natural for humans to assume different roles (leader or follower) during joint actions (Chauvigné & Brown, 2018). This can be observed in situations where two people coordinate their movement to lift and move a large heavy object while providing each other with verbal cues. These cues can also be non-verbal, as seen in artistic activities such as dance or musical performances where participants entrain their movements, assume the role of a leader or follower depending on the structural task (Keller et al., 2014; Noy et al., 2011), and adapt to each others' actions at different temporal scales (Chang et al., 2017; Kirschner & Tomasello, 2009; Noy et al., 2011; Shockley et al., 2003). Music ensembles thus serve as ideal test-beds to study leader-follower relationships in joint actions. They tend to act as self-regulated groups that mutually contribute to commonly shared goals of delivering a flawless performance by avoiding errors. With the objective to fulfill the aesthetic and technical goals of a musical composition, ensemble groups members exhibit non-verbal cues such as synchronized bodily movements, especially upper body movements among string quartets (e.g., Keller & Rieger, 2009). During the collective process of co-creation of music, these movements eventually lead to synchronized states where a musical group slowly converges into a single organism (Camurri et al., 2016; Varni et al., 2010).

In this paper, we investigate such subtler, "Kansei"-level, qualitative features of joint actions, particularly the directionality of influence of a leader-follower relationship that emerges during a music performance, which is often communicated using ancillary body movements such as head and body sway (Alborno et al., 2019; Bishop et al., 2021; Chang et al., 2019; Hilt et al., 2019). Based on previous studies (Badino et al., 2014; Hilt et al., 2019), Granger causality (GC) is utilized to quantify the directionality of influence by making use of trajectory information of the head motion (Granger, 1969). These data are extracted using pose estimation algorithms on video sequences of a professional musical ensemble's performance. Unlike previous methods that made use of marker-based motion capture data (MoCap) (Badino et al., 2014; Chang et al., 2017; D'Ausilio et al., 2012; Hilt et al., 2019), we used video recordings with marker-less techniques to localize body coordinates of interest. An important contribution of this study is to propose a conceptual approach to examine “Kansei”-level information by investigating directional flow of non-verbal communication using only video sequences, thus allowing the examination of musicians’ movements and associated interactions in naturalistic settings. We also use this technique to then address research questions about the effects of musical structure on leadership dynamics.

This paper is organized as follows: in Section 2, we highlight the research objectives and present relevant studies that have examined leadership dynamics in social situations and on the associated effects of musical textures on leader-follower relationships; Section 3 begins by describing our conceptual approach and methodology to measure directionality of influence, and this is followed by presenting the dataset; Section 4 we present statistical results and in Section 5 we discuss results, conclude the paper, and highlight the limitations and possible future activities.

2 RESEARCH OBJECTIVES AND RELATED WORK

In this research, our objectives are twofold:

1. Propose a conceptual approach and framework for extracting “Kansei”-level features for the analysis of leadership dynamics in small group interactions; and
2. Utilize such an approach to investigate the effects of musical texture and directionality of coupling

In this section we summarize the background and related work with regards to the above-mentioned objectives of this study, i.e., (i) existing methods adopted to analyze leadership dynamics in joint musical actions and (ii) studies examining causal relationships of musical textures.

2.1 Social interaction and leadership in joint musical actions

Humans tend to coordinate tasks with each other almost effortlessly, especially in socially engaging situations such as lifting heavy objects together or jointly playing drums where the limbs’ movements eventually synchronize to a common beat (Wallin et al., 2001). In the case of musical ensembles, a shared state of synchronization, often termed entrainment, indicates a spatiotemporal coordination between two or more individuals (Phillips-Silver & Keller, 2012), and is observed among musical performers who engage and communicate with each other non-verbally to achieve the technical and artistic objectives of a musical piece (Clark, 1996; Keller et al., 2016; Sebanz et al., 2006). During such joint actions, the importance of leadership in group dynamics is often highlighted for the successful co-creation of sound (Murnighan & Conlon, 1991; Timmers et al., 2014).

Looking at four relevant studies on GC in musical ensembles, one analyzed position (Chang et al., 2017) and three analyzed acceleration time-series data (Bishop et al., 2019; D’Ausilio et al., 2012; Hilt et al., 2019). Using GC, we can infer the causal relationships between two co-performers’ movement-related time series, to check if one (leader) stimulates movement in another (follower) (Glowinski et al., 2012). Following Chang et al. (2017), we use position time-series information, and in addition to the anterior-posterior head sway, we also made use of proximal and distal head movements. Previous research in small group interactions have suggested that the coordination of upper-body movements, particularly head movements, are correlated with the onset of sounds, showcasing that both audio and visual cues are utilized to communicate during music performances (Bishop & Goebl, 2018; Ragert et al., 2013) and head movement coordination is closely linked with a higher sense of connectedness (Latif et al., 2014; Marsh et al., 2009). Additionally, it has been found that the anterior-posterior sway of upper-body movements is informative about leader-follower relationships (Keller & Appel, 2010).

While our proposed approach specifically addresses musical ensembles, it is in essence being utilized to study leader-follower relationships in small group interactions. Musical ensembles happen to be valuable experimental setups to study subtler aspects of non-verbal communication in small groups, and an added benefit is that, as researchers, we can set strong experimental controls (D'Ausilio et al., 2015).

2.2 Effects of musical texture

In the present study, we address how the variation in directionality of coupling relates to the musical texture, a structural aspect of music related to the complexity of the relationship between multiple simultaneously sounding parts. While it is not definitively clear how textural changes can affect group dynamics and eventual coordination, based on previous research (Novembre et al., 2015; Noy et al., 2011; Sabharwal et al., 2022; Varlet et al., 2020), we hypothesize that our measurement of the influence in directionality of coupling would be higher in homophonic textures than in polyphonic textures. Homophonic textures are those where there is a clear melodic leader while in polyphonic textures the leadership is distributed among co-performers.

3 CONCEPTUAL FRAMEWORK, DATA AND METHODOLOGY

In a previous study (Sabharwal et al., 2022), we proposed huSync (Human Sync), a multimodal computational model and system to study the small group interactions that entail non-verbal social communicative behavior. We utilized huSync to quantify interpersonal coupling in a small musical group and revealed how dyadic synchronization varied as a function of textural demands and position within the musical phrase. As an extension of our previous work, and to address the research objectives of this study, we make an attempt to quantify mutual interaction, and leadership and study the effects of musical structure on the directionality of coupling by making use of relatively long timescales of upper-body movements such as head sway (Alborno et al., 2019; Chang et al., 2019; Hilt et al., 2019).

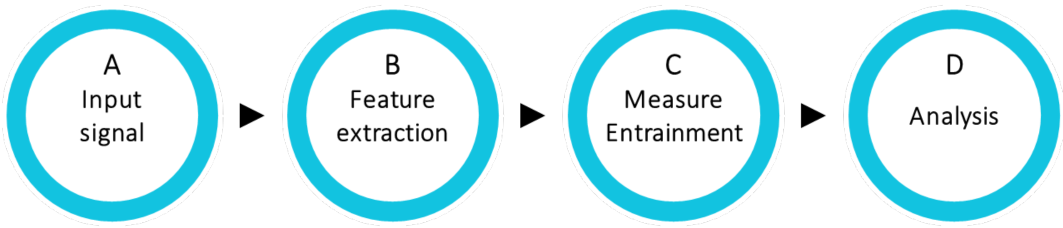

Figure 1 An illustration of our experimental approach

From the computational model shared in Sabharwal et al. (2022) (Ref. Fig. 1), we derive our experimental approach which consists of the following four steps:

1. **Input signal**: In the first step (Fig. 1(A)) we read the video signals from standard video recordings and pre-process using the pose estimation algorithm AlphaPose (Fang et al., 2018), to obtain a json file consisting of trajectory information of (x,y) body part locations sampled at 30Hz.
2. **Feature extraction of relevant key-point(s)**: On observing the outputs available using AlphaPose, the best representation of the head from the available face landmarks was the nose key-point, and here we select it as a cue on head sway. The nose trajectory data are then utilized to quantify directionality of influence among performers in the next block (Fig. 1(B)).
3. **Measurement of entrainment**: In the third block (Fig. 1(C)), we measure the directionality of information flow by applying GC using the Statsmodels Python module (Seabold & Perktold, 2010), on time-series data of the X and Y coordinates separately for all possible dyadic pairs. For the viola player (Fig. 2, center), due to the seating position and being in the center of the camera view, an anterior-posterior sway is not effectively tracked, and thus we also use the Y coordinate to track proximal and distal movements, which were noted to be reliable during our feasibility tests. On performing the GC test to check if time-series A causes B, and if p<.05 we reject the null hypothesis and infer that the past values of A have a statistically significant effect on the current value of B – thereby demonstrating a causal relationship between the two time-series. In musical performances, as in most behaviors, it is common to have a delay in between a stimulus and response (Chang et al., 2017, p. 20; Meals, 2020), and to address this issue, we performed GC tests for a lag of ~1 sec and used multiple lag lengths up to 30 (equal to the sampling rate), for both the X and Y coordinates of the nose key-point separately for each pair.
4. **Analysis**: In the fourth step (Fig. 1(D)) GC results obtained are mapped in a tabular layout for further analysis. Specifically, for each phrase analyzed, a table is made with the column values indicating the Granger causing time-series, with 1 representing the left-most musician (violin) and 5 representing the right-most (clarinet). We assign a '1' for cells where we detect GC (irrespective of lag) and assign '0' for other cells where the time-series were either not stationary or where p>.05. Fig. 3 represents the mapping process adopted to assign binary values to the GC results. Here, 'NC' implies 'Not calculated' since either one of the time-series was not stationary, and was also assigned '0', while NA implies 'Not applicable'.

	X Coordinate				
	Granger Causing				
	1	2	3	4	5
1	NA	Yes	NC	Yes	Yes
2	Yes	NA	NC	Yes	Yes
3	NC	NC	NA	NC	NC
4	Yes	Yes	NC	NA	Yes
5	Yes	Yes	NC	Yes	NA

→

	X Coordinate				
	Granger Causing				
	1	2	3	4	5
1	NA	1	0	1	1
2	1	NA	0	1	1
3	0	0	NA	0	0
4	1	1	0	NA	1
5	1	1	0	1	NA

(A)

	Y Coordinate				
	Granger Causing				
	1	2	3	4	5
1	NA	Yes	NC	Yes	Yes
2	Yes	NA	NC	Yes	Yes
3	NC	NC	NA	NC	NC
4	Yes	Yes	NC	NA	Yes
5	Yes	Yes	NC	Yes	NA

→

	Y Coordinate				
	Granger Causing				
	1	2	3	4	5
1	NA	1	0	1	1
2	1	NA	0	1	1
3	0	0	NA	0	0
4	1	1	0	NA	1
5	1	1	0	1	NA

(B)

Figure 2 Mapping process of GC results to binary values

This framework was used on a dataset consisting of performance recordings by the Omega Ensemble, a professional chamber music group from Australia. For our study, we performed an analysis on recordings (Fig. 2) of the Clarinet Quintet in B minor (Op. 115) written in 1891 by Johannes Brahms (1833-1897).

Figure 3 An image from the performance of the Brahms Clarinet Quintet (Left) and output available with tracked key-points using a pose estimation algorithm (Right)

Videos were recorded using a front camera, and split into parts based on textural annotations (homophonic and polyphonic) that were made using ELAN (ELAN, 2022) based on a musicological analysis of the published score. In Table 1 we report the number of phrases that were selected for our study. We made use of an equal number of homophonic and polyphonic phrases to have balanced textural classifications, and their minimum, maximum, median, and average duration.

Table 1 Summary of the complete dataset and selected phrases for our experiments.

	Complete Dataset					Selected Phrases				
	Duration (s)				Count	Duration (s)				Count
Texture	Minimum	Maximum	Median	Average		Minimum	Maximum	Median	Average	
Homophonic	15.03	38.20	19.74	21.57	27	16.75	34.87	21.60	23.51	12
Polyphonic	15.49	33.08	23.10	23.53	20	15.49	27.55	20.16	21.11	12

4 RESULTS

A two-way analysis of variance (ANOVA) was conducted on the GC values yielded by the analysis procedure (Fig. 1(D)), and statistical tests were run in jamovi version 1.6.23 (The jamovi project, 2021). In line with our hypothesis, the reported estimated marginal means in Fig. 4 indicates that the mean value of homophonic textures, where we observe distinct melodic leadership, is higher as compared to the polyphonic texture where leadership is rather ambiguous.

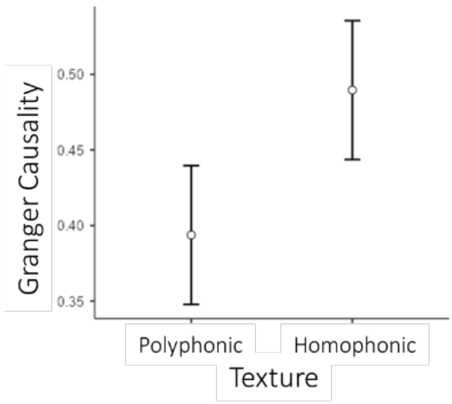

Figure 4 A plot showing the mean values of GC for homophonic and polyphonic textures

An approach for ANOVA using binary values was adopted (Luepsen, 2021), and we entered in it GC results for all combinations of dyadic pairs. Head Sway (Nose trajectory data as X and Y coordinates) was included as a within subjects factor, and Texture (Homophonic, Polyphonic) and Pair (each pair represented as M1-M2, where M1 granger causes M2) as between subjects factors. The ANOVA results are illustrated in Table 2, where values revealing statistical significance have been highlighted in green.

Table 2 ANOVA results for Between and Within Subjects Effects for the Brahms concert

Between Subjects Effects					
	Sum of Squares	df	Mean Square	F	p
Pair	10.15	19	0.534	2.041	0.006
Texture	2.2	1	2.204	8.421	0.004
Pair ✻ Texture	3.21	19	0.169	0.646	0.871
Residual	115.17	440	0.262		

Within Subjects Effects					
	Sum of Squares	df	Mean Square	F	p
Head Sway	4	1	4.004	19.047	<.001
Head Sway ✻ Pair	4.16	19	0.219	1.042	0.410
Head Sway ✻ Texture	1.67	1	1.667	7.928	0.005
Head Sway ✻ Pair ✻ Texture	3.67	19	0.193	0.918	0.561
Residual	92.5	440	0.21		

Results revealed statistically significant main effects of Texture, $F(1,440) = 8.421$, $p = 0.004$, Pair, $F(19,440) = 2.041$, $p = 0.006$, and Head Sway, $F(1,440) = 19.047$, $p<.001$. Additionally, a significant two-way interaction between Head Sway and Texture was also observed, $F(1,440) = 7.928$, $p=0.005$. Head Sway (X and Y coordinates) was included in the ANOVA to account for variance related to movement direction, but this variable was not of theoretical interest and the results will not be presented for the separate dimensions. While these are early findings, results for the texture effect confirms stronger evidence for directional coupling in homophonic textures.

5 DISCUSSION AND CONCLUSION

The contributions of this work are two-fold. On one hand, we present our experimental approach to study the directionality of coupling among small group setups, and we do so using non-intrusive methods. On the other hand, we test our approach on ensemble music performances in an attempt to extract finer subtleties, and aspects, of non-verbal expression. We analyze how head sway influences unfolding leadership dynamics among co-performers, and that stronger directional influence is observed in homophonic textures characterized by the presence of a melodic leader) as compared to a more egalitarian polyphonic textures. A key benefit of this approach is the use of video sequences as input signals which enables experimentation with naturalistic movement patterns.

We would like to highlight some limiting factors observed in our approach. While alternative tracking methods such as marker-based systems are expensive and can cause discomfort among participants, the data available are relatively less noisy as compared to marker-less techniques. There are technical challenges to overcome with marker-less methods such as dependency on frame resolution, occlusion, and variations in illumination, to name a few. Another limitation observed is that the data need to be stationary when using GC. If we apply any techniques to resolve this, we modify the underlying nature of the time-series from non-stationary to stationary, and this can affect the outcome of results. Previous studies (Pearl, 2000) suggest that GC could be used for statistical studies but making use of it for causal relationships is questionable. Additionally, it is still unclear how textural variations affect group entrainment and dynamics, and the preliminary findings of this study are not appropriate for making conclusive or general statements.

In the future, we aim to further investigate the effects of musical structure and phrase position on leadership dynamics in small group setups, and this includes experimenting with more data and validating the results with analysis of acoustic features. As highlighted in Sabharwal et al. (2022) as well, this approach and framework provides a dependable and an unintrusive method in comparison to current methodologies for studying expressive, or “Kansei”-like, aspects of human body movements and their associated qualities.

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APPLICATION OF AHP HIERARCHICAL ANALYSIS AND KANO QUALITY MODEL TO INVESTIGATE THE NEEDS OF EYE DROP USERS AND THE CHARM FACTOR OF THE COMPLIANCE AIDS DESIGN

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ABSTRACT

Previous studies have indicated that many patients with eye diseases are not adherent to eyedrops due to the difficulty in administration. The purpose of using eyedrop compliance aids is to help patients who have difficulties in administering eyedrops. However, this method has not been well recognized and accepted.

This study aimed to upgrade eyedrop compliance aids so that the adherence of eyedrop users could be improved. Among the research methods employed in this study, the analytic hierarchy process (AHP) helped in proposing the best function sequence of the device, and a questionnaire based on the Kano model helped understand the degree of satisfaction with the existing products, as well as discover the appealing factors of their functions and examine their functional relationships. Finally, the results of the two methods were discussed and compared, and the results were used to identify the basic appealing factors influencing consumer satisfaction as well as provide the element attributes and significant features to be weighed in the design of eyedrops. This study suggested that in the design of eyedrops, both the physical and psychological needs of users should be taken into consideration, and reference indexes for aids design that may effectively improve user adherence to eyedrops should be proposed.

Keywords: *eyedrops compliance aid, AHP, KANO model, medication adherence*

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1 INTRODUCTION

Eyedrops are by far the most common route of drug administration for treating eye diseases (Brand et al., 2021; Jumelle et al., 2020). However, many patients have difficulty completing this task independently. Due to their inability to adequately instill a drop into the eye or the fear of self-harm during administration, patients will possibly be non-adherent (Winfield et al., 1990). A number of studies have identified the need for additional assistance in administering eye drops for patients aged above 60 years (Burns & Mulley, 1992; Lacey et al., 2009).

Common problems of patients include difficulty in aiming the drop, difficulty in squeezing the bottle, forgetting to use the eyedrops, difficulty in opening the bottle, and physical limitations between the hands and the head (Dietlein et al., 2008; Virani et al., 2015; Winfield et al., 1990).There are also concerns about the risks of contamination on the bottle tip and damage to the eyes (Solomon et al., 2003). People's understanding of medication methods declines significantly with age, and thus it is necessary to attach more significance to patients' education on medication (Chiu; Hoevenaars et al., 2006).

Eyedrop compliance aids may be an under-appreciated resource for certain patients, and few patients use aids to improve their eyedrop application techniques (Burns & Mulley, 1992). Compliance aids have been verified to improve the usage rate of eyedrops. Many patients express willingness to try using these aids, but it is unclear how these users feel about such aids (Davies et al., 2016; Hocking, 1999; Zhu et al., 2021). Few studies have been made on the functional requirements for aids and their psychological impact on patients.

In an effort to find the significant differences and the functional requirements of users for eyedrop aids, this study proposed a design method for evaluating and optimizing the functions of compliance aids based on the AHP and Kano models. Discussions were made on:

1. AHP and Kano analyses on the importance and relevance of using the aids to meet the users' needs.
2. Examining the existing aids based on the above analysis result.
3. Proposing the overall characteristics of the users' values toward the aids and design guidelines to improve the indexes of the aids.

2 METHODS

2.1 Study Design/Procedures

The research method starts with literature, focus interviews, and analyzes users' difficulties and needs for hierarchies and classifications. AHP helped in proposing the best function sequence of the device, and a questionnaire based on Kano understand the degree of satisfaction with the existing products, as well as discover the appealing factors of their functions and examine their functional relationships., discover the attractiveness factor function that affects users to view the status of existing products. The results of the two methods are discussed and compared.

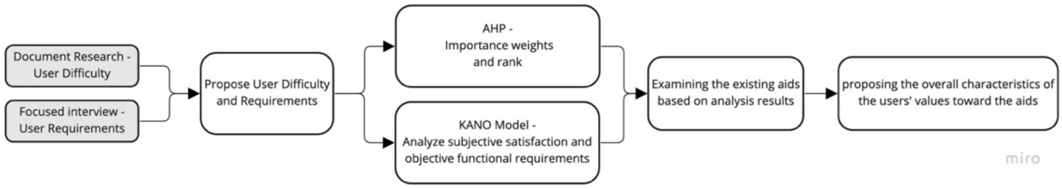


Figure 1. Study Design and Procedures

2.2 Difficulties and Needs of Eyedrop Users

In addition to reviewing the literature to understand the difficulties in using eyedrops, interviews with 16 medical staff and the collection of the patients' needs through an experiment were added as elements. Then, the users' frustrations and needs were analyzed using AHP and the Kano model.

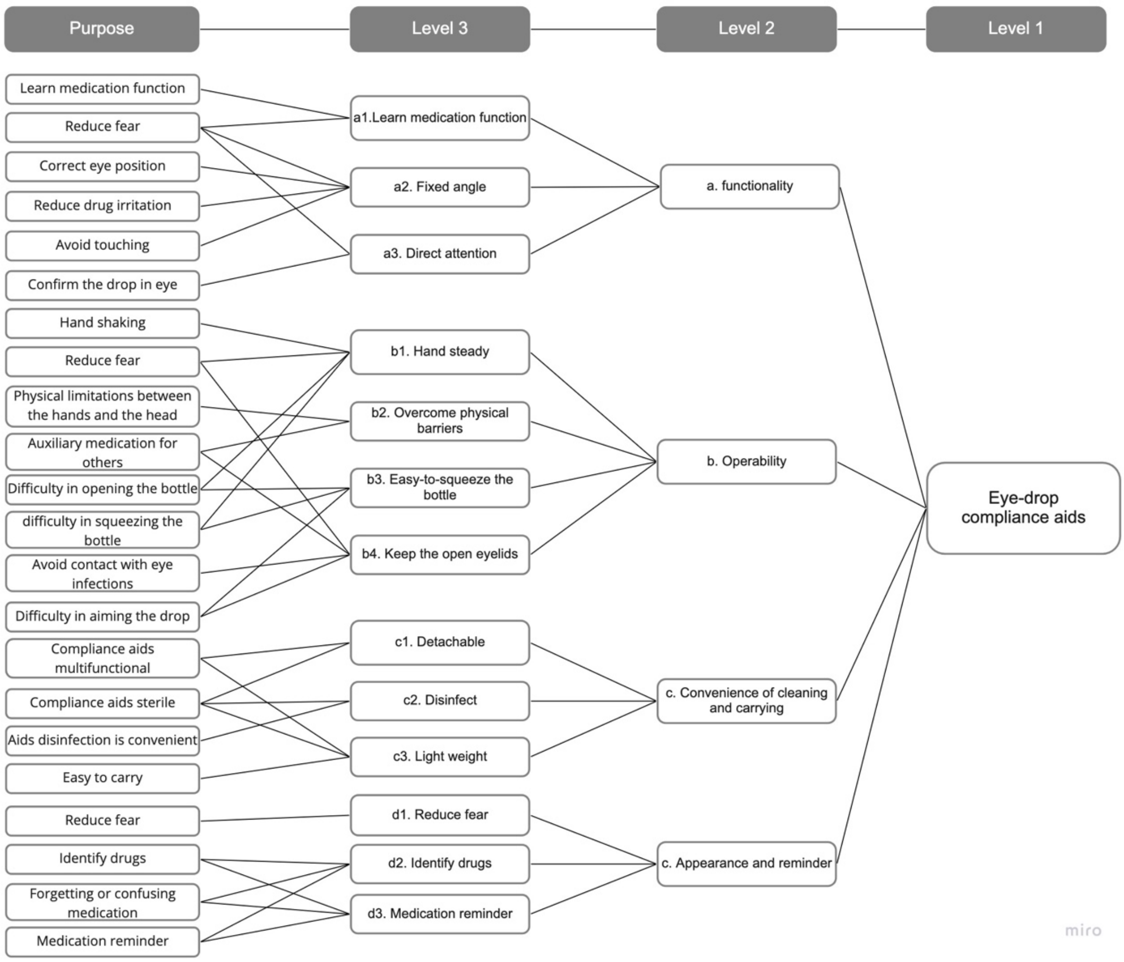


Figure 2. Hierarchy of user difficulties and needs in this study.

2.3 Analytic Hierarchy Process, AHP

Thomas L. Saaty proposed a decision-making process for uncertain situations with multiple evaluation criteria (Satty, 2008). In this method, a hierarchical structure was first established. Next, a paired comparison matrix was built (refer to Figure 2). The consistency ratio (CR) was compared by calculating the weight. If CR < 0.1, the consistency of the judgment matrix is satisfactory; otherwise, the judgment matrix needs to be adjusted until the consistency is qualified. The formula is:

$$CI=(\lambda max-n)/(n-1),$$
$$CR=CI/RI,$$

where λmax is the largest eigenvalue, n is the order of judgment matrix, and RI is consistency index.

Scale	Definition	Description
1	Equally importance	Two CRs contribute equally to objective
3	Moderate importance	Experience and judgement favour one CR over another
5	Essential or strongly importance	Experience and judgement strongly favour one CR over another
7	Very strongly importance	A CR is strongly favoured and its dominance demostrated in practice
9	Extremely importance	The evidence favouring one CR over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgements	As compromise value is needed

	CR_1	CR_2	CR_3	CR_4	CR_5	Sum	Raw importance
CR_1	-	1/3	1/7	1	1/5	1.67	0.04
CR_2	3	-	1/3	5	1/5	8.53	0.20
CR_3	7	3	-	5	1	16.00	0.38
CR_4	1	1/5	1/5	-	1/3	1.73	0.04
CR_5	5	5	1	3	-	14.00	0.33

Figure 3. AHP Scales of judgment matrix. (Song et al., 2014)

2.4 KANO Model

The Kano model, proposed by Noriaki Kano et al., as show in Figure 4. Analyzes the internal needs of customers from a psychological level through questionnaires (Lu & Juan, 2019). Customer needs can be divided into five categories (Berger et al., 1993; Kano, 1984) as Table 1. Common analysis methods are as follows:

1. Discrete Analysis: Discrete analysis calculates the quantity of an object and presents the order of things. Generally, the ordering is shown after the calculation is made and is based on the better-worse satisfaction formula:
   - Increasing customer satisfaction (Better)

$$\text{Coefficient (SI)} = (A + O)/(A + O + M + I) \qquad (1)$$

   - Reducing customer satisfaction (Worse)

$$\text{Coefficient (DSI)} = -(O + M)/(A + O + M + I) \qquad (2)$$

2. Continuous data: Published by William DuMouchel in 1993, the collected data needs to be weighted, after which the average scores of the forward and reverse questions are calculated to classify the functional quality attributes.

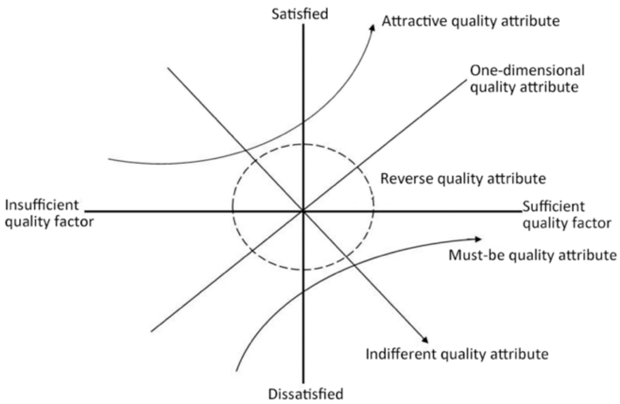


Figure 4. Kano two-dimensional quality model.

Table 1. Categories.

Attractive quality attribute (A):	User will be satisfied when this quality attribute is sufficient and may also accept when this quality attribute is insufficient.
One-dimensional quality attribute (O):	User will be satisfied when this quality attribute is sufficient and will be dissatisfied when this quality attribute is insufficient.
Must-be quality attribute (M):	User will take it for granted but will not be satisfied when this quality attribute is sufficient; will be dissatisfied when the quality attribute is insufficient.
Indifferent quality attribute (I):	User will neither be satisfied nor dissatisfied when this quality attribute is sufficient or insufficient.
Reverse quality attribute (R):	User will be dissatisfied when this quality attribute is sufficient and will be satisfied when this quality attribute is insufficient.
Questionable requirements (Q):	When user misunderstand the survey questions or problems and do not express their opinions correctly.

3 RESULTS

3.1 Analytic Hierarchy Process, AHP - Users' Functional Requirements

After collecting ten questionnaires, the weight vectors were calculated and the consistency test was performed. The results of the consistency tests for Questionnaire 3 and Questionnaire 7 were > 0.1 and failed the test; thus, they were excluded. The weighted analysis and index analysis were performed on the other eight questionnaires, as Table 2.

A comparison of the users' ranking of the functions indicated that experts of different ages had more objective opinions on the selection of the aids' functions. All experts agreed that the most important element is the operability (weight: 0.396737) of the aids which help hand steady, overcome physical barriers or lift the head, easy-to-squeeze eyedrop bottles, and the ability to keep the eyelids open.

Table 2. Importance weights and rank.

Level 2			a. Functionality	b. Operability	c. Convenience of cleaning and carrying	d. Appearance and reminder
No		CR				
A	Over 60 y	0.091	0.106	0.467	0.330	0.097
B	Over 60 y	0.087	0.168	0.620	0.064	0.149
C	20-39 y	~~0.16~~				
D	40-59 y	0.089	0.089	0.454	0.423	0.035
E	40-59 y	0.091	0.058	0.309	0.525	0.108
F	0-19 y	0.088	0.509	0.317	0.033	0.141
G	40-59 y	~~0.12~~				
H	0-19 y	0.076	0.126	0.417	0.033	0.141
I	20-39 y	0.090	0.716	0.155	0.071	0.058
J	40-59 y	0.077	0.318	0.435	0.200	0.046
Weights			0.261231	0.396737	0.211525	0.130507
Rank			2	1	3	4

3.2 KANO Mode Analysis – Users' Subjective Satisfaction and Objective Functional Requirements

A total of 25 users (28% male and 72% female) participated, with age groups in the ranges of 20–39 years old (56%), 40–59 years old (40%), and 60 years old and above (4%). All users had the experience of using eyedrops, and 8% of them knew of and used compliance aids. Refer to Table 3, the analysis of the three attributes showed that item I in the discrete analysis turned into items M in the continuous data.

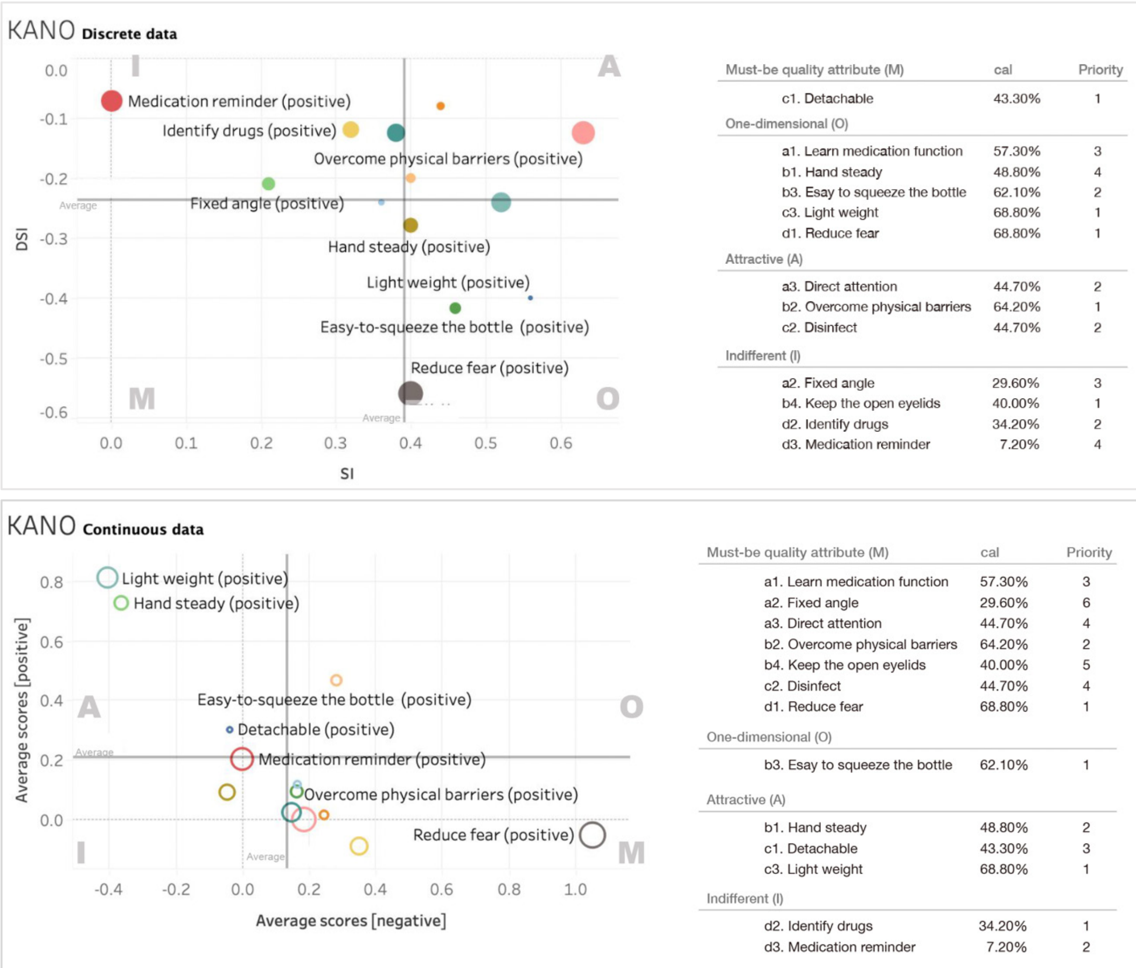
Table 3. Quality improvement matrix.

NO	functional purpose	Functional (SI)	Disfunctional (DSI)	Discrete data	Continuous data
				Category	Category
a1	Learn medication function	0.52	-0.24	O	M
a2	Fixed angle	0.21	-0.209	I	M
a3	Direct attention	0.44	-0.08	A	M
b1	Hand steady	0.4	-0.28	O	A
b2	Overcome physical barriers	0.63	-0.125	A	**M**
b3	Easy-to-squeeze the bottle	0.46	-0.417	O	O
b4	Keep the open eyelids	0.38	-0.125	I	**M**
C1	Detachable	0.36	-0.24	M	A
C2	Disinfect	0.4	-0.2	A	M
C3	Light weight	0.56	-0.4	O	A

d1	Reduce fear	0.4	-0.56	O	M
d2	Identify drugs	0.32	-0.12	I	I
d3	Medication reminder	0	-0.072	I	I

According to the results of the two quality improvement matrixes, the function items were discussed in the order of M > O > A > I > R. It was found that priority should be given to improving the aids in terms of being lightweight and reducing users' fear of medication. Furthermore, easy-to-squeeze bottles and keeping the eyelids open were identified as essential functions. The attractive factor that attracted the users fell into zone A.

Table 4. Compare Discrete analysis with Continuous analysis.



Each function information of the customer satisfaction coefficient is a single standard to measure the change in customer satisfaction, as show in Figure 5. A red (negative) number indicates the users were the most dissatisfied when this function was absent. A green (positive) number indicated they were satisfied when the function allowed them to learn to administer medicine and overcome physical barriers. Moreover, the users were satisfied when the aids not only were lightweight and small-sized but also relieved their fear of using eyedrops.

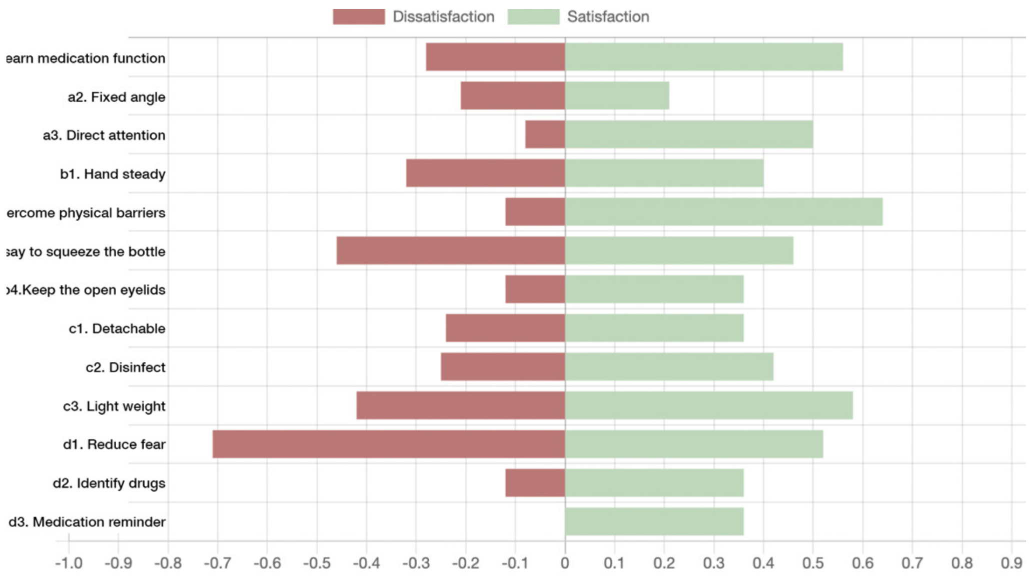


Figure 5. Customer satisfaction coefficients

3.3 Evaluation of Existing Aids

This study evaluated the existing aids reviewed in relevant studies as Table 5. It was found that these aids are universal, cheap, and compatible with the eyedrop bottles of people who use the aids at home (Brand et al., 2021; Zhu et al., 2021).

Table 5. Eyedrop compliance aids representative product.

Product	AutoDrop eye guide (Owen Mumford , Georgia)	AutoSqueeze bottle aid (Owen Mumford)	SimplyTouch eye drop applicator (SimplyTouch LLC, Florida)	Opticare (Cameron Graham Limited, Huddersfield, England)
Pictures				
Illustrate	Intended to guide the user's gaze away from the dropper. This helps to ensure that the nozzle is positioned directly over the eye so that drops are successful.	Ergonomic grip and extra leverage for easy bottle squeezing. This was designed to make eye drop treatment easier for patients with dexterity issues.	A plastic device in the shape of a small paddle. An eye drop is placed on the round edge of the applicator, which securely holds the drop. It also allows patients to instill drops without tilting their heads back and can be applied with or without glasses on. (Zhu et al., 2021)	The aids commercially available are compatible with most eye drop bottles. Enabling a better grip. The device is placed on the eye and the eyepiece holds the upper lid, which helps overcome the blinking reflex while administering eye drops. (Brand et al., 2021)

4 DISCUSSION

The Importance and Relevance of AHP and Kano Analysis to User Needs. According to the AHP analysis of the functional requirements of the aids, the experts attached great importance to the operation functions of the aids, and they believed that these aids should meet the primary needs of the users, such as keeping the eyelids open, not needing to raise the head, and being able to squeeze the bottle easily. Functions that allowed the users to operate the aids with one hand were preferred. In terms of objective functional requirements, the Kano analysis paid more attention to the trouble of squeezing the bottle and the requirements of being lightweight and having a small size. It also proposed that the attractive attributes should be having a learning function, overcome physical barriers, hand steadiness, and being able to be sterilized. In this study, the AHP experts pointed out that the first priority to be considered in terms of the basic functions of the aids should be fulfilling the users' expectations, while the Kano analysis indicated that the charm factor was the psychological function to the users.

A comparison was conducted between Table 4 and Figure 5 Customer Satisfaction Coefficients. It was found that lightweight and small-sized bottles and relieving the fear of using the medicine were both listed as the expectations and attractive factor, and both increased user satisfaction. Especially, the negative result (68.80%) for relief of fear showed that the users were most dissatisfied with the absence of this function. Among the attractive factors of the compliance aids, it was most important that medication be administered without needing to raise the head or the hand (64.20%). In this case, the problems for patients with physical disabilities could be solved (Winfield et al., 1990; Wisher, 1991). However, it was also acceptable if this function was not present (-0.12). The function allowing users to learn to administer medicine (57.30%) was also highly expected, especially in regards to knowledge of medication, which declines with age (Chiu; Hoevenaars et al., 2006). For the negative result in difficulties in squeezing the bottle (62.10%), the function of stabilizing the hand while administering the eyedrops (48.80%) should also be incorporated into future designs as difficulties in squeezing the bottle could have a negative impact on user compliance (Brand et al., 2021).

Results of Examining the Existing Aids. The decision-making priority of the AHP experts was operability over functionality. The AutoDrop and Opticare aids conformed to AHP analysis ranking 1, indicating that the existing aids actually satisfied the operability. Comparison with KANO results, existing aids found to lack the ability to reduce medication fear and learn medication. The Opticare is not light enough and the AutoDrop cannot assist in squeezing the bottle. It is worth mentioning that according to the study results of Zhu and Brand et al., after six weeks of using AutoDrop, the users' favorability dropped to 60%, but their willingness to further use the aids remained at 90% (Zhu et al., 2021). In addition, drug wastage occurred with AutoDrop, while Opticare enhance the probability that the users could operate it independently (Brand et al., 2021). Further in-depth studies should focus on the influence factors causing the decrease in favorability of the users.

The preliminary study concluded that eyedrop aid design should pay attention to both the physical and the psychological needs of users, presumably functional differences due to different user groups, and affect the user's perceptual feedback. Whether the appealing factors of the aids can improve the compliance of eyedrop users should continue to be observed in future studies.

This study compares discrete and continuous data in KANO and finds significant differences in demand items between the two Quality improvement matrix analyses. The Indifferent item in KANO's Discrete Analysis corresponds to the necessary operational requirement elements of AHP, and it is possible to review the functional necessity of existing aids. In this discussion, we found the possibility of developing KANO demand models corresponding to different user groups. The results of this study can provide reference and application for the follow-up research on eyedrop adherence aids design and KANO model changes.

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ASSESSMENT OF CUSTOMER EMOTIONAL STATES WHILE INTERACTING WITH DIGITAL TOUCHPOINTS OF E-COMMERCE PRODUCT PAGES: A KANSEI ENGINEERING APPROACH

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ABSTRACT

The study proposes a method for the assessment of e-shop product pages (PPs) through individual assessments of the touchpoints (TPs) customers interact with while using a PP (e.g., product title, main image, image gallery, Buy Box, rating/reviews number, product description, specifications, cross sales/recommended products, video, and product warnings) rather than an assessment of the product page as a whole. A specific Kansei list is created, customer preferences are collected, and touchpoints can be classified as positive, neutral, or negative (pain points). The assessment method was applied to the assessment of PPs of craft beer e-retailers. Once pain points were identified, two distinct types of TPs among them were individually analyzed (one visual, the Image gallery, and one textual, the Product description.) In both cases, a set of PPs were employed as stimuli and design elements that were deemed preferable by the customers were identified through Partial Least Squares analysis. The results provided valuable recommendations to web designers, content creators, and retailers for improving their PP content by taking into consideration the customers' emotional states and preferences.

Keywords: *product page, Kansei engineering, Kansei words, assessment, design*

1 INTRODUCTION

A product page (PP) of an online shop is where the customers get all their information about the product (e.g., specifications, price, video presentation). Almost all users go through a PP

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before making an online purchase and it is often on the PP that users decide whether or not they want to buy the product. PP design is therefore very important for offering a good e-commerce experience that can lead to a product sale.

The sequence of customer actions while interacting with a PP is often presented in the service marketing/service design literature by a customer journey map. A customer journey map is basically a visual timeline that graphically documents the sequence of service engagements and interactions, showing multiple touchpoints (TPs) and channels throughout. At every step in this sequence of service engagements and interactions, journey maps also present the concomitant customer emotions and perceptions. The customers' emotional states under such conditions are often described with general adjectives like very happy to very unhappy, positive to neutral to negative, or very satisfied to very unsatisfied. In the case of a PP, TPs are well-defined sections of the page with specific and relevant content with which the customer interacts along the purchasing journey. For example, the TP Buy Box refers to the section with the white box on the right side of the PP with the button “Add to Cart”, availability information, price information, etc. Some TPs are textual (e.g., Product Description, Specifications), while others visual (e.g., Main Image, Image Gallery), audiovisual (Video), or textual/visual (infographics).

It is therefore necessary to understand what and how the information about a product should be displayed on each TP as well as all features that are needed to generate good and accurate information and add value to the product. It is also necessary to understand how all this information can (be designed to) appeal to the consumer's senses and emotions in ways that trigger a change in the consumer's mind and arouse motives for consumption (Mendoza & Marasinghe, 2013; Mimura et al, 2020). In this vein, Kansei Engineering can be applied to TP design to show what perceptions and emotions are evoked by different types of information content and functional features, reveal those that best perform according to the customer's emotional preferences, and draw design recommendations. The positive effect of implementing emotional value from the user's perspective in the design of a product by applying Kansei Engineering (KE) has been well recognized. The KE methodology has also been previously applied to e-commerce by several design studies (Kosaka & Shiizuka, 2009; Papantonopoulos & Karasavova, 2021; Qu, 2015; Shiizuka, 2013; Wang et al, 2010).

This study has the following objectives: (a) to create a Kansei scale for the assessment of the PP main touchpoints; (b) to identify the TPs of the PP that evoke a negative emotional feeling in the customers by having them assessed with the created Kansei scale; and (c) to discover the preferable by the customer's design elements that can be used as recommendations for the improvement of problematic TPs, thereby enhancing the e-commerce experience.

2 METHODOLOGY

2.1 Selection of representative sample of product pages

The suggested methodology is shown by being applied to the assessment of the TPs of craft beer PPs. The beer PPs of interest had the following inclusion characteristics:

Table 1. Design matrix of beer PPs (T: textual, V: visual, TV: textual-visual, AV: audiovisual)

Touchpoint	Class	Categories
Product title (PT)	T	fully-featured / not fully-featured
Main image (MI)	V	front image of beer bottle / beer bottle and a glass with beer / white background / non white background
Image gallery (IG)	V	yes / no
Rating/reviews number (RRN)	TV	yes / no
Buy Box (BB)	TV	detailed / limited
Product description (PD)	T	detailed / summary / limited
Specifications (SPE)	T	detailed / limited / none
Cross sales/recommended products (CS)	TV	more than one row / one row / none
Video (V)	AV	yes / no
Product warnings (PW)	T or V	yes / no

were selected from specialized online retailers of primary craft beer; newly updated in 2022; geographically dispersed; type of beer: barrel-aged beer; background of the page: white; language: translatable into Greek. Brewery e-shops PPs, PPs from blogs, Greek online retailers, and Greek beer PPs were excluded (the last 2 for eliminating possible preferable ratings by Greek evaluators.) An initial sample of 66 PPs of bottled beer was collected by including the first 30 links to e-shops retrieved from Google.com, Bing.com, and Yahoo.com by the search query "beer online shopping" and barrel aged or stout. PPs were divided into main sections or touchpoints which are equivalent to the term "items" in KE. A dissimilarity matrix was created based on morphological analysis. This collection of PPs represents 10 TPs and 25 categories (Table 1.) TPs were classified as textual, visual, audiovisual, or textual/visual. The TP Product description was classified based on word count as detailed, limited, and summary. The TP Product title was classified as fully-featured when it included all 5 elements: name, brand, beer type, volume, and alcohol content. A cluster analysis for the 66 PPs was performed to: (a) select representative samples with different designs for each TP to be used as stimuli for the creation of the Kansei scale, and, (b) select PP samples representing the domain for the analysis of the current state of beer PP design.

2.2 Extraction of Kansei words

Suitable adjectives and phrases for each TP were initially collected as candidates for KWs by the use of the automated tool Sketch Engine by Lexical Computing CZ s.r.o. with Corpus 2020 (www.sketchengine.eu.) Each of the 10 touchpoint names/ phrases (e.g., Product title, Product description) was used as the "Key Word in Context" searched in all domains. Although there is a possibility to form a representative sample based on the frequency of use of each adjective for each TP name (phrase), low-frequency adjectives often communicate important qualities. For example, "three-dimensional" is a low-frequency adjective yet it refers to a new way of displaying the product for the TP Main image which is the central and dominant product image first seen on the PP. Next, the initial number of adjectives was reduced manually after

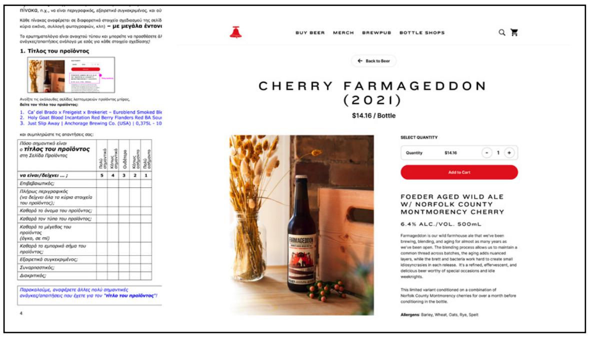

Figure 1. Snapshot of the monitor displaying the arrangement of windows during the assessment process: window with the questionnaire file (L) and open PP (R)

eliminating those describing the following properties: physical (e.g., long, short); technical (e.g., high-resolution), proper (e.g., European), numerical (e.g., several, fewer), superlative condition (e.g., amazing), and degree (e.g., best, most); and those that were synonymous, antonymous, or irrelevant to the type of the TP of interest. Some adjectives were related to the customer's emotional state, e.g., relief, aesthetic appreciation, while others were related to the customer's perspective (e.g., related to sensitive insight). Finally, the adjectives were grouped by the affinity diagram method and reduced to 13-15 for each TP.

2.3 Survey for the creation of the Kansei scale

A survey was performed for the creation of the Kansei scale by selecting the adjectives expressing the most important qualities of each TP. The survey was based on an online questionnaire that included: (a) a description of the purpose of the survey and guidelines requesting from the participant to perform the role of customer intending to purchase craft beer online; (b) demographic questions; and (c) questions on the participant's online shopping frequency, experience, and shopping behavior. The evaluation group consisted of 13 male participants 22-24 year old, found to be very suitable as latest studies have shown that younger people (21-25 year old) and tech-knowledgeable customers have become the brewing industry's key targeted demographic groups. One of the evaluators was identified as an "impulsive buyer" who starts the search and finishes by purchasing during the PP observation period; one "only explores the online environment without the intention to purchase or will purchase offline"; the rest pointed out that they "momentarily explore the alternatives or they are close to the decision, but their purchase happens outside the period of observation". In this context, the evaluators were considered experienced with online researching, discovering, and shopping products.

The questionnaire included snapshots of the TPs for reassuring the participant that he was evaluating the correct TP. Participants were asked to click on the URL address to launch and interact directly with the PP. The reason to use real PP was to capture the customer's perception of the different PP touchpoints within their natural digital environment and "clutter" of elements. Participants were instructed to arrange to MS Word file with the questionnaire on the left and the window of the PP on the right as shown in Figure 1.

To rate the importance of adjectives for each TP, participants were asked to open 3 to 5 PPs which had been selected for featuring a variety of designs of that specific TP; translate each page into Greek; get familiar with the PP design by performing several tasks on the TP in question. Participants were then asked to rate how important each adjective was for them for that TP on a 5-point unipolar SD scale from 5 ("very important") to 1 ("very unimportant"), as well as write any other needs they may considered important. Simple Correspondence Analysis of the data from the survey was used for the reduction of the KWs for each of the 10 TPs to the final list by using Minitab®20 Statistical Software (Minitab, LLC, USA). The Kansei scale was constructed by KWs for which there was high agreement among the participants in identifying the specific adjectives as “very important” and “somehow important”. As a result, the number of KWs associated with each TP varied expressing extent of the agreement among the participants. If the customers suggested additional adjectives for of TP during the open-ended survey, they were incorporated into the scale of that TP.

2.4 Assessment of the TPs of PP samples by the created Kansei scale

Next, the TPs of selected PP samples were assessed by the created Kansei scale containing KWs for each TP. First, a morphological analysis was performed to determine the presence of the design categories and sub-categories of Table 1 in the TPs of the 66 PP samples. Then a cluster analysis of the PP samples was performed and the samples were clustered into 12 clusters and one page was selected as the representative sample from each cluster. Finally, these representative PPs were assessed by the created Kansei scale containing KWs for each TP.

The evaluation employed a questionnaire with the created Kansei scale and a 5-point unipolar SD scale ranging from 5 ("I totally agree that this KW expresses how I feel about this TP") to 1 ("I totally disagree that this KW expresses how I feel about this TP"), the same procedure to the one described in Section 2.3. Eight participants, who did not participate in the first survey, were selected for the evaluation task. The average values from the Kansei ratings for each KW were calculated for each TP and, accordingly, TPs were classified as positive (if the average value was more than 2.55), neutral (if the average value was between 2.5±0.05), pain points (if the average value was less than 2.45), or "zero" when the TP was absent in a particular PP.

2.5 Formulation of recommendations for improving TPs classified as pain points

Recommendations for improving the design of the TPs identified as pain points according to customer preferences were formulated by the use of Partial Least Squares (PLS) analysis. Examples of two pain points are given here: one visual TP, the Image gallery (IG), and one textual TP, the Product description (PD). In each case, a set of PPs with different designs of the TP of interest was used as stimuli. Since the variety of IG designs in the collection of 66 PP samples of specialized beer shops was very limited, it became necessary to collect samples from outside the domain, namely from other kind of beer PPs or even for products with similar packaging, e.g., wine. The IGs of seven beer PPs and one champagne PP with different designs were used as stimuli for the extraction of the design elements most preferred by the customers.

Table 2. Design matrix for the visual TP Image gallery and textual TP Product description

Touchpoint "Image gallery"		Touchpoint "Product description"	
Category	**Sub-category**	**Category**	**Sub-category**
Layout	Vertical, Horizontal	Hard to read sentences	None, ≥ 1
Image of the paper label	Yes, No	Number of adjectives	Up to 11, 20-25
Image of ingredients	Yes, No	Average sentence length, words	11-13, 19-22, 30-40
Image of pairing food	Yes, No	Word count	30-65, 125-160, 230-310
Beer in a glass	Yes, No	Reading time, secs	7 secs, 13-15 secs, 25-35 secs, 60-75 secs
Image number	Three, Four, Five, Seven	Awards information	Yes, No
Inspirational image	Yes, No	Predominant tone of the text	No tone detected, Analytical & confident (AC), Joyful, analytical & confident (JAC), Joyful (J), Joyful & analytical (JC)
Type of the manipulation tool	No manipulation/static, 360° all around, Magnifying glass, Zoom in		
Image in the brewery	Yes, No		

An input matrix for the PLS analysis was constructed for the touchpoint IG by a more detailed morphological analysis of 9 different IGs, representing 9 categories and 22 subcategories (Table 2). A similar matrix was constructed for the TP Product description by a more detailed morphological analysis of 10 PPs with different PDs, representing 7 categories and 21 subcategories selected by cluster analysis of the initial collection of beer PP (there were no samples from outside the initial PP collection) (Table 2.) The evaluation was performed by eight male participants (20-25 years old) who did not participate in the previous two surveys. The procedure was the same as the one described in Section 2.3 with the difference that, once on the page, the participants were evaluating only the IG of the page with the specific KWs for IG. Similarly the PDs with different text characteristics were evaluated. The categories "reading time" and "hard to read sentences" were measured by Hemingway Editor (https://hemingwayapp.com); "word count", "number of adjectives", and "average sentence length" were determined by the web-based language analysis tool "Text Inspector" by Weblingua Ltd. The "predominant tone of the text" of the PD was identified as either having none or joyful, analytical, confident, or combinations of them by IBM Tone Analyzer.

3 RESULTS

3.1 Analysis of the current beer PP design

Cluster analysis of the PPs of 66 beer e-shops with different templates types were used for the examination of the current state of beer PP design (Figure 2a.) The clustering was performed by the use of more general categories shown in Table 1. Data from the grand centroid showed that about 90% of all analyzed PPs do not have video, a fully-featured Product title, or product warnings. About 82% of the PPs do not have an image gallery, meaning that they present the product only with one main

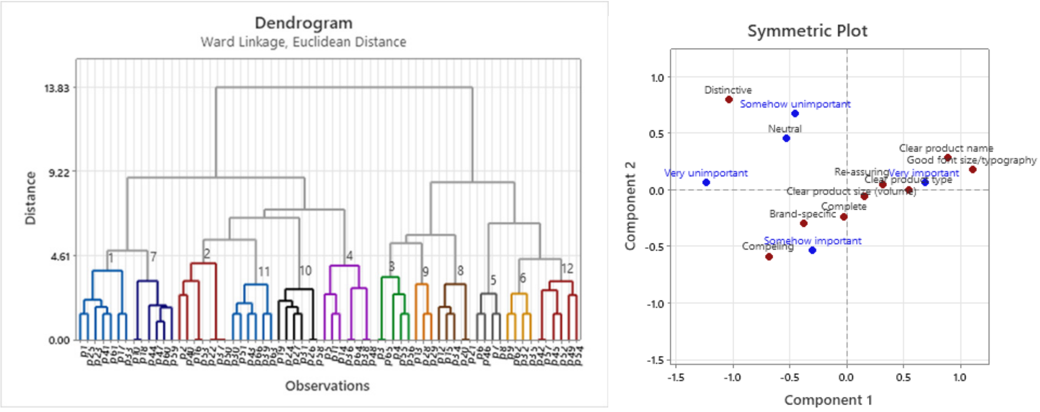

Figure 2. (a) Dendrogram of the 66 PPs profiles grouped into 12 clusters;
(b) Correspondence analysis map generated from customer ratings for the TP Product title.
The two components represent 86.17% inertia. The 9 adjectives are depicted in black font with a red symbol, and the 5 SD-scale attributes are depicted in blue font with a blue symbol

image of the beer bottle. Furthermore, 73% of the pages have limited information in the Buy Box, and 65% of the pages do not display a Rating/reviews number at the top of the page. About 64% have a limited number of titles under Specifications and 44%have short texts describing the product (by number of words). About 80% from the PPs include the TP Cross sales/recommended products under the Product description.

3.2 Selection of Kansei words

A large number of adjectives were extracted which reflect recent vocabulary describing different qualities of each TP for the creation of TP-tailored evaluation scales. TPs such as Product description, Product title, and Product image were found to have very rich descriptions with adjectives (e.g., 120 for Product description), while others had moderate descriptions (e.g., 35-40 for Cross sales and Buy Box). Simple Correspondence Analysis of the data from the survey was used for the final selection of the KWs for each TP (Table 3). An example of the results of the customer ratings for the TP Product title is shown in Figure 2b. The scale includes those Kansei words for which there was a tendency of a high number participants identifying the specific adjectives as “very important” and “somehow important”. If additional adjectives were suggested (e.g., Awards information) by the customers during the open-ended survey, they were incorporated into the scale for the TP.

3.3 Assessment of the customers' emotional impressions while interacting with real PP touchpoints

The assessment of the customers' emotional impressions while interacting with the TPs of 12 real PPs representing the domain was performed by group of customers and the created Kansei scale. Figure 3 shows a graphical representation of the assessment results of one PP which is easy to interpret. The type of the TPs for each PP was identified as positive (with an average value of the Kansei ratings above 2.55), neutral (with an average value of 2.5±0.05), negative (with average values of bellow 2.45), or zero (if the TP is absent from the PP design.) Two pain points were determined according to the customers' Kansei ratings of the page (a visual TP, Image gallery, and a textual TP, Product description) for which further improvements need to be made.

Table 3. Kansei words used in the Kansei scale for TP assessment

	Touchpoint	Kansei words
1	Product title (PT)	Re-assuring, Brand-specific, Clear product name, Clear product type, Clear product size (volume), Compelling, Good typography, Complete
2	Main image (MI)	Attractive, Easy to manipulate, Enjoyable, Special, Tasty, Desired, Revealing, Readable, Memorable
3	Image gallery (IG)	Visually rich, Easy to manipulate, Creative, Attractive, Exciting, Revealing, Memorable, Readable
4	Buy Box (BB)	Fully informative, Trustful, Easy to understand, Easy to locate, Useful, Optimized, Effortless, Transparent
5	Rating/Reviews number (RRN)	Fully-featured, Easy to locate, Good graphical presentation, Latest, Trustful, Good size
6	Product description (PD)	Easy to understand, Enjoyable, Complete, Memorable, Convincing, Attractive, Delicious, Eloquent, Good awards information
7	Specifications (SPE)	Clear, Complete, Easy to understand, Useful, Precise, Easy to find, Interesting
8	Video (V)	Entertaining, Good duration, Effective, Convincing, Memorable, Good Quality, Easy to find, Impressive, Sensual, Promotional
9	Cross sales/ recommended products (CS)	Easy to locate, Attractive, Placed correctly, Good image size, Good number
10	Product warnings (PW)	Easy to find, Understandable, Impactful, Direct, Warning, Ergonomic (all the words were found "very important")

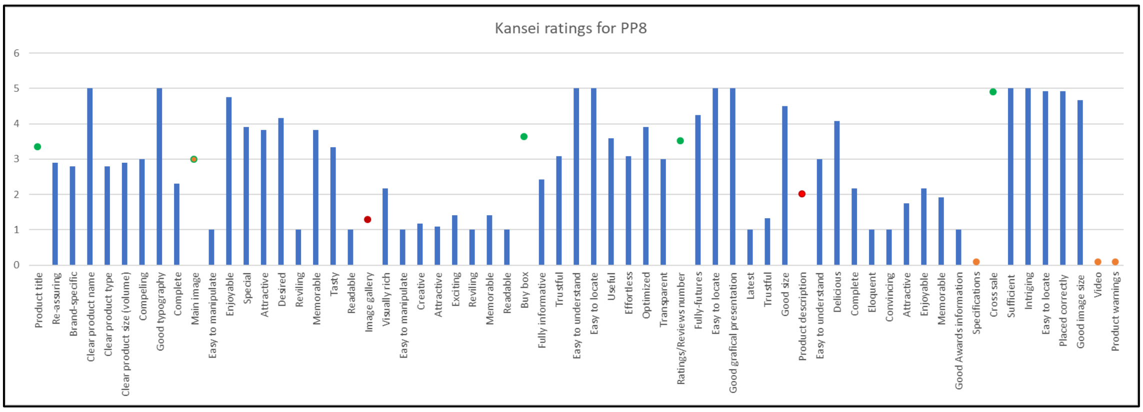

Figure 3. Graphical representation of assessment results of a PP by the created Kansei scale. Green dots refer to positive touchpoints, red to pain points, and orange to absent TPs

3.3.1 Recommendations for improving of the design of the TP Image gallery

The importance and usefulness of displaying different viewing angles of the product so that the visitor can visually gather additional features about the product is well understood. Particularly, when users browse to explore the product, the image gallery is one of the first content elements that most users will explore to quickly retrieve information. From the analysis of the initial collection of 66 beer PPs, it was found that 82% had no Image gallery, probably because standard templates are used or because comparative analysis is carried out by the use of the beer PPs of similar e-retailers. The few available galleries were mainly comprised of 2-3 images of different sides of the beer bottle (front, back, side, or even top view.) This however is probably not very effective for bringing the product close to the customers in order to compensate that the product can not be touched. A statistically significant difference was found between the evaluators' emotional responses while interacting with different IGs as determined by one-way ANOVA with Tukey post-hoc values of $F(8,71) = 8.9$ and $p<0.001$; 2 types of IGs were determined as favorites and 2 samples as the least preferable. The results from PLS analysis showed that including a gallery and enriching its content with inspirational images, images from the brewery, pairing foods, and desirable (cold or not cold) beer in a glass was found to have a higher positive effect (Figure 4.) The most preferable manipulation tools were the magnifying glass and the 360° all around rotation of the bottle with control over to stop and zoom in. The display of an image of the whole paper label was also found beneficial probably because it is much easier to read the label's original information. Another possible reason for this is the fact that beer labels are very graphically impressive, creative, and artistic.

3.3.2 Recommendations for improving of the design of the TP Product description

The results showed what design elements have a positive effect on the customers Kansei toward the TP Product description (Figure 4). On one side, the product description accurately describes what the product is about and its beneficial values using the right language and the right tone, affecting attention and completeness and even educating. On another side, the product description needs to include important keywords so that the page can rank well in search engine rankings. In the initial collection of beer PPs, it was determined that 44 % of the PPs had limited Product descriptions, aiming at giving a strong focus, usually only on the beer taste by several words. The limited PD often resembled the textual information on the physical label or its extended version. Only 24 % of the analyzed PPs had a detailed product description. A variety of predominant tones of the description text were detected. The most preferable was found to be the one being "joyful, analytical, and confident", meaning that there were joyful sentences, e.g., "*We are happy to bring this drink we have been working on for some time, the result of friendship, exchange and collaboration, finally in your glasses!*", analytical ones, e.g., "*All ingredients (apart from the citrus) were harvested within 33 miles of the brewery*", and confident ones, e.g., "*This beer is an exceptional drink that's compatible with all types of food, especially tacos, fajitas, burritos, and seafood*". This aims at giving a much broader overview of the product, from the fermentation process through the idea behind the recipe, the aging time, pairing food, barrel type, and many more in order to impress and convince the customer. Such descriptions educate, explain, and justify the high price of craft beer. As with other TPs, a balance should be achieved between the length of the sentences, the tone of the sentences, and the avoidance of unclear terms, because facts, if over-explained, may have the opposite effect. Unknown terms can make the visitor do extra searches and leave the page. Skilled writers create exceptional product descriptions and lately a copyright symbol can be observed at the end of some product descriptions. It is interesting to further study the extent of control which the company producing the product has over the TPs related to the presentation of their product on e-retail shop product pages. A statistically significant difference was found between the evaluators' emotional responses in the case of PDs with values of F (9,79) = 25.61 and p<0.001; 1 PD stood out as favorite and 2 samples were the least preferable.

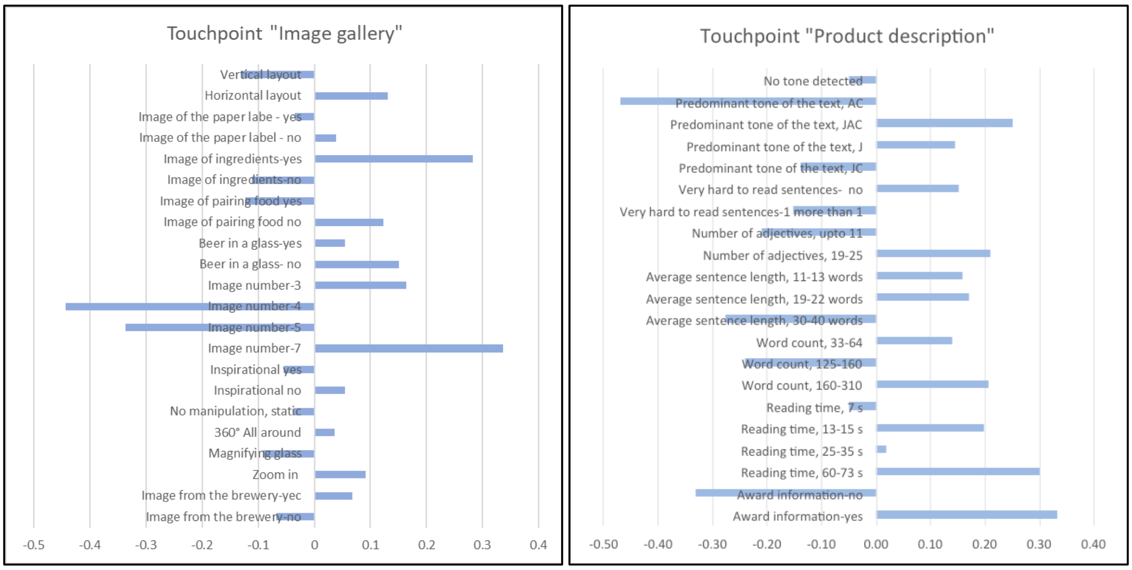

Figure 4. PLS coefficient plots with average values of the Kansei ratings for all KWs

4 CONCLUSIONS

A relatively big collection of beer PPs was used to analyze the current state of beer PP design of specialized e-retailers. A Kansei scale for an assessment of the PPs' main touchpoints was created by applying the KE approach. The scale was used to identify which TPs were positive, neutral, or pain points from a customer perspective. Once the pain points were identified, the design elements deemed preferable by the customers were classified into two types of TPs: one visual, the "Image gallery", and one textual, the "Product description." The findings provide valuable recommendations for web-designers, content creators, retailers and brands for making improvements in the PP content by interpreting and implementing how customers feel. The study will be extended across other products by adapting the KWs evaluating each product's "sensory information" according to its specific characteristics (e.g., assessing the sense of touch.)

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ATTRACTIVE FACTORS OF ENVIRONMENT-FRIENDLY DAILY NECESSITIES

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ABSTRACT

Going green is increasingly important to the market. The present research indicates that functional and emotional factors can achieve the best-perceived effects when choosing an environment-friendly product. Therefore, this study aims to gather these attractive factors from high-involvement groups by using Miryoku engineering. First, we capture the factors through the Evaluation Grid Method and use Quantification Theory Type I for quantitative analysis. Then, generalize four feelings about environment-friendly products, namely "Assured," "Responsible," "Safe," and "Comfortable." We also define a linear dimension with short-, normal-, and far-sight for locating attractive factors and feelings. The result shows that high-involvement groups are more concerned about the long-term impacts of "Responsible" feelings, while low-involvement groups focus more on the obvious benefits of "Responsible" and "Safe" feelings. Moreover, the emphasis on natural ingredients is necessary for achieving "Assured" and "Comfortable" feelings for both the high- and low-involvement groups.

Keywords: *Environment-Friendly Product, Attractive Factors, Evaluation Grid Method, Quantification Theory Type I, Miryoku Engineering*

1 INTRODUCTION

The "Going Green" business is gaining importance with the increase in the environmental knowledge of the consumers (Phuah, Ow, Sandhu, & Kassim, 2018). Consumers believe that active green consumption can induce enterprises to make their production and sales more environmentally friendly. Therefore, the development of environment-friendly products is

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increasing in the industry (Abele, Anderl, & Birkhofer, 2005). Many companies become more "green" to attract and keep consumers, especially in manufacturing and marketing (Vandermerwe & Oliff, 1990). Currently, more and more environment-friendly products are produced without chemical substances (Song, Meysam, & Shaheen, 2016), that can be recycled and will not cause pollution or natural resource depletion (Shamdasani, Chon-Lin, & Richmond, 1993).

In addition to the "green" changes in products, the purchase intention of consumers will also be affected by multiple factors. Among these, emotions play an important role in predicting human behavior. It can indirectly affect the strength or evaluation of our beliefs, thereby influencing our intention and behavior (Ajzen, 2011). Negative emotions may be a barrier to human environmental action, whereas positive emotions may increase environmental performance (Carrus, Passafaro, & Bonnes, 2008). To realize the goal of green marketing, we need to know the emotion type that influences green actions (Kao & Du, 2020), because the rational benefits of green consumption are insufficient for the consumers to adopt green purchasing behavior (Koenig-Lewis, Palmer, Dermody, & Urbye, 2014). For an environment-friendly product, functional and emotional factors are considered complementary, because combining functional strategies with emotional benefits can achieve the highest perceptual effects (Hartmann, Apaolaza Ibáñez, & Forcada Sainz, 2005).

Therefore, this study aims to explore the positive emotional factors of environment-friendly products through interviews of high-involvement groups. These attractive factors will be captured by Miryoku Engineering, as well as using the Evaluation Grid Method to build the connection between functional and emotional factors. The results can help manufacturers develop new products or systems that can enhance green purchasing.

2 RESEARCH FRAMEWORK

The research framework is shown in Figure 1. In this study, we will use Miryoku engineering as the main research approach to help the development of attractive products or services. There have several qualitative and quantitative methods under Miryoku engineering. In this study, we will use the Evaluation Grid Method (EGM) to reveal the connection between functional and emotional factors, and use the Quantification Theory Type I to analyze the data.

In the first part, this study searched for the environment-friendly products approved by the Green Mark on Taiwan's Green-Living Information Platform. In Taiwan, the Green Mark was launched in 1992 to encourage manufacturers to produce fewer damaged products, and consumers may be able to select recyclable, resource-saving, low-polluting products. The Green Mark products were distinguished into several categories, including cleaning products, home appliances, office supplies, monitors, and furniture. Due to the variety of environment-friendly products in the market, this study was only limited to environment-friendly cleaning products, including dishwashing detergent, hand soap, and toilet cleaner. We selected 30 products by focus group and made them into 30 sample cards. These cards were printed with a color image, product name, and simple product descriptions without any price information to eliminate the price factor.

The second part of this study captured the attractive factors through in-depth interviews with nine consumers who had purchased at least six of the products in the samples. The most critical five samples were chosen for the comparison ranking. In this stage, EGM was used to record the information provided by the participants. EGM was introduced by the Japanese scholars Junichiro Sanui and Masao Inui (Sanui, 1986), who modified the repertory grid technique from George Kelly (Kelly, 1955). The participants were asked to evaluate the samples based on "strengths and weaknesses" and "likes and dislikes." During the interview, the researcher focused on the questions which progressed from "what specific conditions" to satisfy "what kinds of attractive features" to achieve "what kinds of feelings." This laddering framework revealed functional and emotional factors to be integrated into a systemic correlation.

In the third part, this study transformed the EGM results into a Quantification Theory Type I questionnaire. In this phase, we investigated the high- and low-involvement groups for potential differences, the high-involvement groups were defined that having bought at least four of the products in the samples. Then, the most important attractive factors were generalized toward every abstract feeling in two groups. According to the Quantification Theory Type I, we can notice the real factors that consumers care about.

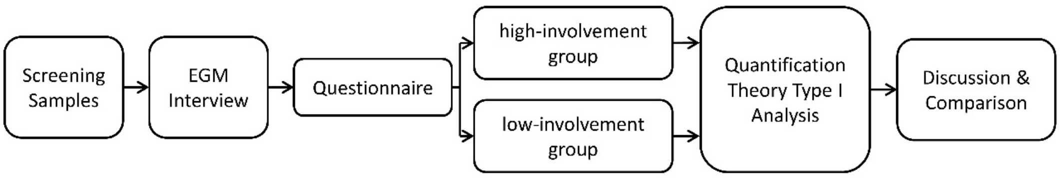

Figure 1. Research framework

3 RESULTS OF THE EGM INTERVIEWS

Based on the results of the in-depth interviews with the nine consumers, nine personal EGM charts were created. The abstract feelings, original evaluations, and concrete conditions had been laddered sequentially from left to right, using solid lines to indicate the relationship among different factors. Each path showed one concept; for instance, "more natural ingredients (concrete conditions)" can be "less irritating to skin (original evaluation)" to achieve the "assured (abstract)" feeling. After the integration of the nine EGM charts, the most mentioned abstract feelings were determined, which included Assured, Responsible, Safe, and Comfortable.

3.1 Assured—EGM Charts

Figure 2 shows the structure of attractive factors toward the "Assured" feeling. The features to create the "Assured" feeling were as follows:

1. Fewer chemicals added: Avoid using a fluorescent agent and bleaching agent, and add more natural ingredients to replace chemical ingredients, which can make the product smell better, cause less harm to the skin, and easy to wash out.
2. No corrosive chemicals added: The absence of strong acids and alkalis in cleaning liquids provides these products with a “Non-toxic” image and leads to the “Assured” feeling.

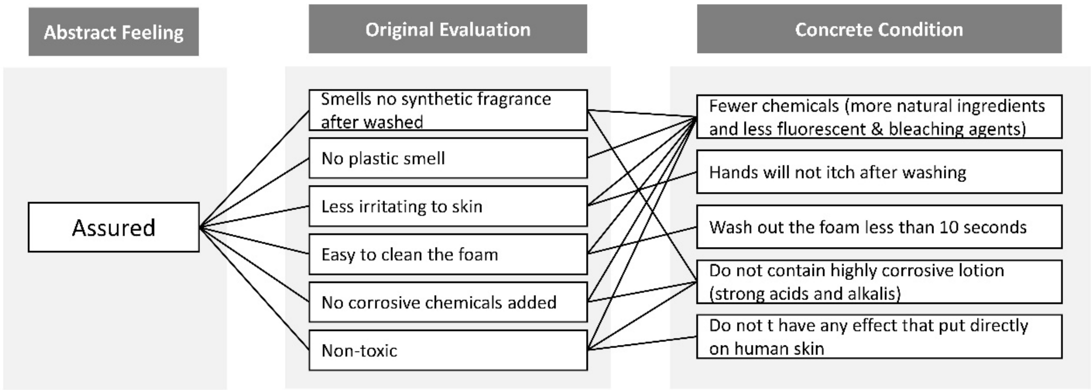

Figure 2. “Assured” EGM chart

3.2 Responsible—EGM Charts

Figure 3 shows the structure of attractive factors toward the “Responsible” feeling. The features to create the “Responsible” feeling were as follows:

1. Fewer chemicals added: Use more natural ingredients to replace chemical ingredients, which can reduce harmful gas production, and avoid polluting the water resource.
2. No corrosive chemicals added: The absence of strong acids in cleaning liquids will help not to kill the beneficial bacteria in the septic tank when washing the toilet.
3. Replace plastic packaging: Replace the plastic packaging with biodegradable materials or use recycled pulp on the packaging to reduce deforestation. A simple packaging design will also prevent lasting garbage and avoid the generation of plastic particles.

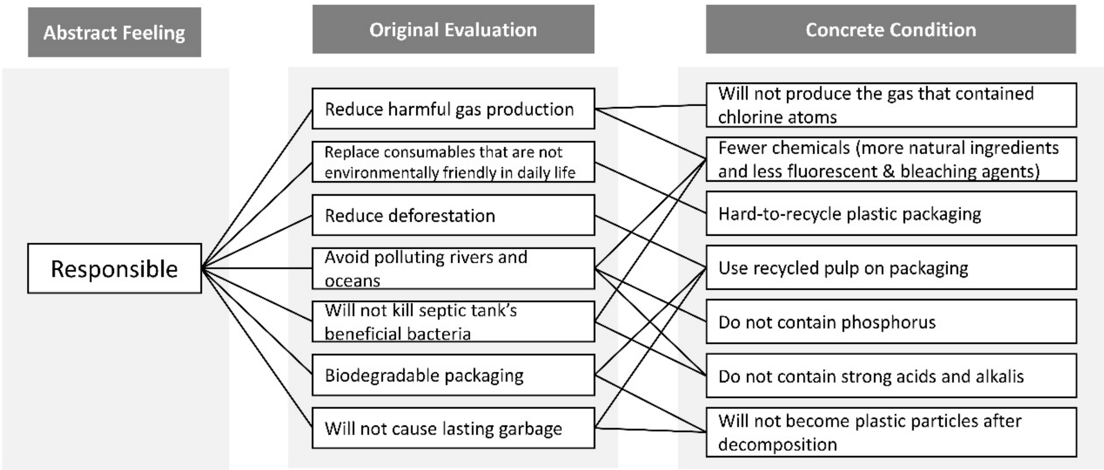

Figure 3. "Responsible" EGM chart

3.3 Safe—EGM Charts

Figure 4 shows the attractive factors' structure toward the "Safe" feeling. The features to create the "Safe" feeling were to use more natural ingredients and fewer chemicals to create a non-toxic product, and the cleaning product should be harmless when touching the user's skin.

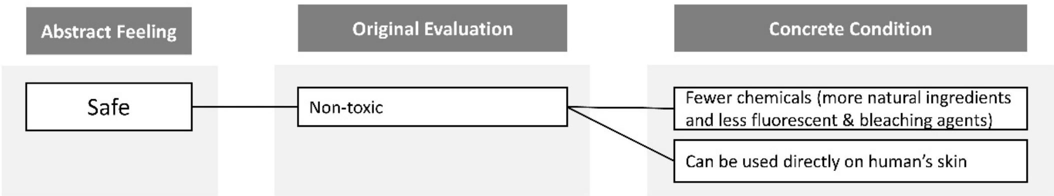

Figure 4. "Safe" EGM chart

3.4 Comfortable—EGM Charts

Figure 5 shows the structure of attractive factors toward the "Comfortable" feeling. The feature to achieve the "Comfortable" feeling was to create "good smelling." We can add some natural ingredients such as tree bark to provide a good-smelling experience for the users.

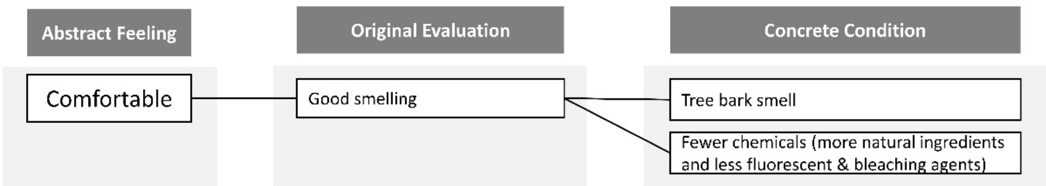

Figure 5. "Comfortable" EGM chart

4 RESULTS OF THE QUANTIFICATION THEORY TYPE I

In this phase, we transformed the EGM results into a questionnaire. The abstract of the original evaluation was transformed into the external reference, the abstract feeling became the title, the original evaluation became the item, and the concrete condition became the category. This study received 32 questionnaire responses from high-involvement groups and 117 questionnaire responses from low-involvement groups. The results of the Quantification

Theory Type I are presented in Table 1. We chose the highest coefficient of partial correlation in every feeling, and the data indicated the weight value of different feelings. The title "R" represented the multiple correlation coefficients, and "R^2" represented the coefficient of determination.

Table 1. Abstract of the result of Quantification Theory Type I

Abstract feeling	Original evaluation (Item)	Concrete condition (Category)	Category score	Coefficient of partial correlation	R	R^2
Assured (High involvement)	Smells no synthetic fragrance after washed	Do not contain highly corrosive lotion (strong acids and alkalis)	0.10	0.46	0.57**	0.33
Assured (Low involvement)	Smells no synthetic fragrance after washed	Do not contain highly corrosive lotion (strong acids and alkalis)	0.18	0.37	0.45**	0.20
Responsible (High involvement)	Will not kill septic tank's beneficial bacteria	Do not contain strong acids and alkalis	0.47	0.53	0.60**	0.36
Responsible (Low involvement)	Replace consumables that are not environmentally friendly in daily life	Hard-to-recycle plastic packaging	0.08	0.22	0.24*	0.06
Safe (High involvement)	Non-toxic	Fewer chemicals (More natural ingredients & less fluorescent agent & bleaching agent)	0.20	0.21	0.21*	0.05
Safe (Low involvement)	Non-toxic	Can be used directly on human's skin	0.43	0.31	0.31*	0.10
Comfortable (High involvement)	Good smelling	Fewer chemicals (more natural ingredients and less fluorescent & bleaching agents)	0.47	0.13	0.68**	0.46
Comfortable (Low involvement)	Good smelling	Fewer chemicals (more natural ingredients and less fluorescent & bleaching agents)	0.29	0.33	0.38*	0.15

Note. *. correlated, **. strongly correlated, ***. very strongly correlated

Both high-involvement and low-involvement groups in the "Assured" feeling believed that "smells no synthetic fragrance after washed" was the most important factor to create the "Assured" feeling. Then, the results of the "Responsible" feeling showed that high-involvement groups were more concerned about the further process after the product had been used; for instance, they considered whether the cleaning liquid killed the beneficial bacteria in the septic tank or not. In contrast, low-involvement groups focused more on the use of plastic packaging in daily life. For the “Safe” feeling, High-involvement groups were more concerned about the ingredient issue, while low-involvement groups were more concerned about using the product directly on the skin. Finally, both the high- and low-involvement groups in the “Comfortable” feeling considered that weaker chemical smells led to a better user experience.

5 DISCUSSION

First, the factors presented in the two main feelings, “Assured” and “Responsible,” are very different. The original evaluations in the “Assured” EGM chart are mainly focused on the cleaning process, experts presented more on user experience using their five senses and the phenomenon caused by the product. However, the original evaluations in the “Responsible” EGM chart focus more on the packaging, with more concern for the packaging material and whether it causes lasting waste or not.

According to the results of the Quantification Theory Type I analysis, we define the attractive factors into three aspects, short-sight, normal-sight, and far-sight factors. These three aspects are in the same linear dimension as Figure 6. The short-sight factors considered the short-term benefits; for instance, the packaging materials or whether the cleaning products will harm our skin or not. These factors can create “Responsible” and “Safe” feelings to attract low-involvement groups. The normal-sight is a transition zone between the short and the far one. In this study, we define the ingredients of environment-friendly products as the main factor in normal-sight. The harmless and natural ingredients are the necessary conditions to create all feelings. In addition, the “Assured” and “Comfortable” feelings are only located in this zone, while the high-involvement group in the “Safe” feeling is also constructed by the same factors. The last one is the far-sight, where factors are broader and with long-term benefits, such as the environmental impact, or the process and conditions after the product has been used. In addition, only “Responsible” feeling in the high-involvement group spans this interval. In conclusion, “Responsible” and “Assured” feelings are more difficult to create, and we may notice the different preferences of different groups.

Finally, we can provide several paths to design an environment-friendly product by referring to the result of the EGM. For example, if we want to create a responsible and assured hand soap, we can use biodegradable packaging and emphasize the natural ingredients through advertising. If the target is the high-involvement group, we may highlight the importance of the status of environmental protection on the packaging or advertisement. This study mainly focuses on environment-friendly cleaning products; however, this method can also be applied to other environment-friendly daily necessities to capture different attractive factors.

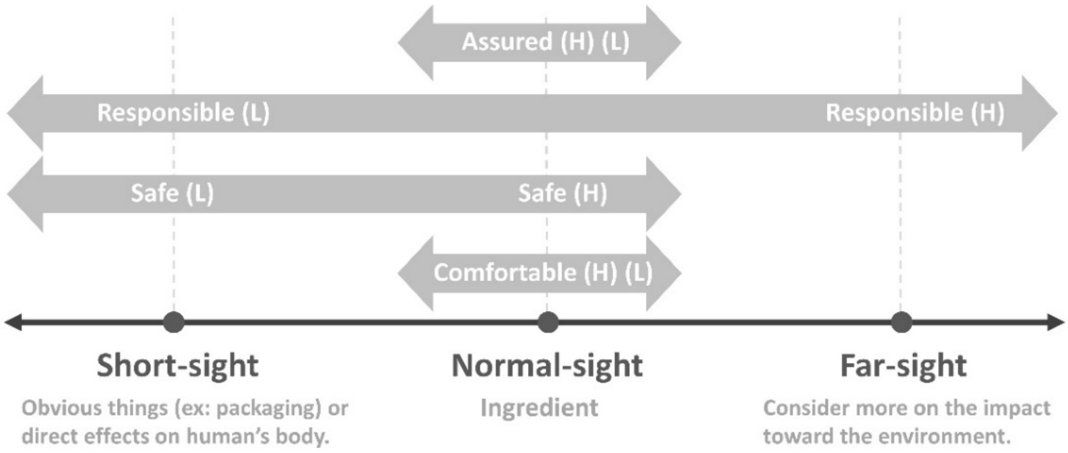

Figure 6. Dimension of environment-friendly products' attractive factors

6 CONCLUSION

This study generalizes the attractive factors and four feelings regarding environment-friendly products through in-depth interviews. These feelings are "Assured," "Responsible," "Safe," and "Comfortable." According to the results of the quantitative analysis, we define a linear dimension of attractive factors, that include short-sight, normal-sight, and far-sight. The "Assured" and "Comfortable" feelings are focused on ingredient factors for the high-involvement and low-involvement groups in the normal-sight. The "Responsible" feeling has the largest span, from the short-sight to the far-sight, and the "Safe" feeling has a middle span, between the short-sight and normal-sight. High-involvement groups in the far-sight are more concern with the impact on the environment after the use of the considered products. In contrast, low-involvement groups focus more on short-term benefits and the effects. In this study, we propose a frame to simultaneously reveal the functional and emotional factors. These attractive factors can be applied in the marketing and design strategies for developing environment-friendly daily necessities.

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CHARACTERISTIC ANALYSIS OF FACIAL STIFFNESS USING AVERAGE FACES OF SCHIZOPHRENIA

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ABSTRACT

There is a significant need for objective assessment methods for schizophrenia. Therefore, this study examined the emotional characteristics of facial stiffness—one of the indicators for estimating patients' flat affect—using average faces. First, we conducted an experiment for psychological evaluation of facial stiffness in 16 Japanese patients with schizophrenia. Twelve medical professionals rated the patients' facial stiffness in 147 videos. Their gaze data were also collected. To extract the physical characteristics of facial stiffness, 11 average faces of 14 male patients and one average face of a group of healthy subjects were generated. The average faces were subjected to an emotion evaluation test by the existing application and 33 medical experts. The results showed that most of the average faces differed in the proportions of the eight emotions between two tests. The most common emotions were anger for the stiffest average face and calm for the healthy average face. In the application analysis, the percentage of emotions other than calm, such as anger and sadness, ranged from 15–65%. In contrast, in the judgment by medical experts ranged from 55–97% for emotions other than calm. The results suggest that “the perception of anger” or “the perception of complex emotions with a mix of anger, confusion, disgust, fear or sadness” is related to the judgment of facial stiffness by medical professionals.

Keywords: *Schizophrenia, Stiffness of facial expression, Average face, Emotion analysis*

1 INTRODUCTION

Evaluation of psychiatric patients' medical conditions requires both interview and observation. However, observation is generally subjective, and formalization of the professional evaluation process would facilitate the development of an evaluation system and be effective in responding to changes in illness. Lack of insight is a problem in schizophrenia, which is a common psychiatric disorder. As it is difficult for these patients to correctly recognize their illness, it is desirable to develop an objective assessment method. The facial stiffness characteristic of schizophrenia is thought to be related to the patient's reactions to hallucinations and flat affect—the latter is a negative symptom of schizophrenia. Specifically, it is a state of decreased emotional reactivity, including facial stiffness, gestures, and lack of appropriate emotional expression. Gur et al. (2006) reported that flat affect is an important clinical feature of schizophrenia and is associated with prognosis because it adversely affects the course of the illness. To assess flat affect, an objective evaluation of facial stiffness, which is one of its indicators, is required. Although facial stiffness has been evaluated based on the subjective judgment of the evaluator, it is necessary to formalize the judgment. A unique feature of this study is that average faces were created and used as the subject of analysis, instead of using the face images of individual patients. An average face is a representation of the positional information, such as eyes and nose, averaged from multiple face images that constitute the average face. It is mainly used in the field of face research because it is suitable for representing the characteristics of faces as a group. It is generally believed that averaging creates more attractive faces, and factors such as facial symmetry (Jones, DeBruine, & Little, 2007) and improved skin texture are cited as contributing factors. Additionally, an attempt to reveal the cognitive component of facial attractiveness (DeBruine, Jones, Unger, Little, & Feinberg, 2007) by processing average faces using morphing techniques has also been reported. Thus, it is believed that the average face shows the characteristics of the faces as a group. Therefore, it is expected that the average faces of schizophrenia, which is the subject of this study, will also show the characteristics of stiffness. In this study, average faces of schizophrenic patients were graded based on their rated values of facial stiffness, and an attempt was made to identify the emotional characteristics of facial stiffness specific to patients. The structure of this study is shown below. In this study, five experiments were conducted. 1) We conducted an experiment in which 12 medical professionals evaluated the facial stiffness of 147 images of patients, and ranked the images according to the evaluation values to confirm whether there was a common evaluation tendency. 2) To clarify the knowledge of medical professionals when evaluating facial stiffness, we showed groups of images created according to the degree of stiffness and interviewed medical professionals. 3) To extract facial stiffness characteristics, average faces were created for each level of facial stiffness. 4) Emotional analysis of the average faces was performed using an application. 5) Emotional judgment experiments by medical professionals were conducted to clarify the emotional characteristics related to the judgment of facial stiffness by each method. Additionally, the agreement and differences between the two methods were examined. Through these experiments, the following findings were obtained: 1) There are two types of criteria for judging stiffness—the perception of anger and the perception of complex emotions with a mix of multiple emotions. 2) The proportions of mixed emotions differed between applications and medical professionals' evaluation. Judgments by medical professionals showed a mix of anger, confusion, disgust, and fear or sadness, suggesting that the perception of more complex emotions is related to the evaluation of stiffness. This study was conducted with the approval of the Ethics Review Committee on Research with Human Subjects of Waseda University and the Ethical Review Committee of Takatsuki Hospital.

2 EXPERIMENT 1：EXPERIMENTAL EVALUATION OF FACIAL STIFFNESS BY MEDICAL PROFESSIONALS

The evaluation experiment of patients' facial stiffness was used to obtain evaluation values and rank the images, and to confirm whether there was a common evaluation tendency.

2.1 Methods

The participants were 12 (6 males and 6 females) medical professionals with at least 10 years of clinical experience in psychiatry, and included five nurses, two occupational therapists, two clinical psychologists, and three mental health workers. They studied the facial expressions of 16 Japanese schizophrenic patients (14 males and 2 females) admitted to a psychiatric hospital. The stimuli for the facial stiffness evaluation experiment were 147 videos of the patients' faces when they entered the occupational therapy room. The time required to recognize facial expressions is less than 400 ms (Tobimatsu, 2012). Additionally, considering the time required to evaluate facial stiffness, the average length of the stimulus videos was 1.96 seconds (standard deviation 0.39). An evaluation application was originally developed to playback the stimulus videos and obtain evaluation values. Figure 1 shows the evaluation experiment. The evaluation was conducted by moving the knob of the evaluation slider. The evaluation values were obtained by a method in which the position information of the knobs was recorded in a text file. At the same time, the gaze position during the evaluation was recorded at 60 fps by an eye-tracking device (Tobii ProX3-120 Eye Tracker) attached to the bottom of the monitor.

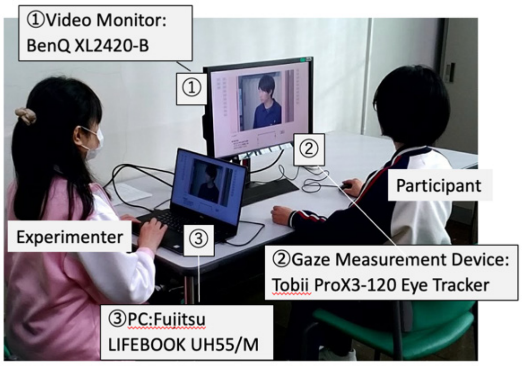

Figure 1. Experiment Environment

2.2 Results

The facial stiffness ratings obtained from the facial stiffness evaluation experiment were standardized. The box-and-whisker plots in Figure 2 show the ranking of video stiffness based on the mean of the standardized scores of the 12 participants, divided into groups of 30 videos each. Figure 2 shows that the variation in scores was lowest in the middle group of stiffness ratings. The variation of the scores was highest in the middle group of the stiffness evaluation, and it was larger in the lower group than in the higher group. Therefore, the F-test was used to compare the variance of each group. The results showed that the following six combinations (1–30 and 61–90, 1–30 and 121–147, 31–60 and 91–120, 31–60 and 121–147, 61–90 and 91–120, and 61–90 and 121–147) had $p<.01$, indicating significant differences in the variability of ratings. In particular, the lowest group (121–120) showed the largest variation in scores, indicating a significant difference from the top-three groups. In other words, the higher scores showed less variation in the evaluation of stiffness, suggesting the possibility that there is some index that medical professionals have in common regarding the evaluation of stiffness.

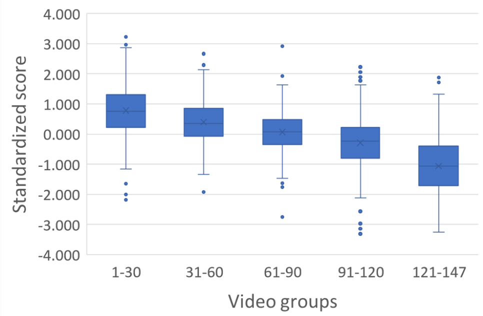

Figure 2. Box-and-whisker diagram of standardized evaluated values of stiffness of facial expression collected per 30 ranks

3 EXPERIMENT 2：INTERVIEWS ABOUT STIFFNESS RATINGS

Interviews were conducted to determine the knowledge of medical professionals in assessing facial stiffness.

3.1 Methods

For each rater, three groups of videos were created from the 147 videos based on the evaluation values. The top-30 videos in terms of stiffness were grouped together as the "group with stiff facial expressions"; the middle-30 videos as the "middle group"; and the bottom-30 videos as the "group with soft facial expressions.” After presenting these group videos to the raters, we obtained their comments on the facial characteristics of each group through semi-structured interviews.

3.2 Results

Eight of the 12 participants in the "stiff facial expression" group responded that the videos were characterized by the state of their facial muscles. Six of the 12 respondents indicated that there was no movement of the muscles. Four respondents answered that they had no facial expression, and one said that their muscles were relaxed. Ten of the 12 respondents related to the eyes. Five of them mentioned the eye direction, especially downward gaze. Five of the 12 respondents mentioned eye movement, and four mentioned sharpness of the eyes. These results suggest that two pieces of information: the state of facial muscles and the state of the eyes, are used as cues in the evaluation of facial stiffness.

4 EXPERIMENT 3： ANALYSIS OF GAZE DATA DURING EVALUATION OF STIFFNESS

To extract facial stiffness features, average faces were created for each stage of facial stiffness. Furthermore, we mapped the gaze data during the evaluation of stiffness onto the average face, and clarified the clues for evaluation based on the characteristics of the distribution of gazing points at different levels of stiffness.

4.1 Methods

4.1.1 Creating average faces

The average faces of the patients were created using 127 videos of 14 male patients out of 147 videos. The most front-facing image was extracted from each video. Average Face PRO (version 4.7.3) was used to create the average faces. Average face 1 was constructed using the images ranked from 1 to 30 in terms of stiffness. Average face 2 is composed of images ranked from 11 to 40. Eleven faces were created by shifting the ranking of the stiffness of the images used in the same manner by 10 (Figure 3). The average number of included patients in the average face was 9.7. Images from the Photo AC website were used to create the average faces of the healthy subjects. After cropping the parts of the faces that were straight and facing forward, and after collecting the 20 faces, 14 were randomly selected to create the average face of healthy subjects (Figure 3).

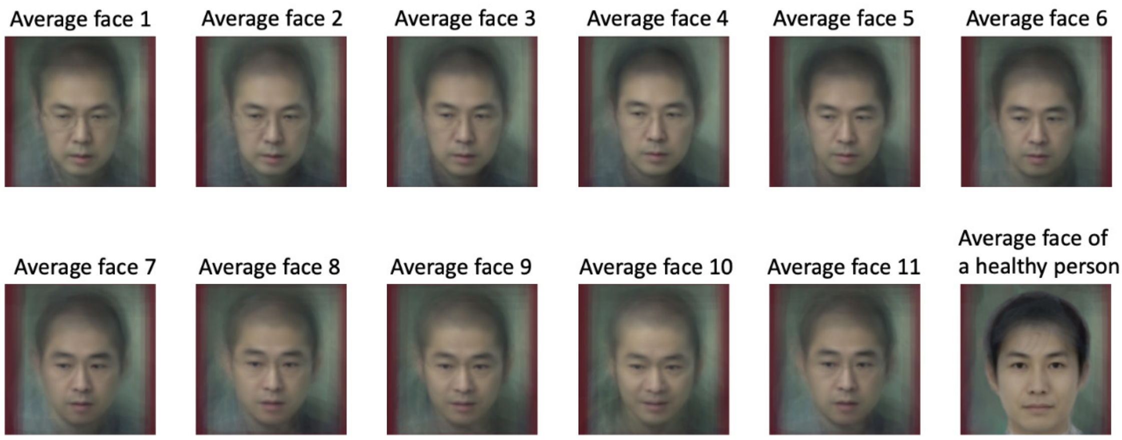

Figure 3. Eleven average faces of schizophrenia by stiffness of facial expression and one average face of a healthy person

4.1.2 Mapping gaze data to average face

For the analysis of the gaze data, the data recorded by the eye-tracking device was output as videos in Tobii Pro Studio. The videos were then divided into frames using a video editing software (Free Video to JPG Converter v.5.0.101 build 201). The position of the gazing point on the patient's face shown in the segmented images was mapped to the relative position of the average face.

4.2 Results

The gaze data of 12 medical professionals during the evaluation of the videos with stiff facial expressions are superimposed in Figure 4. The left figure shows the gaze data of the video with the stiffest facial expression mapped to average face 1. In contrast, the right figure shows the results of mapping the gaze data of the video rated as the seventh stiff expression to average face 1. There were two types of distribution of gazing points in the video group evaluated as having stiff facial expressions: the first was that the gazing points were concentrated around the eyes; the second was that the gazing points were distributed over the entire face. In the videos with the stiffest facial expressions, the gazing points were concentrated around the eyes, inside the eyebrows, and on the upper part of the nose. This is consistent with the "anger" feature of Ekman's six basic emotions (Ekman & Friesen, 1971). In contrast, in the seventh-ranked video, the gazing points were distributed not only around the eyes but also around the entire face, including the cheeks and mouth. Figure 5 shows a mapping of the gaze data during the evaluation of the videos with the softest facial expressions to the average face 11. In the videos with the softest expressions, the gazing points tended to be distributed to the eyes and their extensions at the corners of the eyes. These results suggest that the range of gazing points during evaluation is narrow when emotions can be judged only around the eyes and nose, such as when "anger" or " happy" emotions are expressed, and that the gazing points are widely distributed when no specific emotion is expressed.

Figure 4. Results of mapping gaze data to the average face of the video images rated as stiffest

Figure 5. Results of mapping gaze data to the average face in the video image rated as soft

5 EXPERIMENT 4：EMOTIONAL ANALYSIS OF AVERAGE FACES BY APPLICATION

Eight types of emotional analyses were conducted using the application with the aim of clarifying the emotional characteristics of the average faces.

5.1 Methods

Emotion analysis was performed on each average face using a web-based application (Amazon Rekognition Face Analysis). Emotion prediction with Amazon Rekognition is based on the physical appearance of the person's face in the image, and each emotion is assigned a confidence score. The eight emotions analyzed were calm, angry, sad, confused, disgusted, surprised, happy, and fear.

5.2 Results

The results of the analysis are shown in Figure 6. Average face 1 on the left-side of the figure is composed of the images ranked from 1 to 30 with the stiffest facial expressions. Moving to the right, ranking of the stiffness of facial expressions of the images decreases, and average face 11 is the face with the softest facial stiffness. The rightmost image is the result of the emotion analysis of the average face of a healthy subjects. Average face 1 had the highest confidence in the emotion of anger at 53.6%. All other average faces had the highest confidence in the emotion of calmness, indicating that the characteristics of the average faces are different from average face 1. Average faces 2–5 and 9 contained about 10–20% anger emotion. Additionally, average faces 2–5 contained about 10–15% sadness. Average faces 3 and 5–10 contained about 5–10% confusion. Average face 11 had the highest degree of certainty of being calm (85.4%) among patients' average faces. The average face of a healthy subjects was 99.5% certain of calmness, and contained few other emotions, which was different from the average faces of the patients. In summary, there were two types of average faces that were judged to have stiff facial expressions: those that showed anger, and those that had a mix of anger, sadness, and mild emotion facial features. The average faces judged to be intermediate to soft tended to show a decrease in the proportion of anger and an increase in the proportion of confusion.

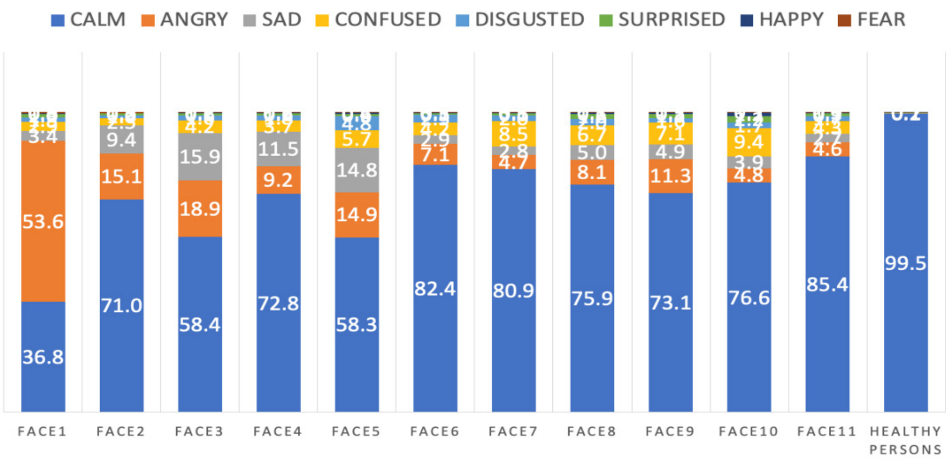

Figure 6. Results of emotion analysis of average faces using the application

6 EXPERIMENT 5：AN EXPERIMENT IN JUDGING THE EMOTIONS OF AVERAGE FACES BY MEDICAL PROFESSIONALS

An emotion judgment experiment was conducted to characterize medical professionals' emotion judgments about average faces, and the results were compared with the results of the application in Experiment 4.

6.1 Methods

The experiment included 33 participants (13 males, 19 females, and one non-binary): four physicians, 16 nurses, four licensed psychologists, five occupational therapists, and four mental health workers employed at a psychiatric hospital. Their ages ranged from 25 to 60 years (mean 40.0 years, standard deviation 9.38). The program for the emotion judgment experiment was created using a questionnaire tool (qualtrics). Emotion judgments were made by selecting up to three possible emotions from the displayed average face images in order of likelihood. After one practice session using the practice images, the participants responded to the 12 average faces that were displayed at random. Eight emotions were selected—same as in the application of Experiment 3. The second and third place selections could also be made by selecting "not applicable."

6.2 Results

Figure 7 shows the percentages of emotions that the raters selected as first place. Average face 1 had the highest percentage of anger, judged at 36.4%, followed by disgust at 30.3%. Average faces 2-6, 8, and 11 had the highest percentage of confusion, ranging from 30 to 50%. In particular, half of the raters (51.5%) were confused about average face 6. The average faces 1 to 6 were rated as disgusting by 12 to 30% of the raters. Average face 7 was rated as mild by the highest percentage of raters (45.5%). For average face 10, 69.7% of the patients judged it as joyful. The average face of healthy subjects was judged as moderate by 78.8% of the total respondents, which was different from the tendency of the average faces of the patients. The application and medical professionals shared the same judgments about the average face 1. The highest percentage of both judgments was anger. In the application's analysis of emotions, the highest confidence was found in the eight emotions, ranging from 60–85%, with the exception of average face 1, which had the highest confidence in the emotion of calm for all the average faces. In contrast, in the judgment by medical professionals, the highest rate of selecting "calm" was 45% for average face 7, followed by 30% for average faces 4 and 9, indicating that emotions other than "calm" were selected in a high percentage of cases. Additionally, a significant difference was that confusion was selected more frequently by the human judges, with more than 30% of the judges selecting this emotion for average faces 2–6, 8, and 11. In the application, the facial features rated as stiffness were a mix of anger, sadness, and calm, but in the judgment by medical professionals, a mix of anger, confusion, disgust, and fear, and a mix of anger, confusion, disgust, and sadness were indicated, suggesting that a more complex perception of emotion is associated

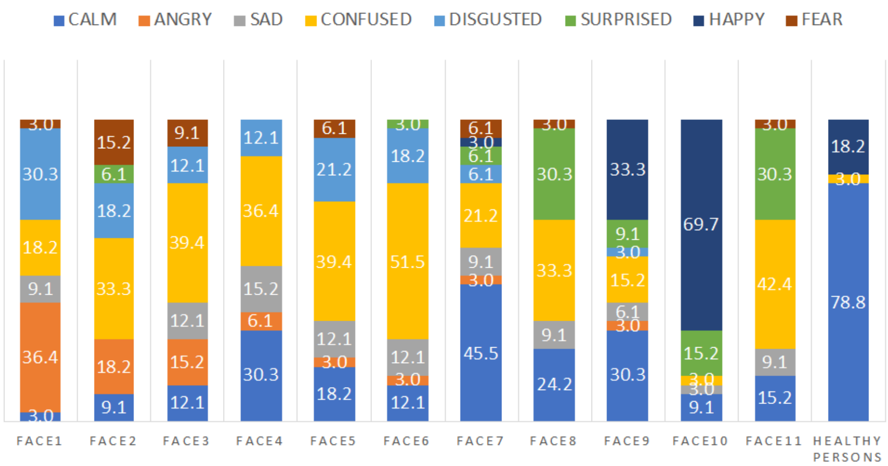

Figure 7. Results of emotion judgment of average faces by medical professionals

with the evaluation of stiffness. The results suggest that a more complex perception of emotions is associated with the evaluation of stiffness.

7 DISCUSSION

With the aim of developing an objective evaluation method for schizophrenia, this study attempted to clarify facial stiffness in patients in terms of emotional characteristics. After interviews with medical professionals, two characteristics were identified in the evaluation of stiffness: state of facial muscles and sharpness of eye contact. This was supported by the fact that the mapping of gaze data showed that the average face with stiffness was distributed to the area that expressed anger emotion. Additionally, we conducted an emotion analysis application and emotion judgments by medical professionals on the average faces, and confirmed the consistency and differences between the two judgments. As a result, the only commonality extracted between the two was that the detection of anger emotion for the stiffest average face 1 was related to facial stiffness and that the average face of healthy subjects was judged as calm. In the emotion judgments for many of the other average faces, the composition of emotions differed significantly between the applications and the medical professionals. Faces rated as stiff by the application showed a mix of facial features of anger, sadness, and calm emotions, whereas medical professionals' judgments showed a mix of anger, confusion, disgust, and fear, as well as anger, confusion, disgust, and sadness, suggesting that a more complex perception of emotions was associated with the stiffness ratings. These results suggest that facial stiffness was evaluated using two criteria. Criterion 1 was the perception of anger and criterion 2 was the perception of complex emotions. A possible reason for the difference between the two groups could be that the facial features of schizophrenics are different from those of healthy people, which had a significant impact on the differences between the two groups. Most emotion analysis applications are based on Ekman et al.'s (2002) Facial Action Coding System (FACS), and emotion judgments are mainly based on positional information of facial parts. Therefore, it is considered that both judgments were consistent for the average face of a healthy person. However, it can be inferred that the application found it difficult to judge the emotions of patients' faces because of the difficulty in expressing typical emotions that can be handled by FACS because of flat affect and parkinsonism. Additionally, confusion was the most frequently selected feature of emotion judgments by medical professionals for many average faces. This may be due to the possibility that patients' psychological states are influenced by psychological symptoms such as auditory hallucinations, which may be harmful to them. The criteria used by medical professionals to judge facial stiffness were a mix of anger, embarrassment, disgust, and fear, or a mix of anger, embarrassment, disgust, and sadness, which were difficult to distinguish from specific emotions. However, it is possible that this ambiguity in facial expressions is related to the Praecox Feeling proposed by Rümke, and this will require further study. Although the accuracy of emotion analysis tools has been improved by the use of big data and deep learning technologies in recent years, there was a difference between the judgment of average faces of schizophrenia by the application and that by medical professionals, suggesting that a system for detecting facial stiffness in schizophrenia requires a different algorithm than conventional emotion recognition.

8 CONCLUSION AND FUTURE WORKS

In this study, we examined the emotional characteristics of facial stiffness—one of the indicators for estimating flat affect in patients—using average faces. There were two types of criteria for judging stiffness—Criterion 1 “the perception of anger” and criterion 2 “the perception of complex emotions”. The extraction of the emotion of anger with a stiff face was common to both the application and medical professionals. However, the proportions of mixed emotions differed between applications and medical professionals' evaluation. Judgments by medical professionals showed a mix of anger, confusion, disgust, and fear or sadness, suggesting that the perception of more complex emotions is related to the evaluation of stiffness. Future work is needed to develop a new sophisticated emotional evaluation system for schizophrenia based on Criterion 2, which is a characteristic of a patient's facial stiffness.

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COMPLEX THINKING FOR KANSEI STUDIES
FOR AN EPISTEMOLOGICAL SHIFT OF THE FIELD

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ABSTRACT

This position paper questions the current situation of kansei studies as a multidisciplinary field of research. The observations on the structure of the research community and on the way papers address the notion of kansei point out the pluridisciplinary nature of the field, centred on the ill-defined notion of kansei. This situation is thought to be an epistemological issue, rather than a structural one. To address this epistemological challenge, we argue to shift towards complex thinking as a paradigm to rethink the field of kansei studies and the notion of kansei. Positioning kansei studies as a complex unit rich of multiple disciplines and of multiple perspectives on kansei lead to a richer dynamic within the research community, and open new ways of collaboration within the community and outside with related disciplines. Therefore, we call for this shift that may impulse a new dynamic in the community actually rich of a great variety of disciplines and practices.

Keywords: *complex thinking, complexity, kansei studies, epistemology, dialogic*

1 AN EPISTEMOLOGICAL SHIFT IN KANSEI STUDIES

This paper starts with an intuition: the difficulty to establish a definition of kansei that would be satisfying and shared by the community of kansei research is actually an epistemological issue. This intuition is scaffolded by two observations, which also provide insights on the reasons for this inquired difficulty.

The first observation relates to the structure of the community of kansei research. Since the first international KEER conference in 2007, we can observe a clear and strengthening categorisation of the research in kansei by topics related to external fields of sciences or engineering, e.g., kansei textile (related to textile engineering), kansei business (related to business studies), or kansei science (mainly related to psychophysiology and cognitive sciences). We call these external fields the *exo-disciplines* of kansei studies. This situation is due to the interdisciplinary nature of kansei studies, historically structured by many fields that are all focusing on a common concept: kansei. This has mainly influenced the way kansei has been considered and described by each disciplinary group (or subcommunity): in a way it is compatible with their related exo-disciplines. This compatibility has obvious practical advantages, as it contributes to the strengthening of each kansei research subcommunity, as well as the improvement of its interactions and mutual contributions with the exo-disciplines. However, at the same time, it dilutes the concept of kansei within the global kansei research community, as the multiple descriptions of kansei are built based on the separate efforts of various subcommunities rather than a common effort. It also brings within the community of kansei research a multiplicity of disciplinary perspectives, and therefore issues related to the multiplicity of ontologies and epistemes, and their irreconcilability. For instance, some branches of kansei science have considered the human mind and behaviour from a mind/brain identity theory (Smart, 2011), e.g., (Lévy et al., 2011), while some branches of kansei design have considered the same topic from a phenomenological perspective (Merleau-Ponty, 2002), e.g., (Lévy, 2013). These two approaches, although significantly contributing to kansei science and kansei design, respectively, are fundamentally irreconcilable on the role of the body in the human experience.

The second related to the kansei research literature. Regarding the way kansei is discussed in the literature, three major patterns were observed:

- As a first pattern, most papers omit to explain what kansei is. This may be acceptable when the targeted audience has a commonly recognised and established definition of kansei. However, as discussed previously, this does not work within the kansei research community, structured subcommunities with specific disciplinary perspectives. In such case, the absence of a description of kansei may lead to unclarity in the comprehension of the paper and therefore of the research work. Moreover, these papers do not contribute, at least directly, to the clarification of kansei.
- As a second pattern, many papers tend to solve this situation by proposing a brief explanation of kansei, which is often sufficient to the work presented in the paper. In other words, it may be sufficient for the comprehension of the research as described and discussed in the paper, but does not contribute either to the inquiry about what kansei is. Therefore, while it may support the clarity of the paper and its contribution to the subcommunity, it does not help the entire community of kansei research to discuss and clarify kansei.
- The third pattern relates to papers which have tentatively defined kansei as their main focus (e.g., (Harada, 2003; Lee et al., 2000; Lévy, 2013; Lévy & Yamanaka, 2006; Nagamachi, 2006; Schütte, 2005)), which target the entire kansei community, and often beyond as an audience. Although, many tentative have been published throughout the last two decades, none of these papers seem to have successfully been recognised by the community as a major foundation towards a shared common explanation on what kansei is, or even to have launched a constructive discussion towards such explanation. Therefore, either the dynamics of the community has failed to start such a dynamic, or there might be a sort of resistance towards such endeavour, which prevents from

formalising kansei despite its status of being the core concept for the community. In this research, we inquire on the second condition.

Based on these two observations, it appears that over the past 20 years of research in kansei, the community has not been able to establish a description of the concept of kansei capable of satisfying the community at once while being effective for the variety of fields and research programmes involved in the community. If the ambition of the kansei research community is to hold as a coherent field of research, this situation seems problematic.

We argue that if resistance there is, the actual issue is mainly of an epistemological nature relative to the field of kansei studies, rather than it is about a structural one of the community. The essential interdisciplinary nature of kansei studies, and the previously discussed consequential epistemological conflicts make it difficult, possibly impossible to find the sought definition of kansei in a way that would be both satisfactory for all the community, effective in each field of practice, and compatible with the epistemological (and often ontological) perspective of each involved discipline. It appears then that the search for a coherent and common definition of kansei is a lost quest.

This call for taking another perspective on kansei studies at large, which eventually may have consequences on the way kansei is considered as the core concept of kansei studies. To address this challenge, we propose in this paper an epistemological shift of kansei studies. We suggest to address the interdisciplinary nature of kansei studies as a *complex unity*, enabling a *dialogical* interplay between kansei disciplines, especially on the fundamental concept of kansei.

2 COMPLEX THINKING

The two terms *complex unity* and *dialogic* are proposed by Morin (2014) to describe and to structure complex thinking. The premise of complex thinking is the complexity of the world as we intend to make a comprehensive sense of it. Morin suggests that the world is like a fabric made of multiple threads. These threads are material and immaterial *stuff* of the world. Their composition that creates the fabric of the world is inherently complex. Comprehending the world – or actually any complex concept – requires another strategy than reductionism, which may be powerful to understand one thread but not the fabric. To address the fabric and its complexity, the strategy ought to involve a complex thinking approach. Such an approach is opposed to a simplifying approach, such as reductionism, which disregards the variety of perspectives that may be taken to address an object of inquiry and tends to unify the world through a single vision, getting 'blind' to what does not fit this vision. In other words, while simplifying thinking focuses on one aspect of a reality and intends to elaborate a coherent understanding of this reality through a unique selected lens (e.g., one discipline), complex thinking intends to pay attention to the complexity of the world fabric, to pay attention to multiple lenses and to their interactions in order to create a more comprehensive understanding of this fabric. Complex thinking is therefore a strategy to address a broad concept that can only be addressed partially and improperly through simplifying or unidisciplinary approaches. As discussed in the first section, as a multidisciplinary field, kansei studies and by extension kansei seem to be in this situation, and therefore complex thinking may be a strategy to address the field.

To pragmatically understand complex thinking, we will now discuss the terms *complex unity* and *dialogic*, which are contributing to the structuring of complex thinking, and apply them to the field of kansei studies.

A complex unity is a coincidence (or an organisation) of various logics, possibly contradictory to each other, in a complementary, concurrent, and possibly antagonist unit. Such unit gives the possibility to think a concept, e.g., kansei studies in our case, through a complex thinking approach, keeping together the diversity within the concept while comprehending this concept as a unit. In our case, we intend to keep the diversity of kansei disciplines while considering kansei studies as one. Therefore, we may consider here kansei studies as a complex unit (the fabric), brought together through the common focus on kansei, yet framed by diverse logics involved in diverse kansei disciplines or subcommunities (the threads).

Such complex unity can operate through dialogic. Dialogic is an approach “offered by tensions, oppositions, and contradictions among explanations of the same phenomenon” to “stimulate the development of more encompassing theories” ((Poole & van de Ven, 1989) in (Kristensen, 2020)). It enables then the aforementioned logics to interact as a complex unit, without losing their own unity. In the case of kansei studies, while the differences and the contradictions between the kansei disciplines remain, these can continuously interact within the complex unity (i.e., kansei studies as a whole), learn from each other and consequently progress without the intention to reach a synthesis (which is not of a dialogic nature, but rather of a dialectical one, possibly towards a simplifying thinking). Diversity is maintained within unity, which is maintained within diversity.

3 KANSEI AS THE CORE OF THE COMPLEX UNITY

As kansei is the core topic of the dialogic within kansei studies – now considered as a complex unit –, the attempt to propose one definition of kansei to be commonly agreed among all disciplines appears useless and actually vain. Such reductionistic attempt would fail because of the inherent contradictions among kansei disciplines, which thread the complexity of kansei studies. Moreover, it would have as a major effect to constrain disciplines regarding their own understanding of kansei, and consequently their evolution over time. The complex thinking may support each kansei discipline to open towards others as well as towards exo-disciplines. Overall, this regard on kansei studies transformed what was seen as a critical issue in the first chapter as a strength and richness in the complexity of kansei studies (the second chapter).

The aim of discussing kansei is therefore not to obtain a common definition of kansei, but rather to engage in discussions that maintain the dynamics and the liveliness of kansei studies while supporting the progress of kansei disciplines in their diversity.

4 CONSEQUENCES FOR KANSEI STUDIES

The first consequence for kansei studies is its endeavour towards the definition of kansei. We clearly propose here to stop looking for a unified definition of kansei for the entire field of kansei studies. Differently, we suggest that the definitions or descriptions of kansei proposed by each kansei disciplines (or subcommunities) should be exposed, shared, and discussed to enrich each perspective, to enrich each discipline without the aim of harmonising the entire field. Its richness will come from the variety of perspectives and from their capability to learn from each other.

Consequently, inquiring kansei studies as a complex unit invites to inquire kansei disciplines through their interactions, rather than in an isolated way (relations rather than disjunctions). It is also about questioning the effect of these interactions rather than their nature (effectiveness rather than causality). The pragmatic ambition is to consider kansei studies as a whole – keeping in sight the diversity and the possible contradictions within it – and to determine how the various disciplines can contribute to each other through dialogic.

Moreover, it is also valuable to consider the organisation of the kansei studies from this perspective. The notion of organisation covers here both the state and the processes involved in kansei studies, as well as the dynamics leading to the evolution of the field. How do the kansei disciplines operate together, and impact each other and the whole at the same time. As Morin states, the aim of inquiring the organisation is not to look for a "romantic" harmoniously structured totality, but rather to "find the principles of common organisation, the principles of these principles, and the characteristics of their diversification" (Morin, 2014).

As a last consideration, the common principle among kansei disciplines is that they all interact with exo-disciplines (cf. chapter 1), as well as with each other through the notion of kansei. Therefore, kansei studies interacts with multiple disciplines outside the system, feeding its own internal organisation and principles to remain its unity while continuously evolving, and feeding exo-disciplines as well from the original positions and research programmes conducted by kansei researchers. This way, exo-disciplines play the role of co-organisers to the field of kansei studies, enriching its organisation as a complex unit. Conclusively, kansei studies can be seen as an open system, necessarily connected to external fields, yet with a specific identity structured around kansei.

5 CONCLUSION

This paper takes a radical position on kansei studies and on its old project to define kansei. Considering the challenges experienced by the field during the past decades, we argue that the issue is not structural but epistemological. Based on this consideration, we propose a novel way to progress on the development of kansei studies, now taken as an open system requiring complex thinking to be handled and developed further as a complex unit of research.

From this perspective, two programmatic consequences can be elaborated. First, we argue for the multiplicity of definitions of kansei. This demands that each kansei discipline elaborates a specific definition of kansei to be coherent with the discipline and effective for the practices within this discipline. Second, the variety of kansei definitions demands that these definitions are shared and discussed, so that each discipline can learn from the others and continue developing, with no intend to reach a common definition of kansei. To the opposite, differences are the strength for disciplines to support each other.

Such dynamics created in the field of kansei studies will hopefully bring the kansei disciplines closer together, strengthening their collaborations, strengthening in the same movement the relevancy and the effectiveness of kansei studies as a field, and last but not least, contributing to informing exo-disciplines (design, engineering, business studies…) how kansei can be handled and support their own fields as well.

We hope the call for this shift towards complex thinking, considering kansei studies as a complex unit, to be considered by multiple members of the kansei community within multiple kansei disciplines, as it is obvious that this research intent will not reach satisfying results by the sole effort of one discipline.

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CONCEPTUALISING KANSEI IN AFFECTIVE WORK EVENTS COUNTERPRODUCTIVE WORK BEHAVIOUR MODEL

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ABSTRACT

Studies on Counterproductive Work Behaviour (CWB) have attracted wide interest among scholars. CWB is a subset of unethical behaviour that seems unbearable since it intentionally harms both organisations and people in the organisations. In general, literature holds that CWB is determined by work events and affective state. However, most studies are restricted to examining a single work event which prevents us from understanding the simultaneous effect of multiple work events. In addition, prior research widely utilised a self-reporting mechanism in capturing the affective experiences at work resulting in common method bias and other issues like time constraints, low response rate, etc. Drawing on Affective Events Theory (AET), affective work events, and CWB literature, this article provides an important extension to the CWB literature by proposing multiple work events that predict affective experiences and CWB at work. Additionally, the Kansei Engineering-Kawakita Jiro method is introduced as a substitute for the existing self-reporting mechanism in capturing affective work events. This article offers theoretical insights that may facilitate empirical research to explore the role of affective

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experiences within the CWB spectrum. The introduced conceptual ideas are targeted to be a useful guide for practitioners to craft appropriate strategies to combat employees' CWB.

Keywords: Counterproductive Work Behaviour, Affective Experience, Kansei Engineering

1 INTRODUCTION

Among the keystream of ethical behaviour, research emerged to concentrate on "bad apples" or employees who engage in Counterproductive Work Behaviour (CWB). Perhaps because of the significant negative impact on both employees and the organisation, which involved billions of dollars in financial losses, low psychological well-being, and morale among employees (Baharom, Sharfuddin, & Iqbal, 2017). The AET postulated that specific work events functioned as an antecedent of employees' affective experience and subsequent behaviours (e.g., CWB). The proximate cause of affective reactions in the workplace is thought to be work events generated as a result of consistent work environment elements (Weiss & Cropanzano, 1996). Thus far, numerous empirical studies have confirmed the AET propositions. In this case, affective experiences were found to be linked to CWB positively and negatively (Bauer & Spector, 2015; Williams, 2020; Hu, Chen, & Ye, 2021). In reviewing the affective events literature, it appears that most of the studies concentrated on a particular work event as a single variable in defining employees' affective state. Among the events are psychological contract breaches (Griep & Vantilborgh, 2018; Liang, 2019), workplace interactions (Mao, He, & Yang, 2020; Qin & Liu, 2019), task-related (Koon & Pun, 2018; Thompson & Bruk-Lee, 2020), and mistreatment (Fatima, Bilal, & Imran, 2019; Jahanzeb, Fatima, & De Clercq, 2020; Hu, Chen, & Ye, 2021). Various mechanisms and approaches were utilised to investigate the antecedent events that elicit employees' emotions at work, including diary study, survey-based, open-ended questionnaire, and experience sampling methodology (ESM). However, over-reliance on the self-reported methodology led to common method bias. Hence, applying a substitute mechanism may add value to CWB literature. Although Kansei Engineering (KE) has been established as being well-suited to be applied in understanding human emotions and psychology, it appears that this measure has not been thoroughly explored in CWB research. Therefore, in efforts to resolve CWB occurrence among employees, it is important to identify and explore new strategies to enhance employees' emotional well-being. Drawing on AET, this paper conceptually investigates the effects of work events and employees' emotions on CWB. In addition, this paper introduced the Kansei philosophy to give insights into its usefulness in the organisational behavioural perspective.

2 THEORETICAL OVERVIEW

2.1 Affective Experiences and Counterproductive Work Behaviour

CWB is conceptualised to be a subset of unethical behaviour in which an act intentionally causes harm and often breaches social norms (Wiernik & Ones, 2018; Feinberg, Ford, & Flynn, 2020). CWB refers to dysfunctional behaviour that intentionally harms both organisations or members of the organisations (Spector & Fox, 2002). A great deal of the CWB's research has concentrated on determining the factors that motivate people to commit harmful workplace behaviours (e.g., Mercado, Dilchert, Giordano, & Ones, 2018; Chen, Richard, Boncoeur, & Ford, 2020). Research focusing on antecedents of CWB can typically be divided into predictors focusing on the person and predictors focusing on the situation (Sackett & DeVore, 2001). Spector and Fox (2002) introduced a well-known and accepted categorisation, namely environmental antecedents and personal antecedents. Another study suggested situational factors, individual factors, and integrative approaches as CWB predictors (Clark, 2013). Situational antecedents have repeatedly been revealed as significant predictors of CWB engagement (e.g., Jahanzeb et al, 2020; Gürlek, 2021). Furthermore, personal antecedents have also been shown as important predictors of engaging in CWB (e.g., Filipkowski & Derbis, 2020; Nguyen, Pascart, & Borteyrou, 2021). Stemming from the emerging research of workplace affectivity, researchers started to investigate the influence of individuals' emotions on CWB.

There are numerous eliciting events that have been investigated independently. Among the antecedent that have been studied are task-job-related events (e.g., Oerlemans & Bakker, 2018; Eatough et al, 2016), employee-supervisor interaction (Cropanzano, Dasborough, & Weiss, 2017; Reynolds Kueny, Francka, Shoss, Headrick, & Erb, 2020), relationship conflict (Meier, Gross, Spector, & Semmer, 2013), subordinates' behaviours (Schwarzmüller, Brosi, & Welpe, 2018), interactions with customers (Rueff-Lopes, Navarro, Caetano, & Silva, 2017; Yue, Wang, & Growth, 2017), organisational policies (e.g., Erol-Korkmaz, 2010; Matta, Erol-Korkmaz, Johnson, & Biçaksiz, 2014), and organisational climate (Wang, Guchait, & Pasamehmetoglu, 2020). Although negative experiences are prevalent in predicting CWB, positive workplace experiences are essential in mitigating dysfunctional behaviour. For example, Nagamachi (2014), in his research on the car manufacturing industry, found that when employees are allowed to have fun and a sense of pride in their challenging work, their motivation will be tremendously boosted, and productivity will be increased up to 150% level. In reviewing the literature, it appears that each work events carry a different emotional impact and these emotions lead to diverse behavioural consequences. For example, malicious envy could result in CWB targeted at the supervisor (Braun, Aydin, Frey, & Peus, 2018). In contrast, violation feelings lead to CWB targeted at organisation (Griep, Hansen, & Kraak, 2022). It implies that appropriate methodologies are required to capture the eliciting events based on the respective contextual setting.

3 CURRENT METHODS ON WORK EVENTS-AFFECTIVE STATES STUDIES

Based on the affective work events literature, thus far, various mechanisms have been employed to identify the work events that preceded employees' emotional reactions at work. Woznyj, Shanock, Heggestad, and Banks (2021), for example, utilised a diary study to capture the events that influenced employees most at work. They asked participants to complete two daily surveys (midday and afternoon). At all three daily time intervals, discrete emotions (anger and happiness) were measured using a reduced 10-item version of the Weiss scale. Meanwhile, Demerouti and Cropanzano (2017) asked participants to complete the morning and afternoon measurements of the diary survey on three consecutive workdays. The momentary pleasant affect was evaluated in the afternoon and the morning. They employed seven items from the Job-Related Affective Well-being Scale on both occasions. Similar to Woznyj, Clark, Robertson, and Carter (2018) asked the participants to indicate if a positive or negative event (or both) occurred related to their work, a coworker, or a supervisor during the afternoon and end-of-day surveys. While pleasant and unpleasant moods were measured with three items from the Current Mood Report adjective checklist. Unlike diary studies, participants in Experience Sampling Methodology (ESM) are deliberately triggered at various points during the day to lessen the participants' dependence on long-term memory to re-create past events (Van Berkel, Ferreira, & Kostakos, 2017). With experience sampling, data is acquired by self-reports submitted by participants, much as it is in classic diary studies. Reindl, Lang, and Runge (2021) are among the researchers that employed an ESM design that focused on work events and event-related discrete emotions. They attempted to determine whether the work events occurred within the previous hour and what feelings the participants were experiencing at the time. Whilst Matta et al (2014) utilised ESM via web-based diary surveys. They asked the participants to describe significant work events (e.g., relations with colleagues, supervisors, and customers) that positively or negatively impacted them. They also measured negative emotional reactions with a limited number of items from PANAS (Watson, Clark, & Tellegan, 1988). Basch and Fisher (1998), on the other hand, utilised a cross-sectional study design to develop the prominent affective events matrix. They employed ten affect scales based on established measures to identify the pool of affective work events. They asked participants to retrospectively describe a recent work event or circumstance that made them feel one of the ten emotions. Unlike Basch and Fisher (1998), Junça-Silva, Pombeira, and Caetano (2021) employed the 18 items from Daily Hassles and Uplifts at Work scale to assess the frequency of daily hassles. Both positive and negative affect were evaluated using the 10-item PANAS (Watson et al 1988). While Erol-Korkmaz (2010) used two different open-ended questionnaire forms to identify as many events as possible that were associated with different emotions or moods. Unlike others, Casper, Tremmel, and Sonnentag (2019) employed a longitudinal research design via three data collection waves to test the hypothesised relationships and examine relationships' consistency. Positive interpersonal and task-related (positive and negative) work events were assessed in four waves (within three months intervals) using the affective events matrix developed by Basch and Fisher (2000). Whereas negative interpersonal work events were assessed using four items by Giebels and Janssen (2005). In addition to that, they utilised the PANAS by Watson et al (1988) to assess positive and negative affect. Having said that, the current method utilised by affective work events scholars predominantly relies on a self-reporting mechanism that is vulnerable to common method bias and other limitations. Therefore, this article provides insight into the usefulness of the Kansei Engineering-Kawakita Jiro (KJ) method to minimise current method limitations as it offers a platform to capture affective work events based on group consensus.

4 INTEGRATING KANSEI ENGINEERING AS A NEW APPROACH

Kansei is often used to communicate people's feelings about their surroundings or situations. Although Kansei is difficult to define in other languages because it is solely inherited from Japanese culture, it can be translated as sensitivity, sensibility, feeling, and emotion in general (Lokman, 2010). The KJ method is one of the KE approaches that are well suited to gathering qualitative data via fieldwork to identify human affective responses via group consensus. The KJ technique is thought to best extract and organise social structure constructs that support individual behaviour within an organisation on a multilateral basis (Norikoshi, Kobayashi, & Tabuchi, 2018). Via qualitative technique that involves a brainstorming session, the KJ method helps organise ideas, problems, and solutions into similar groups. It aids in classifying and organising a significant amount of disjointed and ambiguous data into logical, cohesive categories (Mohd, Othman, Ibrahim, & Jaafar, 2018; Mahmud, Jaafar, & Ibrahim, 2018). Affinity diagrams, also known as KJ diagrams, are a type of brainstorming tool that groups vast amounts of disorganised data and information based on natural relationships (Pareek & Satapathy, 2020). Besides, the emotion classification tool called Lokman's Emotion and Importance Quadrant (LEIQ™) could be utilised to indicate the priority of the identified events based on positive and negative taxonomy (Lokman et al, 2019). While the initial development of KE has been concentrated on tangible products, recent studies have shown a growing interest in human resource aspects (Tan, Lee, Bong, & Sofian, 2017; Tsuchiya et al, 2018; Tsuchiya, 2019; Zhao, Yang, Liu, & Zeng, 2018; Butlewski, 2019). The KJ method has also been utilised to identify employees' emotions in a workplace domain (e.g., Mohd et al, 2018; Tsuchiya, Lokman, Kadir, & Noordin, 2018; Mahmud et al, 2018; Tsuchiya, 2019). Most importantly, the KJ Method was utilised to identify the eliciting events that invoked employees' emotions (happiness) at a public university domain (Tsuchiya et al, 2018; Tsuchiya, 2019). Therefore, the following framework for methodological approach (Figure 1) is proposed to integrate the Kansei-Based KJ Method mechanism into the CWB model:

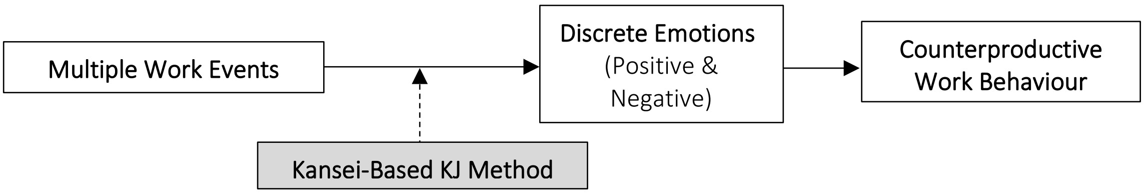

Figure 1. The Integrated Kansei-Based KJ Method in Multiple Affective Work Events-CWB Model

The reason for recommending the KJ method is to generate as many as possible the events that elicit employees' positive and negative emotions based on group consensus. As illustrated in Figure 2, the KJ method flow process is adapted from Lokman et al (2019).

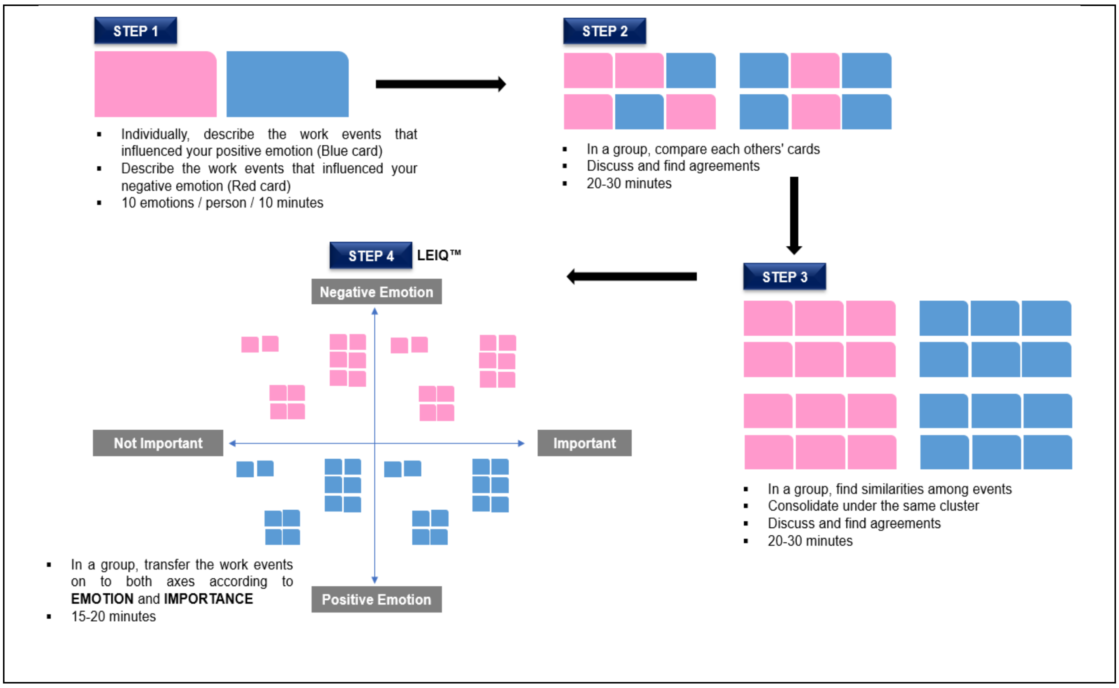

Figure 2. KJ Method Flow Process

5 DISCUSSIONS

The growing body of evidence established various workplace events as a primary cause of employees' affective states (positive and negative emotions). Thus far, the empirical evidence supports the notion that both negative and positive emotions significantly influenced CWB through positive and negative interaction. Hence, understanding the work events that arouse negative and positive emotions would enable comprehensive mitigation actions against such contributing factors. This effort is thought to be relevant as different work events affect employees' emotional states differently, which in turn leads to diverse CWB. Based on the affective work events literature, thus far, various mechanisms have been employed to identify the work events that preceded employees' emotional reactions at work. Generally, previous research utilised four common research designs: diary study, ESM, cross-sectional study, and longitudinal study. The approach for each design is identical in terms of the survey studies and self-reporting mechanism, but the procedures appear to vary from one another. Note that there are various limitations associated with the daily reporting mechanism. For example, the amount of information collected in such a survey using daily reporting is limited due to time constraints (Matta et al, 2014). Moreover, a low response rate is a common challenge faced by daily study design researchers (Clark et al, 2018). Participants did not disclose any positive or negative events because of their reluctance to commit extra effort by frequently reporting similar work events over several days (Ohly & Schmitt, 2015). In addition, it seems that the assessed unpleasant events weren't all that bad because people were forced to record a negative and a positive event every day. This has been confirmed by the fact that negative events have much lower mean intensity scores than positive events (Demerouti & Cropanzano, 2017). Notably, the daily diary study sample was also limited to employees who had an internet connection and could use it during work hours (Woznyj et al, 2021). Meanwhile, the limitations of the other two designs (i.e., cross-sectional and longitudinal study), which are identical to daily study design, are the reliance on self-report to measure affective events that might be vulnerable to common-method bias (Demerouti & Cropanzano, 2017; Clark et al, 2018). Furthermore, the existing methods, which rely on survey mechanisms, cannot be used to obtain any additional clarification. As a result, data reliability is strongly influenced by survey design and response quality. Moreover, it does not capture respondents' feelings, behaviour, or emotional changes. In contrast, focus groups can offer a wider range of information and the chance to ask questions if there are any areas that require more clarity (Queirós, Faria, & Almeida, 2017). Unlike other focus group techniques, the KJ method enables both data collection and analysis to be performed simultaneously. It is plain to see common focus group techniques require subsequent activity, including transcribing and analysing. Additionally, a conventional focus group involves participants with specific characteristics that limit a greater generalisation (Smithson, 2000). Hence, the KJ method contributes to time-saving and reduces extra effort to analyse the data separately. In addition, KE based KJ method would enable the generation of cohesive implicit responses based on group consensus, hence minimising the effect of self-reporting bias. In addition to that, with the use of LEIQ™, the priority of the events can be identified.

6 CONCLUSION

This article contributes to the respective literature in numerous aspects. First, although the past decade of research has discussed the importance of multiple affective work events (e.g., Basch & Fisher, 1998; Erol-Korkmaz, 2010; Matta et al, 2014), the recent studies appeared to focus on a single work event as a single composite variable in defining employees' emotional state and CWB at work (e.g., (e.g., Jahanzeb et al, 2020; Griep et al, 2022). According to Kansei's philosophy, subjective emotions are formed as a result of various stimuli, and this subjectivity must be objectified so that the stimuli and the subsequent emotional reaction are explicit. Therefore, in defining the CWB, the multiple work events that elicit employees' emotions need to be captured to understand a general pattern of affective needs that requires further attention. Second, most researchers investigating affective work events have utilised self-reporting mechanisms to capture the daily affective events. It's worth noting that this method results in common method bias and other issues like time constraints, low response rate, and rigid survey structure. Although KE has been established as being well-suited to be applied in understanding human emotions and psychology, it appears that this measure has not been thoroughly explored in the CWB research. Thus, this article contributes to the importance of methodology by introducing a new approach, i.e., the Kansei-Based KJ Method, in identifying the affective experiences at work via group consensus, hence minimising survey studies and self-reporting drawbacks. Finally, on top of the proposed framework, this article provides a KJ Method flow process that future studies could replicate to assess employees' affective experience in defining other organisational behaviour. Notwithstanding that, this paper suggests a practical way to reach optimum quality and validity of the data that practitioners could employ. This article is not excluded from its downsides. For example, focus groups can be challenging to organize, regulate, and persuade people to participate. Thus, they might not be an accurate representation of non-users (Queirós et al, 2017). As previously mentioned, this article explicitly focuses on AET as a descriptive framework for describing the affective events and discrete emotions that influence employees' CWB. Thus, we see various alternative theoretical explanations for the proposed model that might assist inform future research. Despite understanding employees' affective experience, other underlying mechanisms could be incorporated to mitigate the CWB prevalence. For instance, if moral and religious rules are embodied and bind individuals, they will willingly reduce their proclivity for transgression. Therefore, religion is one of the major aspects impacting one's ethical considerations (Dora & Azim, 2019). Despite behavioural control measures, religiosity was found to be significant in emotion regulation strategies (cognitive reappraisal) (Vishkin, Bigman, Porat, Solak, Halperin, & Tamir, 2016). From this theoretical point of view, religiosity-based emotion regulation strategies may serve as a significant variable to buffer the affective state-CWB relationship.

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CONSTRUCTION OF FACIAL SKIN TEMPERATURE-BASED ANOMALY DETECTION MODEL FOR DAILY FLUCTUATIONS IN HEALTH CONDITIONS

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ABSTRACT

A method for estimating health conditions is required to monitor daily health conditions. Various types of data have been used in healthcare studies; however, imaging data are superior because they allow quick and remote measurements. Thermal face images can be measured safely and economically using infrared thermography. Many physiological and psychological states have been evaluated based on the data from these images. A previous study, using short-term experiments, confirmed that an anomaly detection model constructed using a variational autoencoder enables the detection of anomalous states of thermal face images. A long-term experiment is essential to estimate long-term fluctuating human states, such as health conditions. The purpose of this study is to construct a facial skin temperature-based anomaly detection model for human health conditions. The authors obtained thermal face images with health condition questionnaires for approximately a year. Based on the questionnaire responses, the thermal images in good and poor health conditions were labeled “normal state” and “anomaly state,” respectively. The facial skin temperature-based anomaly detection model for health conditions was constructed using a variational autoencoder with only thermal face images in the normal state. The AUC, which represents anomaly detection performance, was 0.70. In addition, an increasing trend of the performance of the model by learning a wider area of skin temperature was confirmed.

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Keywords: Thermal face image, Human health monitoring, Healthcare monitoring, Poor health conditions, Deep learning

1 INTRODUCTION

Everyone knows the importance of understanding their own health conditions and dealing with them appropriately. An increasing number of companies are focusing on providing healthcare for their employees. To realize daily health monitoring, a method for estimating the health conditions is required because it is difficult for people to be fully aware of their psychological and physical issues. In healthcare studies, the application of machine learning methods has been increasing, and deep learning methods, in particular, have demonstrated high performance and potential for multiple tasks (Miotto et al., 2018). Deep learning methods can effectively obtain information from complex data, such as biometric data. Various types of data used in these studies include health records (Solares et al., 2020), genomic data (Fakoor et al., 2013), electroencephalogram data (Acharya et al., 2018), and magnetic resonance imaging data (Liu et al., 2014).

Imaging data are superior because they allow quick and remote measurements, and thermal face images are often used in studies to estimate physiological and psychological states. A thermal face image is the skin temperature image of a face and can be measured quickly, remotely, safely, and economically using infrared thermography (Ring, 2014). Skin temperature varies with the amount of skin surface blood and is controlled by the autonomic nervous system. Therefore, it is a reliable tool that estimates physiological and psychological states (Ioannou, Gallese, & Merla, 2014). Based on this information, evaluations of various human states such as stress (Engert et al., 2014), emotions (Ebisch et al., 2012), and drowsiness (Bando, Oiwa, & Nozawa, 2017) have been performed. Studies applying deep learning to thermal face images have estimated some human states such as drunkenness (Koukiou & Anastassopoulos, 2015), exercise-induced fatigue (Lopez, del-Blanco, & Garcia et al., 2017), and drowsiness (Adachi, Oiwa, & Nozawa, 2019). In these studies, estimations were conducted using classification models.

Estimating human health conditions using classification models requires training the model using thermal face images under poor as well as normal health conditions. Generally, obtaining thermal images under poor health conditions is much more challenging than obtaining them under normal health conditions. Anomaly detection methods can solve this problem. A variational autoencoder (VAE) (Kingma & Welling, 2013), known as a deep generative model, enables the construction of anomaly detection models using only the normal data (An & Cho, 2015). Thus, an anomaly detection model for human health conditions is constructed, without the use of thermal images under poor health conditions, using the VAE.

Masaki et al. confirmed that an anomaly detection model constructed using the VAE enabled the separation of two states of thermal face images (Masaki et al., 2021). Two states of the thermal face images were obtained in a short-term experiment; one state was obtained when the subject was just set in a chair, and the other state was obtained when the subject raised their blood pressure by breath-holding. Takano et al. performed anomaly detection considering diurnal variations in thermal face images (Takano et al., 2022). Thermal face images in normal and anomalous states were obtained every hour in a 16-hour experiment using the method described by Masaki et al. In these studies, thermal face images were obtained during the experiment in a day, and high blood pressure caused by breath-holding was defined as an anomalous state. However, obtaining thermal face images through a long-term experiment is essential to estimate long-term fluctuating human states, such as health conditions. Additionally, defining poor health conditions as anomalous states is needed to evaluate an anomaly detection model for health conditions. The purpose of this study is to construct a facial skin temperature-based anomaly detection model for human health conditions. To achieve this, thermal face images were obtained for approximately one year, and an anomaly detection model was constructed. Finally, the performance of the constructed model was evaluated using thermal images under good and poor health conditions.

2 METHODS

2.1 Data collection

2.1.1 Experiment systems

Thermal face images with health conditions questionnaires were obtained for approximately a year (September 2020 to November 2021). The subjects constructed of 33 healthy adult males aged 21–51 years. The measurement environment is illustrated in Figure 1. An infrared thermography camera (Boson, FLIR Systems, Wilsonville, OR, USA) was placed at 1.0 m in front of the subject. A tablet (iPad, Apple, Cupertino, CA, USA) was placed near the camera to complete the questionnaire. The measurement was conducted at a room temperature range of 25.3–30.9 °C at the subject's discretion. The temperature resolution of the camera was 0.1 °C. The size of the thermal image was 256 × 320 pixels. An example of a measured thermal images is shown in Figure 2.

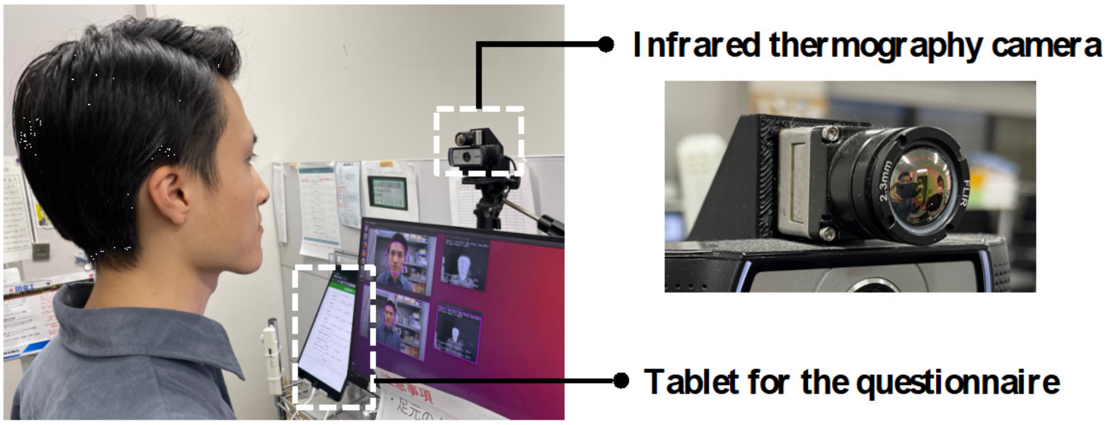

Figure 1. Measurement environment

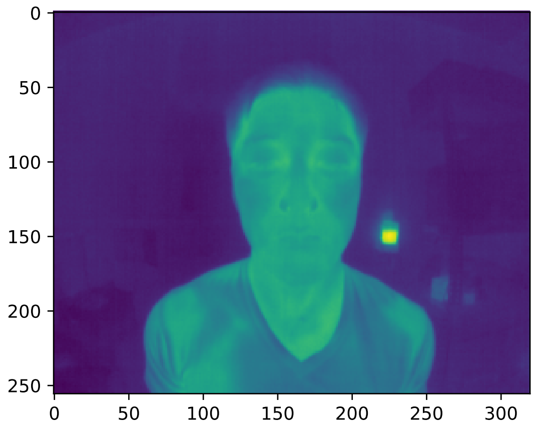

Figure 2. Example of measured thermal image

The subjects were asked to complete the questionnaire immediately after measuring their thermal images. The screen for answering the questionnaire is shown in Figure 3. The questionnaire consisted of four questions regarding health conditions, and the participants choose only one answer for each question.

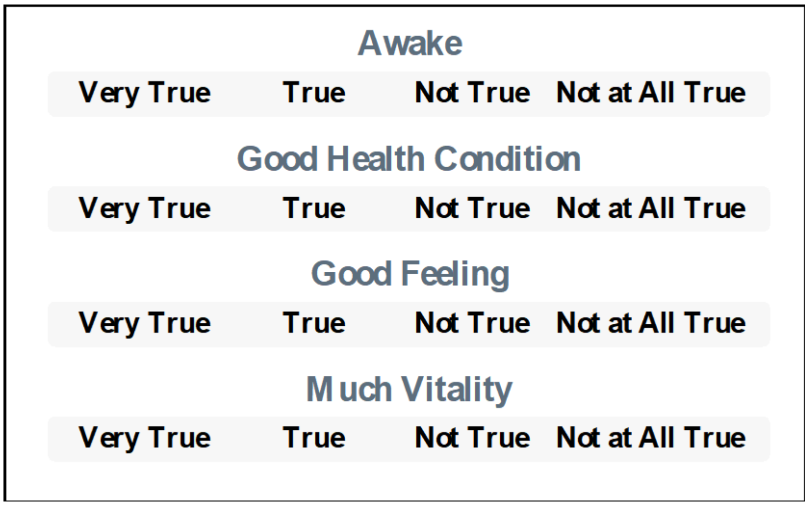

Figure 3. Screen for answering the questionnaire

2.1.2 Definitions of Normal and Anomaly

The obtained thermal face images were labeled as "normal state" and "anomaly state" based on the questionnaire answers. If all answers were "Very True," the thermal image was labeled as "normal state," indicating good health conditions. If at least one answer was "Not at All True," the thermal image was labeled as "anomaly state," indicating poor health conditions. Among obtained 612 thermal images, 175 were labeled as "normal state," and 66 were labeled as "anomaly state." 371 thermal images not labeled as "normal state" or "anomaly state" were not used in this study.

2.2 Model construction

2.2.1 Overview of VAE framework

VAE is an autoencoder-type network, as shown in Figure 4. The input and output data have the same dimensions, and the latent variables have fewer dimensions than the input data. The VAE comprises an encoder, which transforms the input data into the latent variables, and a decoder, which reconstructs the input data from the latent variables. The difference between the input and the reconstructed input is called the reconstruction error. Training is performed to minimize the reconstruction error. Through this process, the VAE learns the probability distribution of latent variables to reconstruct the input data. An anomaly detection model is constructed under the framework of semi-supervised learning using only the normal data for training the VAE. The reconstruction error calculated by inputting data into the trained VAE indicates the anomaly degree of the data.

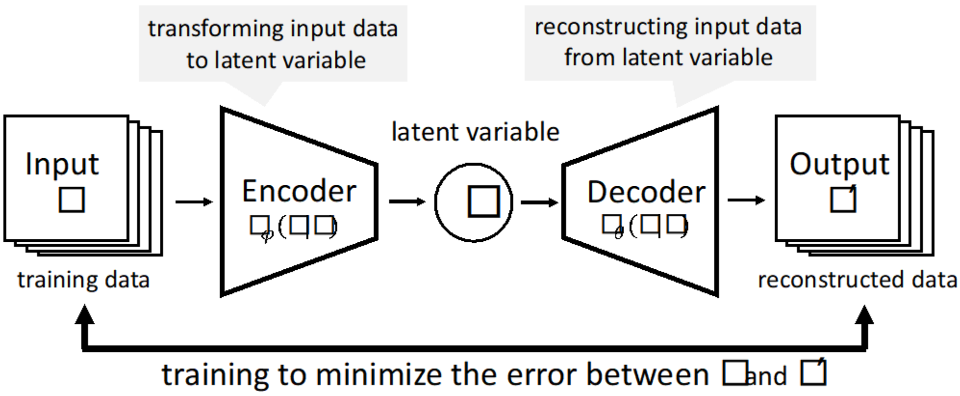

Figure 4. Overview of VAE

2.2.2 Model construction using VAE

The anomaly detection model was constructed using 109 thermal face images in the normal state. Model performance evaluation was conducted using 66 thermal face images in both, the anomaly state and as well as the normal state; these images were not used for model construction. The thermal face image was cut out from the thermal image based on 68 facial landmarks. Facial landmarks were obtained using a method proposed by Nagumo et al. (Nagumo et al., 2021). The examples of thermal image with 68 facial landmarks and cut-out image are shown in Figure 5; the red plots are facial landmarks, and the black square frame represents the cut-out area

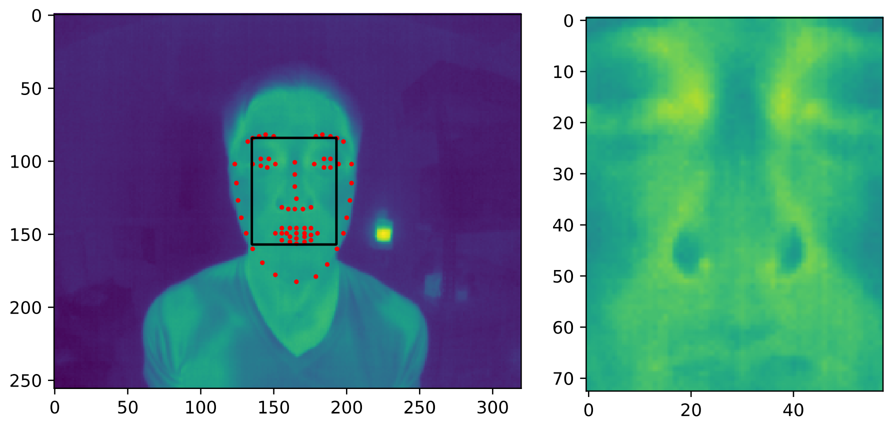

Figure 5. Examples of thermal image with facial landmarks and cut-out thermal face image

Each thermal face image was resized to 66 × 66 pixels. The mean and standard deviation of the pixel values were set to 0 and 1, respectively, using z-score normalization. The VAE was trained using 100,000 patches that were randomly cut from 109 resized thermal face images in the normal state. The patch size was set to $S_p \times S_p$ pixels, and S_p was selected from $S_p \in \{8, 16, 32, 64\}$. The dimensions of the latent variables N_z were selected from $N_z \in \{2, 8, 16, 32, 64\}$. Nine models were constructed for each condition, considering the variations in model performance.

2.3 Anomaly detection

Anomaly detection was performed by plotting the thermal face images based on the mean unregularized score (Matsubara et al, 2020). The unregularized score M_{VAE} was calculated by applying a thermal face image for evaluation to a trained VAE. The equation for the unregularized score is as follows.

$$M_{VAE} = \sum_{i=1}^{N_x} \frac{1}{2} \frac{\left(\boldsymbol{\mu}_{x_i} - \boldsymbol{x}_i\right)^2}{\boldsymbol{\sigma}_{x_i}{}^2} \Bigg|_{z=\mu_z} \tag{1}$$

The above equation is directly related to the reconstruction error. N_x and $\boldsymbol{x}_i$ represent the number of pixels in the image and pixel value, respectively. $\boldsymbol{\mu}_x$ and $\boldsymbol{\sigma}_x$ are a pair of mean and variance vectors for the conditional probability of the latent variables $\boldsymbol{z}$. The mean unregularized score was calculated by dividing the unregularized score by the number of pixels.

3 RESULTS AND DISCUSSION

An example of thermal face images plotted for model evaluation is shown in Figure 6.

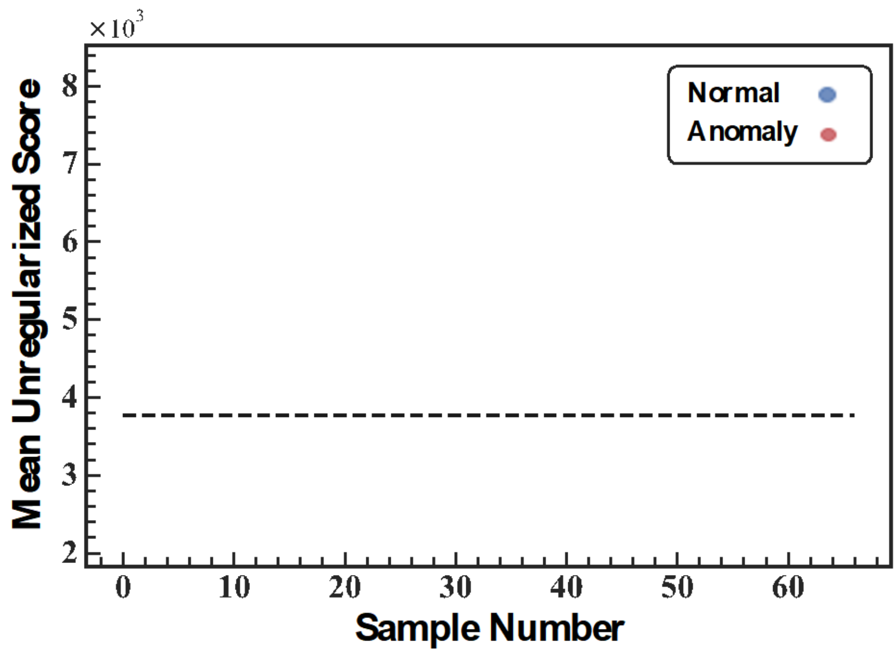

Figure 6. Example of thermal face images plotted for evaluation

Plotting was performed by the VAE trained under the conditions of $S_p = 64$ and $N_z = 64$. The red plots are thermal face images in the anomaly state, and the blue plots are thermal face images in the normal state; these images were not used for model construction. The black dotted line represents the threshold for anomaly detection. A mean unregularized score at which the sum of the true positive rate and the true negative rate is maximum was set as the threshold. The true positive rate is the proportion of correct predictions in the anomaly class, and the true negative rate is the proportion of correct predictions in the normal class. The equations for the true positive and true negative rates are as follows.

$$True\ Positive\ Rate = \frac{(True\ Positive)}{(True\ Positive\ + False\ Nagative)} \tag{2}$$

$$True\ Negative\ Rate = \frac{(True\ Negative)}{(True\ Negative\ + False\ Positive)} \tag{3}$$

In this example, the true positive and true negative rates were 0.67 and 0.68, respectively. This result indicates that facial skin temperature-based anomaly detection models enable the detection of poor health conditions. The receiver operating characteristic (ROC) curve of the model under the conditions of 64 for S_p and 64 for N_z is shown in Figure 7.

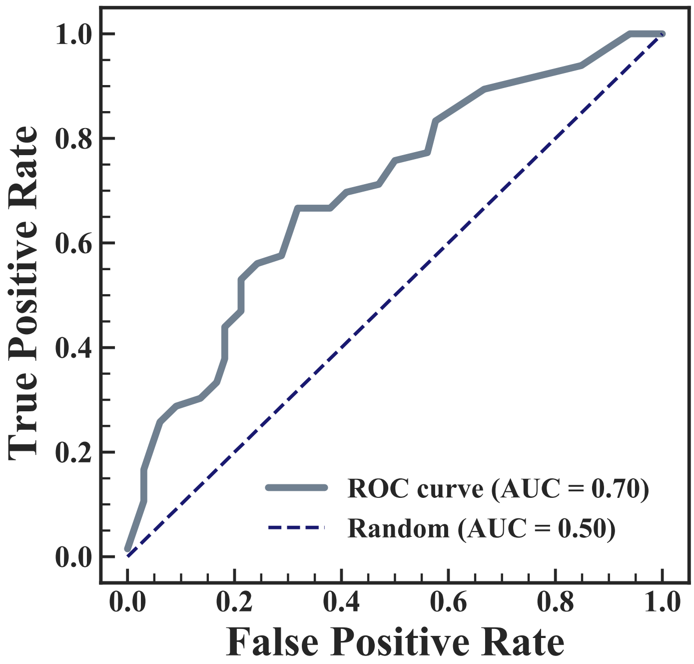

Figure 7. Example of a ROC curve

The ROC curve is a two-dimensional graph that plots the true positive rate on the y-axis and false positive rate on the x-axis. The false positive rate is the proportion of incorrect predictions in the normal class. The equations for the false positive rate are as follows.

$$Folse\ Positive\ Rate = \frac{(False\ Negative)}{(True\ Positive\ + False\ Nagative)} \tag{2}$$

The area under the ROC curve (AUC) is a single scalar value that represents the expected classification performance of a model (Fawcett, 2006). In this example, the AUC of the model was 0.70. The maximum AUC for each condition is shown in Figure 8.

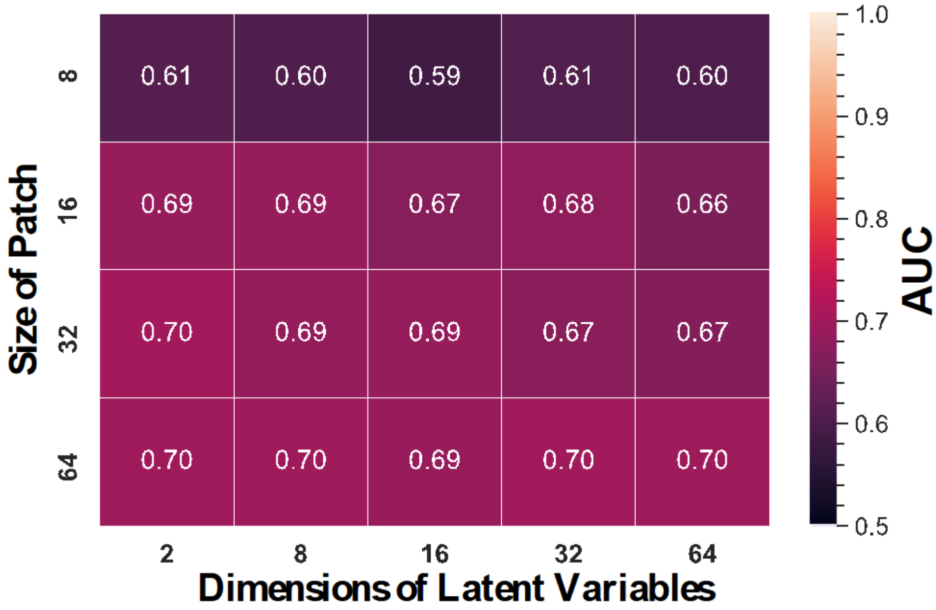

Figure 8. Maximum AUC for each model construction conditions

The overall maximum AUC was 0.70, and the AUC was higher for conditions with a larger patch size. This result indicates that learning a wider area of skin temperature improves the classification performance of the model. Oiwa et al. concluded that long-term variability of facial hue information around the periorbital region could be related to health conditions (Oiwa et al., 2021). This suggests a relationship between a wide range of facial hue information and health conditions. The authors believe that facial skin temperature is also related to health conditions because facial skin temperature also varies with the amount of skin surface blood, similar to facial hue information.

4 CONCLUSION

The purpose of this study was to construct a facial skin temperature-based anomaly detection model for human health conditions. The authors obtained thermal face images for approximately one year and constructed an anomaly detection model. Finally, the performance of the constructed model was evaluated using thermal face images under good and poor health conditions. Consequently, thermal face images in poor health conditions were detected using the proposed detection model. The AUC of the model with the highest accuracy was 0.70. The AUC was improved by learning a wider area of skin temperature. However, continuous data collection is required in the future to improve accuracy. Moreover, investigations on the influence of ambient temperature and construction of models using other information, such as facial hues, are needed to gain better insights.

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CROSS-MODAL EFFECT BETWEEN TASTE AND SHAPE CONTROLLED BY CURVATURE ENTROPY

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ABSTRACT

In recent years, cross-modal effects in which perceptions interact with each other have been drawing attention. In the case of the cross-modal effect between vision and taste, the effect of the angularity of shapes on taste has been widely studied while there has been little research on the other features of shapes. Previous studies have shown that the emotional valence arisen from visual perception causes the cross-modal effect between vision and taste. Therefore, this study focuses on the complexity of shapes, which is said to influence emotional valence, as a visual stimulus and aims to confirm the cross-modal effect induced by its sensation. First, based on previous research, the hypotheses about the effects of the complexity of shapes on taste were made. Second, by using particle swarm optimization algorithm, closed curve shapes were generated based on curvature entropy, a quantitative index of the complexity of shapes, which indicates the randomness of curvature transition. Third, cup holders, which had these closed curve shapes on their sides, were created by using a 3D printer. Finally, by comparing the tastes of orange juice in these cup holders, the effect of the complexity of shapes on the perception of sweetness, sourness and intensity was confirmed. The results suggest that the complexity of shapes controlled by curvature entropy weakens the perception of sweetness whereas it enhances that of sourness and intensity. This finding can be used for reducing sugar intake in bottle packaging.

Keywords: *cross-modal, shape, complexity, taste, curvature entropy*

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1. INTRODUCTION

In recent years, cross-modal effects in which perceptions interact with each other have been drawing attention (Yanagisawa, 2018; Lin et al., 2021). In the case of the cross-modal effect between vision and taste, the effect of the angularity of shapes on taste has been widely studied (Blazhenkova & Kumar, 2018; Velasco et al., 2015; Velasco et al.,2016; Ngo et al., 2011; Becker et al., 2011; Van Rompay et al., 2017) while there has been little research on the other features of shapes (Turoman, 2018; Salgado-Montejo et al., 2015). Previous studies have shown that the emotional valence arisen from visual perception causes the cross-modal effect between vision and taste (Turoman, 2018; Salgado-Montejo et al., 2015). Therefore, this study focuses on the complexity of shapes, which is said to influence emotional valence (Palmer, Schloss, & Sammartino, 2013), as a visual stimulus and aims to confirm the cross-modal effect induced by its sensation. From the previous studies, it is estimated that the complexity of shapes controlled by curvature entropy weakens the perception of sweetness whereas it enhances that of sourness and intensity.

This paper is organized as follows. Section 2 illustrates the method to generate shapes using index of the complexity of shapes. Section 3 presents the method of the experiment. Then, Section 4 shows results and discussion of the experiment. Lastly, Section 5 provides conclusions.

2. SHAPE GENARATION

2.1. Quantification of complexity

Curvature entropy H was proposed as a quantitative index of the complexity of shapes (Ujiie et al., 2012; Matsumoto et al., 2019; Okano et al., 2020; Kato & Matsumoto, 2020). On calculation of H, firstly, the closed curve shape is divided into equal portions and the curvature κ on each portion is calculated. Next, using the maximum diameter D of the shape, the dimensionless curvature κ^* is calculated by Equation (1). Here, κ^* is used to obtain the dimensionless curvature function $\kappa(l)$, which is a function of the curve length l and κ^*, as shown in Fig. 1.

$$\kappa^* = \kappa D \tag{1}$$

Then, κ^* on each portion is quantized into each state s_i ranging from -E to E (the total number of states is V) as shown Fig.1.

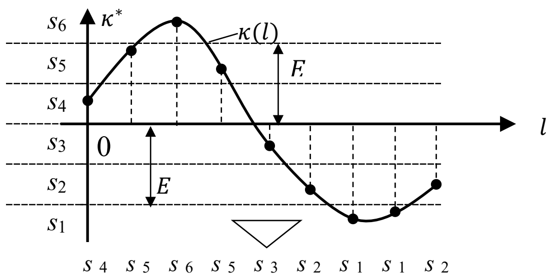


Figure 1. Plotting curvature of each curve unit and classifying curvatures into some groups (quantization)

Lastly, H is defined as Equation (2) based on q_i (the occurrence probability of state s_i) and $q_{i,j}$ (the transition probability from state s_i to state s_j).

$$H = -\frac{1}{\log_2 V}\sum_{i=1}^{V}\sum_{j=1}^{V} q_i q_{i,j} \log_2 q_{i,j} \tag{2}$$

2.2. Generation of closed curve shapes

In this study, closed curve shapes are drawn by cubic Bézier curves with 14 connection points. Cubic Bézier curves are the curves defined by connection points and control points (Yamaguchi, 1988). Next, this study used particle swarm optimization algorithm for generation of closed curve shapes. This is an algorithm to search for a global solution by considering the parameters for the optimization as particles (Kennedy, 1995). Each particle has four pieces of information: current position, private best position, global best position, and velocity. Based on this information, an optimal solution candidate is obtained by updating the current position and velocity of each particle until the degree of adaptation f satisfies the allowable range $f_{\max}$. In generation, the distance moved from each connection point of the basic shape was used as the current position in the particle swarm optimization. Additionally, the symmetry of the shape, the flatness of the upper and bottom parts, and the maximum distance moved from each connection point were set as the constraints for the generation of closed curve shapes.

3. METHOD

This section illustrates the conditions for the experiment.

1. Participant：

In order to verify the effects of the complexity of shapes against other shape features, samples were divided into 3 groups, showing other shape with the same level of complexity for each group. Additionally, the previous research pointed out that age can modulate the degree of cross-modal effects (Forde & Delahunty, 2004). Therefore, subjects were divided with minimum age differences within and between groups.

- 1st group: 10 participants (7 males, 3 females), ranging in age from 20 to 22 years (M = 21.4, SD = 0.8).
- 2nd group: 10 participants (7 males, 3 females), ranging in age from 20 to 23 years (M = 21.6, SD = 1.0).
- 3rd group: 10 participants (7 males, 3 females), ranging in age from 19 to 22 years (M = 21.0, SD = 1.1).

2. Sample shapes：

The parameters of H on cupholder shapes were optimized for human cognition, and a coefficient of determination R^2 of logarithmic approximation was 0.634 when {E, V} were {0.4, 15}. Under these parameter settings, 12 closed curve shapes (three shapes for each level of H) were generated in total, using the four levels of H as the objective function to generate shapes other than the basic shape, as shown in Fig.2. Cup holders with the generated closed curve shape on its silhouette was created by using a 3D printer. Then paper cups in these cupholders were filled with 100% orange juice and presented to the participants. Besides, the cup holders were painted black to make it easier to recognize the silhouette of cupholders referring to the past research (Van Rompay et al., 2017).

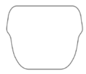
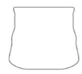
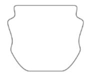
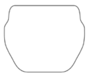
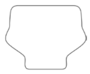
	Sample 1 (Basic Shape)	Sample 2	Sample 3	Sample 4	Sample 5
Curvature entropy	0.047	0.071	0.095	0.118	0.142
Group 1					
Group 2					
Group 3					

Figure 2. Closed curve shapes generated by PSO

3. Environment：

To minimize the effects of sound (Guetta & Loui, 2017), temperature (Maehashi, 2011), and lighting (Van der Heijden et al., 2021), experiment was conducted in a quiet room where the temperature was kept at about 20 degrees Celsius, and the illumination was kept at about 520 Lx. As shown in Fig.3, two samples placed at eye level were tasted with a straw, without being touched by hands since the surface roughness of cupholders can affect taste (Van Rompay et al., 2021).

Figure 3. Experimental environment

4. Evaluation：

From the two samples out of five samples allocated for each group, the participants were asked to select the sample with the greater sweetness, sourness, and intensity. Evaluations were conducted 21 times per one participant, with the first evaluation being a practice session.

To eliminate the effect of the presentation order, which has been pointed out in previous studies (Pich et al., 2020), the participants were asked to evaluate the samples both in the order of sample A to sample B and sample B to sample A.

4. RESULTS AND DISCUSSION

Based on Thurston's pairwise comparison method, evaluated values on Thurston's scale of taste were calculated (Indo, 1962). Using the evaluation value of the basic shape (Sample1) as the reference value, these evaluation values were corrected by calculating the difference from the reference value in order to make comparisons between groups. Figures.4-6 illustrate the relationship between curvature entropy and corrected Thurstone's scale of sweetness, sourness and intensity.

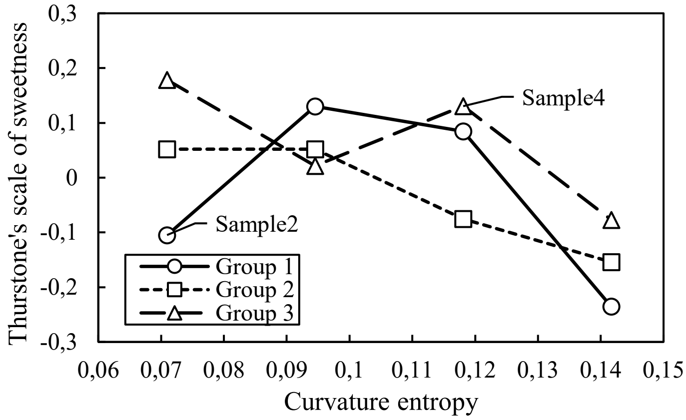


Figure 4. Relationship between curvature entropy and Thurstone's scale of sweetness

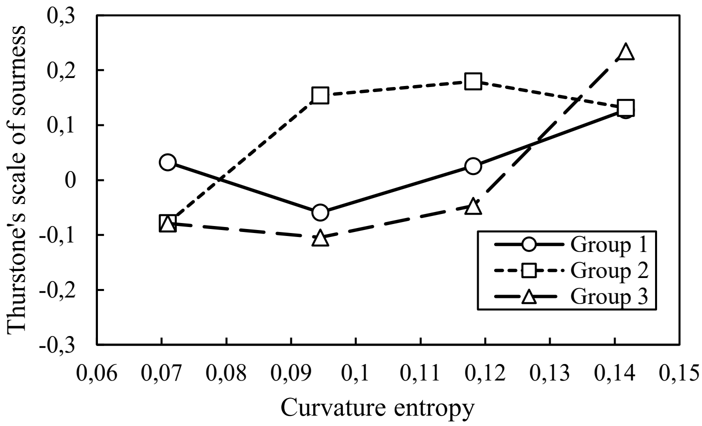


Figure 5. Relationship between curvature entropy and Thurstone's scale of sourness

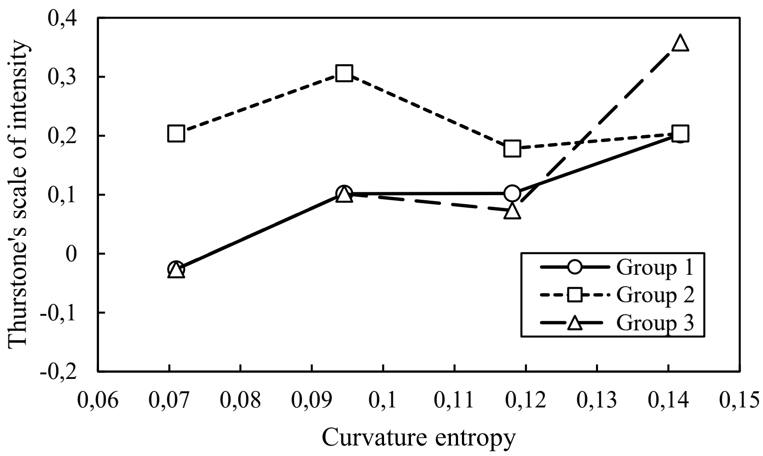


Figure 6. Relationship between curvature entropy and Thurstone's scale of intensity

For these corrected values, a one-way analysis of variance was conducted to examine the significance of the variability between groups relative to the variability within each group. The results were significant at the 5% level for sweetness, sourness and intensity. In other words, H was found to be a factor that modulates sweetness, sourness, and intensity. Then, the correlation coefficients were calculated in order to examine what kind of trends existed in the sweetness, sourness, and intensity according to change in H. The result illustrates that sweetness had a negative correlation with H, while sourness and intensity had a positive correlation. (Sweetness: -0.559, Sourness: 0.667, Intensity: 0.557)

Here, we discuss the shapes that deviated from the trend shown in Figs.4-6. Due to space limitation, we mainly discuss the result of sweetness which shows characteristic trend. Firstly, the evaluated value of sweetness for sample 2 in the first group was low compared to the trend. Since the impression of sweetness is high when the center of gravity is low (Arboleda & Arce-Lopera, 2020), we can estimate that the evaluated value of sweetness was low because the center of gravity position was higher for sample 2 in the first group than for the other shapes. As for sample 4 in the third group, the evaluated value of sweetness was high compared to the trend. Since rounded shapes tend to give the impression of sweetness (Van Rompay et al., 2017), we can estimate that the evaluated value of sweetness was high because the gentle curve near the mouth of the cup easily illuminated when output in 3D, and it may have been emphasized and gave the impression of roundness.

5. CONCLUSION

This study focused on the complexity of shapes controlled by curvature entropy as a visual stimulus and aimed to confirm the cross-modal effect induced by its sensation. The results suggest that the complexity of shapes controlled by curvature entropy weakens the perception of sweetness whereas it enhances that of sourness and intensity. This finding can be used for reducing sugar intake in bottle packaging.

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DESIGN AESTHETICS RECOMMENDER SYSTEM BASED ON CUSTOMER PROFILE AND WANTED AFFECT.

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ABSTRACT

Product recommendation systems have been instrumental in online commerce since the early days. Their development is expanded further with the help of big data and advanced deep learning methods, where consumer profiling is central. The interest of the consumer can now be predicted based on the personal past choices and the choices of similar consumers. However, what is currently defined as a choice is based on quantifiable data, like the product features, cost, and type. This paper investigates the possibility of profiling customers based on the preferred product design and wanted affects. We considered the case of vase design, where we study individual Kansei of each design. The personal aspects of the consumer considered in this study were decided based on our literature review conclusions on the consumer response to product design. We build a representative consumer model that constitutes the recommendation system's core using deep learning. It asks the new consumers to provide what affect they are looking for, through Kansei adjectives, and recommend; as a result, the aesthetic design that will most likely cause that affect.

Keywords: *Product design, Recommendation system, Consumer design perception, Kansei engineering.*

1 INTRODUCTION

Recommender systems have been crucial for online commerce, and their importance keeps growing with the increasing amount of products in the market. While the consumer profiling systems have effectively solved the problem of product recommendation, the problem of "design

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recommendation" is more challenging because an aesthetic design cannot be handled in a quantifiable manner, similarly to the product features. Therefore, solving this problem requires recommender systems to handle design aesthetics and consider that consumer perception of design is variable.

Different consumer groups perceive the same design differently (Perez Mata et al., 2017). Research studies related to consumer perception of a product design suggested that we adopted a unified position in product aesthetics appreciation; thus, consumers from different backgrounds can perceive modern design similarly (Lin et al., 2007). It was found that consumer basic profile like gender and age, is not significant in aesthetic perception; however, consumer personality, namely the aspect of openness to experiences, correlates with perception variation of aesthetic design (Antinori et al., 2017; Fujiwara & Nagasawa, 2015b).

Recommender systems were born out of necessity in the early days of the internet due to the exponentially growing amount of information. The earlier items recommendation systems were centered around consumer feedback, where early consumer rating is used to rank the content for new consumers (Resnick et al., 1994). Then, hybrid recommenders introduced the use of consumer action information, such as buying an item or consuming content, besides manual rating (Burke, 2002). This idea encouraged collecting actions of multiple users, which led to more powerful recommenders based on consumer profiling (Pazzani & Billsus, 2007) coupled with the use of item information (Lorenzi & Ricci, 2003). Further development was made through context-aware recommender systems (Adomavicius & Tuzhilin, 2011).

Several recommendation systems stem from these basic ideas, such as the group recommendation system, where a preference of a group member related to an item can help predict the position of all group members regarding that item (Stettinger et al., 2015). Other recommendation systems assume that consumers with neighbouring characteristics most likely have similar preferences (Ricci et al., 2015). Or manually insert consumer preferences constraints in the consumer profile (Jameson et al., 2015). Personality is first introduced in such systems (Bologna et al., 2013) to consider that consumer rating is highly dependent on the personality aspect of agreeableness (Karumur et al., 2016). Then later, to take advantage of the similarity of presences between closely positioned personalities in music (Wang et al., 2021), TV programs (Asabere & Acakpovi, 2020), video games (Abbasi et al., 2020), and products (Huang et al., 2020).

In Kansei studies, the consumer affect is considered the current emotion compound. It corresponds to the most abstract, positive or negative, responses to a product design (Favart et al., 2016; Lévy, 2013). Machine learning methods have been employed efficiently in Kansei studies (Kobayashi et al., 2022; Kobayashi & Kinumura, 2017; Shieh et al., 2018; Ueda et al., 2021; Yamagishi et al., 2018). And used to model the affective response in the emerging field of aesthetic design recommendation (Kobayashi & Takeda, 2021; Yu et al., 2021). In this paper, we suggest a new method for aesthetic design recommendation based on consumer openness traits and wanted affect. The article is organized as follows; first, we present the proposed aesthetic recommendation system, then the implementation procedure for consumer affect modelling, describe the consumer affect experiment, and discuss the results.

2 PROPOSED AESTHETIC DESIGN RECOMMENDER SYSTEM

Figure 1. Illustrate the proposed aesthetic design recommendation system (ADRS) based on multiple affective responses and wanted affect. It consists of two parts: the first part is the offline modelling of the affective response to a set of variable designs collected from various consumers. And the second part consists of the interactive recommender, which will collect the personal aspects of an individual consumer and the affect they are looking for from a design and suggest the design that will most likely fit the affect wanted by this particular individual.

In a consumer modelling problem, an individual can be represented by multiple variables such as age, gender, work, etc. However, in our research review, we found that, when it comes to product design evaluation, only a few parameters have an observable connection with the aesthetic evaluation of a design. Namely, the personality aspect of openness, the prior exposure to similar designs, and mood at the moment of evaluation. So in this study, we attempt to model an individual consumer based on this information.

On the other hand, we collect the affective response to a set of designs using affective adjectives. Figure 2. Illustrate the research framework of the proposed method where we select the design variables of interest and create product variations. We then collect the affective responses of various consumers, using a set of designs that cover the scope of design variables. At the same time, we collect the consumer's characteristics. Using a Deep Neural network, we build the model mapping the connection between the individual character of the consumers and their affective responses. And used to predict the affective reaction of new consumers, using personal characteristics as input.

The recommender system then uses the consumer's wanted affect as the reference and finds the product design variation corresponding to that affective response's maximum. This response can be different from one consumer to another because their predicted affective response can be different based on their characteristics.

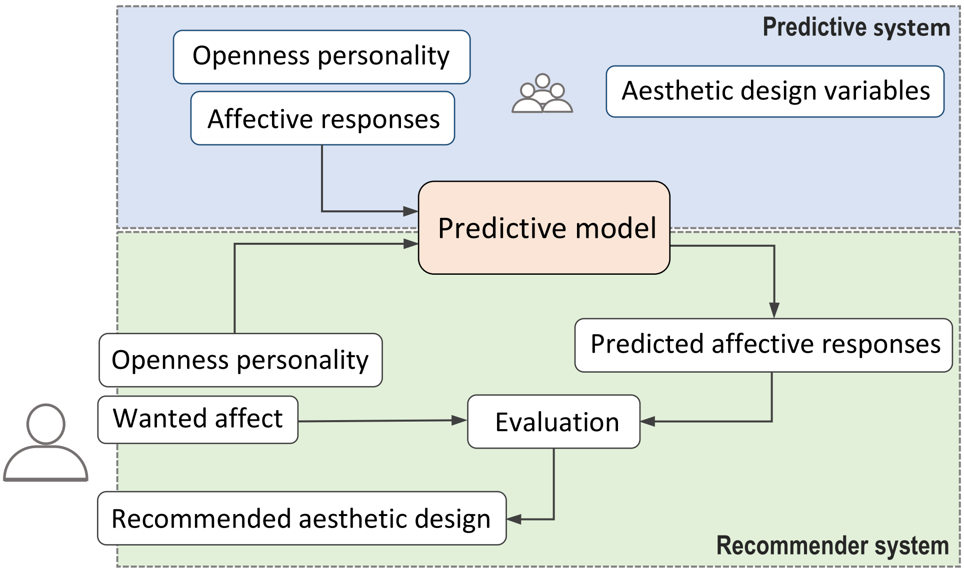

Figure 1. Overview of the affective response based ADRS

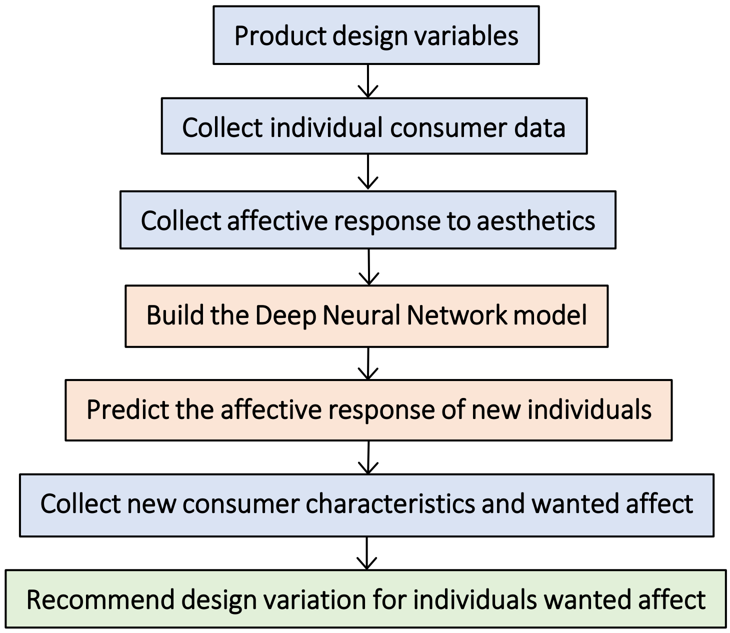

Figure 2. The research framework for the predictive model

3 IMPLEMENTATION PROCEDURES

We selected for this study the vase product for three reasons. First, it is a typical product that most people are familiar with and many own. Second, its aesthetics can be very distinguishable; therefore, variation in its design can evoke a wide range of affective responses. And lastly, decent designs can be generated mathematically, allowing flexibility in terms of automatic design generation and optimization based on consumer affective needs.

A vase here has two design variables: the size of the opening and the curvature. Plus two additional variables for texture, namely the number of vertical lines and the number of horizontal lines. The combination of these variables results in various aesthetic designs. Figure 3. Depicting the nine examples considered in the affective response experiment, they were chosen to represent diverse aesthetic looks, defining every design variable and at least treating each variable twice.

Participants were asked to rate the affective response of each design by selecting five degrees of affect (strongly disagree, disagree, neutral, agree, and strongly agree) in 12 affective adjectives, namely: Feminine, Emotional, Delicate, Elegant, Technological, Strong, Gentle, Traditional, Loud, Stable, Practical, and Luxurious. These Kansei adjectives were chosen based on research that studied vase design affective response and justified the relevance of these adjectives (Mata et al., 2019; Perez Mata et al., 2017; Shieh et al., 2018).

From the perspective of personal characteristics, we considered one question for mood, one question for exposure, and five questions for openness personality. These questions are as follows:

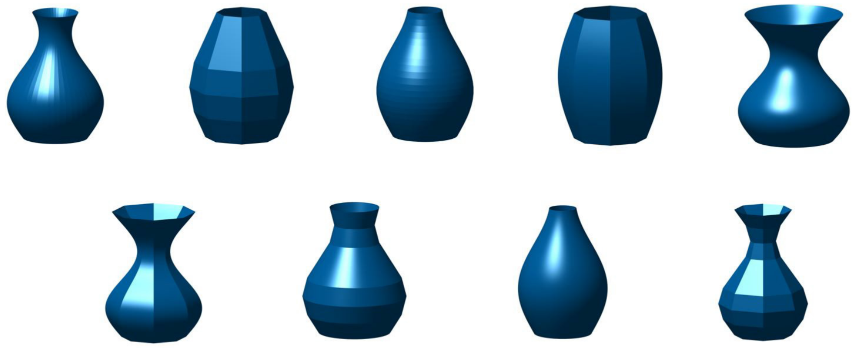

Figure 3. Representative Aesthetic design samples

1. How is your day going?
    - Options: Terrific!, Good and Other.
2. Do you own a vase at home?
    - Options: Yes and No.
3. Is it fun to be in the museum?
4. Do you enjoy discussing new ideas?
5. Do you love adventure?
6. Are you excited to try new activities?
7. Do you avoid philosophical discussions?
    - Options in question 3 to question 7: Not at all, Not much, A little and Very much.

We collect the affective response data using an online survey, where participants rated the pictures of the vase designs by selecting radio buttons corresponding to their affective responses. All participants rated the entirety of the design examples using all affective adjectives, resulting in 108 affective responses from each user. We collected 88 responses from participants of various backgrounds, ages, genders, and cultures, 41 participants were Japanese speakers, and 47 were English speakers.

Several research studies investigated the individual characteristics of the consumer but found a weak significance in consumer profile (Perez Mata et al., 2017), intelligence (Myszkowski et al., 2018), and culture (Higgins, 2017). However, personality (Fujiwara & Nagasawa, 2015a; Myszkowski & Storme, 2012) and exposure (Silvia & Barona, 2009) were found to be the strongest individual factors influencing the consumer design response. To investigate that, we clustered the participants based on their personality characteristics using the K-means algorithm.

The clustering result is considered after 100 algorithm runs. We found that the language did not significantly correlate with clusters, and each cluster contained equivalent members from the different language speakers. Figure 4. Shows the average affective response for vase 1, with participants clustered in 2 and 3 clusters. And Figure 5. Shows the average affective response for vase 5, with participants clustered in 2 and 3 clusters.

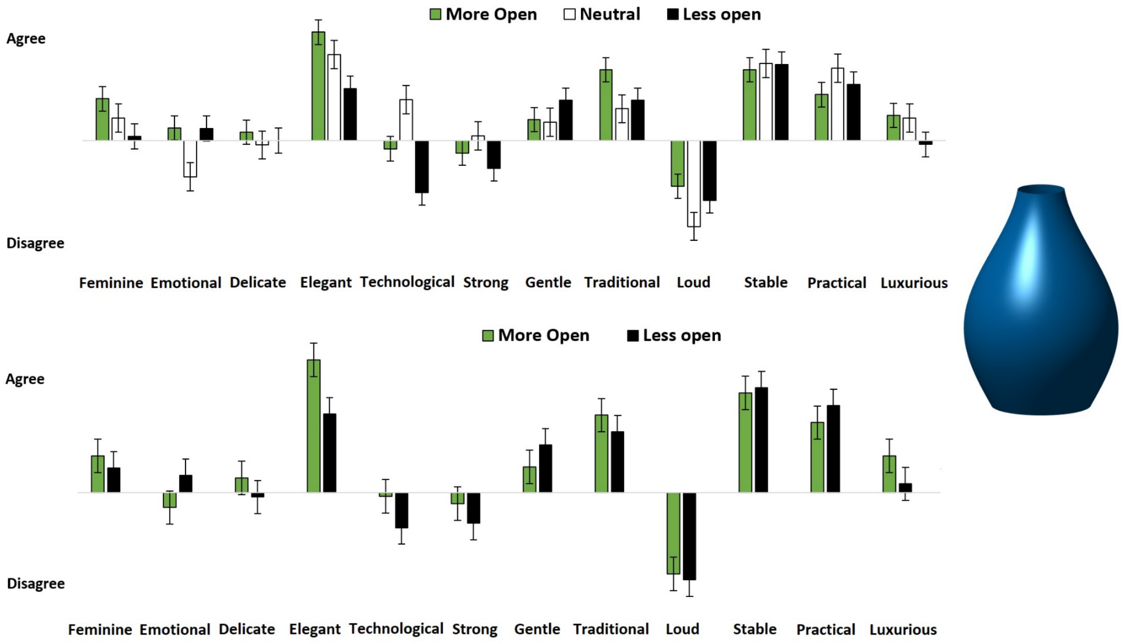

Figure 4. Average affective response for vase1, with 2 and 3 personal characteristic clusters

These figures show that the participants with more open personalities and lower open personalities have a similar affective response in most cases, but almost every time to a different degree. They have some disagreements, like in the case of "Emotional" in vase 1 and the case of "Loud" in vase 5. The cluster "Neutral personality" also has its differences from the later clusters, like in the case of "Emotional" in vase 1 and "Traditional" in vase 5. This response deference is in line with the research findings and confirms the significance of the personality factor in the individual product design response.

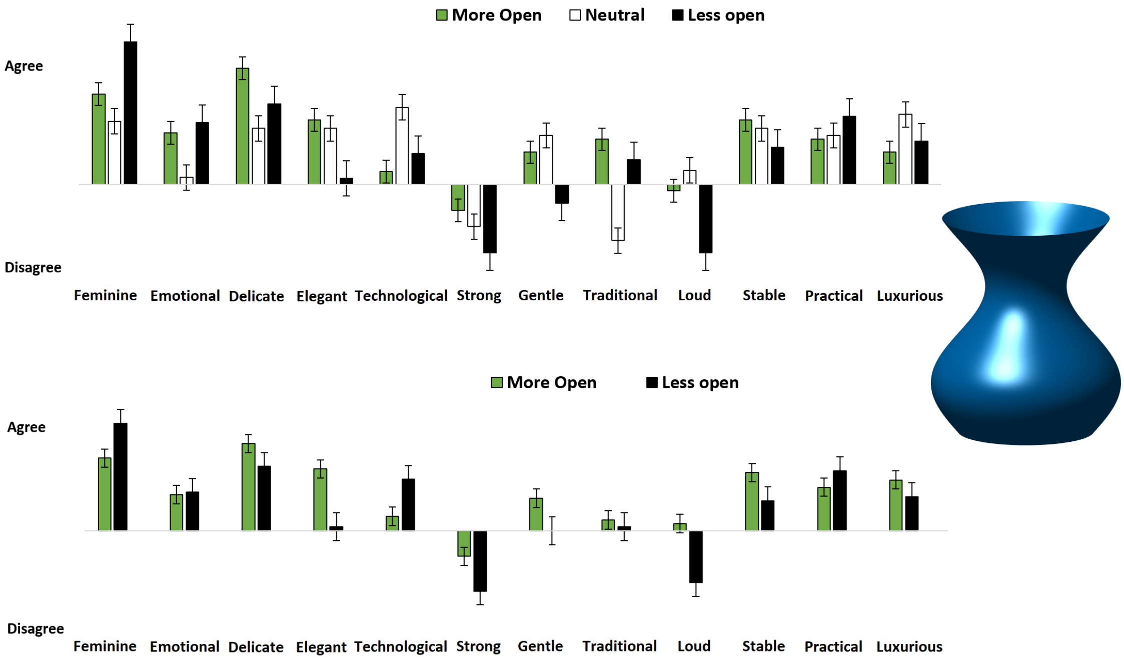

Figure 5. Average affective response for vase 5, with 2 and 3 personal characteristic clusters

4 RECOMMENDER SYSTEM RESULTS

To model the affective response of consumers, we use a feedforward Deep Neural network and conjugate gradient for network training. The network has eight hidden layers. And the recommendation algorithm is based on the idea of comparing the wanted affect with the predicted affect and outputting the design that corresponds to the highest value in that particular affect adjective.

In this experiment, we consider six testing participants and assume they are all looking for the same affects for the sake of consistency, namely "Feminine" and "Technological". The result of this experiment is presented in figure 6. It shows that this system can recommend different aesthetic designs for different people based on their personality characteristics. This system also allows recommending the same design for different desired affects of different individuals. Such as the recommended aesthetic designs for the 2nd and 5th individuals. And lastly, it may recommend the same design for different wanted aesthetic affects, like in the case of 1st individual.

We ask the testing participants to rate the recommendation accuracy according to their affective response to the two adjectives "Feminine" and "Technological". Their answers are shown in Figure 7. These results suggest that the recommender has good accuracy in the "Feminine" adjective, averaging 92%. And a lower accuracy in the "Technological" adjective, averaging 64%. This could be due to the participants' high disagreement with this adjective, like what we observe in Figures 4 and 5. The participants with "Neutral openness of personality" tend to have the opposite "technological" affect as people that have "more open" and "less open" personalities.

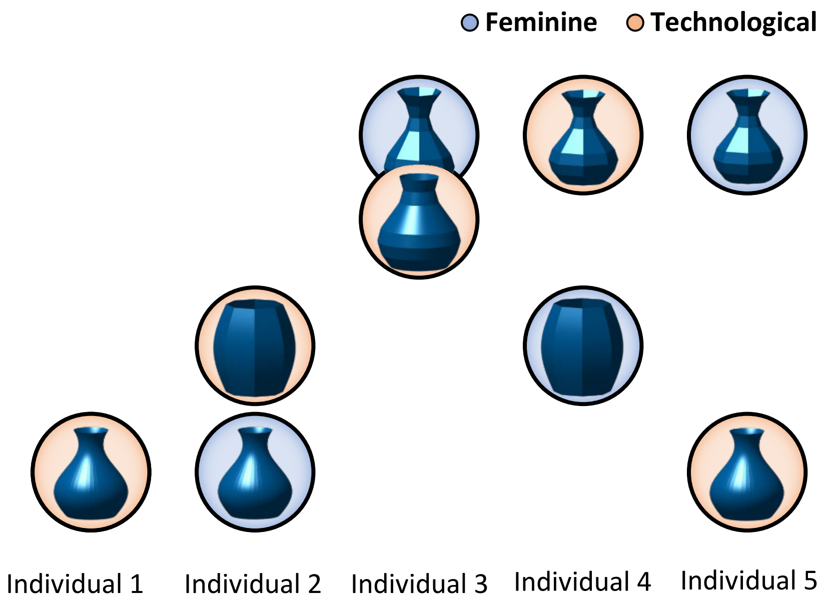

Figure 6. Recommended designs for "Feminine" and "Technological" affects

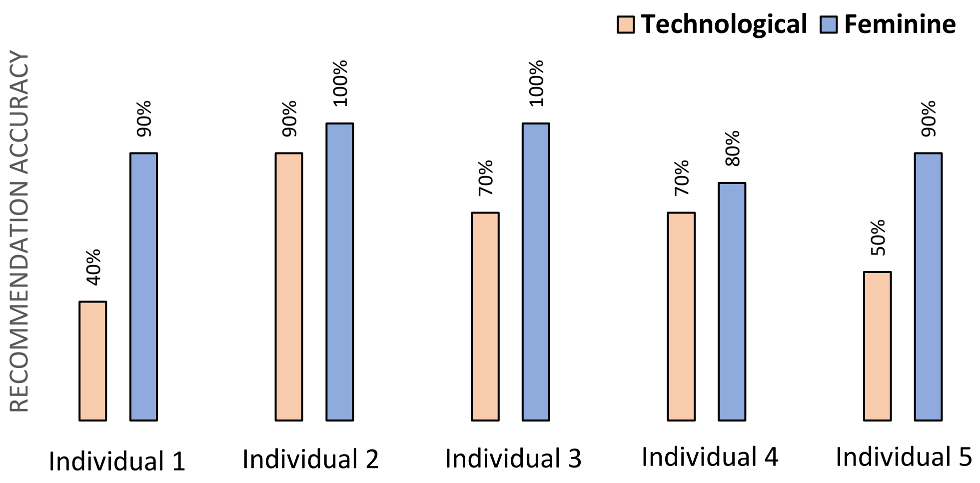

Figure 7. Feedback on the accuracy of the aesthetic design recommendation

5 CONCLUSION

This study investigates the problem of aesthetic design recommendations. Using vase design, we suggested an approach based on multiple affective responses and wanted affect. This system recognizes that people have a different affective response to aesthetic designs and models the individual response to aesthetics in relation to the aspect of openness in personality, plus the element of exposure and the mood during the aesthetic evaluation. The results showed that these individual characteristics are relevant and helped build a representative model that can predict the affective response to a set of designs using the answers to 7 questions.

The recommender part of this system uses the consumer's desired affect and returns the aesthetic design that corresponds to the highest value in that particular affect. Thus, this combination can recommend different designs to different people based on their wanted affect. Also, recommending different designs for the same desired affect, for individuals with different characteristics of openness.

This approach is not limited to vases designs. Because the connection between the individual characteristics of openness and the general aesthetic perception is established in the literature, this can be employed in other product design applications. In the future, further studies will be made at the level of the predictive model in terms of optimizing the weights of the personality questions and adjectives. Also, investigate the connection between the aesthetic features and the affective response in order to build a more flexible design recommender that can generate designs instead of recommending from a limited set of designs.

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DEVELOPMENT AND PRELIMINARY EVALUATION OF A USER-FRIENDLY AND ENGAGING VIRTUAL REALITY PROGRAM FOR REHABILITATION

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ABSTRACT

We have developed a user-friendly and engaging virtual reality (VR) program called "Let's stand up and travel the world!" which is used for performing sitting-down and standing-up rehabilitation exercises. This program allows patients to actively engage in rehabilitation exercises every day with the feeling of traveling while viewing images of landscapes from around the world. Because the achievement levels in the exercise plans are connected to the completeness of the images presented, the program helps patients to actively engage in rehabilitation exercises for long periods without becoming bored (patented). The progress of the program is guided by text and voice on the VR screen and can be executed by gazing at icons or by hand movements (touching virtual icons), achieving a universal design.

The effectiveness of using the program as a home rehabilitation program for the elderly was evaluated by asking an experimental participant to perform sitting-down and standing-up exercises. As a result, the participant was able to perform rehabilitation, which involved 30 standing and sitting movements, every day for 7 days. In psychological evaluation using a two-dimensional mood scale–short term (TDMS-ST), the mean scores for the "Level of Vitality," "Level of Stability," and "Level of Pleasure" significantly increased after performing the program's exercises. The results show that the participant felt lively, excited, calm, and relaxed after exercises using the VR program.

Keywords: *Virtual Reality, Rehabilitation, Exercise, Interactive Image Change, Universal Design*

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1 INTRODUCTION

Sustaining patient motivation to perform simple and repetitive exercises is a problem in rehabilitation aimed at the recovery of physical function. The outcome of recovery-phase rehabilitation work on stroke patients is improved by such measures as feeding back specific evaluation results, improving mood disorders, and providing social support. A study investigating the relationship between motivation and physical functions, psychological/mental aspects, social aspects, and the quality of life, has shown that motivation is related to daily life ability, independence, good communication skills, mood, and vitality [Note 1].

In recent years, game-based rehabilitation devices have become available. Previous studies suggesting rehabilitation devices using game images have been shown to be effective in rehabilitation of hemiplegic stroke patients or fingers [Note 2, 3]. Other previous studies reported rehabilitation effects using Virtual Reality (VR) devices. In VR rehabilitation, we can experience the real environment or play games [Note 4, 5].

In the VR program called "Let's stand up and draw art in the sky!", developed by the author in 2016, images projected on a VR head-mounted display change interactively in conjunction with the sitting-down and standing-up movements of patients to guide simple, repetitive exercises [Notes 6 and 7, patented]. We confirmed that it was possible to maintain the participants' motivation to continue working on the program by progressing through the achieved levels of quantity and quality of exercise to the completeness of art images. The same effect was confirmed in the "Let's keep wiping to draw pictures!" program also in 2016. Both are creative programs in which art images are completed when the target number of exercises is attained [Note 8].

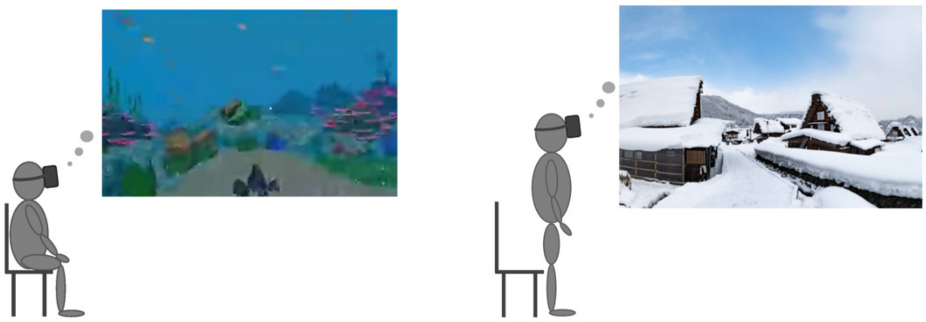
The "Let's stand up and draw art in the sky!" program was evaluated at recovery-phase rehabilitation hospitals and day care facilities on a practical basis, and was shown to have positive psychological and physical function-related effects [Notes 9-11]. As inpatients who need to work on their rehabilitation may find it difficult to go out, viewing scenic images of places they feel like visiting, and completing those images, may help to maintain their motivation to perform rehabilitation exercises. As the scenic image changes every time the patient stands up, anticipation of a new image urges the patient to perform the next movement.

"Let's stand up and draw art in the sky!" uses Oculus Rift as a VR device to execute the program. It requires a PC connection and sensors to detect body movements. There are five choices of landscape images to be projected. The objective of the current study is to upgrade the "Let's stand up and draw art in the sky!" program to develop a user-friendly, engaging program that people will want to use continuously for long periods. We aim to revise the choices of landscape images presented to ensure that patients will continue to actively engage in long-term, repetitive rehabilitation exercises. This study also develops a new program/device system that can be executed using simple equipment, so that rehabilitation work using the program can be performed even alone or at home. The study also evaluates the effectiveness of the newly developed program on a practical basis and investigates its effectiveness as a rehabilitation program that alleviates the need for care.

2 DEVELOPMENT OF THE “LET’S STAND UP AND TRAVEL THE WORLD!” PROGRAM

Meta Quest 2 (Oculus Quest 2) was selected as the device to execute the newly developed program in this study. This device, which has a built-in sensor to detect body movements such as standing up and sitting down, is easy to operate because it can be programmed without a PC connection. As a result, medical institutions and facilities with limited staffing, as well as the elderly at home who are not accustomed to operating a PC, can easily engage in rehabilitation work. Meta Quest 2 is designed to allow users to listen to audio without the need to wear headphones or earphones, thus promoting user-friendly program progression and equipment operation through a design that works visually and aurally.

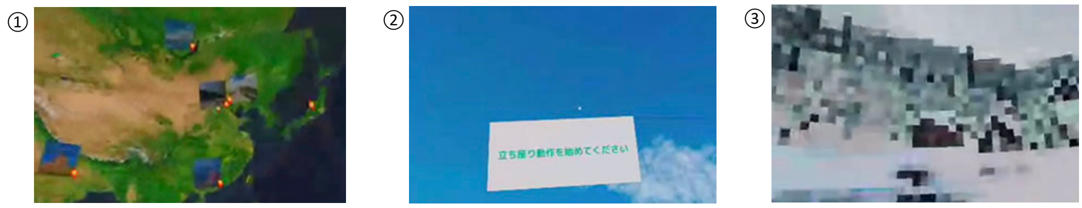
The program design also allows the user to select any landscape image projected from a world map, so that the engaging program can be used repeatedly over a long period without the user getting bored. This can motivate patients to actively engage in rehabilitation while viewing images of landscapes from around the world to create the feeling of traveling. The program newly developed in this study has been named “Let’s stand up and travel the world!” (Fig. 1).



When sitting (underwater image) When standing (landscape image)

Figure 1. Images presented in the “Let’s stand up and travel the world!” VR Program (patented)

The “Let’s stand up and travel the world!” program allows users to select their favorite images from 30 domestic and foreign landscape images shown on a world map, so that they can engage in rehabilitation work while viewing landscape images of different locations every day for a month. Because the pattern of image changes linked to the standing-up and sitting-down movements is varied each time, the user can enjoy viewing infinitely varied patterns until the completion of landscape images. The progress of the program is guided by text and voice on the VR screen and can be executed by gazing at icons or by hand movements (touching virtual icons), thus achieving a user-friendly universal design (Fig. 2). In addition, a manual illustrated with images has been created to explain screen transitions and steps from program startup to termination.



①Select any landscape image from around the world. ②Start actions by text and voice guidance. ③The landscape image changes every time the user stands up.

④The landscape image becomes clearer as the user proceeds with the sitting-down and standing-up exercise. ⑤The image is completed when the target number of movements is attained. ⑥It is possible to print out the landscape image corresponding to the achievement level of exercise.

Figure 2. Series of images presented in the "Let's stand up and travel the world!" VR program (patented)

3 PRACTICE AND PRELIMINARILY EVALUATION OF HOME REHABILITATION USING THE "LET'S STAND UP AND TRAVEL THE WORLD!" PROGRAM

3.1 Method

One elderly person living in her own home (an 83-year-old woman requiring Japanese Level 2 care support, with spinal canal stenosis) took part in a practical evaluation to investigate the feasibility of this program. The experimental participant performed a seven-day program consisting of 30 cycles per day of sitting down on a chair and standing up. A psychological evaluation using the two-dimensional mood scale–short term (TDMS-ST) [Note 12] was conducted before and after the sitting-down and standing-up exercise in the program.

The TDMS-ST is a psychological scale system used to evaluate levels of vitality, stability, pleasure, and arousal. Eight moods (calm, irritated, lethargic, excited, relaxed, nervous, lazy, and lively) are rated in six grades. The "Level of Vitality" is a measure of the psychological state in which comfortable liveliness and unpleasant calmness are the two extremes; positive scores represent a vivid and active state and negative scores represent a lethargic and inactive state. The "Level of Stability" is a measure of the psychological state in which comfortable calmness and unpleasant liveliness are the two extremes; positive scores represent a relaxed and calm state and negative scores represent an irritated and strained state. The "Level of Pleasure" is a comprehensive measure of the psychological state in which comfortableness and uncomfortableness are the two extremes; positive scores represent a comfortable and positive state and negative scores represent an uncomfortable and negative state. The "Level of Arousal" is a comprehensive measure of the psychological state in which excitement and calmness are the two extremes; positive scores represent an excited and active state and negative scores represent a sleepy and inactive state. The TDMS-ST is suitable for investigating changes in mood between before and after a certain event, and for making rapid evaluations. It can be used to verify the psychological effects of such factors as exercise, living environments, and equipment.

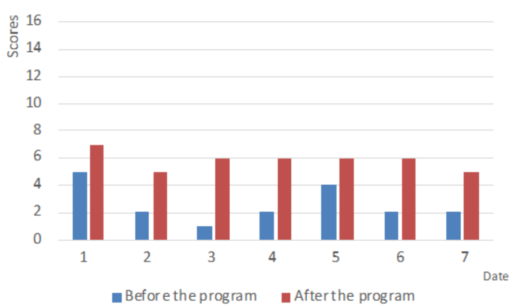
3.2 Results and Discussion

As a result of practicing rehabilitation at home using the “Let’s stand up and travel the world!” VR program, the experimental participant was able to practice 30 cycles of sitting-down and standing-up movements every day without fail for seven days. In addition, the psychological evaluation using the TDMS-ST indicates that the scores of the “Level of Vitality,” “Level of Stability,” “Level of Pleasure,” and “Level of Arousal” increased after performing the exercises (Figs. 3-6).

A one-way analysis of variance was performed on the mean scores for “Level of Vitality,” “Level of Stability,” “Level of Pleasure,” and “Level of Arousal” during the seven-day program period. The results showed a significant difference in the “Level of Vitality,” ($F(1,12) = 4.75$, $p < 0.001$), “Level of Stability,” ($F(1,12) = 4.75$, $p < 0.001$), and “Level of Pleasure” ($F(1,12) = 4.75$, $p < 0.001$), and a significant trend ($F(1,12) = 4.75$, $p < 0.06$) in the “Level of Arousal” (Fig. 7). The mean scores for “Level of Vitality,” “Level of Stability,” and “Level of Pleasure” increased significantly after performing the exercises in the program. The results show that the participant felt lively, excited, calm, and relaxed after performing the sitting-down and standing-up exercises of the “Let’s stand up and travel the world!” program.

From the observation of the behavior of the experimental participant during the program's sitting-down and standing-up exercises, it was found that the pace of the exercise quickened every time around the 20th cycle of movement, when the resolution of the landscape image increased and the participant began to perceive the complete image. It is assumed that the participant was eager to see what kind of landscape image would be created and was motivated to engage in the exercise to complete the image quickly.

In the preliminary evaluation, the effect of the VR program in a short-term experiment was confirmed by a limited number of participants, but it is considered that important basic data for practical evaluation were obtained. In the future, it will be necessary to increase the number of the experimental participants and to conduct long-term practical evaluations, using the same program method.



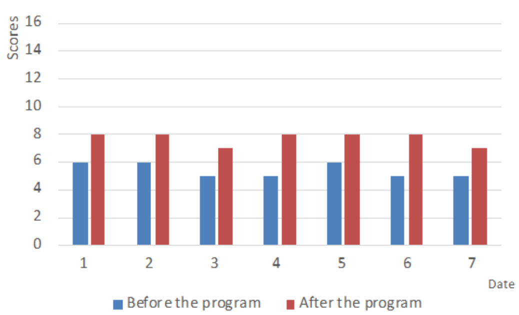


Figure 3. Level of Vitality

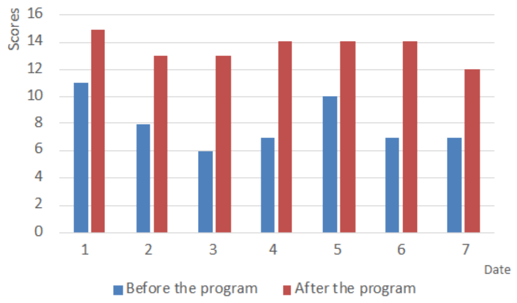


Figure 4. Level of Stability

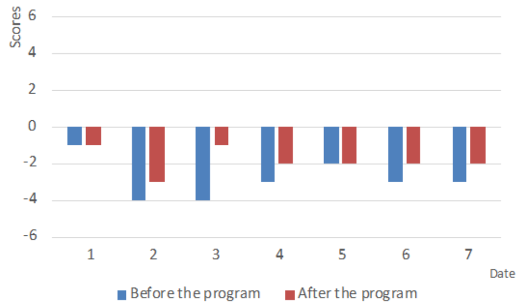
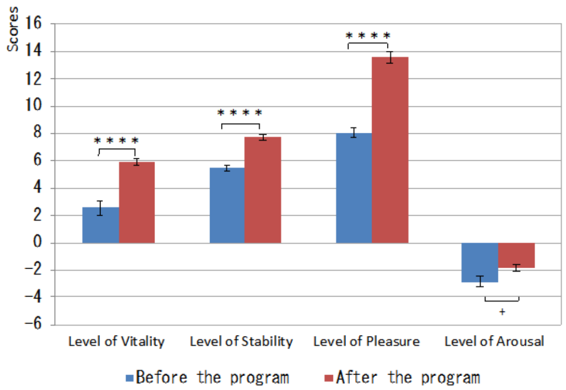


Figure 5. Level of Pleasure

Figure 6. Level of Arousal



*p<.05, ****p<.001

Figure 7. Comparison of mean TDMS-ST scores before and after the program

4 CONCLUSION

We have developed the “Let’s stand up and travel the world!” VR program, which is a user-friendly and engaging program that patients will want to use continuously over a long period. This program allows patients to actively engage in rehabilitation exercises while viewing images of landscapes from around the world to create the feeling of traveling, and helps maintain the patients’ motivation towards performing simple and repetitive exercises for long periods without becoming bored. Because the program can be executed using simple equipment, elderly people who are not accustomed to operating equipment can easily work on rehabilitation even alone or at home, or at medical institutions or facilities where staffing is limited. Moreover, the progress of the program is guided by text and voice on the VR screen and can be executed by gazing at icons or by hand movements (touching virtual icons), achieving a universal design.

The effectiveness of “Let’s stand up and travel the world!” was evaluated by asking an experimental participant to perform sitting-down and standing-up exercises as a home rehabilitation program for the elderly. The participant was able to perform 30 cycles of sitting-down and standing-up movements every day in a seven-day rehabilitation program. A psychological evaluation using the TDMS-ST indicated that the mean scores for "Level of Vitality," "Level of Stability," and "Level of Pleasure" significantly increased after performing the sitting-down and standing-up exercises. The results show that the participant felt lively, excited, calm, and relaxed after exercises using the "Let's stand up and travel the world!" VR program. We will continue to evaluate the program at medical institutions and facilities on a long-term practical basis, while keeping a close eye on the status of COVID-19 infections.

This research was conducted with the approval of the Research Ethics Committee of Meisei University.

Rehabilitation support device and program patent inventor: Kiyomi Yoshioka (Meisei University)

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DEVELOPMENT OF A CUSTOMER AFFECTION SYSTEM AIMED AT INCREASING LOYALTY AMONG BOTH CUSTOMERS AND EMPLOYEES

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ABSTRACT

This research aimed to develop an information-sharing system between customers and employees and utilize it for practical purposes. We named it the "Caffe System (Customer Affection System)," a system for sharing customer service notes and feedback to improve their satisfaction and loyalty and facilitate the sharing of customer information among employees. As a non-mainstream service, "message to customers" has been used by some stores. For example, Starbucks coffee provides with a particular message service to impress customers: providing the drink with a message or illustration. However, we have no way to know its specific impact on customer satisfaction and loyalty. In this study, we launched the "cup message card," since we conducted the demonstration experiments in a dine-in coffee shop. One of the focuses was to investigate the satisfaction difference between the "cup message card" and "conversation with clerks," which had already become one of the most mainstream service.

Keywords: *System, customer & employee, cup message card, demonstration experiment*

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1 INTRODUCTION

Increasing customer loyalty by improving the experience value provided by overall services, such as customer service, is expected to increase customer satisfaction in the field of in-store product sales.

With the Caffe System in mind, we have been conducting demonstration experiments in actual coffee shops since 2018 to improve customer service and verify the system. Although, due to COVID-19, our experiments were suspended from 2020 to 2021, during which we made some improvements to the system's internal design. We restarted the experiment in a coffee shop from February to March 2022.

2 RELATED RESEARCH

The Ritz-Carlton has introduced an information sharing system, called "Preference Pad," as an initiative to improve the value of customers experience. By sharing customer information and preferences noticed by the employees, they can provide services to improve customer satisfaction next time (The Ritz-Carlton Leadership Center, 2019).

Noting that only information from the employee perspective was shared in The Ritz-Carlton, Sugiyama (2018) conducted an experiment, in which information from the customer’s perspective was shared with employees in a coffee shop, and found that the customer’s experience was improved. Fukuda (2019) aggregated further information from employees by improving the interface to allow them to enter information in a shorter time and surveyed employees regarding the loyalty they felt toward the experimental store and customer perspective.

Zhang (2020) considered that the new coronavirus infection (COVID-19), which has been spreading since 2020, has increased the demand for services with less contact between clerks and customers. A questionnaire survey was conducted to examine the factors important for customer service, which included non-face-to-face & face-to-face customer service. It was confirmed that customer impressions and satisfaction were increased for "conversation" during face-to-face interaction and "cup messages," which are performed for both face-to-face & non-face-to-face customer service. In addition, Zhang also investigated the differences in nationality, gender, and personality characteristics.

3 METHODS

3.1 Description of the experiment

We conducted a demonstration experiment using our Caffe system in an actual coffee shop. A total of 10 customers and two employees participated. They were asked to complete a questionnaire before, during, or after the experiment. The details are given below. (One customer was not included in the questionnaire analysis due to an employee's operational error.)

3.2 System Overview

Customers and the Store use easy-to-operate Web applications prepared for each in this Caffe system. Customers can provide feedback to the stores on their purchased products and their impressions of the products and customer service. The store, after having looked at the customer's purchase history and feedback, recommended products, provided customer service (conversation, cup message card, etc.) that lead to a favorable impression, and registered the new customer service details. In addition, employees could review individual customer service details and feedback.

This cycle of information sharing was expected to improve the "sense of being cared for," “product recommendations and customer service with high customer satisfaction on the customer side, and "more effective work" on the customer, store, and employee’s sides, respectively.

In the system, four themes of conversation, "Small Talk, Product, Weather, and Special Greeting," were set, along with eight contents of the cup message card: "また来てね(Come back again)," "よろしくね(Nice to meet you)," "ありがとう(Thank you)," "元気でね(Be well)," "頑張ってね(Come on)," "今日もお疲れ(Good job today)," "Have a nice day!," and "Thank you!" In addition, two types of orders, "multiple orders" and "recommendation," and three types of reactions, "happy, normal, or dislike," were set. Furthermore, the same tone color scheme of PCCS on the screen design was utilized to provide employees with a consistent web application interface, which improved their comfort and convenience of information input and the registration speed and rate.

3.3 Service Flow after System Installation

1. Customers were asked to register with the web application on their cell phone and were then divided into "three groups of cup message cards" according to their customer IDs. When customers came to the store, they first had to provide their customer IDs.
2. Employees were asked to use tablets (with the in-store web application downloaded) to input customer IDs and check customer information, purchase history, product reviews, details of customer service provided during previous visits, and customer feedback.
3. Based on the information, employees provided recommendations and services that corresponded to the groups (according to customer preference).
4. After the customer service was completed, the employee completed the customer service information and added what they had noticed.
5. Customers were asked to respond to the store-visit feedback in the web application.

3.4 Experimental Procedure

To conduct the experiment, the in-store web application was used by employees in parallel with their normal work. Customers also used the web application on their cell phones to measure the frequency of their visits, preferred products, and improvements in evaluations.

Customer Side: First, we recruited experimental collaborators through the website and within Chuo University. Next, they were asked to register for the web application on their cell phone and assigned an customer ID. They were further asked to complete the store-visit feedback on the prerequisite that they had to visit the store more than once. Finally, they were asked to respond to the customers' post-experimental questionnaire after the experiment.

Employee Side: Employees were asked to complete the pre and post questionnaires before and after the experiment. Based on the pre-assigned customer IDs, the customers were divided into three groups: "no message group," "uniform group (received the cup messages that always had the same content)," and "diverse group (received the cup messages with different content for each order)." During the experiment, employees gave the corresponding message cards to the three groups of customers.

3.5 Questionnaire Items

In this study, customers were asked to complete the store-visit feedback after each visit to the store during the experimental period. The store-visit feedback included: the product's photo, review comments, questions regarding their satisfaction, etc. As an evaluation criterion, satisfaction was out of 5, while other questions were out of 10.

In addition, with support from a previous study, customer loyalty was positioned as Cognitive, Affective, Conative, and Action Loyalties based on the Four-Stage Model of Loyalty (Oliver, 1999). After the experiment, customers' post-experimental questionnaire enquired for responses on these four stages, customer service satisfaction, the surrounding evaluation of the cooperating store, and personality trait. The Big Five personality trait survey was used, which suggested five broad dimensions commonly used in psychology to describe the human personality and psyche: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness (to experience). We used the Japanese version of the 10-item Personality Inventory (TIPI-J) developed by psychologists Shingo Koshio, Shingo Abe, and Pino Cutroni (2012). All questions were evaluated on a scale of 7 using the SD method. (worst 1 - 7 best)

With the same evaluation criteria, employees were asked to complete a pre-questionnaire regarding their evaluation of the service and self-competence and a post-questionnaire with 10 more questions regarding the Caffe System in addition to the same questions.

4 RESULTS & DISCUSSION

4.1 The Customer Side

Responses to the store-visit feedback were obtained from 10 people. Among them , the "no message group," "uniform group," and "diverse group," contained four, three, and three people, respectively. Table 1 presents the means and standard deviations for the three groups of cup message cards.

Table 1. Summary of store-visit feedback

	no message group (Mean)	uniform group (Mean)	diverse group (Mean)	no message group (Std. Deviation)	uniform group (Std. Deviation)	diverse group (Std. Deviation)
Satisfaction	4.63	4.83	4.33	.518	.408	.816
Q1：Do you like what you ordered for today?	8.63	9.00	8.17	1.061	1.095	1.472
Q2：Would you recommend what you ordered today to friends?	8.38	8.17	7.33	1.302	1.602	1.506
Q3：Are you satisfied with the conversation you had with the clerk today?	9.25	7.67	7.17	.886	2.658	.753
Q4：Are you satisfied with the cup message card you received from the clerk today?	4.75	8.33	8.33	5.120	1.366	1.366
Q5：What is your impression of the experimental cooperative store?	9.00	9.17	9.00	1.069	1.329	.632
Q6：Would you come back to this store again?	8.50	8.50	9.17	1.512	1.225	.408
Valid N (listwise)	4	3	3	4	3	3

The "uniform group" had the highest satisfaction, and the deviation value was relatively small. Meanwhile, the "diverse group" had the lowest satisfaction, and the deviation value was the largest. Furthermore, we observed that customers who received the message cards all rated their satisfaction with the “cup message cards” slightly higher than “conversations with the clerk,” and also had a slightly higher impression of the store.

After the experiment, nine of the 10 answered the questionnaire (three people in each group). Table 2 summarized the means of the results of the whole and three groups, respectively.

Table 2. Summary of the customers’ post-experimental questionnaire

		Mean	no message group	uniform group	diverse group
Cognitive Loyalty	Q1: Do you have a good impression of the experimental cooperation stores?	6.11	6.33	6.33	5.67
	Q2: What are the good points of the experimental cooperation store?	5.56	5.67	5.67	5.33
Affective Loyalty	Q3: Do you have familiarity with the experimental cooperation stores?	6.11	6.33	6.33	5.67
Conative Loyalty	Q4: Do you want to introduce experimental cooperation stores to friends and acquaintances?	5.67	5.33	6.00	5.67
Action Loyalty	Q5: Do you want to continue to use the experimental cooperative store?	5.67	5.00	6.00	6.00
	Q6: If the price increases, by how much would you continue to choose the experimental cooperative store?	2.89	2.33	2.33	4.00
Satisfaction	Q7: Please indicate your current level of satisfaction with the level of customer service provided at the stores where the experiment was conducted.	6.11	6.33	6.33	5.67
Surrounding Evaluation	Q8: Please tell us what your friends and acquaintances say about the experimental cooperative store.	5.11	5.33	5.33	4.67
cup message card	Q9-1/9-2: Please comment on your level of satisfaction with the cup message card.	5.39	5.00	5.83	5.33
	Q9-3: Do you think cup messages can have a communication effect with staff now that they seek a means of service with less contact in the Covid19?	5.56	5.67	5.67	5.33

Judging from the customers’ post-experimental questionnaire results, there was no significant difference between the "no message group" and " uniform group." Furthermore, the overall result of the "diverse group" was lower compared to that of the other two groups. However, it was significantly higher than the other two groups in Q6. Considering that the reclassification would yield more contrasting results, we performed a cluster analysis using the above data based on the Japanese version of the 10-item Personality Inventory (TIPI-J) [6] and obtained the following results.

Table 3. Cluster Analysis of the customers' post-experimental questionnaire

	Cluster 1	Cluster 2
Extraversion	3.17	4.83
Agreeableness	5.50	5.17
Conscientiousness	5.67	3.75
Neuroticism	2.83	3.75
Openness (to experience)	4.67	4.58
Cases in each Cluster (customer)	D, I, H	C, M, B, E, K, L
Valid N (listwise)	3	6

Two clusters had good scores for Agreeableness and Openness, and there were no significant differences. Moreover, Cluster 1 (three people) tended to have lower scores for Extraversion and Neuroticism than Cluster 2 (six people), while Conscientiousness was higher.

The two clusters of customers were described as follows：

Cluster 1: People who were more introverted and emotionally stable, had their own life rules, and were cautious but curious.

Cluster 2: People who were more outgoing, curious and sensual, lived a spontaneous life.

Based on the cluster analysis results of the customers' post-experimental questionnaire. The statistical results of store visit feedback are summarized in Table 4.

Table 4. Summary of store visit feedback by Cluster Analysis

	Cluster 1 Mean	Cluster 1 Std. Deviation	Cluster 2 Mean	Cluster 2 Std. Deviation
Satisfaction	4.83	.408	4.50	.650
Q1：Do you like what you ordered for today?	9.17	.983	8.36	1.216
Q2：Would you recommend what you ordered today to friends?	9.00	1.095	7.57	1.399
Q3：Are you satisfied with the conversation you had with the clerk today?	8.67	2.066	7.93	1.685
Q4：Are you satisfied with the cup message card you received from the clerk today?	9.17	1.329	5.93	4.028
Q5：What is your impression of the experimental cooperative store?	9.17	1.329	9.00	.877
Q6：Would you come back to this store again?	9.17	1.329	8.50	1.092
Valid N (listwise)	6	6	14	14

For satisfaction and all the questions, Cluster 1 had an average rating higher than Cluster 2, especially in Q4 (Cluster 1 = 9.17, Cluster 2 = 5.93). Satisfaction with the cup message cards was the largest discrimination between the two clusters. Compared to Cluster 1, people in Cluster 2 were significantly less satisfied with the cup message cards and conversation with the clerk. These findings foresaw that a personality trait survey would be an important tool for classifying customers and providing services accordingly.

In addition, both clusters had low standard deviations for satisfaction. However, Cluster 1 had Q3 (Are you satisfied with the conversation you had with the clerk today?), and Cluster 2 had Q4 (Are you satisfied with the cup message card you received from the clerk today?), with a higher standard deviation (greater than 2). The high deviation for these two questions was mainly due to the limited number of people who participated in this experiment. In other words, the attitudes held by each person in a given scenario to a service that contained something specific (e.g., a cup message card with different content, a conversation on a different topic) varied considerably.

Table 5 shows the correlations between satisfaction and other questions based on the two clusters.

Table 5. Correlations of store-visit feedback (Satisfaction of 2 Clusters)

Satisfaction of each Cluster		Cluster 1	Cluster 2
Satisfaction	Pearson Correlation	1	1
	Sig. (2-tailed)		
Q1: Do you like what you ordered for today?	Pearson Correlation	.581	.730**
	Sig. (2-tailed)	.226	.003
Q2: Would you recommend what you ordered today to friends?	Pearson Correlation	.447	.507
	Sig. (2-tailed)	.374	.06
Q3: Are you satisfied with the conversation you had with the clerk today?	Pearson Correlation	.632	.105
	Sig. (2-tailed)	.178	.720
Q4: Are you satisfied with the cup message card you received from the clerk today?	Pearson Correlation	.430	-.161
	Sig. (2-tailed)	.395	.581
Q5: What is your impression of the experimental cooperative store?	Pearson Correlation	.430	.270
	Sig. (2-tailed)	.395	.351
Q6: Would you come back to this store again?	Pearson Correlation	.430	-.054
	Sig. (2-tailed)	.395	.854

**. Correlation is significant at the 0.01 level (2-tailed).

Cluster 1 showed some correlation between all the questions and satisfaction. However, no statistically significant difference was observed at a significance level of 1%. In Cluster 2, there was a statistically significant difference between Q1 (Do you like what you ordered for today?) and satisfaction at a significance level of 1%. In addition, when we focused on Q4(Are you satisfied with the cup message card you received from the clerk today?), the correlation coefficient for cluster 1 was 0.430, which indicated a slightly positive correlation; while the correlation coefficient for cluster 2 was -0.161, which indicated no correlation (negative).

4.2 The Customer Side

Responses to the employee side were obtained from two people. Responses (changes) to the common three questions asked in both the pre- and post-questionnaires are shown in Figure 1.

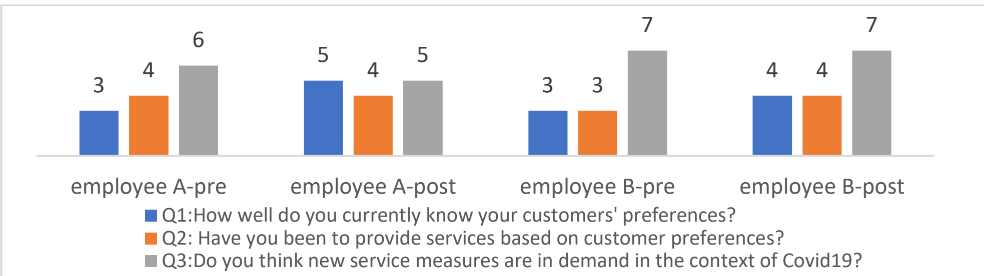

Figure 1. Scores of common questions in the pre-and-post employee questionnaires

In Q1, both employees increased their ratings which meant that through the Caffe System, employees had a better grasp of customer preferences. In Q2, employee A's rating was unchanged; however, employee B's rating went up, which meant that through the Caffe System, employees had the tendency to provide services that matched the customer preferences. Furthermore, in Q3, employee B's rating was unchanged and employee A's rating went down which showed that through the demonstration experiment, offering the service of cup message cards to customers had led to a tendency for employees to reduce the demand for other new means of service.

The other 10 questions in the post-questionnaire are shown in Table 6.

Table 6. Scores of questions in the post-questionnaires (without the common questions)

	employee A	employee B	Mean	Std. Deviation
Q4: Has the "Caffe System" made it easier for you to understand your customers' preferences?	5	5	5.00	.000
Q5: Have you been able to have conversations with customers based on their preferences?	5	4	4.50	.707
Q6: Have you been able to provide cup messages based on your preferences with your customers?	4	3	3.50	.707
Q7: Do you think that providing cup messages can bring satisfaction to customers instead of conversation?	6	4	5.00	1.414
Q8: Do you refer to your customers' feedback?	5	6	5.50	.707
Q9: Do you think your motivation is enhanced by referring to customer feedbacks?	6	6	6.00	.000
Q10: Do you refer to your own and other employees' contributions to customer service information?	6	6	6.00	.000
Q11: Do you think you can be more motivated by sharing your own and other employees' evaluations?	6	6	6.00	.000
Q12: Are you (your employees) satisfied with the service provided to customers through the "Caffe system"?	5	5	5.00	.000
Q13: Have you achieved customer satisfaction through our "Caffe system"?	5	5	5.00	.000

All questions were rated on a 7-point scale, and all questions except Q6 (Have you been able to provide cup messages based on your preferences with your customers?) were rated above the middle of the scale. Therefore, it was observed that through the practical use of the Caffe System in the demonstration experiment, the various satisfaction ratings and utilization of the Caffe System were relatively positive for the employee side. However, the distribution of cup message cards originated from the automatic distribution of the system, which did not achieve 100% conformity to the customer preference. Hence, in the future, prior service preparation using customer personality categories could be attempted.

Regarding standard deviation, the variation in Q7 (Do you think that providing cup messages can bring satisfaction to customers instead of conversation?) was relatively large. Furthermore, it was shown that the degree of availability of system-set cup message cards in different scenarios might vary significantly compared to conversations where the topic could be changed at any time.

5 CONCLUSION

In this study, we prepared various interface designs for the Caffe System, applied our system to customer service, and conducted a demonstration experiment in a coffee shop. However, the actual number of participants in this experiment was minimal due to the prevalence of the COVID-19. Hence, the conclusions were somewhat limited and incomplete. This study was a fascinating and timely attempt to use the "cup message card" service as a new means of communication between store employees and customers. The overall satisfaction of both the employees and customers was investigated in various aspects. Furthermore, the development of the relationship between them was also investigated in an innovative and futuristic way.

Although the personality trait survey existed only as an analytical method in this study, it showed the potential of "finding customer preferences through personality profiling." If we can find a connection between these two in the future, it may be possible to meet the needs of more customers while making the work of store employees more efficient and humane.

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ECOLOGICAL INFORMATION INTERFACE DESIGN, SYSTEM USABILITY, AND USER EXPERIENCE

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ABSTRACT

This study focused on bird species in Taiwan, investigating the design and usability of an app for Taiwan's endemic bird species through simplified bird images, interactive framework, text icons, and user interface, along with heuristic evaluation and usability testing. The usability test results verified that the app system designed had a usability score of 74.773 with the level between "good" and "excellent"; and was rated "excellent" in dependency, stimulation, and novelty under user experience; was rated "good" in attractiveness and efficiency, and was rated "above average" in perspicuity. Furthermore, significant usability and user experience differences were observed in introducing bird information between the interface using narrative and text icons. When the same ecological information interactive framework is applied, the use of simplified bird images and text icons helps improve the system's usability, as well as the attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty of the system in terms of user experience.

Keywords: *interface design, ecological information, user experience, system usability*

1 INTRODUCTION

Interaction-based information on a smartphone interface involves both static and dynamic representations; the viewer can freely determine the viewing method, speed, and duration. The user can seek information related to how they understand wildlife, thereby ensuring that the information is accessible and engaging. Specifically, visual representations through cell phone interfaces are restrained through carrier dimensions and must balance between visual fatigue and visual aesthetics. Therefore, graphics or icons are primarily in simplified and flat form. Representations of wildlife graphics and information on cell phone interfaces must operate within norms and restrictions. The connection and recognizability of graphics concerning the real world must be maintained to convey information properly. Popular science and illustrated books are used as the primary materials for learning and teaching about bird species; birds are represented chiefly through highly realistic wildlife photographs and intricate illustrations, accompanied by text descriptions, thus intuitively demonstrating their features, categories, and distribution (Liao, 2012; Liu, 2015). The information thus represented is rich and comprehensible but may be unsuitable for quick search and outdoor usage. This study designed an application (app) to introduce bird species endemic to Taiwan. An interactive information structure was conceived to meet user expectations, and representations of bird graphics and relevant information for the cell phone interface were examined. Furthermore, the correlations of the interface design with system usability and user experience were investigated, thereby summarizing the principles of applying ecological information to interactive interface design.

2 LITERATURE REVIEW

2.1 Visual graphics

Whether an image can enhance the reader's understanding and learning efficiency of biological knowledge is essential in designing wildlife illustrations through an information visualization structure. Based on the level of graphic stylization, Meyer and Laveson (1981) classified graphics (from realistic depictions to pure abstractions) into the following five levels, which are natural photography, pictorial illustration, graphical rendering, graphic symbology, and abstract symbology. Through a comparison of the aforementioned five-level stylization hierarchy with existing presentation of information about bird species, this study revealed that popular science and illustrated books are the primary materials for learning and teaching bird species, with birds represented through natural photography and graphical illustration with enhanced realism. However, the rather intricate structures of these graphics and images prevent readers from immediately grasping the essential details. In addition, transporting and consulting these images outdoors is inconvenient, particularly in outdoor birdwatching, thus decreasing the practicality of the current illustrated books on birds. Moreover, because smartphones have become the most widespread information carrier, styles of visual communication design have been modified accordingly. Interface icons have more vital functions than text descriptions and can guide the user in intuitive operation (Lin & Lai, 2015). In addition, graphics or icons are chiefly represented in flat form, pertaining to the level of graphical rendering, graphic symbology, and abstract symbology.

2.2 Interaction-based information

The category and structure of information affect representations conveyed through information visualization and include information design, graphic design, and chosen carrier. Interactive representations consist of static and dynamic representations; the user can autonomously explore the content through interactive clicking and searching (Pimenta & Poovaiah, 2010; Lankow, Ritchie, & Crooks, 2013). The interaction-based information function of allowing users to determine the duration and method of viewing has changed the user's reading habits and enhanced the efficiency of absorbing information through the function setting, thereby providing more detailed information (Dur, 2014). According to related studies, in facilitating individual learning and comprehension through multimedia, the simultaneous provision of visual, auditory, verbal, and nonverbal stimulation yields greater individual learning outcomes compared with the provision of only one type of stimulation, thereby allowing the learner to effectively memorize and store information (Mayer, 2001; Mayer, Lee, & Peebles, 2014). Therefore, interactive information visualization must prioritize visual aesthetics and pleasure for the user. In addition, the operational convenience of the interface must match the user's habit to maximize the effectiveness of the operation. Hence, an appropriate information structure is essential in interactive design and must be accompanied by an interface design that assists the user in relating the operation or content of information to real-life experiences or memories, thereby creating a good user experience and promoting long-term memory.

2.3 Interface design

Interface design involves mutually corresponding images, text, and color. The configuration of these components and interactions affects the information reception, attention, learning, and memory of the user during system operation. Therefore, user satisfaction can be improved using a system with an adequate interactive interface design. An interface design that centers on the visual aesthetic of the interface and overlooks the principles of user experience often necessitates complex operating procedures for browsing information, which reduces information-use efficiency and the user's operation motivation. The interactive design prioritizes a user's rapid adaptation to the system interface, effectively obtaining information and enjoying a pleasurable user experience (Hoffman & Novak, 1995). Facilitating the user's information operation through the appropriate planning of the content, interface, and function settings is essential in information design to enhance the cognitive efficiency of users in the digital age. The size and location of icons in an interface influence the accuracy and speed of system operation by the user, which further affects user satisfaction (Park & Han, 2010). Specifically, Nielsen (1994) proposed ten basic usability heuristics in interactive interface design, namely (1) visibility of the system status; (2) match between the system and the real world; (3) user control and freedom; (4) consistency and standards; (5) foolproof mechanisms; (6) recognition rather than recall; (7) flexibility and efficiency of use; (8) aesthetics and minimalist design; (9) assistance for users to recognize, diagnose, and recover from errors; and (10) assistance and documentation.

3 DESIGN PROCESS

3.1 Design of interactive structure and interface

This study designed an interactive structure and interface using a focus group and heuristic evaluation. The focus group comprised six members interested in birds or wildlife activities and with more than two years of experience in interactive design research and practice. They established the basic structure and functions of the app for introducing endemic birds in Taiwan and proposed potential problems and solutions regarding usability. The primary functions of the app are as follows: (1) information about bird species; (2) personal profile; (3) community; and (4) search. The information about bird species covered the environment and habitat altitude, size and length of the body, color and shape of the beak, and color of the feathers; a search function was incorporated owing to the outdoor usage scenario.

After completing the interactive structure and interface design, a highly accurate prototype was produced for the heuristic evaluation. Five experts who had worked in interface design or interactive product design for more than five years were invited to conduct a heuristic evaluation and examine issues regarding the interactive structure interface design details. The following multistep evaluation was conducted: (1) review of the interactive structure chart; (2) free operation of the prototype; (3) semi-structured interview; and (4) expert opinion and feedback. The content of the semi-structured interview referred to the ten usability principles proposed by Nielsen, with the experts requested to evaluate the system usability and provide feedback. The process was repeated twice to identify and solve problems regarding design details and repeated prototyping, thereby improving the accuracy of the prototype.

3.2 Sample design

After the interactive structure and interface were revised, a sample design was created for a usability test to explore whether, in the same interactive structure, differences in interface representation correlated with usability. The samples were divided into an experimental group and a control group. The interactive structure for each group was identical, but the interface of the experimental group used text icons, while the control group used narrative in introducing bird information (see Figure 1).

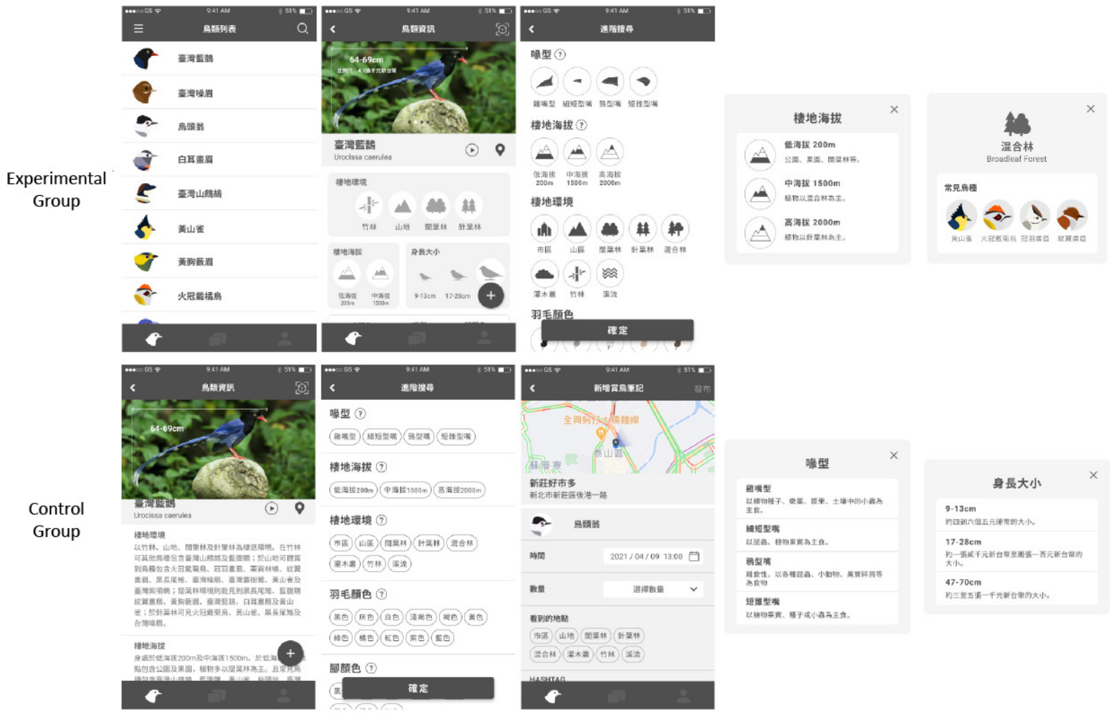

Figure 1. Interface comparison between the experimental group and control group

3.3 Usability Test

In response to the COVID-19 pandemic, the usability test in this study was conducted using remote testing on the Maze website. The participants comprised Taiwanese adults over 20 years old who owned smartphones and used social media. The experimental and control groups were subject to intergroup testing. The test included task operation, free operation, completion of a questionnaire survey, and provision of feedback after the test. The questionnaire's content was based on the System Usability Scale (SUS) and User Experience Questionnaire (UEQ). The SUS is widely applied for measuring a product or system; according to one large-scale study, the scale's reliability coefficient was 0.91 (Bangor, Kortum, & Miller, 2008). The total score is classified into five grades, namely Grades A, B, C, D, and F, representing the system's most positive and negative user perceptions, respectively (see Figure 2).

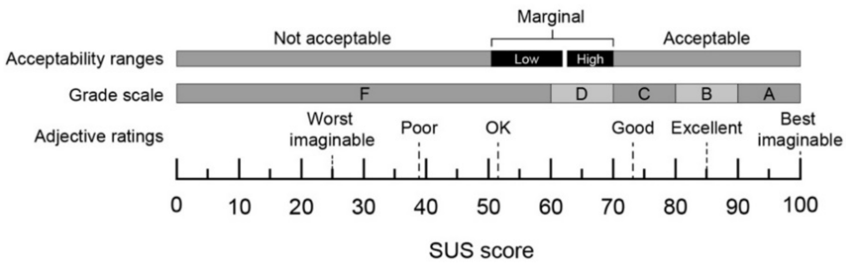

Figure 2. Basis for the SUS score interpretation (Brooke, 1996)

The UEQ measures the user experience of interactive products on a 7-point Likert scale, comprising 26 items with semantic differences; the score for each item ranges from −3 to 3. (Schrepp, Hinderks, & Thomaschewski, 2017). The UEQ results offer a comprehensive impression of user experience, including product usability and user engagement. This questionnaire contains six items or scales: attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty scales. Attractiveness refers to the overall evaluation of a product. Perspicuity, efficiency, and dependability measure the product's practicality (i.e., whether the user can effectively achieve their goal in operating the product). Finally, stimulation and novelty represent the enjoyment gained from the use of the product, with a focus on the user's perception of product operation. The results of the UEQ measurement are ranked according to five grades, namely "excellent," "good," "above average," "below average," and "bad."

4 RESULTS

The usability test of this study included 70 effective samples, of which 33 were used in the experimental group and 37 in the control group. In the experimental group, the average total SUS score was 74.773 (standard deviation [SD] = 15.147), and the average user acceptance in terms of usability was “acceptable” (Grade C), ranging between “good” and “excellent.” The result demonstrated the higher quality of the app developed in this study than similar products in general. In the control group, the average total SUS score was 62.297 (SD = 18.07); the average user acceptance was “not acceptable” (Grade D), ranging between “ok” and “good.” According to the independent samples t test results, the p value of the total SUS score of both groups was 0.003 (<0.05), indicating that, in the same interactive structure, using simplified bird graphic icons could improve system usability. A significant difference was thus observed between the icon-based and narrative-based interfaces in terms of usability (see Table 1).

Table 1. Independent sample t test results for the SUS score of the developed app

Group	N	M	SD	Grade Scale	T	P
Experiment Group	33	74.773	15.147	C	3.109	0.003
Control Group	37	62.297	18.07	D		

The result of the user experience and independent sample t test results of the six UEQ scales indicated that the experimental group's average total score ranged between 1.6 and 1.9; the grade was "excellent" in the scales of dependability (M = 1.765), stimulation (M = 1.742), and novelty (M = 1.682), "good" in the scales of attractiveness (M = 1.848) and efficiency (M = 1.796), and "above average" in the perspicuity scale (M = 1.697). The control group's average total score was lower and ranged between 0.6 and 1.1; the reported grade was "above average" in the novelty scale (M = 0.845), "below average" in the attractiveness (M = 0.887), efficiency (M = 0.838), dependability (M = 1.047), and stimulation (M = 0.926) scales, and "bad" in the perspicuity scale (M = 0.669). The independent sample t test results revealed significant differences between the two groups in all six scales. This indicated that in the same interactive structure, simplified bird graphics and icons could lead positive user experiences for the system, which was consistent with the users' cognition and was easier to learn to operate than the interface used narrative in introducing bird information, allowing the users to complete their task with greater ease (see Table 2).

Table 2. Grades of the six UEQ measurement items and related t test results

Scale	Group	N	M	SD	Grade	T	P
Attractiveness	Experiment Group	33	1.848	0.858	Good	4.396	0.000
	Control Group	37	0.887	0.957	Below Average		
Perspicuity	Experiment Group	33	1.697	0.960	Above Average	4.184	0.000
	Control Group	37	0.669	1.082	Bad		
Efficiency	Experiment Group	33	1.796	0.804	Good	4.654	0.000
	Control Group	37	0.838	0.906	Below Average		
Dependability	Experiment Group	33	1.765	0.760	Excellent	3.476	0.001
	Control Group	37	1.047	0.944	Below Average		
Stimulation	Experiment Group	33	1.742	0.993	Excellent	3.543	0.001
	Control Group	37	0.926	0.935	Below Average		
Novelty	Experiment Group	33	1.682	1.103	Excellent	3.163	0.002
	Control Group	37	0.845	1.108	Above Average		

Interface design affects how information entries are conveyed. A synthesis of the SUS and UEQ results indicated that, between the two interfaces with an identical interactive structure, the system usability and user experience of the interface with simplified bird graphics and text icons were rated higher than those of the interface used narrative in introducing bird information, and the differences were significant. In addition, the simplification of bird graphics effectively improved the perspicuity of the information, thereby enhancing operational efficiency for the users and improving their trust in the system. Therefore, representing ecological information using clear icons and touch keys was critical and increased users' ease of learning, thereby effectively improving their engagement with such information.

5 CONCLUSION

This study developed an interactive information app for the ecology of birds endemic to Taiwan through graphic design, interactive structure, interface design, heuristic evaluation, and usability testing. Moreover, this research analyzed whether system usability and user experience were affected by different representations of graphics and icons in the same interactive structure. In the interactive structure developed in this study, and interface applying simplified bird graphics and text icons, the system usability was rated "good"; user experience, dependability, stimulation, and novelty were rated "excellent"; attractiveness and efficiency were rated "good"; and perspicuity was rated "above average." The app's system usability and user experience were more favorably scored than the interface used narrative in introducing bird information. Moreover, according to the statistical results, using simplified bird graphics and text icons in the interactive information interface improved the user experience in terms of the system's usability, attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty. The interactive prototype for the proposed app must be continually reviewed according to the results above and expert suggestions, and the correlations of different types and aspects of interface design (such as navigation interface and representation of bird species information) with system usability and user experience must be further explored. The study results provide a reference for establishing structures for ecological information in design and education, thereby improving citizens' understanding of the ecological environment and more effectively disseminating related knowledge and information. Moreover, users are more likely to be inspired to respect the ecological environment in Taiwan and raise awareness of environmental protection, fostering identification with and care for the land.

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EFFECT OF CULTURAL FACTORS ON MANNER AWARENESS POSTER IMPRESSIONS

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ABSTRACT

Indonesian design practitioners have shown interest in adapting the established cute visual culture, commonly used in Japan, to improve public service communication. This assimilation effort may enhance communication effectiveness; however, previous research has shown that cultural factors can harm communication effectiveness. We conducted this study to determine if and which public service poster impressions are affected by cultural factors. We compare impressions of Japanese and Indonesian subjects when looking at selected manner awareness posters. We measure the intensity of impressions with an online survey method. Participants had to score the poster images based on ten impressions previously selected through a preliminary experiment and translation check process.

Fifty-nine Japanese (n = 29) and Indonesian (n = 30) adults participated in the survey. Impressions with major effect were realness and casualness, while Impressions with a slight effect were reassurance, playfulness, imaginativeness, importance, preference, and sharing intention. Finally, we found that the impression of cuteness and picture-text orientation were least affected by cultural factors. We conclude that cognitively evaluated impressions, such as reassurance, realness, and casualness, appear more affected by cultural factors than cuteness. We confirm the universality of cuteness impression, which we may adapt for visual communication across different cultures.

Keywords: manner awareness poster, impression, cultural factor

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1 INTRODUCTION

Indonesian design practitioners have shown interest in improving Indonesia's public service quality by taking examples from Japan. They have determined emotion as one of the reasons that Japanese popular culture products, such as manga, are readily accepted in Indonesia (Ahmad et al., 2012). They have established efforts to assimilate the Japanese cute *yuru-chara* concept with Indonesia's own to introduce the idea of city branding (Wiratmo et al., 2021). The newly established Jakarta Mass Rapid Transit company has recently published public service posters that resemble Japanese manner posters. Many of these efforts are focused on adapting the cute visual culture that Japan is known for. These cute visuals are observed in Japanese merchandise, fashion, and food industry and are a staple in Japanese public services exhibited by the case of manner awareness poster design. Indonesia's adoption of assimilating foreign visuals showed the prospect of using a cute visual expression in achieving effective public service communications in various cultures. However, previous research in user experience has stressed the tendency of cultural factors to disrupt media effectiveness. A media designed to arouse specific experiences in target users of one culture might fail to cause the same reaction in another (Santoso & Schrepp, 2019). This study tested that assumption in response to public service communication. We compare impressions between Japanese and Indonesian toward manner awareness poster designs to identify if cultural factors should cause worry for visual communicators.

2 CUTENESS IN MANNER AWARENESS POSTER

Manner awareness poster is a public communication medium which use intricate image and text to promote proper public behavior. Although the term is mainly associated with Japanese posters, the manner awareness poster genre could include public etiquette posters found in other countries, which we often associate with Public Service Announcements (PSAs) posters (Bayne, 2018; Schimkowsky, 2021). A distinct characteristic of Japanese manner awareness posters is their use of cute visual expression. This visual expression refers to an image that induces a positive, warm, safe, and arousing feeling. Visual features which portray cute include a large head, stubby proportion, big eyes, small nose, and rounded shape (Bar & Neta, 2006; Glocker et al., 2009). Studies have also shown that cuteness increases attention focus behavior and improves intrapersonal relationships (Nittono, 2016), potentially explaining how cute visual expressions are effective as a marketing strategy.

Outside of Japan, the cuteness strategy was successfully implemented in the case of the award-winning viral sensation Dumb Ways to Die campaign by Metro Trains Melbourne. The campaign promotes awareness of train-related accidents by using cute cartoons to depict dark humor, comparing death caused by stupid decisions to accidents around trains (Brownsell, 2013). Despite its success, critiques have raised concern regarding the risk of using cuteness as a marketing strategy, stating how it may cause the viewers to think the message is unimportant (Long, 2014). Based on this concern, we questioned if cute visual expressions are appropriate for poster design outside Japan.

3 EXPERIMENT

The objective of our experiment is to determine the difference in impressions on manner awareness poster design between Japanese and Indonesian. The experiment was developed in three steps: experimental material selection, translation check and main experiment.

3.1 Selection of poster characteristics and experimental materials

The researchers collected 48 samples of manner awareness posters published on the internet with varying visual designs and language. Additionally, we collected 38 common impressions relating to the cuteness of manner posters from various literature. We evaluated the posters based on each impression item by assigning a binominal score. We further analyze this dataset with Hayashi's Quantification III method (Hayashi, 1992) to determine three main characteristics that explain the distribution of manner poster design, which are as follows:

- Message explicitness: The verbal aspect of the poster that is characterized by a direct or indirect verbal approach.
- Visual reality: The visual expression presented in the poster. In other words, it explains whether the poster expressed the message through a realistic or fantasy.
- Form of information: The dominating form of information in the poster. On one side is the picture-oriented poster, and on the other is the text-oriented poster.

Next, we reduced our poster collection and impression item through hierarchical cluster analysis to select experimental material for the main experiment. With this process, we reduce our initial 48 posters to 16 sample posters. Meanwhile, our 38 impression items were reduced to 8 impressions, which are "casual", "realistic", "important", "reassuring", "playful", "imaginative", "cute", and "picture oriented". Additionally, we decided to include two new impressions that make a total of 10 impression items used in the main experiment. The additions were the impression of "preference (like / do not like)" and "sharing intention (want to share / do not want to share)", which are often indicative of an advertisement's successful performance.

In this step, the researcher evaluated all the posters in black and white to simplify the experiment. Color is a vital factor for emotions, and by omitting it, we expected to see a more substantial effect of culture on shape expressions (Nonomura et al., 2016).

3.2 Survey tool translation check

Due to the need for universal comprehension of the research, impression words in the experiment were shown in English. However, we were worried that the subtle difference in English understanding between the Japanese and Indonesian might influence the result. Therefore, we conducted an impression word translation survey with a selected Japanese and Indonesian group. In these surveys, we asked evaluators to score the meaning equivalence for each impression item with their translation in Indonesian and Japanese. The English – Japanese and English – Indonesian translation survey were each evaluated by a group of native speakers who has English proficiency and use it professionally. Meanwhile, the Japanese – English – Indonesian translation survey was evaluated by language teachers and professionals who have proficiency in all three languages.

The result of the translation check suggested unequal translation in the Indonesian word for reassuring / not reassuring and playful / not playful; hence it was updated into something more appropriate. Consequently, the translation of the impression of casual / not casual is introduced to replace organic/geometric because both Japanese and Indonesian evaluators thought that the implied meaning was ambiguous.

3.3 Method

In the main experiment, we tested the significance of cultural factors by comparing Japanese and Indonesian impressions of manner awareness poster design. We collected our data by measuring the intensity of impressions felt by both nationalities with an online survey method. The survey asked participants to evaluate poster designs based on impression items with a 7-point Likert scale. Two sets of questionnaires were prepared. One includes a Japanese translation of impression items, and another includes an Indonesian translation of the items. Each set was given to each respective nationality.

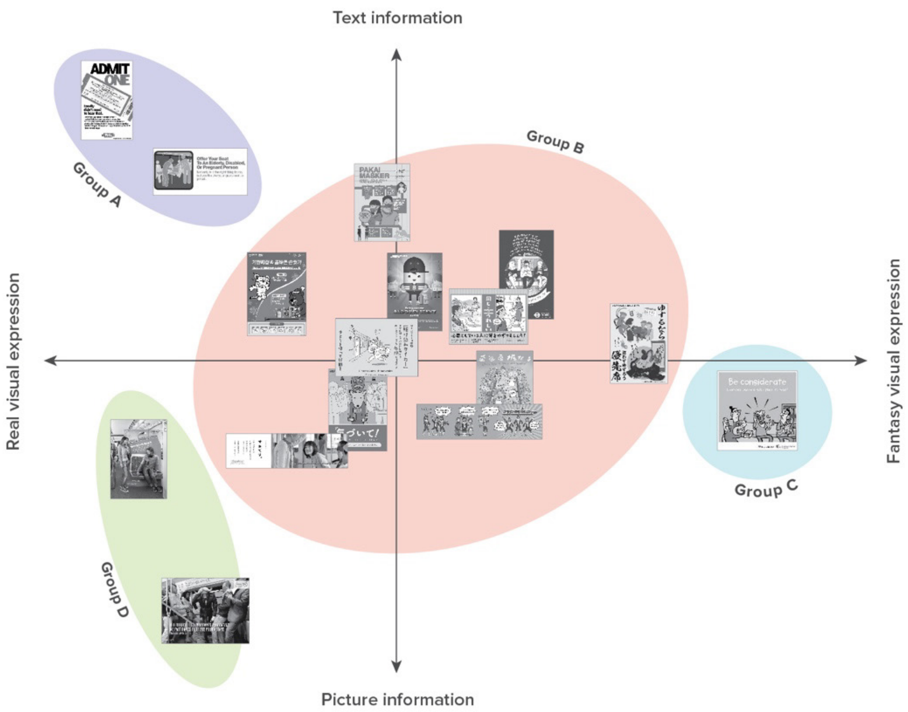

Figure 1. Categorization of poster properties based on visual reality (x axis) and form of information (z axis)

3.4 Procedure

Survey participants completed the experiment by answering an online questionnaire. We distributed its access link separately in the Japanese and Indonesian communities of the University of Tsukuba through social networking services.

The questionnaire consists of three sections. In the first section, we asked participants to provide their demographic. The second section was the poster evaluation; last, in the third section, participants were asked about their comprehension of the posters and several open-ended questions regarding their overall survey experience. In answering the second section, participants were explicitly asked to answer spontaneously based on what they saw. The questionnaire also instructed them to evaluate based on feelings without minding understanding of texts on the poster. Participants were allowed to take as much time and breaks as needed to finish the questionnaires.

3.5 Result

We collected responses from 59 participants, which consisted of 29 Japanese and 30 Indonesian. Their nationality was confirmed by cross-checking their country of origin and native language. Our record also had a balanced gender ratio within the total participants of each nationality. All participants are fluent in their native language, have English communication abilities, and showed a degree of poster comprehension.

Poster evaluation responses are analyzed by considering impression scores as dependent variables, while nationality, gender, and poster properties as independent variables. We configured the level of poster properties based on the manner of awareness poster's visual reality and the form of information characteristics identified in our characteristic selection step. The categorization of the two characteristics is shown in Figure 1. Then we examined the relationship between independent variables using ordinal multivariable logistic regression analysis. A significant effect is determined by P=<.05 and LogWorth > 2.

Table 1. Comparison of multivariable logistic regression result

Result of multivariable logistic regression analysis

		Nationality		Gender		Poster Properties	
		P value	LogWorth	P value	LogWorth	P value	LogWorth
Main culture effect	Casual	<.001**	7.11	<.001**	4.58	<.001**	8.64
	Realistic	<.001**	6.22	.332	0.48	<.001**	3.39
Moderate culture effect	Important	<.001**	3.79	.004**	2.43	.010*	2.01
	Preference	<.001**	3.88	.035*	1.46	<.001**	14.41
	Reassuring	<.001**	3.27	.545	0.26	<.001**	26.50
	Share Intention	.001**	3.04	.007*	2.19	<.001**	12.10
	Playful	.004**	2.39	.035*	1.46	<.001**	28.86
	Imaginative	.005*	2.31	.002**	2.76	<.001**	8.04
No culture effect	Cute	.110	0.38	.418	0.96	<.001**	56.08
	Picture Oriented	.332	0.48	<.001**	9.32	<.001**	23.39

*Significant effect is determined by P= **<.005, *<.05 and LogWorth > 2.

The comparison showed three different cultural effects on impressions (see Table 1). First is the group with the main cultural effect, which includes "casual" and "realistic". Second is the group with a moderate cultural effect that consists of "important", "preference", "reassuring", "share intention", "playful", and "imaginative". The third is the group with no cultural effect, including "cute" and "picture oriented". The table also shows that poster properties significantly affected all impression evaluations. Impression of importance was the only evaluation where poster properties showed significance to a lesser degree. On the contrary, impressions grouped into the no culture effect; "cute", and "picture oriented" showed some of the most significant main effects of poster properties.

Out of the two impressions with the main culture effect, the result for “realistic” showed a difference. Japanese consider group D realistic and groups A, B, and C not realistic. Meanwhile, Indonesians consider A, B, and C slightly realistic and felt group D was neutral even though it contains photo expressions (see Figure 2). In the group of moderate cultural effects, “reassurance” showed the most evident cultural effect Japanese, and Indonesian consider poster groups B and C reassuring, while groups A and D are less reassuring. However, the Indonesian evaluation scored slightly higher than the Japanese for each group (see Figure 3). Last, we observe no participant factor effect on “cute”. Both nationalities evaluated poster groups B and C as cute, while group D is less cute and group A as least cute. There was no significant difference in cute impressions between Japanese and Indonesian (see figure 4).

4 DISCUSSION

Observation of the result with the main culture effect shows a contrasting response between Japanese and Indonesian impressions of “realistic”. Japanese had an expected scoring for each poster group, while Indonesian gave all poster groups a moderately realistic evaluation, suggesting that their assessment was caused by another factor independent of the poster properties.

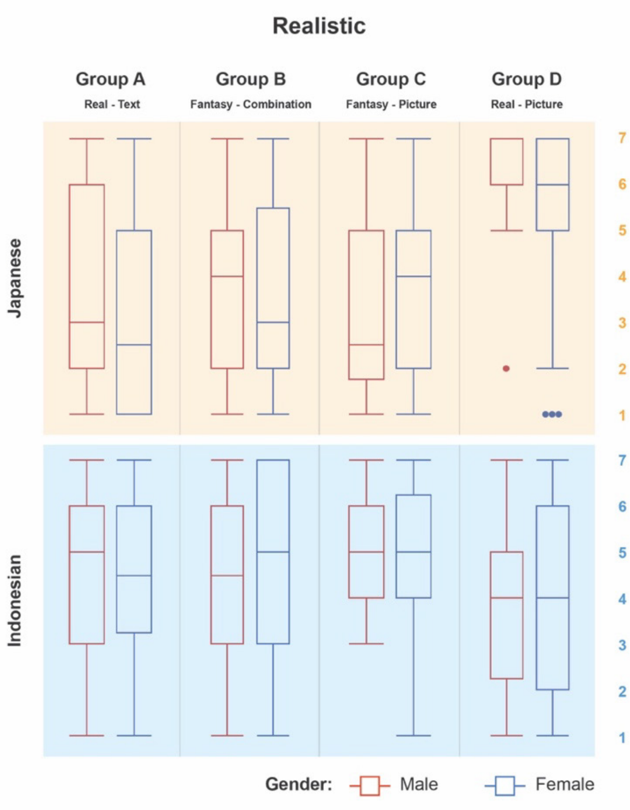

Figure 2. Result of “realistic” impression

The cultural component of language may serve as the cause of this difference in realness impression, where the Japanese understanding of the translated word “realness” has a more photorealistic focused meaning than Indonesian translations. It is supported by the fact that the kanji *写* used in the word *写実的*, used as a translation for “realness”, has a meaning of “to be photographed” and is used in the word *写真*, which means photographs. With this way of understanding words, the Japanese could easily infer the meaning of “realistic” to the word “photograph”, while Indonesian may have a more abstract idea since the Indonesian way of understanding the translated word, *realistis*, is like English.

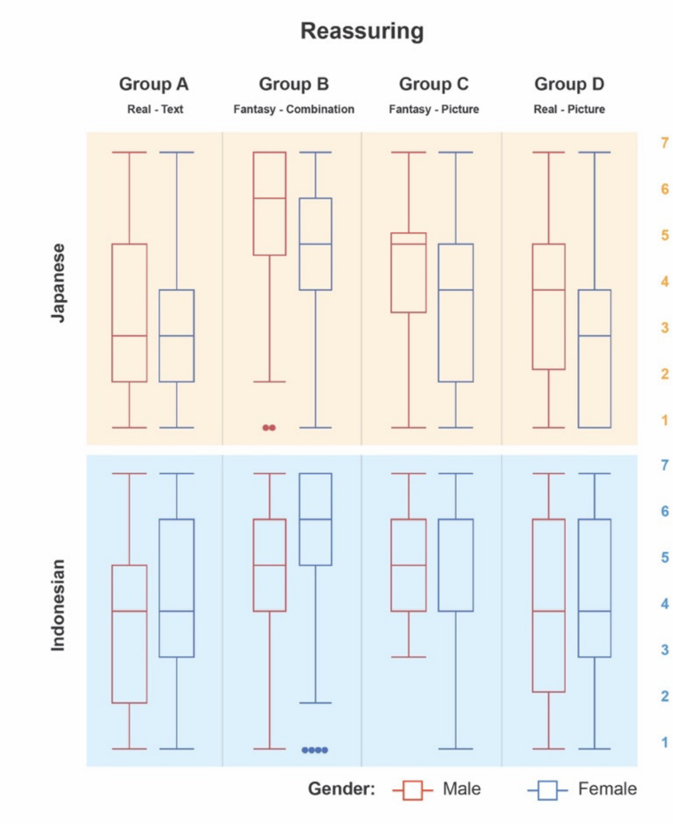

Figure 3. Result of “reassuring” impression

We have anticipated this effect of the language factor by conducting a translation check for our impression items. However, in the case of Japanese and Indonesian languages, this cultural component is still very significant considering the contrasting writing system between the two nations; while Japanese writing system is logographic, Indonesian uses the alphabet.

In the moderate culture effect impression group, the average evaluation score for reassurance showed that poster group B is considered high in reassurance. In contrast, poster group A is considered low on reassurance. Subsequently, we observe significantly stronger reassurance impressions in Indonesian participants when comparing Japanese and Indonesian responses. We assume this as a modest example of a desensitization effect reported in studies of tobacco warning labels. The desensitization effect refers to the decrease in the perceived effectiveness of warning labels in a group exposed to tobacco warning, such as heavy smokers, compared to light smokers who still view the warning as somewhat effective in encouraging less tobacco use (Drovandi et al., 2019).

Considering manner awareness posters prevalence in Japan, the Japanese are more familiar with poster media, which are produced to reinforce the expectation in public manners. However, in Indonesia, manner awareness posters are rare and are not promoted by the official government. Hence, for Indonesian, the posters are slightly more effective in evoking a sense of being looked after and thus reassured.

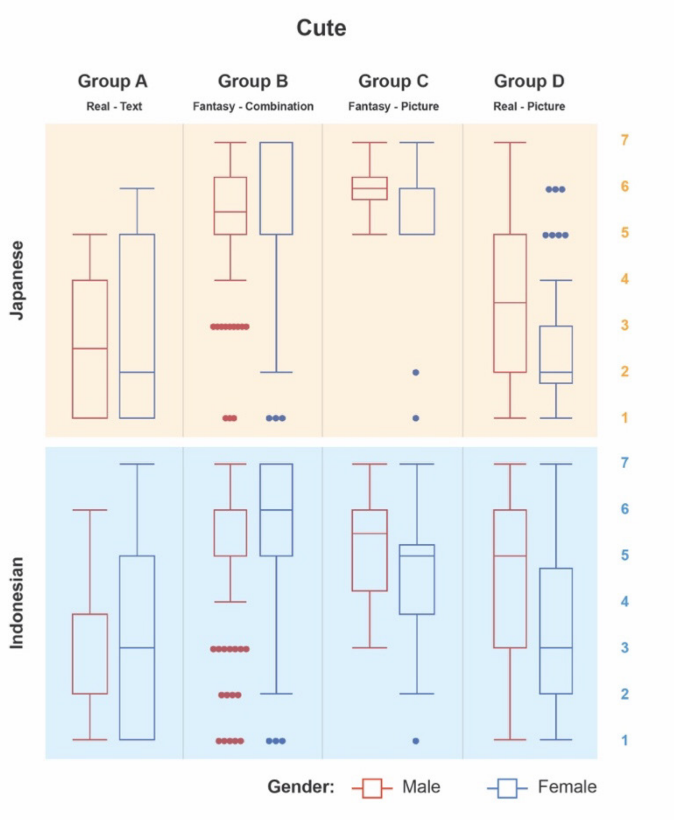

Figure 2. Result of “cute” impression

In the category with no cultural effect, the result of the cuteness impression stands out the most. It is mainly affected by poster properties and has no cultural or gender effect. This finding is consistent with a study by Glocker et al. (2009), where they found that baby facial features may cause a difference in caretaking motivation between gender, yet no difference in cute perception rating, which suggest that even when female experience more willingness to take care of a baby than male, the intensity of feeling cuteness is the same. Our result further strengthens the finding by confirming that cultural factor also has no significance. It supports the recognition of cute as a universal emotion.

Additionally, we observe a significant difference in each poster group’s evaluation pattern. Participants evaluated poster groups B and C, which had fantasy attributes, as cute, while poster groups D and A, which had real attributes, were considered less cute and least cute. This striking pattern of the cute impression among the poster group confirms that our poster categorization method was successful. Therefore, the categorization method based on visual realities and form of information characteristics is appropriate to distinguish each poster group.

5 CONCLUSION

The observed difference in “realistic” impression suggests that control of language factor is critical for successful experimentation on cultural effect. Therefore, when establishing an understanding of the impression word, the researcher should consider differences in writing systems. This finding also leads us to reconsider the inclusion of text in our sample posters as a potential disrupting factor in measuring the cultural difference. Subsequently, the identified desensitization effect in the impression of reassurance would justify the need to periodically update public service media to maintain effectiveness by staying fresh and attractive in the audience’s mind. Finally, our study did not find any cultural effect on the impression of cute, suggesting that cute feeling is universally felt by anyone regardless of nationality.

Our outcome revealed how cultural factors affect impressions that need a more complex appraisal process, such as the impression of realness and reassurance. A complex appraisal process means that people tend to have more considerations when assessing those impressions. In this regard, we conclude that the appraisal of the cute impression happens instantaneously, like how we determine if a poster has more text or pictures.

The limitation of this study includes the limited selection of posters in the extreme poster groups, which are groups A, C, And D and the lack of samples in the upper right quadrant (see Figure 1). For future investigation, a carefully structured and complete variety of sample posters are needed. If the experiment set-up is improved, it would be interesting to expand this study further to include more subjects with various demographic and background categories. We hope this study will serve as an insight into the topic of manner awareness posters design and leads to further exploration of its visual information design aspect.

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EFFECT OF MEN'S SHIRTS ON IMPRESSIONS OF WEARERS' MOTIVATION AND PERFORMANCE

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ABSTRACT

We investigated the effect of men's dress shirts on impressions of wearers' motivation and performance in the workplace, and appearance. A ready-made commercial shirt was used as a reference. Four types of shirts associated with high status (a high-priced ready-made shirt, a custom-made shirt, a high-end brand shirt, and a luxury brand shirt) were presented either alone or with neckties, on identical mannequins. Fifty-one Japanese university students in their 20s and 85 office workers in their 20s to 60s evaluated their impressions of the shirts. We provided no information about the shirts. Compared with the standard shirt, the evaluations of some shirts associated with high status were higher in both groups of participants. However, the presence of wrinkles was associated with lower evaluations, even for luxury brand shirts. Wearing a necktie improved participants' evaluation of appearance and impression for all shirts. Overall, the results revealed that dress shirts affected participants' impression of wearers' motivation and performance.

Keywords: *men's dress shirts, neckties, image evaluation, motivation, performance*

1 INTRODUCTION

Clothing has a range of effects, including impacting observers' impressions of the wearer's motivation and performance. Elements of clothing, such as color, pattern, and style affect the wearer's psychology in terms of consciousness, and impression [2]. Moreover, clothing elements can affect the performance of wearers. Adam and Galinsky [4] suggested that the image that the garment portrays and the actual wearing of the garment affect the wearer's performance. Naito et al. [3] proposed that the relationship between the colors of a wearer's suit, shirt, and tie were strongly related to the business suit's impression.

In recent years, clothing in the workplace has diversified, and various types of clothing have been worn. In Japan, because of the influence of "casual Fridays" since the 1990s, the Japanese "Cool Biz" initiative from 2006 allowing lighter, more casual clothing to reduce air conditioning use, and an increase in working from home because of COVID-19 in 2020, clothing in workplaces has increasingly transitioned from traditional business suits to more casual clothes [1]. Although the prevalence of casual clothes has increased, shirts are still a critical item in the workplace. However, the effect of shirt shape and status on impressions of clothing is currently unclear.

The current study focused on men's dress shirts (hereinafter referred to as shirts), which are worn by office workers daily in the workplace. We investigated the effect of shirts on others' impressions of the wearer's motivation and performance in the workplace, and appearance. In addition, we examined the characteristics of shirts that could improve wearer's motivation and performance at work. In a previous study [5], we conducted an impression evaluation using a sample of shirt images presented on a website to clarify the characteristics of the image portrayed by the clothing. However, impressions of a photograph may differ from those of a physical object. In the current study, we evaluated participants' impressions of actual shirts.

2 EXPERIMENT

We prepared two identical shirts for each of five shirt types (standard and samples A–D), worn by 10 identical mannequins. Five of the shirts were worn with no necktie, and in the other condition, the same shirt was worn with a necktie. Participants then evaluated the actual shirts viewing them arbitrarily without touching them. Two kinds of evaluations were conducted: performance impression evaluation and appearance evaluation. Performance impression evaluation was carried out for 10 evaluation items: "attention," "concentration," "confidence," "persuasiveness," "sense of responsibility," "motivation," "ability to think," "quick thinking," "communication ability," and "energy" on a seven-point scale from "very low: −3" to "very high: +3." Appearance was evaluated with nine items: "no wrinkle," "beautiful," "fit," "looks good," "looks easy to move," "looks slim," "elegant," "expensive," and "preferred" on a five-point scale from −2 (not at all disagree) to +2 (strongly agree). The standard shirt was set at 0, and we conducted a comparative assessment.

Participants were 51 Japanese university students in their 20s (31 men and 20 women) and 85 office workers in their 20s to 60s (38 men and 47 women). No information about the price and brand of the shirts was given to participants. We conducted a one-way analysis of variance, multiple comparisons, and correlation analysis.

Experimental sample details are shown in Table 1. In addition to a ready-made commercial shirt priced at 3,900 JPY (34 USD) that was set as the standard (100 JPY = 1.14 USD), four types of shirts associated with different statuses were prepared (A: high-priced ready-made shirt priced at 8,700 JPY [75 USD], B: custom-made shirt priced at 10,000 JPY [87 USD], C: high-end brand priced at 18,700 JPY [162 USD], D: luxury brand shirt priced at 69,400 yen [603 USD]). All five shirts were also prepared with neckties. The shirt sizes were 38 or 39 cm for neck circumference and 84 or 85 cm for length from back neck point–shoulder point–wrist. Details of the dimensions are shown in Table 2. Sample images are shown in Figure 1.

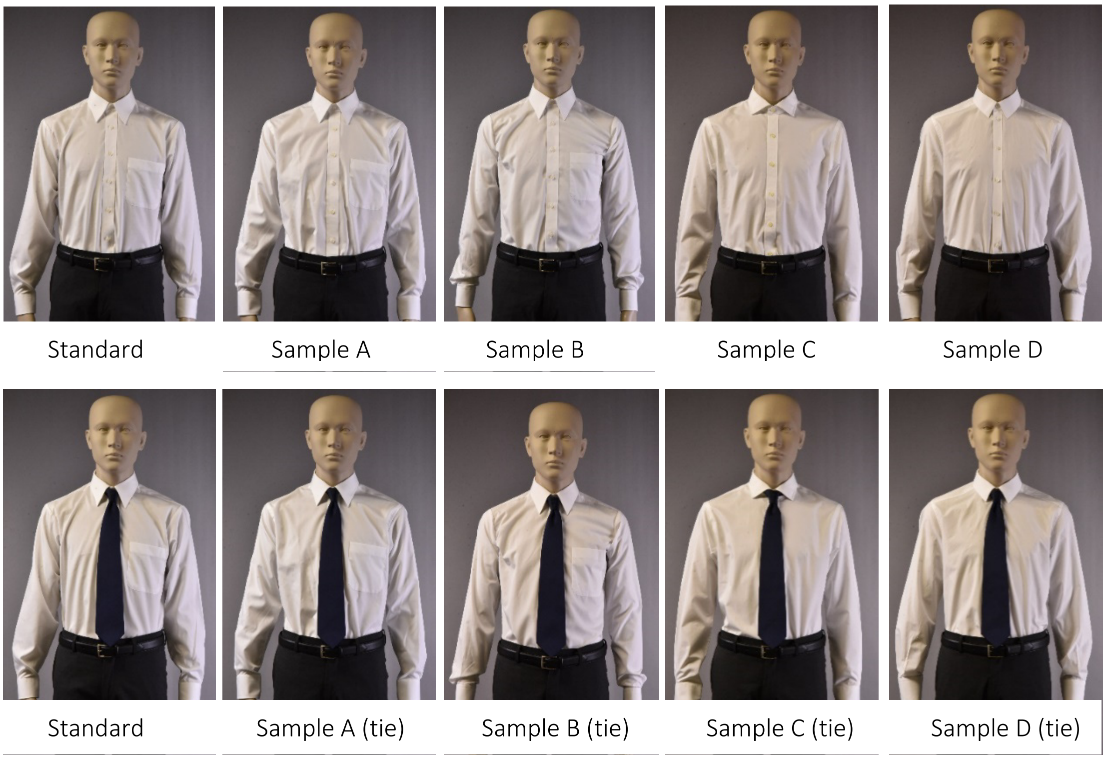

Figure 1. Sample Images

Table 1. Details of the experimental sample (100 JPY = 1.14 USD)

Sample name	Brand	Price(yen)	Fabric composition
Standard	Common commercial ready-made	3,900 (34 USD)	75% cotton, 25% polyester
Standard (tie)			
Sample A	Expensive ready-made	8,700 (75 USD)	55% cotton, 45% polyester
Sample A (tie)			
Sample B	Custom-made shirt	10,000 (87 USD)	75% cotton, 25% polyester
Sample B (tie)			
Sample C	High-end brand	18,700 (162 USD)	100% cotton
Sample C (tie)			
Sample D	luxury brand	69,400 (603 USD)	100% cotton
Sample D (tie)			

Table 2. Dimensions of shirt samples (cm)

Sample name	Neck circumfe rence	Back neck point–shoulder point–wrist	Across shoulder	Lengt h	Chest	Waist	Hips	Armhole	Cuffs
Standard	38.3	84.0	45.0	78.4	107	96.0	101	21.5	22.8
Sample A	39.5	84.5	45.0	79.0	113	103	106	21.5	24.1
Sample B	38.3	84.3	42.5	79.2	100	87.0	104	19.0	20.8
Sample C	39.8	84.8	45.8	80.8	108	99.0	108	24.0	26.5
Sample D	39.3	84.5	44.0	79.8	101	89.0	101	22.3	25.2

3 RESULTS AND DISCUSSION

Figures 2 and 3 show the results for samples A–D (shirts only) for the students and office workers, respectively. Regarding students' performance impression evaluation, a significant difference ($p < 0.05$) was found between sample D and the other samples, and between sample A and the other samples. Correlation analysis showed a positive correlation ($0.50 < r < 0.75$) between the appearance evaluation items "beautiful," "looks good," "elegant," "expensive," and "preferred" and performance impression ratings. The results revealed that the more expensive and preferred by students, the better the performance impression rating, except for sample D. Office workers' responses exhibited a significant difference ($p < 0.001$) between Sample D and the other samples. Correlation analysis showed a positive correlation ($0.50 < r < 0.75$) between "wrinkle-free," "beautiful," "fit," "elegant," " expensive," and "preferred," and performance impression improvement. Sample D received the lowest evaluation among the samples for both groups of participants. Sample D was made of 100% cotton fabric without wrinkle-resistant finishing, so fine wrinkles were noticeable when viewed closely. Regarding students' performance impression evaluation, Sample A received the second-lowest evaluation. Sample A had a larger body width than the other samples and seemed to not fit the body well, contributing to the lower assessment.

Both students' and office workers' impressions were improved by the inclusion of a necktie, with significant differences ($p < 0.05$) between some shirts with and without the necktie. Wearing a necktie improved the evaluation of appearance and impression, and even commercially available ready-made shirts were evaluated as equivalent to a luxury brand shirt. Thus, the impression evaluation was found to be enhanced by wearing a necktie.

In the online survey in our previous study [5], the "looks slim" item influenced the evaluation of performance impression for both students and office workers. However, in the actual shirt evaluation in the current study, participants paid more attention to the presence of wrinkles and compatibility with the body than to the slimness.

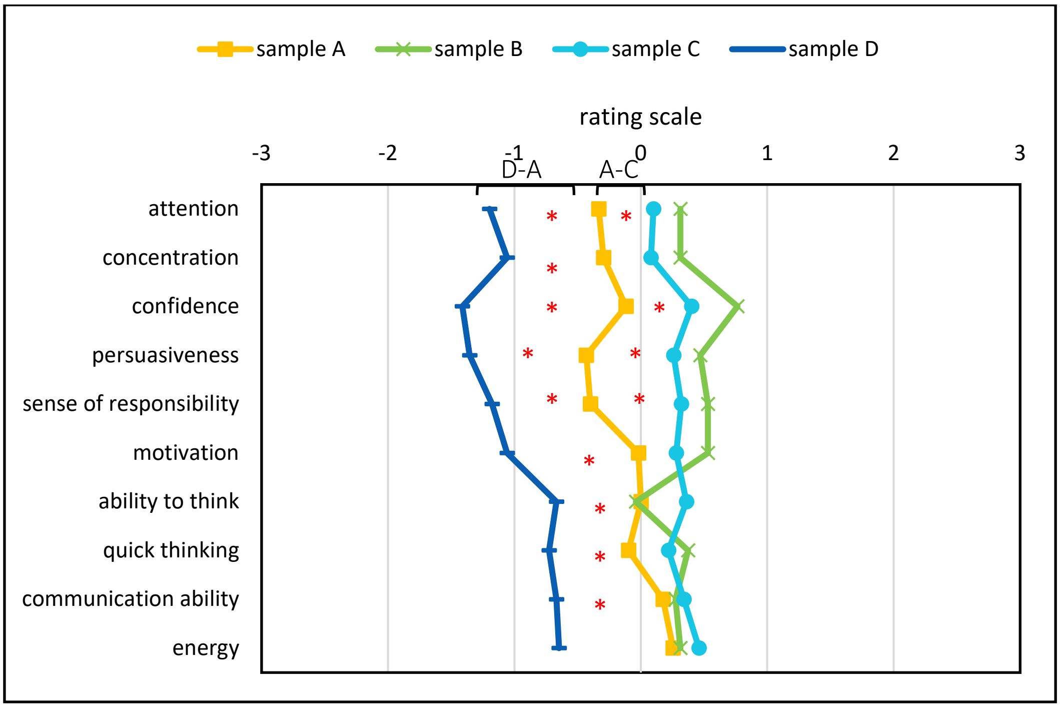

Figure 2. Performance impression evaluation by students (* : $p < 0.05$)

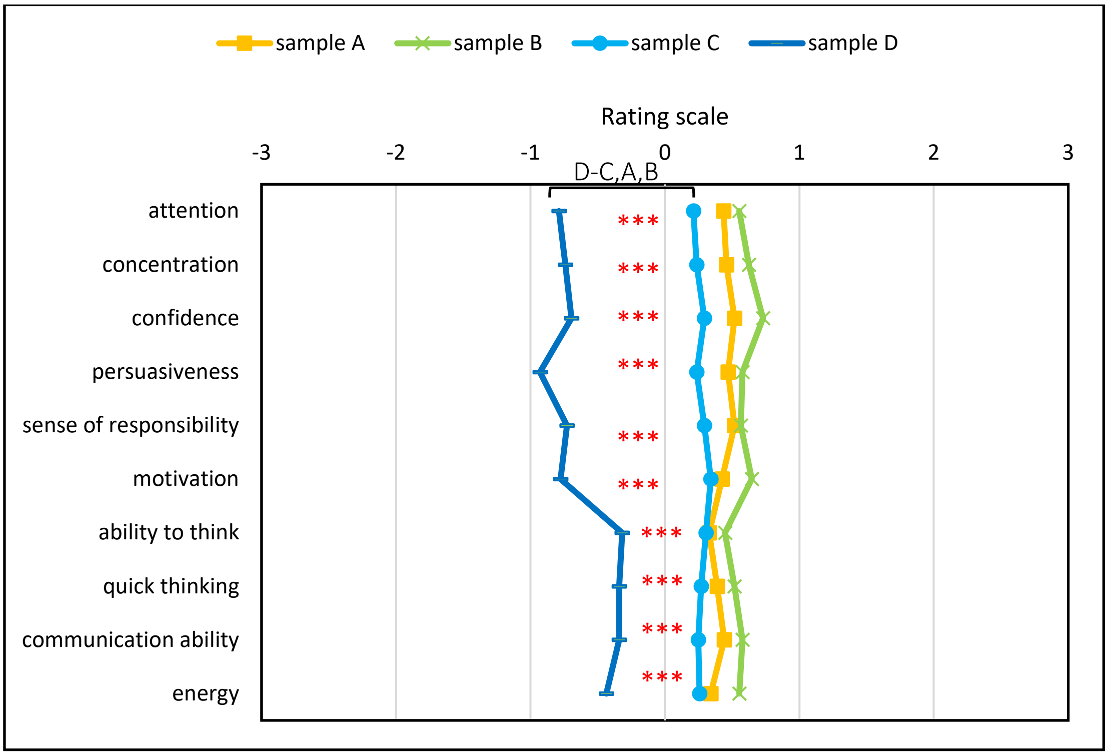

Figure 3. Performance impression evaluation by office workers (*** : $p < 0.001$)

4 CONCLUSION

We investigated the effect of men's dress shirts on viewers' impressions of wearers' motivation and performance in the workplace, and appearance. It was found that the appearance of the shirt influenced the viewer's impression of performance when the shirts were evaluated. The impression evaluation was enhanced by wearing a necktie. A lack of wrinkles and a better fit of the shirt to the body improved the impression of performance. In addition, differences were observed in evaluation between students and office workers. Office workers paid more attention to the presence or absence of wrinkles. This may be because of differences in their experiences of wearing and observing shirts.

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EFFECTIVENESS OF AN IMAGE GENERATION METHOD THAT EXPRESSES THE VISUAL IMPRESSION OF SPACE FOR TWO-POINT PERSPECTIVE LANDSCAPES

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ABSTRACT

Photographs and CG images are generally rendered using a perspective projection. However, because a perspective projection image does not always represent the visual impression of a real space, we occasionally feel a sense of incompatibility when viewing such images. We believe that clarifying the human visual characteristics will enable the creation of more realistic images. A previous study investigated the human perception of size in a real space and proposed a magnification-rate function that shows the relationship between the subjective visual size of an object to be drawn and the observation distance. Images applying the magnification-rate function provide an impression closer to that in a real space than do perspective projection images. However, these results have only been verified for single-point landscapes. In this study, to investigate the impression of an image, we applied the magnification-rate function to images portraying landscapes with a two-point perspective. The results show that the magnification-transformed images were evaluated as being closer to the impressions in a real space than those of perspective projected images. This is similar to the evaluation of transformed images for one-point perspective landscapes, suggesting that an image transformation using the magnification-rate function is effective for two-point perspective landscapes.

Keywords: *Magnification-rate function, Two-point perspective, 3DCG, Visual impression*

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1 INTRODUCTION

With the recent spread of digital cameras and advances in 3dimensional computer graphics (3DCG) technology, there have been increasing opportunities to view photographs and videos drawn using the perspective projection method.

Perspective projection is one of the graphical methods used to represent three-dimensional objects on a plane. Since the Renaissance, many painters, including Leonardo da Vinci and Albrecht Durer, have applied the perspective projection method. Depending on the viewpoint and vanishing point, there are three types of perspective projection: one-point, two-point, and three-point perspective. One-point perspective is suitable for representations that emphasize frontality, such as a room, while two-point and three-point perspective are suitable for representations that emphasize three-dimensionality, such as a building.

Such photographs and videos are indispensable not only in movies and games but also in a wide range of fields such as education, industry, architecture, medical care, and various simulators. However, when we view a photograph, we may feel an unnatural sense in terms of the size of the object and distance.

Such unnaturalness occurs when photographs and videos are represented using the perspective projection method. With this method, the distance to the object is inversely proportional to the object size. However, the human vision system reconstructs space based on various depth clues from the images reflected on the retinas of both eyes. It is therefore known that the relationship between the distance and size perceived by a person in a real space is different from that in a perspective projection owing to such visual characteristics as the size constancy (Gibson, 1947, Smith & Gruber, 1958, Matsuda, 1970, Yasuda,1979, Watanabe, 2004).

Nagata et al. (2008a, 2008b) investigated the effect of magnification, which indicates how many times greater the size perceived in a real space is in comparison to that in a perspective projection image, and proposed the magnification-rate function (i.e., Eq. (1)) using the observation distance as a variable (Figure 1). The function is defined as follows:

$$f(D) = e^{A}$$
$$A = \frac{\alpha N_0 D^{\alpha}}{\alpha + \lambda N_0 (D^{\alpha} - 1)} - C \quad (1)$$

where D is the observation distance, and α, λ, and C are parameters. As the experimental results indicate, when the reference distance is 4 m, these parameters are α = 0.87, λ = 0.29, and C = 1.82. The magnification rate is 1.0 at the reference distance. After creating an image by applying this function and evaluating the impression to determine how well the actual object was reproduced, it was found that the actual impression could be reproduced better than the perspective projection image.

However, this study was applied from a one-point landscape perspective. There is no knowledge that the magnification-rate function can be applied to both two- and three-point perspective landscapes. The purpose of this study is thus to apply the magnification-rate function to a two-point perspective landscape and investigate its effectiveness.

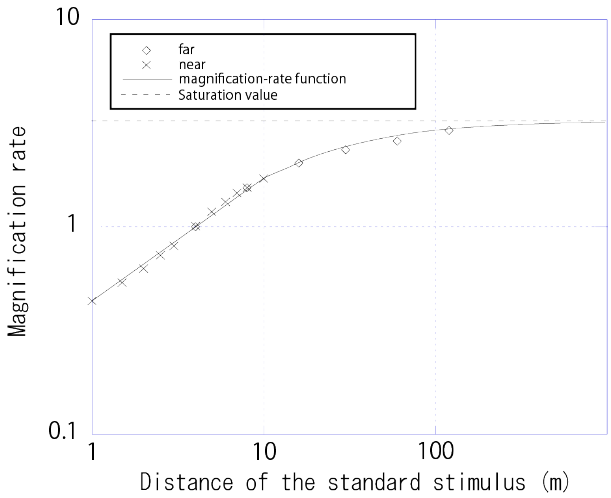


Figure 1. Magnification-rate function showing the relationship between the magnification and observation distance (Nagata et al., 2008b)

2 METHODS

2.1 Participants

Seven university students (1 female and 6 males), aged 21–24, participated in this study.

2.2 Evaluation image

The evaluation images were created using CG, and four evaluation images with different conditions were prepared. Two images (P15 and P20) were drawn with an angle of view equivalent to focal lengths of 15 and 20 mm, respectively, when considering the use of 35 mm film, and two magnification-transformed images (E15 and E20) were created (Figure 2). The algorithm developed by Mizukami et al. (2007) was used for the image transformation. All evaluation images were drawn using the rendering engine EEVEE in Blender 3.1.1 3D computer graphics software (Blender Foundation). The image was saved as a PNG file with a pixel resolution of 1524 × 1074. The parameters in the magnification-rate function were set to $\alpha = 0.87$, $\lambda = 0.29$, and $C = 1.82$. Four evaluation images were printed on glossy photo paper (PT -201A320, Canon) using an inkjet printer (PIXUS PRO-10S, Canon). The size of the printed image was 127 mm × 89 mm.

(a) f = 15 mm (perspective projection, P15)

(b) f = 20 mm (perspective projection, P20)

(c) f = 15mm (converted, E15)

(d) f = 20 mm (converted, E20)

Figure 2. Evaluation Images

2.3 Procedure

An experiment was conducted on a straight road adjacent to the Research Building #2 on Yamaguchi University campus.

The position of the viewpoint was the edge of the road, 12 m north and 8 m east from the corner of the building, with a height of 1.2 m (Figure 3). A chin rest was placed on the left side of the street at an angle of 25° in order to fix the direction of the face and to observe the building. The position and angle of the camera when generating the CG images were the same as the viewpoint in the real space.

The observer sat on a chair at the position as shown in Figure 3 and observed the building and evaluation image. The observer compared the evaluation image with the real space and evaluated on an 11-point scale whether the visual impression received from the image matched the visual impression when observe the real space. When the visual impression received from the image completely matched the visual impression while observing the real space, the value was set to 100%, and when it did not match at all, the value was set to 0%.

The evaluation image was presented at a position at which the height of the center of the image was 1.2 m, the presentation angle was 55° to the left from the front of the observer, and the distance from the viewpoint was 0.45 m. On the day of the experiment, the weather was either sunny or cloudy. The experiment was conducted from 12:00 to 16:00, and the season was from December to January.

The evaluated items are presented in Table 1. The locations of the evaluated targets are shown in Figure 4. The observer was instructed to observe each target without changing the face direction. The observers were prohibited from observing with their eyes narrowed, their peripheral vision, of only one eye, and from measuring the size of the object to be evaluated with their hands or tools. The evaluation images were presented in random order.

For a stable evaluation, the observers practiced in advance the same procedure as that used in the experiment. As the evaluation images used for the practice session, three images were randomly selected from those images with focal lengths of 10, 25, 35, 50, and 70 mm.

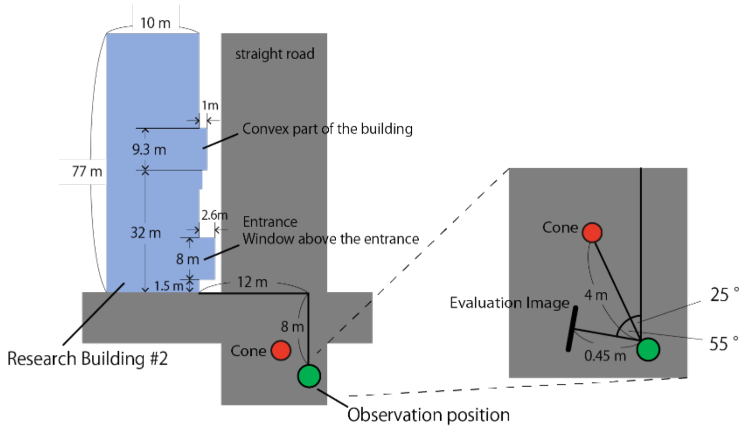


Figure 3. Observation position

Table 1. Evaluated items

Evaluated Item	Evaluated target
Distance to nearby objects	• Cone • Entrance
Size of nearby objects	• Cone (height) • Entrance (width, height) • Window above the entrance (width, height)
Distance to distant objects	• Convex part of the building
Size of distant objects	• Convex part of the building (width, height)
Angle formed by lines of the building (see Figure 4)	• Whole Building
Field of view	• Horizontal angle of view • Vertical angle of view
Comprehensive evaluation	• Whole landscape

Figure 4. Evaluated target

3 RESULTS AND DISCUSSION

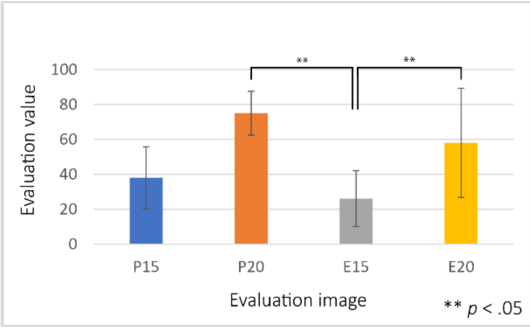
Figure 5 shows the average and standard deviation of the evaluation values of all observers. The evaluations (distance and size) of the nearby objects were the mean evaluation values of the cone, entrance, and window above the entrance. The evaluations (distance and size) of the distant object were the values evaluated for the convex part of the building. "Comprehension evaluation" indicates the evaluation value of the overall landscape impression. "Integrated evaluation" is the mean value of each evaluated item without a comprehensive evaluation.

A one-factor analysis of variance was conducted for each evaluated item using the evaluation image as a factor. Consequently, the main effect of the factor was significant at the 5% significance level. Table 2 presents the *F* and *p* values for each evaluated item. Multiple comparisons (Ryan method, significance level 5%) were conducted between each image. A combination of images with significant differences is shown in Figure 5.

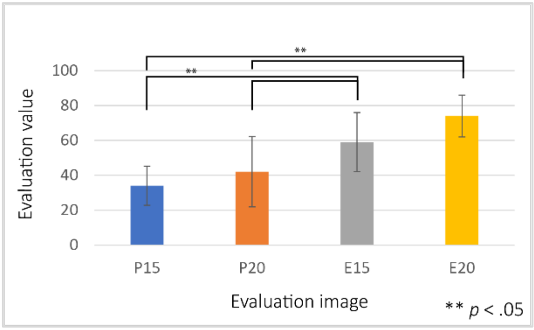
Table 2. *F*- and *p*-values for each evaluated item (see Table 1)

Evaluated item	*F* value	*p* value
Distance to nearby objects	$F(3,24) = 8.656$	$p < .001$
Size of nearby objects	$F(3,24) = 15.229$	$p < .001$
Distance to distant objects	$F(3,24) = 13.051$	$p <. 001$
Size of distant objects	$F(3,24) = 16.799$	$p < .001$
Angle formed by lines of the building	$F(3,24) = 7.094$	$p < .005$
Field of view	$F(3,24) = 3.411$	$p <. 05$
Comprehensive evaluation	$F(3,24) = 12.160$	$p < .001$
Integrated evaluation*	$F(3,24) =14.216$	$p < .001$

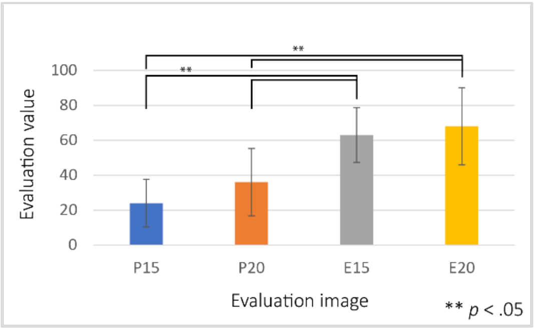
*The mean value of each evaluated item without a comprehensive evaluation.



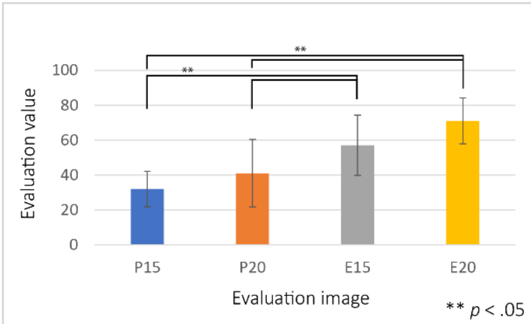
(a) Distance to nearby objects



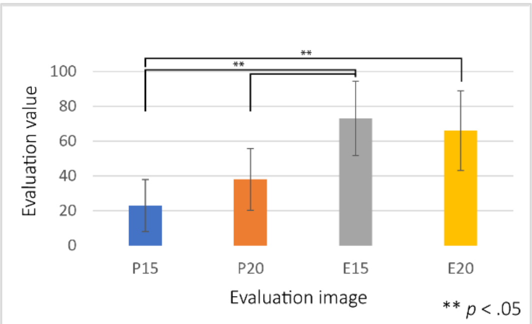
(b) Size of nearby objects



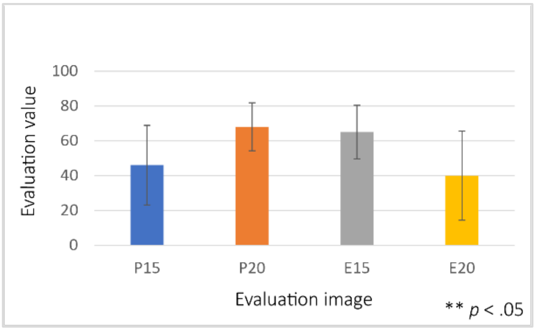
(c) Distance to distant objects



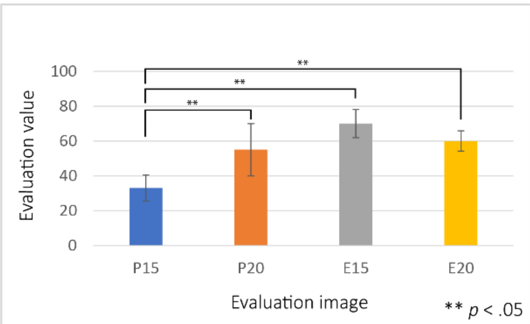
(d) Size of distant objects



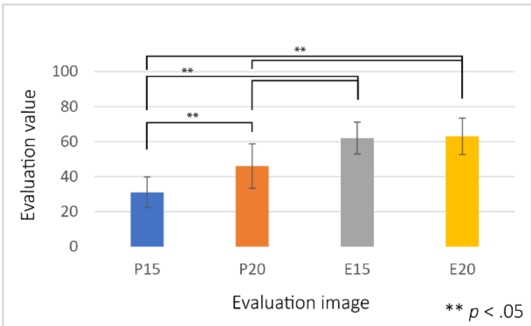
(e) Angle formed by lines of the building



(f) Field of view



(g) Comprehensive evaluation



(h) Integrated evaluation

Figure 5. Results of each evaluated item for the target image

For the “distance to nearby objects,” the evaluations of P20 and E20 were significantly higher than that of E15. If the focal length is too short, the sense of distance to nearby objects will be degraded as shown in a previous study (Nagata et al., 2008).

For the “size of nearby objects,” the evaluation of E20 was the highest and was significantly different from those of P15 and P20. Furthermore, the evaluation of E15 was significantly higher than those of P15 and P20. Therefore, it was found that the magnification-rate function was effective for the perception of size at short distances.

For the “distance to distant objects,” the evaluation of E20 was the highest and was significantly different from those of P15 and P20. Furthermore, the evaluation of E15 was significantly different from those of P15 and P20. In previous studies on single-point perspective landscapes (Nagata et al., 2008), the magnification-rate function improved the sense of distance at long lengths. This result showed that the magnification-rate function was also effective in a two-point perspective landscape.

For the “size of distant objects,” the evaluation of E20 was the highest and was significantly different from those of P15 and P20. In addition, the evaluation of E15 was significantly different from those of P15 and P20. The magnification-rate function was also effective in a two-point perspective landscape.

For the “angle formed by the lines of the building,” the evaluation of E15 was the highest and was significantly different from those of P15 and P20. The second-highest rating was for E20, which was significantly different from that of P15. In a two-point perspective landscape, the magnification-rate function improved the depiction of the angle of the building in comparison to the perspective projection image.

For the “field of view,” no significant difference between the images was confirmed through the multiple comparison procedure.

For the “comprehensive evaluation,” the evaluation of E15 was the highest, followed by those of E20 and P20. In addition, the evaluations of P20, E15, and E20 were significantly different from that of P15. For the “integrated evaluation,” the evaluation of E20 was the highest, followed by that of E15 and P20. Moreover, the evaluation of P20 was significantly different from that of P15, and the evaluations of E15 and E20 were significantly different from those of P15 and P20. Comparing the “comprehensive evaluation” and the “integrated evaluation,” both P15 and P20 showed the same tendency.

As described above, the effectiveness of the magnification-rate function in the two-point perspective landscape is shown in many of the items. By contrast, in the evaluation of the "field of view,” there was no difference from a perspective projection. In a landscape drawn from a one-point perspective, the distance to centrally located objects is often great and the objects can easily fit within the screen. In a two-point perspective landscape, the central object tends to be closer than in a one-point perspective. Therefore, in a magnification-transformed image, it is difficult to fit the central object within the image, which is responsible for the results of the “field of view.”

4 CONCLUSIONS

An impression evaluation experiment was conducted by comparing a perspective projection image and a magnification-transformed image with a real space for a two-point perspective landscape. As a result, the magnification-transformed image received a high evaluation for many of the evaluated items, similar to that of the images for one-point perspective landscapes. Image transformation using the magnification-rate function is effective even in a two-point perspective landscape. In a two-point perspective landscape, a problem occurs in that the object to be drawn does not fit the screen. Since there was no difference in impression between the magnification transformed image and the perspective projection image in terms of distance to the nearby object, it is interesting to apply the magnification function to images with a higher viewpoint (e.g., 3-D CG games and animations with a third-person viewpoint) for expanding applications.

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EFFECTS OF NONVERBAL COMMUNICATION ON CHATBOT'S PERCEIVED PERSONALITY AND USER SATISFACTION

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ABSTRACT

As artificial intelligence develops rapidly, companies have created exclusive chatbots to facilitate conversational commerce and establish an emotional connection between their brands and their customers. Therefore, shaping the chatbot personality to match the brand image is often the focus of chatbot design. Two studies were conducted to investigate how nonverbal communication elements (avatar, sticker, emoji) affect users' judgment of chatbot personality and explore the effect of chatbot personality on user satisfaction. In Study 1, Kansei engineering was adopted to conduct an online survey using six combinations of nonverbal elements as experimental conditions and the five dimensions of the Brand Personality Scale as Kansei vocabularies. The results revealed that the three nonverbal elements did affect users' perceptions of chatbot personalities; however, the impacts of each element on different personality dimensions varied. In Study 2, based on Study 1, two crowdfunding chatbots with distinct personality traits, sincere and insincere, were developed as the experimental conditions to interact with participants within FB messenger. One hundred fifty valid questionnaires and the click rate of participants during the experiment were collected to measure participants' satisfaction. The results showed that participants were more satisfied with the sincere chatbot than the insincere chatbot. In addition, the personality of the chatbots also affected the participants' judgment of the quality of the messages as well as their willingness to use the chatbots.

Keywords: *Chatbot, Nonverbal Communication, Brand Personality, Kansei Engineering, Conversational User Interface*

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1 INTRODUCTION

With the rapid growth of artificial intelligence and conversational commerce, chatbots have become necessary for large enterprises. A chatbot is a software application that enables users to verbally interact with companies, services, or brands on the communication software they are familiar with via texts, images, and voices (Nguyen, 2017). Therefore, it is a crucial design strategy for large enterprises to make chatbots with distinct personalities to have social interaction with users through social media platforms, enhance the user experience of e-commerce, and create brand segmentation in conversational commerce (Vlahos, 2019). Studies have investigated the impact of chatbot personality on users (Dibitonto, Leszczynska, Tazzi, & Medaglia, 2018; Thies, Menon, Magapu, Subramony, & O'neill, 2017). However, most of these studies focused primarily on the impact of text-based scripts on chatbot users and rarely considered nonverbal interactions.

Nowak & Biocca (2003) found that making virtual agents more human, such as giving them anthropomorphic appearances or avatars, can significantly facilitate the emotional communication between virtual assistants and users and strengthen brand identity. In addition, Ganster, Eimler, and Kramer (2012) argued that non-verbal cues such as emojis could help people perceive the emotion of the conversation content and feel more immediate and robust about the speaker's personality in computer-mediated communication. Emojis for text conversations are like the speaker's facial expressions, complementing the reader's feeling of not being able to communicate face-to-face with each other.

In addition to emojis, recently, stickers have become very popular among Taiwanese users on communications platforms. For example, according to the official statistics of LINE in Taiwan, users in Taiwan download 18 stickers on average, which is twice the number in Japan (Oung, 2020). Moreover, the usage rate of information models of stickers in each age group is very even (Huan & Xie, 2020), indicating that the Taiwanese generally have accepted expressing their feelings with stickers. Therefore, the study probed into how a chatbot's nonverbal communication contributes to users' perception of the chatbot's personality and further affects user satisfaction. Through two experiments, we intended to discuss the following two questions: (1) whether the nonverbal communication elements (avatar, stickers, emojis) of chatbot influenced people's perception of its personality, and (2) in the conversational commerce, whether the personality of chatbot influenced the satisfaction of e-commerce users.

While it would have been possible to conduct one study to explore the two research questions mentioned above, such a complete factorial design seems unwarranted until the impact of nonverbal communication cues on users' judgments of chatbot personality is clarified first. Then, we can further examine the impact of chatbot personality on user satisfaction. Therefore, two separate experiments were conducted. The following two studies presented here represent investigations into the effect of nonverbal communication on users' judgments of chatbot personality and satisfaction.

2 STUDY 1

Study 1 investigated whether and how chatbot's avatars, emojis, and stickers may affect users' perception of chatbot personality in conversational interactions. Kansei Engineering (KE) was adopted to explore the impacts of the three nonverbal elements on chatbots' perceived personality.

2.1 Kansei Engineering

Consumers' expectations for products or services are often in terms of their feelings and preference, like "luxury, gorgeous, stable," but not specific design features. In order to translate customer perception of the product into design elements, Nagamachi initially proposed the Kansei engineering methodology in the 1970s. The underlying presumption in Kansei engineering is that affective impact on the customer results from the composition of the different product features and properties. Hence, to maximize customer satisfaction, the optimal strategy is to choose the best combination possible. This approach has been successfully used to develop products in a wide range (Nagamachi, 1995; 1999).

Kansei is a Japanese word for people's feelings or perceptions of things. This technique often uses scales and statistical analysis of semantic expressions (Kansei vocabularies) representing different consumers' feelings to explore the relationship between design elements and specific perceptualities. The design elements of a product are called "Items," and the possible options of each item are called "Categories." The main processes include collecting product samples and Kansei vocabularies, selecting representative product samples and representative Kansei vocabularies, deconstructing and sorting product samples to determine the significant items and categories, and establishing the correlation between design elements and Kansei vocabularies (Nagamachi et al., 2008).

The reason to use Kansei Engineering in this research is based on the ability of the method to clarify the effect of each design parameter of a particular product on people's hidden impressions, which can serve as a reference for designers in building chatbots personalities in the future.

2.2 Method

In this primary investigation, we applied the framework of Kansei engineering in an online experiment. We used the avatar, stickers, and emojis as the "Items" and Aaker's (1997) five dimensions of the Brand Personality Scale as the Kansei vocabularies to explore whether and how non-verbal communication design elements in conversational interactions may affect users' perceptions of chatbot personality.

The experiment adopts a 2X2X2 within-subjects design. There are three independent variables (or items in KE): chatbot's avatars, the use of stickers, and the use of emojis (Table 1). For each variable, there were two options (categories in KE). The two avatars used in Study 1 were based on the findings of Huang & Yous' (2019) investigation of the effects of avatar design on chatbot brand personality by Kansei Engineering methodology. For example, avatars with dark hairstyles, smiling eyes, and a grin would give people a feeling of sincerity, competence, and sophistication.

In contrast, avatars with unnatural hair color (e.g., green), a bare forehead, darker-lens glasses, and expressionless faces tended to make people feel the opposite.

Table 1. Independent variables of study 1: nonverbal communication elements of chatbots

Item	Category	
Avatar		
Sticker		No Sticker
Emoji		No Emoji

Table 2. Dependent variables of study 1: 10 questions from the brand personality dimension

Brand Personality Dimension	Kansei vocabularies (Perception of Personality)	
Sincerity	Sincere	Friendly
Excitement	Exciting	Trendy
Competence	Reliable	Intelligent
Sophistication	Feminine	Upper class
Ruggedness	Masculine	Tough

We used the orthogonal design to reduce the number of experimental conditions to six to reduce participant fatigue. Based on the experimental conditions, six animated videos were created to simulate the conversations between chatbots and their users on Facebook messenger using the same dialogue scripts. Participants were then able to view them through an online questionnaire platform. The dependent variables (Kansei vocabularies) were the ten personality traits selected from Aaker's (1997) Brand Personality Scale (Table 2).

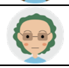
The chatbots in the simulation videos served as the recommendation assistant of a movie promotion site in the experiment. All simulation videos use the same dialogue script. Therefore, we only manipulated the non-verbal communication elements of chatbots in the dialogue to generate different experimental conditions. Once the participants were recruited, they were asked to view the videos, then express their impression of each chatbot by filling up an online questionnaire on a five-point Likert scale based on Aaker's (1997) five dimensions of the Brand Personality Scale. Afterward, regression analysis was used to analyze the effects of non-verbal communication elements on chatbots' perceived personalities.

2.3 Results

Two hundred forty-one participants (121 males and 120 females) aged 20-49 were recruited online in Study 1. Through the multiple regression analysis of Hayashi's Quantitative Theory Type 1, the study analyzed the influence of three nonverbal communication elements on five brand personality dimensions: sincerity, excitement, competence, sophistication, and ruggedness. The analysis results are summarized in Table 3.

As shown in Table 3, the analytical findings are as follows: (1) the use of avatars, stickers, and emojis in chatbots could contribute to participants' perception of the chatbot's personality; however, the effects varied; (2) A chatbot's personality traits were strengthened by adding stickers to convey "sincerity," "excitement," "competence," and "sophistication"; (3) Users perceived chatbots to be more "sincere," "excited," and "competent" when they used emojis; (4) the avatar of chatbots had more influence on users' perception of "sophistication" in chatbots and little on other personalities. Finally, (5) stickers affect users' perception of chatbots' brand personality the most, followed by emojis and avatars.

Table 3. Analytical Results of Hayashi's Quantitative Theory Type 1

Item	Category	Sincerity		Excitement		Competence		Sophistication		Ruggedness	
		Category Score	PCC	Category Score	PCC	Category Score	PCC	Category Score	PCC	Category Score	PCC
Avatar		0.00	0.07	0.01	0.27	0.01	0.31	0.05	0.97	(-0.00)	0.14
		(-0.00)		(-0.01)		(-0.01)		(-0.05)		0.00	
Sticker		0.19	0.99	0.19	0.98	0.06	0.72	0.03	0.87	(-0.02)	0.47
	No Emoji	(-0.10)		(-0.10)		(-0.03)		(-0.01)		0.01	
Emoji	😀☺️😊😄	0.03	0.85	0.04	0.81	0.03	0.57	(-0.00)	0.40	(-0.02)	0.52
	No Sticker	(-0.03)		(-0.04)		(-0.03)		0.00		0.02	
Constant		3.53		3.12		3.56		2.78		2.91	
R		0.99*		0.98*		0.80		0.97*		0.66	

PCC: Partial Correlation Coefficient

Furthermore, by using the scores and constants of each nonverbal communication item (and category) in the five personality dimensions in Table 3, the predicted ratings of a chatbot's specific personality trait can be obtained by summing up the "category score" of each item under that personality trait and then adding it to the constant. By doing so, the ratings of the five personality traits for any possible nonverbal combinations in this study can be deduced. In other words, as long as we know which avatar a chatbot uses and whether it uses stickers, emojis, or not, now we can predict how it is perceived by participants in the five brand personality traits.

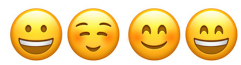
3 STUDY 2

Study 2 investigated whether chatbot personality affected participants' satisfaction through a between-subject experiment. Based on the result of study 1, we could use avatars, emojis, and stickers to create specific combinations of nonverbal elements for chatbots to elicit certain brand personality traits and further explore the impact of chatbot personality on user satisfaction in e-commerce. The chatbots in the experiment were set as the intelligent assistants on the Facebook messenger app exclusively for a crowdfunding platform. The experimental scenario was that a chatbot recommended its users merchandise through conversational interaction.

3.1 Method

The independent variable was the chatbot's personality trait elicited by its non-verbal communication. The conversational scripts of both chatbots were identical, and the only difference was their use of nonverbal elements. Therefore, we took the combinations of nonverbal elements with the highest and lowest sincerity personality scores in Study 1 to serve as the cues for chatbot personality (see Table 4). The dependent variables of the experiment were the participants' subjective ratings of satisfaction with chatbots and the number of clicks participants made throughout the conversational interaction. The experiment adopted a between-subject design; each participant only talked to one chatbot. The experimental process was as follows. First, the chatbot introduced itself, followed by a crowdfunding plan recommendation to the participant. Then, according to the participant's answers, provided a link or recommended the next crowdfunding plan until the participant terminated the conversation. Afterward, participants completed a five-point Likert scale questionnaire about their satisfaction with the chatbot.

Table 4. The combination of nonverbal elements for the sincere and insincere chatbots

Experimental Condition	Avatar	Sticker	Emoji
Sincere Chatbot			
Insincere Chatbot		No Sticker	No Emoji

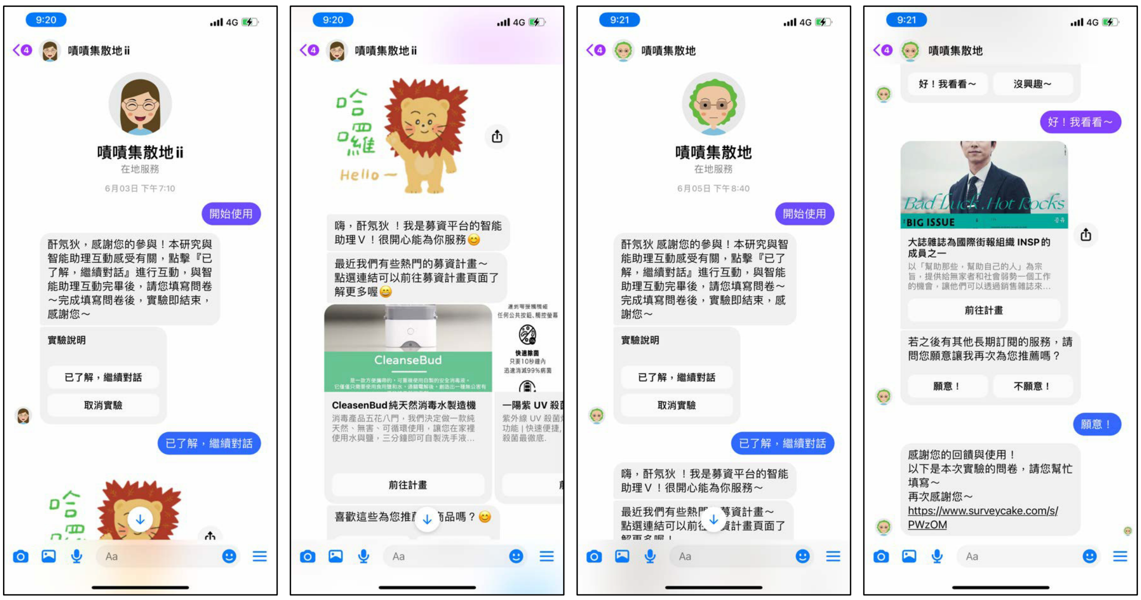


Figure 1. Screenshot of dialogues between chatbots and participants in Study 2

The two experimental conditions were "sincere chatbot" and "insincere chatbot." The two scripted chatbots were created through the chatbot construction platform Super 8 (Figure 1). The satisfaction measures for Study 2 were based on the chatbot satisfaction scale proposed by Ashfaq, Yun, Yu, & Loureiro (2020) with six constructs, namely Information Quality (5 items), Service Quality (3 items), Perceived Enjoyment (3 items), Perceived Ease of Use (4 items), Satisfaction (2 items), and Continuance Intention (3 items). In addition, the click counts of chatbots' recommendations provided by Super 8 were also collected.

3.2 Results

In Study 2, 150 participants (36 males and 114 females) were recruited. Randomly assigned to two groups, 60 participants interacted with the sincere chatbot, and 90 interacted with the insincere chatbot. The average ratings received in each item of the satisfaction scale for the two chatbots are shown in Table 5. According to Table 5, the sincere chatbot received higher ratings than the insincere chatbot in most satisfaction items except item 7, "the chatbot gives me a prompt response." It indicated that participants' satisfaction with the sincere chatbot was slightly higher than with the insincere chatbot.

Table 5. The comparison of average ratings in the chatbot satisfaction scale

Construct	Items	Sincere chatbot	Insincere chatbot
Information quality	1. The information provided by this chatbot is sufficient.	4.16	3.88
	2. The information provided by this chatbot is clear.	4.21	3.93
	3. The information provided by this chatbot is accurate.	4.05	3.92
	4. The information provided by this chatbot is up to date.	3.96	3.76
	5. The information provided by this chatbot is reliable.	4.03	3.76
Service quality	6. The chatbot has a modern-looking interface.	4.05	3.71
	7. The chatbot gives me a prompt response.	4.25	4.34
	8. The chatbot has visually appealing materials.	3.88	3.52
Perceived enjoyment	9. The conversation with the chatbot is exciting.	3.55	3.26
	10. I enjoy choosing products more if they are recommended by the chatbot than if I choose them myself.	3.35	3.14
	11. I was absorbed in the conversation with the chatbot.	3.70	3.46
Perceived ease of use	12. My interaction with the chatbot is clear and understandable.	4.36	4.13
	13. Interaction with the chatbot does not require a lot of my mental effort.	4.28	4.11
	14. It is easier to use the chatbot to find products that I want to buy.	3.86	3.63
	15. I find the chatbot to be easy to use.	4.23	4.05
Satisfaction	16. I like interacting with the person who provides the service.	4.01	3.84
	17. I feel satisfied about the overall experience of using the chatbot.	3.98	3.85
Continuance intention	18. I intend to continue using this chatbot in the future.	3.66	3.32
	19. I will always try to use this chatbot in my daily life.	3.65	3.37
	20. I will strongly recommend others to use it.	3.53	3.34

Additionally, we used factor analysis and reliability analysis to confirm the factorial structure and reliability of the questionnaire. After removing inappropriate question items, the six constructs in the original satisfaction scale were re-divided into three groups. We renamed the three groups Continuance Intention, Information Quality, and Perceived Ease of Use. The reliability of the scale was then assessed with the three reclassified constructs. The KMO and Bartlett sphere test results indicate that the measure shows acceptable validity and reliability. Then, we applied the one-way analysis of variance (ANOVA) to investigate the effect of chatbot personality on user satisfaction in a merchandise recommended scenario. The results of the ANOVA are presented in Table 6. The results indicate statistically significant differences in the Continuance Intention and Information Quality constructs. Therefore, the chatbot personality prompted by manipulating nonverbal elements indeed affects the participants' satisfaction ratings.

Table 6. Analysis of Variance (ANOVA) results of effects of chatbot personality traits

Tests of Between-Subjects Effects						
Independent Variable	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Chatbot Personality	Continuance Intention	2.230	1	2.230	3.977	0.048*
	Information Quality	1.923	1	1.923	5.563	0.020*
	Perceived Ease of Use	0.538	1	0.538	1.685	0.193

Finally, according to the click count of the chatbot's recommended crowdfunding plan provided by the super 8, the participants' click-through rate (CTR) under different chatbot conditions is compared. The results showed that:

1. The CTR of the five crowdfunding products recommended by the sincere chatbot was 90%, and the CTR of the product recommendations by the insincere chatbot was 55.8%.
2. The CTR of the public welfare projects recommended by the sincere chatbot was 81%, and the CTR of the public welfare projects recommended by the insincere chatbot was 58%.
3. The CTR of accepting further recommendations from the sincere chatbot is 75%, and the CTR of accepting further recommendations from the insincere chatbot is 38%.

To sum up, in the online experiment of crowdfunding plan recommendation with chatbots in the social platform, the participants' click behavior will change slightly due to the chatbot's personality. Moreover, the sincere chatbot can lead to higher click-through rates in referrals for crowdfunding programs.

4 CONCLUSION

The study primarily probed into the influence of nonverbal communication elements on users' perception of chatbot personality and satisfaction in the scenario of merchandise recommended on the crowdfunding platform. Upon the two-stage experiment, the conclusions of the study are as follows:

1. People can perceive different personality traits in chatbots, and the personality traits can be better affirmed with more non-verbal elements. Therefore, chatbot developers could use the non-verbal elements of conversational interaction, such as avatars, emojis, and stickers, to create a chatbot personality that conforms to the corporate image.
2. The chatbot's personality could influence users' satisfaction with a crowdfunding website chatbot. Even though the dialogue scripts for both product recommendation chatbots are identical, merely implying the personality trait of a chatbot through its avatar, stickers, and emojis is enough to affect user satisfaction, causing fluctuations in click behavior.

The presumption in Kansei Engineer holds that the personality traits expressed by a chatbot and its personality perceived by users are not innate characteristics or qualities possessed by the chatbot. Instead, they are users' feelings resulting from the composition of the different design elements in the conversational interaction. The mere change of avatars or use of stickers and emojis could contribute to users' perception of the chatbot's personality and even cause statistically significant differences in user satisfaction. This result indicates that in conversational commerce, besides dialogues, designers can also use nonverbal interaction elements of chatbots to affect users' attitudes towards chatbots and even users' shopping behavior. A substantial portion of communication in our daily life is nonverbal; hence the types of non-verbal communication are wide and varied. However, this preliminary study focused only on avatars, emojis, and stickers. More non-verbal elements could be discussed in-depth on shaping chatbots' personalities for further study. Additionally, different usage scenarios can also be considered to clarify context issues regarding chatbot personalization.

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EFFICACY OF USING AROMA MOUTHWASH IN RECOVERYING FROM SHORT-TERM COGNITIVE STRESSOR

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ABSTRACT

Mouthwash prevents bad breath and sterilizes bacteria that cause dental caries and periodontal disease, so it provides important means for improving oral hygiene in our daily life. Along with active ingredients such as bactericides, mouthwash contains a variety of aromas to mask the bitterness of base ingredients and increase palatability. However, given that numerous aroma studies have demonstrated various physiological efficacies of aromas on autonomic/central nervous systems, it is no wonder that aroma mouthwash has some sort of physiological impact when it is used. In this study, we investigated the effect of aroma in mouthwash on peripheral and cardiac autonomic nervous system activity. The experiment was carried out in a within-subject design wherein 20 healthy women under 5 conditions, which are 4 types of mouthwashes: peppermint, peppermint + bergamot, peppermint + orange, and peppermint + lavender, and water as a control. Participants performed a 20-minute calculation task as a cognitive stressor, and then rinsing by a mouthwash or water. We evaluated the recovery period from acute stress response for 20 minutes after the task. As a result, it was observed that a mouthwash with citrus flavor had a relaxing effect in terms of subjective scores and recovering from physiological stress response. The results may illustrate a potential benefit of using aroma mouthwash.

Keywords: *mouthwash, aroma, skin conductance level*

1 INTRODUCTION

Mouthwash has the efficacy of preventing bad breath and sterilizing the bacteria that cause dental caries or periodontal disease, so it provides important means for improving oral hygiene along with tooth brushing (Barnett et al., 2006). In addition to active ingredients such as bactericides (commonly used cetylpyridinium chloride: CPC, Chlorhexidine: CHX, etc.), mouthwash often contains alcohol and aromas to bring a refreshing feeling on mouth. This feeling of use may also lead to psychological refreshment. In a recent study, Seo et al. (2017) found that using mouthwash after work reducing subjective stress and improving bad breath for nurses. However, to our knowledge, the psychophysiological effect of using mouthwash has not been systematically investigated so far.

On the other hand, when it comes to aromas, many studies have investigated their psychophysiological effects. Lavender relieved job-related stress among nurses (Chen et al., 2015). Bergamot essential oil reduced preoperative anxiety before ambulatory surgery (Ni et al., 2013). Our previous study revealed that orange essential oil inhalation inhibits the cardiac stress response (Lekamge et al., 2017).

Given that numerous studies of aroma have demonstrated various physiological efficacies of aromas on autonomic/central nervous systems, it is no wonder that aroma mouthwash has some sort of physiological impact when it is used. In this study, we investigated the effect of aroma in mouthwash on peripheral and cardiac autonomic nervous system activity.

2 METHODS

2.1 Subjects

Twenty healthy female adults (20-24 years old), were recruited for this study. No study has ever done on this, so this study was conducted by homogeneous population. The study was approved by the ethics committee of Nagaoka University of Technology.

2.2 Experimental procedure

The experiment was conducted using a within-subjects design, which consisted of a 10-min initial rest period as the initialization period (denoted as R1), a 20-min calculation task to induce cognitive stress (denoted as T), and a subsequent 20-min recovery period (denoted as R2), as depicted in Fig. 1.

As a short-term cognitive stressor, simple mental calculations similar to those used in the so-called Kraepelin test, was used in the study, where the subjects were required to continuously add single digit numbers displayed on a computer screen (Figure 2). All subjects were instructed to perform the calculation task as quickly and accurately as possible. Even though the calculation task is simple, it requires sustained concentration and attention. Therefore, it has been frequently used to induce acute stress in various studies. (Hioki et al., 2007, Lekamge et al. 2017)

2.3 Condition of Intervention

A general mouthwash formulation, contained surfactant, glycerin, etc. was used in this study. Each of the four types of aromas (peppermint: PM, peppermint + bergamot: MB, peppermint + sweet orange: MO and peppermint + lavender: ML) was added to the basal mouthwash at the final concentration of 0.1%.

Right after T period, subjects rinsed their mouth with 10 mL of mouthwash or water (control) measured in a plastic cup for 20 seconds and then spat out to another cup (Figure 3). Each subject conducted each condition at almost the same hour on five separate days with the order of mouthwash presentation counter-balanced. The subjects were not allowed to eat, drink except for water, strenuous exercise, or any oral care for an hour prior to starting each experiment. They were not given any instructions in advance about contained aroma of the mouthwashes.

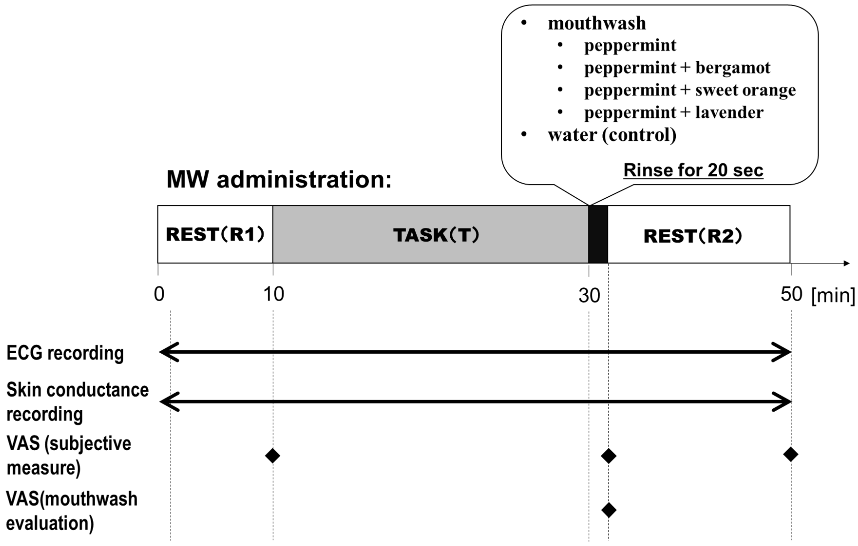

Figure 1. Schematic presentation of the protocol

Figure 2. Image of screen and during calculation as a cognitive stressor

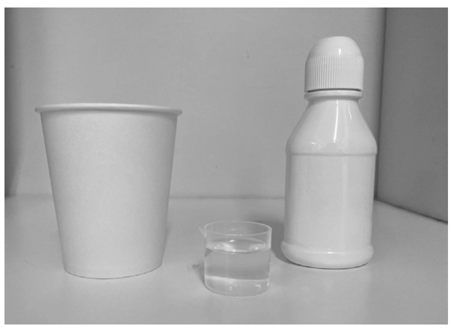

Figure 3. Image of mouthwash and a measuring cup

2.4 Aroma formula

Each aroma was prepared by blending 40% peppermint (Mentha arvensis), 30% l-menthol, an essential oil (MB: 10% bergamot, MO: 15% sweet orange, ML: 5% lavender and PM: none) and adding propylene glycol up to 100%. The concentrations of each essential oil were determined by professional panels in Sunstar Inc. to have the same intensity for all mouthwashes.

2.5 Measurements

2.5.1 Subjective assessment of psychological parameter

Subjects were asked to complete a visual analog scale (VAS) comprising five items: “fatigue”, “tension”, “refreshing”, “drowsiness”, and “relaxing” at the end of R1, after using mouthwash, and at the end of R2. Additionally, subjects assessed the mouthwash, which they used about “flavor preference”, “stimulus”, “cooling sensation”, and “refresh feeling in their mouth” by VAS after using the mouthwash.

2.5.2 Objective assessment of physiological parameter

A skin conductance level (SCL) and an electrocardiogram (ECG) were recorded throughout the experiment (R1-T-R2) using a bio-amplifier (MP150, BIOPAC Systems Inc., USA) at a sampling rate of 200 Hz of and resolution of 16 bit. The ECG data were used to analyze heart rate (HR) and heart rate variability (HRV), which is a frequency domain of beat-to-beat transition in ECG, or R-R interval transition, in a time series. The high-frequency component (HF component; 0.15–0.40 Hz) of HRV represents cardiac parasympathetic nervous system activity. SCL refers to a tonic component of electrodermal activity (EDA), which measures sweating activity on the surface of the skin. SCL represents sympathetic nervous system activity because the sweat glands are innervated by the sympathetic nerves (Andreassi, 2009). In particular, under constant thermal environment, SCL responds sensitively to mental activity and its changes (Umezawa et al., 1994).

2.6 Statistics

In statistical analysis, paired t-tests were performed for comparisons amongst conditions. The level of statistical significance (p) was set at 0.05.

3 RESULTS

3.1 Subjective assessment

With the use of mouthwash, the VAS scores after R2 for “fatigue” and “relaxing” were lower and higher than control. In particular, MB and MO were significantly lower and higher as compared to control (Figure 4). The VAS scores after R2 for “tension”, “refreshing”, and “drowsiness” had no significant differences among the five conditions.

There was no significant difference for “flavor preference”, “stimulus”, “cooling sensation”, and “refresh feeling in their mouth” among the mouthwashes.

3.2 Objective assessment

The SCL was higher at T than at R1, and returned to baseline at R2. These changes represent a typical acute stress response. Figure 5 shows the average change (decrease) in SCL during the R2 after using mouthwash. The decrease with MO during R2 is significantly larger compare to control or PM. That is to say, the recovery from stress response with MO was significantly larger compare to control or PM.

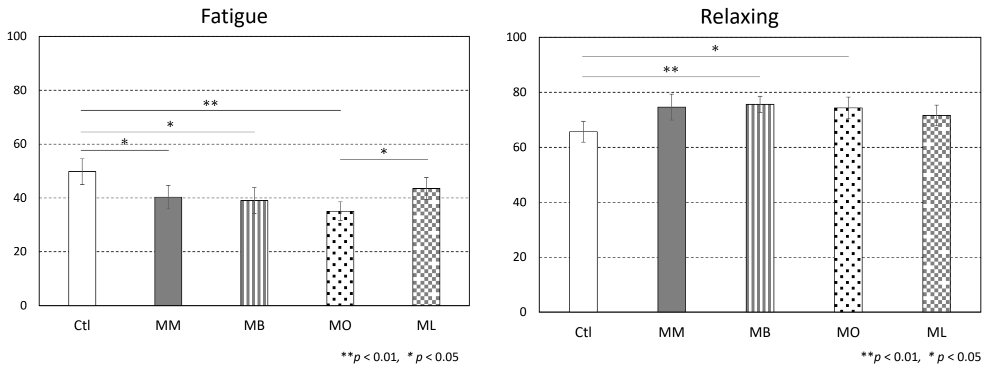

Figure 4. Mean (SE) of subjective assessment (VAS) after R2

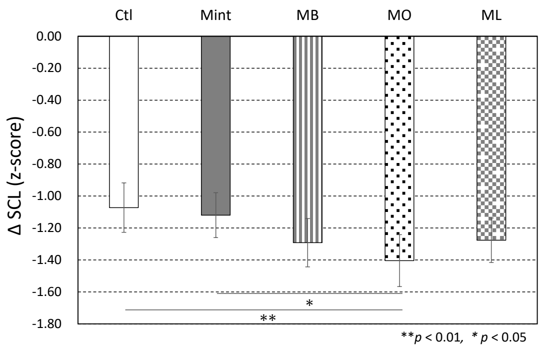

Figure 5. Change in SCL after using mouthwash (Error bar: SE)

4 DISCUSSION

In this study, we investigated the effect of aroma mouthwash containing essential oil on peripheral and cardiac autonomic nervous system activity under stressful conditions. With all mouthwashes, the recovery from acute stress response in SCL, an index of peripheral sympathetic nervous system activity, was larger than control; besides, it was accompanied by subjective recovery in fatigue and relaxing. Particularly in citrus essential oils, bergamot and orange showed significant recovery as compared to control.

As mentioned above, previous studies have reported the efficacy of reducing stress on citrus essential oils. This study revealed that mouthwash with citrus essential oils also have efficacy of recovering from acute stress response. It suggests that psychophysiological effects of citrus essential oils are also demonstrated with just 20-second use of mouthwash. On the other hand, though lavender essential oil is also reported to have a relaxing effect, no significant effect was observed in this study. The effect of aroma may vary depending on the concentration and the method of administration. Further research with different composition of aroma will provide better understanding of the effect of aroma mouthwash.

5 CONCLUSION

In this study, we investigated the psychophysiological impact of using aroma mouthwash during the recovery period from the acute stress response. As for results, it was observed that a mouthwash with citrus flavor had a relaxing effect in terms of subjective scores and recovering from physiological stress response. It was suggested that the use of aroma mouthwash not only improves oral health, but also provides psychophysiological benefits such as relieving stress. This result may illustrate the proposal of new benefit of using mouthwash.

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EMOTION AND BODY MOVEMENT

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ABSTRACT

Human needs shift from material to mental with time. And the final need is Self-Actualization. In other words, our needs shifts from product to process. We actualize ourselves to satisfy our emotions. Emotions are interpreted as our feelings toward outside stimuli. But as the fact that etymologies of emotion and motivation come from the same Latin "movere" indicates, emotion means that we are stimulated and motivated by the environment and situation, so that we "move out" into the Real World to establish our own world. It is said that only humans can think about the future. That created "Engineering" to make our dreams come true. As our needs started from material, we eventually looked for better products and for better technologies. And it brought the Industrial Revolution. But the Industrial Society is getting to its ceiling and we need to explore a new society which is emotion-focused. Another important point which we discuss here is the importance of body movement. Although DX is getting wide attention these days, Analog plays an important role in the Real World. Blood is analog and it carries signals and keeps our body organ running after brain death. And Blood and Body Movement plays a crucial role in arousing emotion. When our heart leaps up, our blood boils. And the idea of weight, length are based on our deep sensation of our body movement. This paper discusses how emotion and body movement are deeply associated.

Keywords: *Emotion, Body Movement, Self, Proprioception, Instinct*

1 MOVEMENTS

Living things are called "Creatures". Why? It is because we. Living things, "Create Movement to Survive". Movement is indispensable for living. Human movements are divided into two: One is Motion, which can be observed from outside. The other is Motor, which is the movement inside our body, such as muscles, etc.

Nikolai Bernstein clarifid the behavior of Motion (Bernstein, 1967), (Figure 1).

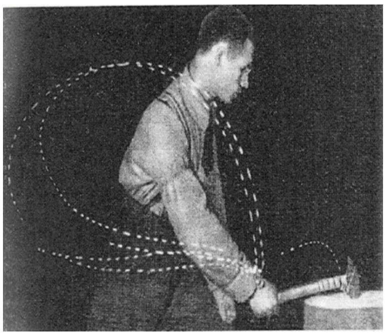

Figure 1. Motion

At first, our motion trajectories vary widely from time to time. But as we get close to our target object, muscles harden and move together with the skeleton. So, we can easily identify parameters in this musculoskeletal system and control its trajectory. Most studies on human movements focus on this stage and discuss control.

But why does it vary so widely at first. It is to cope with the continuously changing environments and situations. We coordinate all parts of our body to deal with the changes. So, although we are observing motion, we mobilize motor to make strategic decision what actions we should take. We "sense" the situation by "feeling" bogy movement. Motor, such as muscles, plays a very important tole.

2 WHAT WE CAN LEARN FROM THE OCTOPUS

Peter Godfrey-Smith published a very interesting and enlightening book (Godfrey-Smith, 2016). He tells us we can learn many things from the octopus. They die immediately after their babies are born, So, they do not inherit knowledge from their previous generation. They have no other way but to live on their own instinct.

They have eight arms, and they coordinate them very skillfully. Their heads are very large, but these heads are used for coordinating the arms. They are known as the "expert of escape". They can escape from any environments and situations. Surprisingly enough, they can escape even from a screwed container. If we, humans, put in the same situation, we would be panicked and may not do anything.

Although their heads are very large, the brain is small, and its capability is about the same level as that of a dog. But it is Body that interacts with the outside world directly. And Body interaction is not only direct, but also it is done in real time.

Brain receives information from Body and accumulates them and structure them into Knowledge. Thus, knowledge is a thing of the past and it is very much personal. Our body builds and the ways to move our bodies are different from person to person. So, Knowledge is just "feedback". To move appropriately, we need "feedforward". The octopus teaches us how we can make the most of our Instinct

The octopus is invertebrate, and the human is vertebrate. They are positioned on the opposite side of the Evolution Tree. But humans rely on Brain, while the octopus rely on Body. Thus, intelligence of the octopus is Body Intelligence, while that of the human Is Brain Intelligence. We should remember that the word “Intelligence” originates from the Latin “to understand the situation”. So, the octopus is truly intelligent.

Further, the octopus can recognize self in a mirror. In invertebrates, only they can. In vertebrates, only humans and apes can. Why they can recognize themselves in a mirror is because they can “feel” the movement of their bodies. They see the mirror and the image there moves in the opposite way. So, they understand the image is theirs. They can “feel” how their bodies are moving. Dogs can see their images in a mirror, but they cannot be aware that the image is theirs (Figure 2).

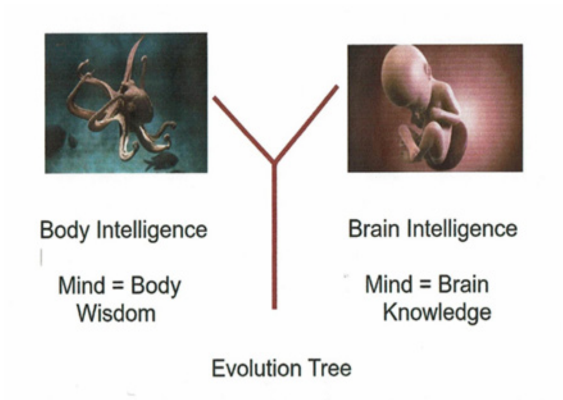

Figure 2. Body Intelligence and Brain Intelligence

3 EMOTION, MOTIVATION

The etymology of Emotion and Motivation is the same. They originate from the Latin “movere (motion)”. Thus, emotion means to move out (e=ex=out).

So, we cycle the loop (Figure 3). We perceive the environment holistically and become aware of the environment and the situation. That motivates us to act, and we make a decision what actions we will take. The action brought us emotional excitement and motivate us to go further (Figure 3).

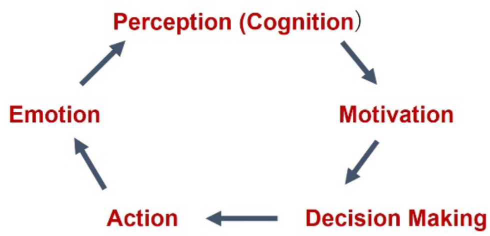

Figure 3. PMDAE cycle

4 DIGITAL, ANALOG

As described earlier, movement is indispensable for living. Another important thing we should remember is blood is analog. Blood carries signals to all parts of our body. We are focusing on Brain too much. Indeed, Brain plays a very important role. But even after brain dies, blood circulates all over our bodies and we are still living. That's why we can transplant body organs even after brain death.

Medical doctors watch blood flow. They can understand the situation and come up with the diagnosis. Current computers, however, are processing numbers, based on 0-1 framework. So, DX works well with the current cardinal based Euclidean approaches. Their approach is discrete. But most objects are hard, and analog. So, not much attention has been paid to direct interaction with the outside world until recently. We could identify what it is by our eyes alone, even from a distance.

But with remarkable progress of material engineering, materials are getting softer and softer. So, to identify what it is and to find out how to handle it, direct interaction becomes necessary.

5 HUMAN NEEDS

Maslow clarified Human Needs (Maslow, 1943). He pointed out that our needs shift from material to mental with time, and "Self-Actualization" is the highest. "Self-Actualization" is nothing other than emotion and it interests us to know that his paper is titled "A Theory of Human Motivation". He clarified what needs motivate us to action (Figure 4).

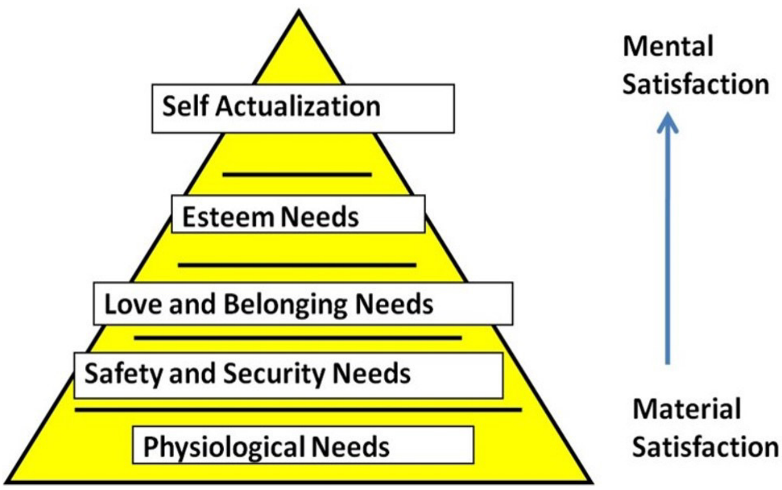

Figure 4. Maslow's human needs

6 HEART, MIND

Figure 5 shows Mind-Body-Brain. As Mind contains Body and Brain, and we say "Make up your mind" when we ask somebody to decide, so the topic of Mind often comes up. Mind is rational. When our needs are material- or product-centric, we needed cardinal and logical thinking. In another word, Euclidean space approach.

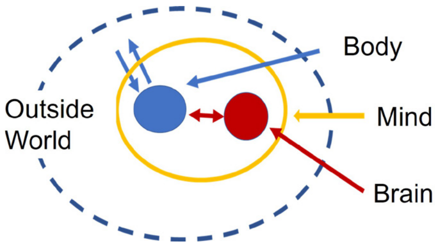

Figure 5. Mind-Body-Brain

But as Maslow points out, our needs shift from material to mental, i.e., emotional. Then, it is better to discuss Heart more. Such expressions as "My heart leaps up", "My heart beats fast" indicate that Heart is deeply associated with Emotion. But our shifts from products to emotion occur recently, so that Heart is rarely discussed in engineering.

In the field of technology, rational or quantitative approaches are important. But technology and engineering are different. Engineering started to make our dreams come true. So, engineering is a matter of Heart. We should focus more attention to Heart. Thus, we should keep in mind technology is rational. but engineering is emotional.

And if we pursue Emotion in engineering, we can develop another society for the next generation. It Is Self-Satisfying and Self-Sustaining Society (SSS). Then, we can come back to our old days and start to work for ourselves again. Now we are working for others in the Industrial Society. So, we cannot get the maximum satisfaction as Deci and Ryan pointed out in their SDT (Deci & Ryan, 1985).

But if our society goes emotional, then we will be happy, because we work for ourselves and we can satisfy our "Self". And the society will shift from product-centric to process-focused. A typica example is Lego. They provide only blocks and customers build up their own products in their own way. They are no more consumers. They become truly Customers. They enjoy customizing the process. During this process of combination, their Heart is excited. It is no labor anymore. It is a joy.

7 MAHALANOBIS DISTANCE-PATTERN (MDP)

Based on the above discussion, Shuichi Fukuda developed Mahalanobis Distance-Pattern (MDP) Approach to process Analog data by combining Mahalanobis Distance and Pattern (Fukuda, 2022).

To process dynamic data, we can introduce Recurrent Neural Network (RNN). But RNN assigns links to nodes in a random manner. It is a black box. We cannot manipulate the system as we wish. Therefore, Reservoir Computing (RC) is introduced here. RC enables us to make adjustments at the output. So, we can manage the system as we wish (Figure 5).

Another great benefit of RC is it enables us to introduce micro technologies. So, we can make our sensors and actuators extremely small. In fact, we can make them part of our body. Up to now. machines and humans work in separate worlds. And machines follow human's instructions. But now the true Things Team, which Ashton proposed in his IoT (Ashton, 2009), is realized.

Up to now HMI means Human Machine interaction. Their worlds were different. But now it means "Human Machine Integration". Until now, we, humans, had to give instructions to machines, but since humans and machines are integrated, machines can play the role of humans. They can now understand what we want. If the handicapped needs help, they offer the help that is needed without any instructions. They can help the seniors to realize what they want. They can act spontaneously.

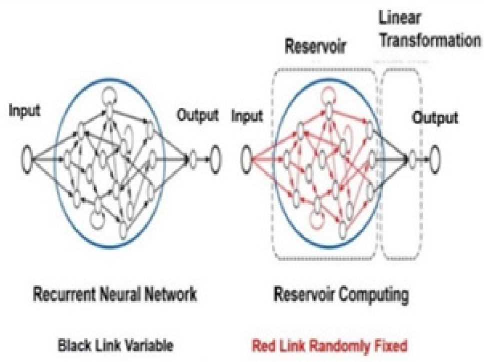

Figure 5. Reservoir Computing

7.1 Basic concept of MDP: Swimming as an example

Let us take swimming to explain how MDP works. In swimming, water changes from moment to moment. So, we cannot identify parameters and we cannot apply mathematical approaches. But if we put wearable sensors on the swimmer or take images of swimming, we can obtain the data sheet on the right (Figure 6). Each row represents individual muscle.

We apply MD to this sheet and compute MD between Time T_1 and Time T_2. If MD is decreasing, that muscle is working all right. If MD is increasing, we need to change the moving style of that muscle to improve swimming. As our muscles and how we move them vary from person to person, there is no other way but to learn swimming on our own. Self-learning is the only way to learn swimming.

This MDP approach can be applied to other applications, such as in buiness, in team sports, and in many other fields. MDP approach is very useful for making strategic decision what action we should take.

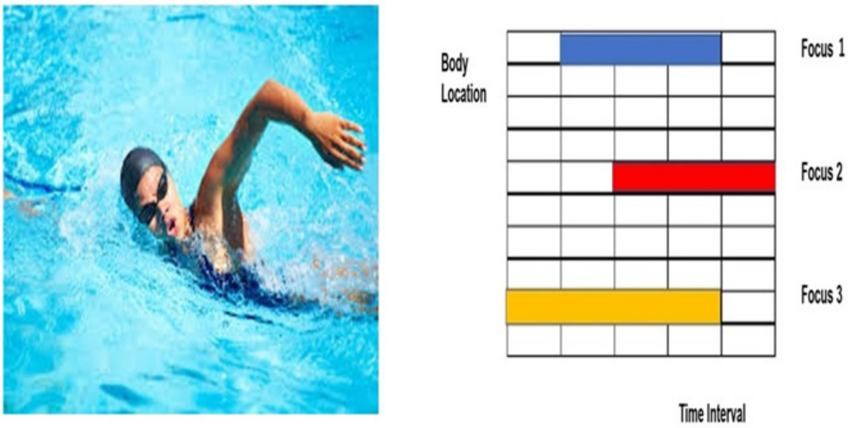

Figure 6. Mahalanobis Distance-Pattern (MDP)

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APPENDIX

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EMOTION-REACTING FASHION DESIGN INTELLIGENT GARMENT AND ACCESSORY RECOGNIZING FACIAL EXPRESSIONS

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ABSTRACT

Although mental disorders have emerged as serious social challenges, social stigma, including prejudice and misunderstanding, hinder suitable treatment for the patients. It is crucial to monitor our internal psychological and emotional states to avoid the unconscious progression of mental disorders. This research aims to achieve emotion-reacting garments and accessories, based on a passive and continuous emotion recognition system in real time. First, this study proposes a systematic design for emotion-reacting garments and accessories, which employs emotion estimation based on facial expressions. Next, emotion-reacting fashion design is discussed for intelligent garments and accessories that interact with our bodies and mind. To achieve this system, a functionally extended collar made of transparent polycarbonate material is designed for integration with the digital camera modules. In addition, this study discusses how to create a physical stimulus on emotion-reacting garments and accessories. The intelligent garments and accessories using RGB-LEDs create visual effects that reflect emotions. In terms of audio effects, emotion-related keywords are employed to select the music played in intelligent garments. Finally, prototypes reacting to emotions are shown.

Keywords: *Emotion-reacting garment, Facial expression, Wearable computing, Fashion design*

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1. INTRODUCTION

In the context of the widespread usage of information and communication technologies, including smartphones and mobile devices, positive computing has been proposed to preserve an individual's physical and mental health and obtain well-being (Carvo & Peters, 2014). The present designs and forms of smartphones and mobile devices will be altered in the future. For example, flexible devices based on printed electronics can be combined into clothing and the human body as a second skin (Oh & Bao, 2019). In the field of social robotics for a few decades, humanoid or pet robots have achieved communication with artificial intelligence and remote interpersonal communication (Leite, Martinho & Paiva, 2013). In addition, wearable, soft robots supporting human body movements have also been designed (Zhou et al., 2021). In some way, these robots can be regarded as active and functional clothing. Thus, active and functional clothing should be considered in the next-generation clothing, which pushes the boundaries of the existing clothing framework. Based on these technological innovations, clothing defined as "the second skin" needs to be redefined.

Instant messaging applications have been employed to send and receive text messages between computers in near real time since the 1990s. Since the introduction of smartphones in 2007, the globally accessible WhatsApp and Facebook Messenger applications have become fundamental for daily communication. In emotion-enhancing garments (Tsetserukou et al., 2009), AffectIM was employed to estimate nine emotions and their intensity by examining text data of instant messenger. Users wearing emotion-enhancing garments input text messages to ensure the system recognizes their emotions. However, this is a restriction of the system, which must be enhanced to passively recognize emotions. This research intends to create an emotion-reacting garment employing a passive and continuous system to estimate emotions in real time. This research describes how to develop and implement a wearable system that reacts to emotions based on a prototype (Kai et al., 2022).

2. EMOTION RECOGNITION

This research considers (i) high-level psychological states, including self-actualization and self-esteem in terms of emotion, affect, and mood, and (ii) low-level emotional states including joy, anger, and sadness, as demonstrated in Figure 1. The high-level psychological states are categorized in the upper levels of Maslow's hierarchy of requirements. The low-level emotional states, which are present in both human beings and primates, are closely related to instincts. Verbal information obtained from the linguistic analysis of text data is adequate to identify high-level psychological states. In Student Life (Wang et al., 2014), smartphone-based online questionnaires and the ecological momentary assessment were employed to estimate psychological states. Furthermore, a smartphone's accelerometer and GPS were employed to record body movements and mobility. In addition, conversations obtained from phone calls and sleep states estimated by an illuminance sensor were employed. In MIND (Zaman, Silenzio & Kautz, 2020), the browsing history of YouTube, SNS, etc. were employed to estimate high-level psychological states, based on the assumption that a person with low self-esteem does not search for specific information.\

Many studies on identifying lower-level emotions employing biometric information, including electroencephalography (EEG), electrocardiogram (ECG), pulse wave, skin conductance resistance, skin temperature, and respiration, have been reported (Dzedzickis, Kaklauskas & Bucinskas, 2020). These approaches map biological signals to the valence and arousal components of Russel's circumplex model of affect (Russell, 1980). Recently, machine learning techniques have been employed in multimodal biological signals to enhance the accuracy of emotion estimation. There is a close relationship between the arousal level and biological signals, including the heart and respiration rates. However, the relationship between the valence component that shows positive and negative emotions and biological signals is unclear. Although brain wave (EEG) analysis can estimate the valence component, further research would be needed at this time.

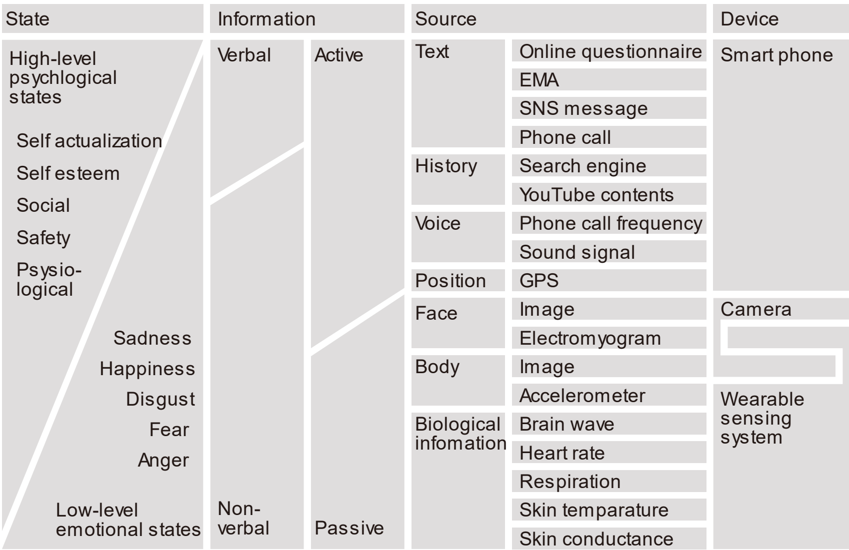


Figure 1. Information and source data for emotion recognition

Since the 1970s, Ekman has investigated basic emotions, including joy, anger, and sadness, which appear in facial expressions (Ekman & Friesen, 1971). A facial action coding system designed to describe facial expressions was employed to identify facial expressions in computer vision. Nowadays, cloud services, including Microsoft Azure Cognitive Services, which are capable of estimating emotions from facial images, have already been commercialized. Gaze movements are also employed to estimate emotions based on a detailed analysis of facial expressions. Compared to other animals, primates' visual perception and their ability to control muscles of facial expression have evolved to a high level. These perception and expression abilities make them communicate their emotions through facial expressions without employing language. Facial expression monitoring is a reasonable choice to estimate emotional states compared to the biological signal analysis. Thus, facial expressions were chosen as the source for estimating emotional states in this research.

3. SYSTEM DESIGN

3.1. Emotion estimation based on facial expression

Figure 2 demonstrates a schematic of emotion-reacting clothing that creates audiovisual effects. Emotional states were estimated by employing facial expression images captured using a digital camera. A wide-angle digital camera module (Simlu OV5647 Camera Module) is linked to a single-board computer (Raspberry Pi 4) through MIPI CSI-2 to capture facial images. To miniaturize the hardware system, a wide-angle camera was chosen to reduce the distance between the camera and the face. The computer sends facial images to Microsoft Azure Cognitive Services through the Face API and receives an 8D facial expression vector. In emotion estimation, landmarks reflecting facial expressions are examined by digital image processing as demonstrated in Figure 3.

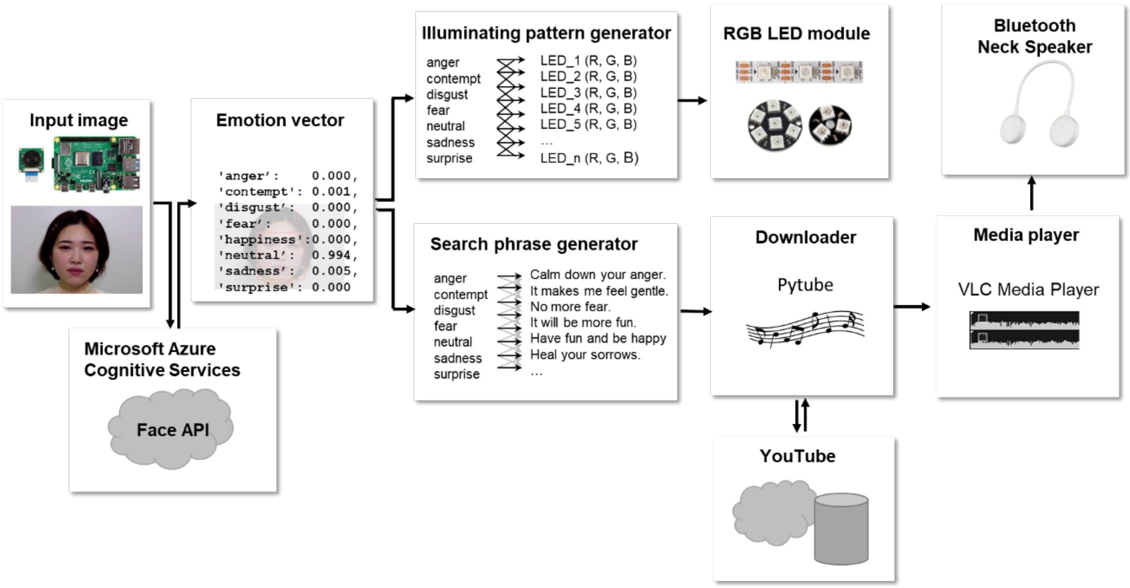
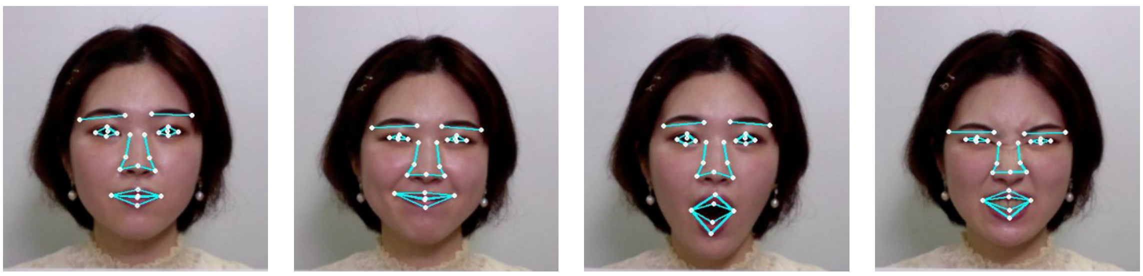


Figure 2. Schematic of the wearable system creating visual and audio effects



(a) Neutral (b) Happiness (c) Surprise (d) Disgust

Figure 3. Extracted feature points reflect facial expressions

Figure 3 demonstrates the landmarks of the eyebrows, eyes, nose, and mouth for several facial expressions. These landmarks are as follows:

- Eyebrows: inner and outer points
- Eyes: inner and outer points, top and bottom points, and centers
- Nose: root points, top and outer points of the nose alar, and tip points

- Mouth: Corners of the mouth, top and bottom of the upper lip, and top and bottom of the lower lip

For instance, when we feel happy, the zygomaticus major and minor muscles contract and raise the corners of the mouth. Based on the digital image analysis, the Face API returns an 8D facial expression vector made of anger, contempt, disgust, fear, happiness, neutral, sadness, and surprise. the 8D facial expression vector's elements range from 0 to 1, showing the confidence rates.

3.2. Visual effects reacting emotion

The wearable system creates visual impacts using illuminating RGB-LED modules linked to the computer through a general-purpose input/output interface. We designed an illuminating pattern generator that creates RGB values of the LED modules in response to the 8D facial expression vector. In social robot research expressing emotions by illumination (Terada, Yamauchi & Ito, 2012), mapped colors to Plutchik's wheel of emotion (Plutchik, 2001) were employed. The mapped colors are roughly consistent with the commonly known psychological impacts of color. Thus, our wearable system also uses the mapped colors in Plutchik's wheel of emotion in the initial trial. A close relationship between emotions and hue is known, but a single color is frequently mapped to various emotions. Thus, we also considered dynamic color patterns based on affective color in visualization (Bertram, Patra & Stone, 2017).

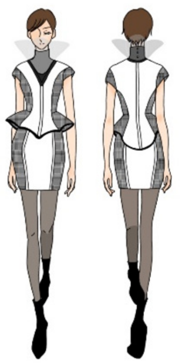
3.3. Visual effects reacting emotion

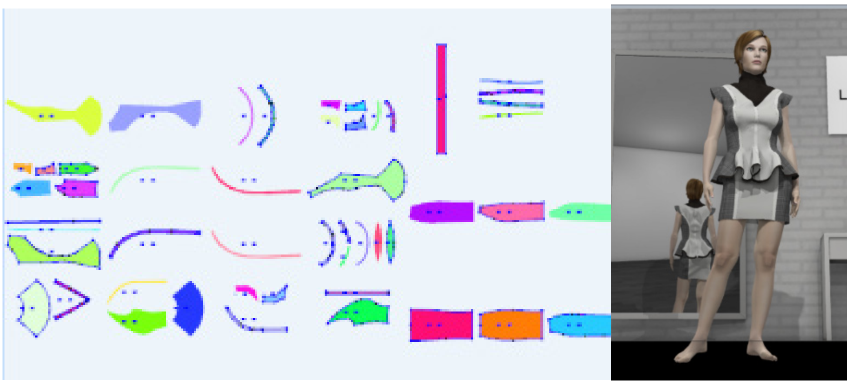
Based on the 8D facial expression vector, a rule-based search phrase generator produces a phrase for audio effects, which correlates with the music to be played on the system. For instance, if the emotional intensity of "anger" is high, the phrase generator produces the phrase "calm down your anger," which suppresses the negative emotion. The downloader searches for the content stored on YouTube (based on the produced phrase) and downloads the matching files employing the polytube module. Many phrases can be integrated to search the content; for instance, the search phrases composed "calm down your anger," "chill out," and "music" recommend the content—"Irritated mood, accumulated stress, and fatigue will disappear | Music for healing the autonomic nervous system." The media player plays the downloaded mp3 or mp4 files, and the audio signal is digitally transmitted to a Bluetooth neck speaker.

4. FASHION DESIGN

When combining the emotion recognition system into clothing, the attachment of a small digital camera module to capture facial images poses a design challenge. Various design ideas for combining the digital camera module into hats, ornaments, and accessories were discussed. Finally, it was decided to use an extended collar. Figure 4(a) demonstrates the fashion design of emotion-reacting garments. The fashion design concept was "retro-futurism," which imagines a bright and optimistic future imagined by the people of the past. A black ribbon-like decoration placed at the upper garment's hem highlights the peplum's 3D shape. A semi-tight skirt was integrated with the upper garment to create an outfit. The transparent collar, which was combined with the digital camera module, was expanded from the neckline. A 20-mm-wide flat cable linking the digital camera module to the control computer was a fashion design limitation. However, white ribbon-like areas on the front and back center lines joined the flat cable into a unified design. In addition, the integration of a transparent collar with a black high neck unified the whole design in a monotonic design but highlighted the contrast between black and white.

According to the illustrations demonstrated in Figure 4(a), 2D patterns were produced, and 3D virtual prototyping was conducted employing Lectra Modars 3D V8R3, as demonstrated in Figure 4(b). The color scheme and texture's detailed design are estimated in this prototyping process. The glen-check fabric (called the Prince of Wales checks) employed on the left and right sides is a symbol of British tradition and highlights the contrast with the futuristic silhouette. Figure 4(c) demonstrates a sequence of computer animation produced by CLO Virtual Fashion CLO3D employing the patterns in Figure 4(b).


(a) Illustration


(b) Pattern making and 3D virtual prototyping


(c) Computer animation

Figure 4. Fashion design and 3D virtual prototyping.

5. IMPLEMENTATION

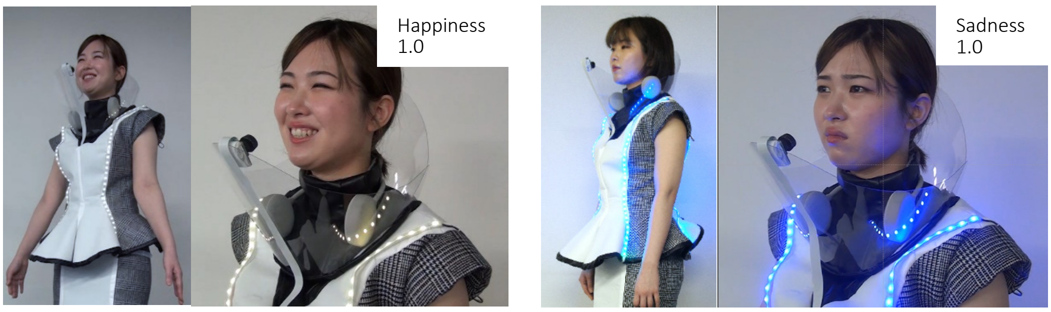
Figure 5(a) demonstrates the designed emotion-reacting garment. A woolen glen-check fabric was employed for the side parts of the upper garment and the skirt. White high milon, a raised fabric with a matte texture, was employed in the upper garment and the skirt's front and back center parts. White synthetic leather, which is unified with the digital camera module's flat cable, was stitched on the front and rear center lines. Black synthetic leather was stitched at the peplum's hems to highlight the spatial curves. RGB-LED strips for visual impacts were placed at the woolen glen-check fabric's boundaries and the white high milon fabric, producing a design accent that even the LEDs could not emit light. Gray Bluetooth speakers to produce audio effects were attached to the neck.

The extended collar, which was combined with the digital camera module, was composed of a transparent polycarbonate material. A ribbon-shaped fabric with concave-convex snap buttons was stitched at the back of the camera module. Since the transparent polycarbonate collar’s tip has a hole, the snap buttons can fix the digital camera module’s position and detach it. The control computer, the rechargeable mobile battery, and the 3.5-in. LCD panel were challenging to mount on the garment’s surface. Therefore, they were combined into a waist pouch composed of black synthetic leather, as demonstrated in Figure 5(b). The flat cable linked to the camera module goes through the V-shaped neckline’s tip, from the outside to the inside, and is linked to the control computer in the waist pouch.

Figure 6 shows the emotions estimated from facial expressions. In Figure 6(a), the “happiness” emotion visible on the facial expression emites the RGB-LED yellow color. Simultaneously, music content related to “more fun” was searched and downloaded from YouTube. The control computer plays the downloaded music content and transmits it to the Bluetooth speakers. In Figure 6(b), the “sadness” emotion visible on the facial expression emites the RGB-LED blue color. Simultaneously, music content related to “Heal your sorrows” is searched for and downloaded from YouTube. The control computer plays the downloaded music content and transmits it to the Bluetooth speakers. We visualized a negative emotion including sadness for the illustration, although it may be reasonable not to visualize negative emotions in this intelligent garment.

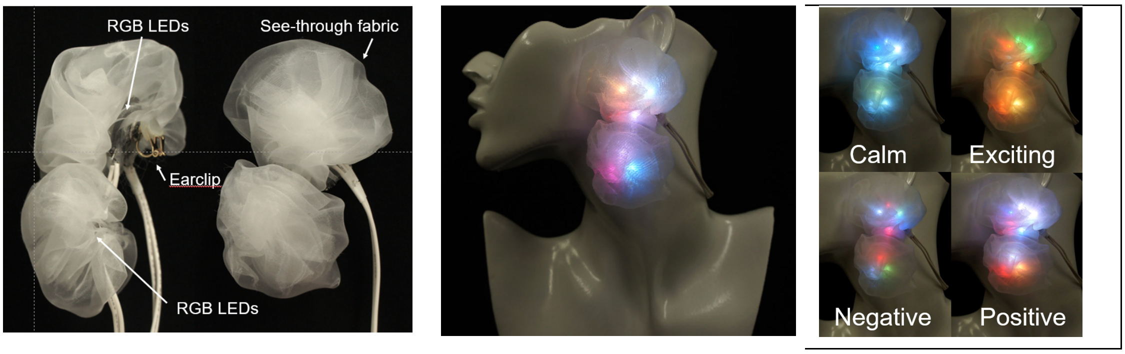
(a) Emotion-reacting garment and extended collar (b) Waist pouch storing hardware

Figure 5. Implemented emotion-reacting garment.



(a) Happiness (b) Sadness

Figure 6. Reactions to “happiness” and “sadness.”



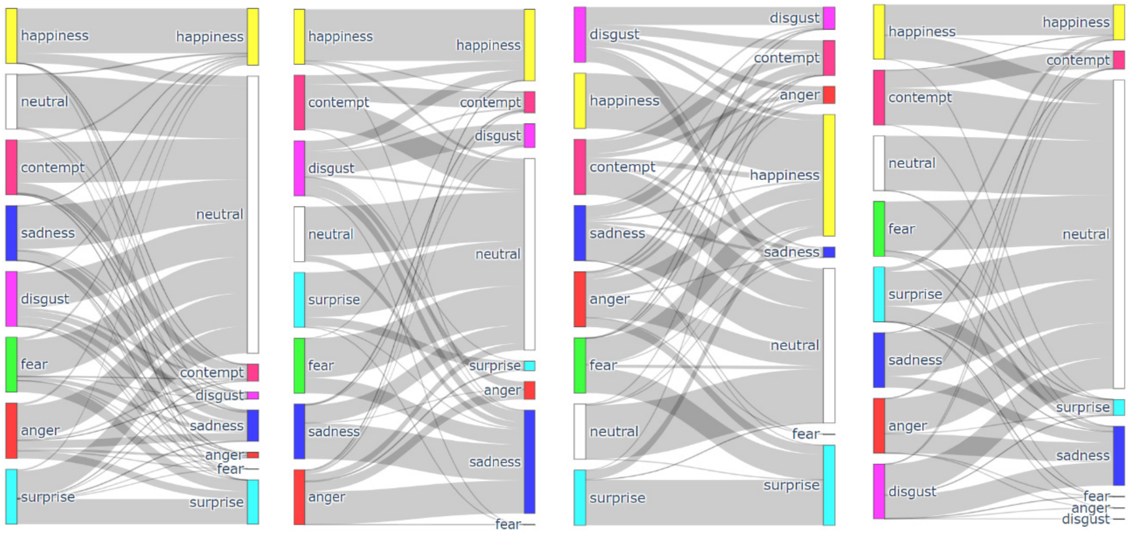
(a) Prototype (a) Operating states

Figure 7. Intelligent earrings.

Figure 7 (a) shows a prototype of intelligent earring that consists of RGB LEDs on round boards, a microcontroller, batteries as well as earclips and see-through fabrics for diffusing emitted light. We propose a spatiotemporal conversion to reflect impressions based on color bubble charts (Bertram, Patra & Stone, 2017) for this intelligent earring. In the color bubble chart, various colored and sized circles are randomly arranged in a plane. The spatiotemporal conversion maps the area of circles to the duration of RGB LEDs' colors to create similar impressions of the color bubble chart in the limited number of color elements. Figure 7(b) shows the operating states of the intelligent earring in which the RGB LED colors are controlled. According to the color bubble chart expressing calm, exciting, negative and positive emotions, the colors of RGB LEDs are dynamically controlled.

6. FACIAL EXPRESSION RECOGNITION

In this study, the accuracy of a facial expression's recognition is confirmed by employing Microsoft Azure Cognitive Services. First, facial image data were captured by shooting eight types of facial expressions. These data reflect emotions including anger, contempt, disgust, fear, happiness, sadness, surprise, and neutral. The estimated emotions from facial images were then compared, and the correlating emotion appeared in the facial expression in the image data. In the experiment, the participants were 10 females with a mean age μ = 22.9 and a standard deviation σ = 1.58. In this experiment, 10 facial images were captured for each facial expression reflecting emotion, and 800 facial images were captured and processed.



(a) All subjects (b) Subject A (c) Subject B (d) Subject C

Figure 8. Estimated emotions using facial expression image analysis.

Figure 8(a) demonstrates the Sankey diagram, which shows the relationship between the estimated 8D emotion vector and the emotions that appeared in facial expressions. Although many facial expression images (except the neutral) were misidentified as neutral, happiness was identified almost correctly. For the surprise emotion, roughly 50% of the estimations were correct and the rest were incorrect. Table 2 demonstrates the correct estimation percentages for eight emotions. Figures 8(b)–(d) illustrates the findings obtained using three participants (A, B, and C); Figure 7(b), which shows the findings obtained using participant A, part of the anger and fear were misidentified as sadness, in addition to the correct estimation of sadness; Figure 8(c), which shows the findings obtained using participant B, part of the anger and fear were misrecognized as happiness, in addition to the correct estimation of happiness; and Figure 7(d), which shows the findings obtained using participant C, disgust and anger were misidentified as sadness, in addition to the correct estimation of sadness. Overall, many facial expression images were misidentified as neutral.

This experiment verified that happiness could be correctly identified, but the other emotions' recognition accuracy was not high. This finding proposes that the system should focus on happiness in the emotion estimation. For instance, the occurrence of happiness in a facial expression could be used for an emotion-reacting garment if we consider the misidentification of emotions based on facial expressions.

Table 2. Percentages of correct estimations

Emotion	Anger	Contempt	Disgust	Fear	Happiness	Sadness	Surprise	Neutral
Percentage	4.1	18.5	12.7	0.8	81.1	17.3	45.7	96.4

7. CONCLUSION

Users wearing emotion-enhancing garments must input text messages to help the system identify their emotions. Although verbal information is suitable for identifying high-level psychological states, it is incompatible with passive and continuous monitoring. In this study, an emotion-reacting garment employing a passive and continuous emotion recognition system operating in real time was proposed. Particularly, a fundamental design of a wearable system, whose core function is to estimate emotions by examining facial expressions obtained from facial images, was proposed. Next, 3D prototyping was employed to determine detailed fashion design components based on the “retro-futurism” concept. The design and implementation of hardware and software modules that offer audiovisual stimuli based on emotions were described, and a prototype was designed. Advanced algorithms for audiovisual stimuli based on an illuminating pattern generator and a search keyword generator that efficiently controls emotional states were also discussed. Accuracy of facial expression recognition depends of individual faces, so that personalization is required to operate the system. Moreover, the negative effects of emotional reaction must be avoided. Intelligent earrings to express emotions based on color bubble charts were also discussed. However, the performance examination remains a challenge to be addressed in the future.

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EVALUATION OF THE SOFTNESS AND ITS IMPRESSION OF VISUAL STIMULI IN VR SPACE

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ABSTRACT

To examine the softness and impression of visual objects in VR (Virtual Reality) space, the impression of the visual stimuli in VR space was measured using the subjective evaluation of a seven-rank scale by changing with each the value of the deformation resistance of the stimuli, of shapes, and colors. The value of the deformation resistance of the stimuli expresses the degree of deformation to return to the original of the object when touching it in VR space. The lower value indicates the larger deformation like pudding and the higher one is the smaller one like thick rubber they were used three types of values lower and higher, and no-deformation of the objects. The shapes of objects as the stimuli were three shapes (sphere, cube, pyramid). The colors of the stimuli were selected from five colors (red, green, green, gray, and white) and they have used two types of the feeling of materials (matte and metallic) in each color. Ten participants were asked to subjectively evaluate the softness and impression of the stimulus. In the results, the evaluation changes from soft to hard by increasing the values of deformation resistance in all the stimuli in VR space. It is suggested that the degree of the deformation to return to the original can express the softness of objects when touching them in VR space even though the user does not touch them physically. It also discussed the relationship between softness and its impression of the stimuli in VR space.

Keywords: *VR, softness, deformation, touch, subjective evaluation*

1 INTRODUCTION

Recently, due to Covid-19 related situation, ICT (Information and Communication Technology) that avoids the "Three Cs" (1: Closed spaces with poor ventilation, 2: Crowded places with many people nearby, 3: Close-contact settings such as close-range conversations) and is non-contact is desired. And the displaying and presentation of prototype stuff by remote technology using VR (Virtual Reality) are paying attention (Nikkei Inc., 2020). When prototypes are evaluated in a VR space, as mentioned above, the evaluation method has shown a certain degree of effectiveness in terms of appearance, and the previous study has shown that the impression of the prototype is not so different from that of the real object (Sakurai & Takenaka, 2021). On the other hand, there are still issues related to tactile impressions such as softness, weight, and robustness when touching objects in VR space. For example, when touching pudding or jelly, softness can be judged from the apparent deformation of the object's shape. In this study, it was presented visual stimuli that expressed tactile softness in a VR space and aimed to evaluate the softness of the stimuli in the VR space and their impressions.

2 METHODOLOGY

2.1 Stimuli

The visual stimuli used in this study have been expressed as the tactile softness that the user's hand was synchronously displayed in the VR space by hand tracking when the hand touched an object, the object was deformed accordingly. The degree of softness of the stimuli was selected in three levels: 0.1: very soft (deforms like a pudding and returns to its original shape), 1.0: slightly soft (deforms slightly and returns to its original shape), and no deformation (N). Three shapes (sphere, cube, and pyramid) were chosen. Five surface colors (red, green, blue, white, and gray) and two surface textures (metallic and matte) were selected. Thus, there were a total of 90 stimuli in this experiment. Figure 1 shows the examples of the stimuli in this experiment and the properties of shapes, colors, and surfaces. Figure 1(a) indicates the shapes in stimuli according to the survey of previous studies. Figure 1(b) represents the tactile softness of each stimulus when touching it. It can be seen in the changing shape when touching it. Figure 1(c) indicates each property of colors and surfaces as the stimulus image of the sphere. The visual stimuli and experimental applications in this study were created using Unity (Ver. 2021.1.14f1) and the asset Obi Softbody (Ver. 6.2).

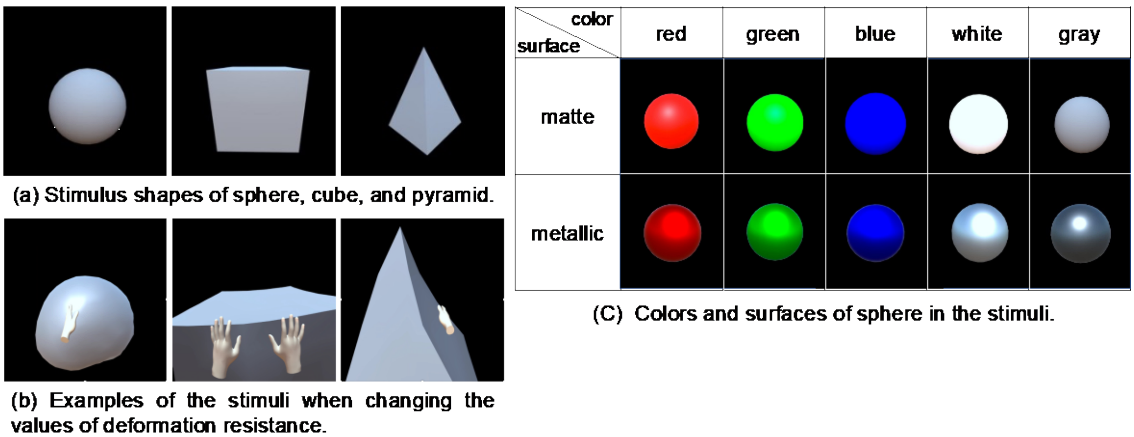

Figure 1. Example of the stimuli in this experiment and properties of shapes, colors, and surfaces.

It was necessary to measure the screen in the HMD (Head Mounted Display) to see what kind of color reproduction was achieved since there has been little research on colorimetry to color reproduction in VR space. The screen of HMD (Oculus Quest) used in this study was measured using the colorimeter (CS-200, Konica Minolta) and the luminance meter (CL-500A, Konica Minolta). Figure 2 shows the gamut of HMD in this experiment on the CIE1931 *xy*-chromaticity diagram compared with those of BT.709 (HDTV) (International Telecommunication Union, 2002) and BT.2020 (UHDTV) (International Telecommunication Union, 2015). This figure shows that there is little difference in the measurements of both measuring instruments and enough for gamut compared them.

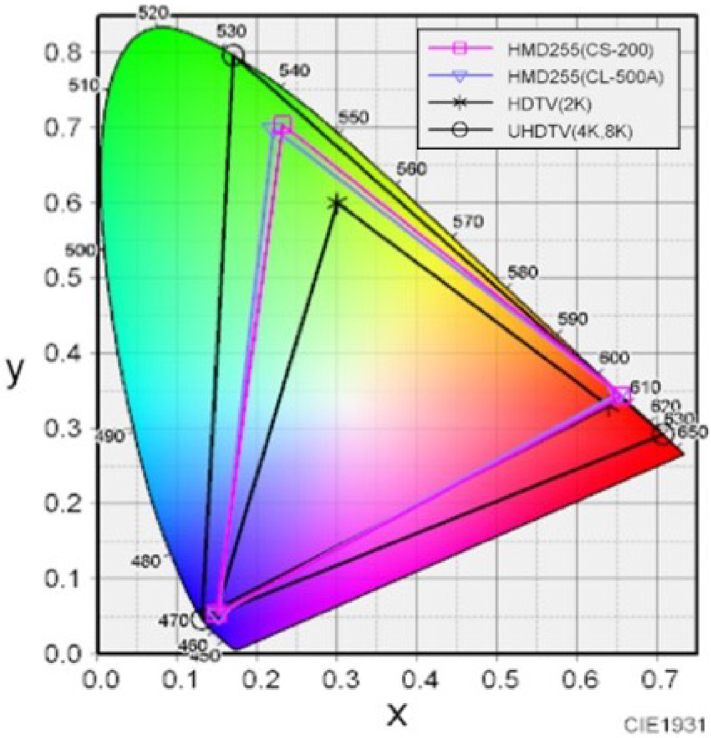

Figure 2. The Gamut of HMD in this experiment.

2.2 Procedure

The participants wore the HMD (Oculus Quest) and touched the randomly presented visual stimuli in the VR space with one hand and both hands, and responded verbally by rating the softness and its impression on a seven-rank scale in the subjective evaluation with five adjective pairs. The subjective evaluation used five adjective pairs: soft-hard, light-heavy, do not have touch feeling-have touch feeling, do not have a metallic feeling-have a metallic feeling, and cold-hot, and each adjective pair was placed on both poles, and a seven-rank bipolar evaluation using the degree of "extremely (-3), very (-2), slightly (-1), neither nor (0), slightly (1), very (2), and extremely (3)" was used. The evaluation was made on the seven-rank scale and for example, the light-heavy evaluation was as follows; -3: extremely light, -2: very light, -1: slightly light, 0: neither nor 1: slightly heavy, 2: very heavy, 3: extremely heavy. Before the evaluation in the experiment, the participants have enough time to practice.

2.3 Apparatus

Figure 3 shows the actual space and VR space of the apparatus in this experiment. Figure 3(a) indicates the actual space in this experiment and the participants sat on the chair and wore the HMD in the experimental space. Figure 3(b) represents the VR space in this experiment and the participants could see the stimulus like this figure. The transparent wall in this figure was placed not to go somewhere the stimulus when touching it.

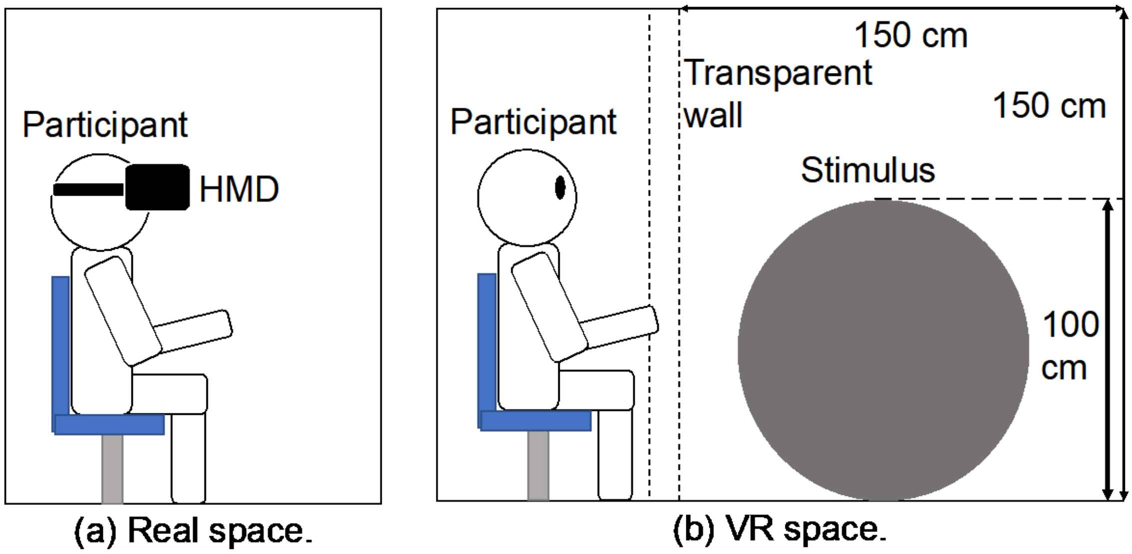

Figure 3. Apparatus in this experiment.

2.4 Participants

Ten students participated in this experiment. They were in their twenties. They have normal color vision.

3 RESULTS AND DISCUSSIONS

Figure 4(a) – (b) shows the average results in the impression of subjective evaluation in gray metallic surface and red matte surface based on all the participants' responses, respectively. The horizontal axis indicates the subjective evaluation value of the seven-rank scale. The vertical axis also indicates the adjective pairs on both poles. Each symbol corresponds to the top of this figure.

From both graphs, the stimulus with the softness of 0.1 in all the shapes is evaluated as extremely or very soft, 1.0 as slightly soft, and no deformation (N) is rated as very hard. Therefore, it is suggested that softness can be evaluated by the degree of deformation of the hand in the VR space synchronized with its hand movements, even if the hand is not physically touching the stimulus. It corresponds to the previous study report that different softness is felt depending on the deformation of the deformed virtual object and the movement of the plucked finger (Kato et al, 2017). In light-heavy adjective evaluation, the soft ones tended to feel lighter and the hard ones heavier. On the other hand, the evaluation of the touch feeling was in the "neither-nor" range, suggesting that further improvement of the touch feeling is desirable. Although from Figure 4(a), gray metallic stimuli feel metallic, the metallic feeling is suggested to be related to hardness rather than surface texture according to the overall results. From Figure 4(b), red color stimuli feel hot, and the hotness of red tended to be hotter, and the coolness of blue tended to be cooler, suggesting the warm-cool trend known in color psychology.

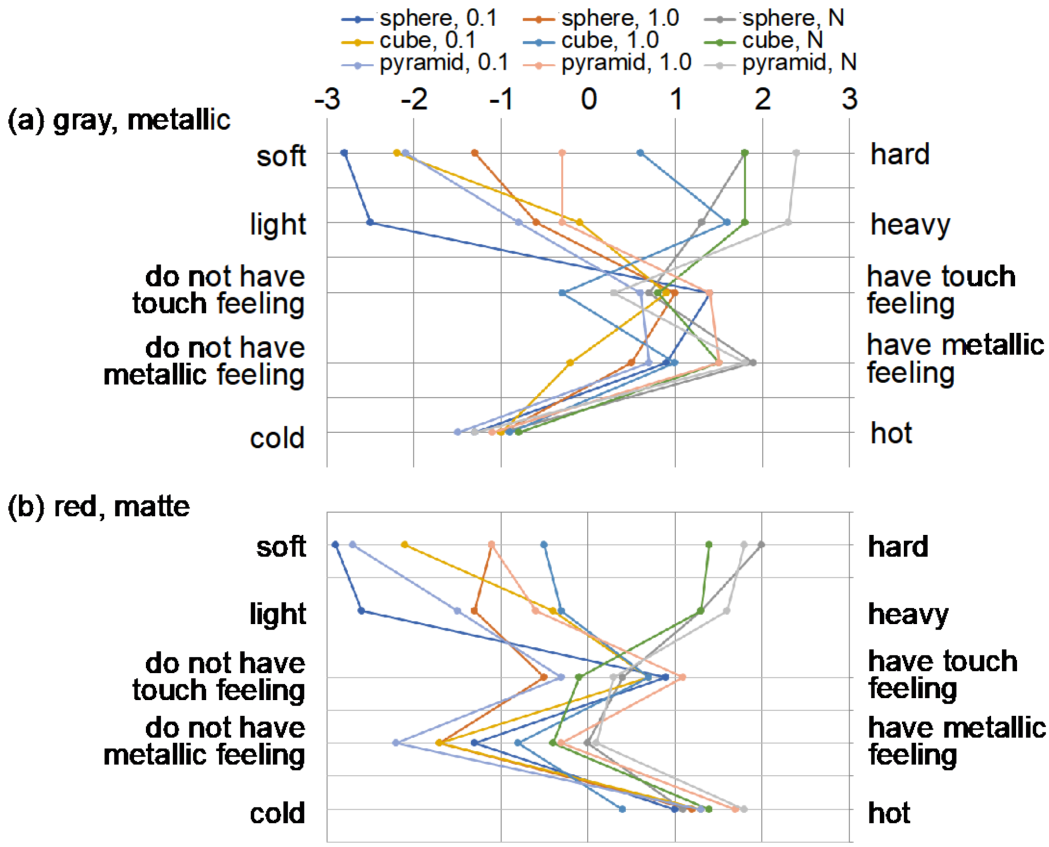

Figure 4. Average results in the impression of subjective evaluation in gray metallic surface and red matte surface. (a) gray, metallic surface, (b) red, matte surface.

4 CONCLUSION

To examine the softness and impression of visual objects in VR (Virtual Reality) space, the impression of the visual stimuli in VR space was measured using the subjective evaluation of a seven-point scale by changing with each the value of the deformation resistance of the stimuli, of shapes, and colors. The visual stimuli used in this study have been expressed as the tactile softness that the user's hand was synchronously displayed in the VR space by hand tracking. When the hand touched an object, the object was deformed accordingly. Three types of deformation resistance, three shapes of objects, five colors, and two surfaces were selected as stimuli in this experiment. Ten participants were asked to subjectively evaluate the softness and impression of the stimulus. In the results, the evaluation changes from soft to hard by increasing the values of deformation resistance in all the stimuli in VR space. It is suggested that the degree of the deformation to return to the original can express the softness of objects when touching them in VR space even though the user does not touch them physically. In light-heavy impressions, the soft ones tended to feel lighter and the hard ones heavier. On the other hand, the evaluation of the touch feeling was in the "neither-nor" range, suggesting that further improvement of the touch feeling is desirable. This finding could be utilized in a prototype evaluation system using VR.

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EXPERT DESIGNERS' PERCEPTIONS ABOUT DESIGNING USING KANSEI ENGINEERING RESULTS

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ABSTRACT

In a KE study to determine the emotional design features of a traditional product from Turkey, expert designers' opinions were collected for the *span the semantic space* and *span the space of properties* steps of the KE methodology and an additional discussion came up. It was noted that the expert designers raised several questions about KE. They seemed to approach the potential KE results with caution because it was perceived as an intervention to their creative processes.

During the interviews the following arguments came out: Design problems are irrational and wicked and do not have only one solution. What KE offers is scientific, but it may interfere with the creative process needed for designing. It can be useful for novice designers, but some experts think that they already have the intuitive knowledge of Kansei.

After discussing with other KE researchers, about the similar experiences working with expert designers, there was the need to explore the issue in more detail.

First, interviews were conducted with 4 expert designers. A scale was developed to assess their attitudes towards using KE results in design problems. Data was collected with an online questionnaire from 59 experts on the scale. The findings can be used in creating new strategies to introduce KE to design experts in a way that they can be convinced to use KE in their further design processes.

Keywords: *Expert Designer, Kansei Engineering, Design Process, Design Creativity*

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1 INTRODUCTION

Designing is a high level cognitive ability which is mostly defined as creative problem solving (e.g. Akın, 1986; Cross, 2006; Dorst & Dijkhuis, 1995; Dorst & Cross, 2001) involving many cognitive processes as divergent, convergent and reflective thinking, cognitive flexibility, associative processing, analogy making, decision making as well as intuitive and emotional processes (Simon, 1969; Dorst & Cross, 2001; Lawson, 2005; Cross, 2006; Hasirci & Demirkan, 2007; Lawson & Dorst, 2009). Design problems are irrational in nature (Reitman, 1965; Rittel & Webber, 1973; Newell, 1969; Simon, 1969, 1973). They are not problems for which all necessary information is available to the problem solver. Both the definition of the problem and solution spaces depend on the knowledge, cognitive abilities, insight and experience of the designer. Design process starts with defining the problem, setting the frame followed by generating possible creative solutions. It is an iterative process which may require the reformulation of the problem. As British Design Council's "Double Diamond Design Process" model (2005) clearly depicts both design problem formulation phase and solution generating phase progresses together, uses divergent thinking that is seen as the core ability of creative thinking. Defining the problem space is seen as the most important phase of creative cognition (Russ, 2014).

Kansei Engineering providing data about the emotional connections between the design features and user perceptions, clearly defines the problem space by starting with the *span the semantic space* and *span the space of properties* steps where the possible/potential design features are selected to be tested (Schütte et al. 2004). Even only this part could be seen as the initial attempt for 'defining the problem' phase of the design process. After the KE study is completed, the results give a clear picture of how the design features could lead to different emotions of users. However, many experts were observed to be reluctant to use Kansei Engineering claiming to find it to be something which limits their divergent thinking. This could be the reason why this methodology has not been widely incorporated with design practice, design related professions and design education.

This study has been conducted to investigate expert designers' perceptions of the KE methodology and their attitudes towards using the results of KE in designing. As the preconceptions about KE are clarified and opinions are determined, tools may be designed to introduce use of KE to expert designers so that they will be willing to try KE in their future design processes.

2 METHOD

In this study, for the purpose of determining perceptions and attitudes of expert designers towards using KE results in their designs, data were collected through interviews and a questionnaire.

2.1 Interviews

Semi-structured interviews were conducted with 4 expert designers. Three of them were familiar with the concept of KE but one has never heard of KE before. First the expert designers were presented with an introduction to the KE methodology and sample KE results from the study of Erol & Leblebici Basar (2021). Then they were asked about the potential advantages and disadvantages of using the KE results in designing. They were also asked if they would consider using KE results in their own design processes and the reasons were discussed. Finally, they were asked if KE would help novice designers during design education.

2.2 Questionnaire

A questionnaire was developed taking the comments of the expert designers from the interviews into consideration. After each interview was transcribed, the main issues were coded and categorized. In preparing the questionnaire several items were developed for each category indicating a relevant issue regarding using KE results in design. The items corresponded to both positive and negative attitudes. The most suitable 20 items were selected to form the scale.

The questionnaire was administered to a total of 59 participants online. The participants were experts from the fields of design such as industrial design, architecture, interior design, landscape design, UX design, and engineering design. They had at least 5 years of experience. They were residents of the countries Austria, Finland, Germany, Italy, Netherlands, Sweden, Turkey, United Kingdom and United States. 54% of the participants were female and 46% were male.

3 RESULTS

According to the results of the semi-structured interviews, expert designers expressed both interest and some concerns regarding the idea of using KE results in their design processes. The issues which came up could be discussed under several categories such as: data-based design opportunity, guidance for designers like technical specifications, impact on creativity and authenticity, interference to expertise.

The data that were collected with an online questionnaire from 59 experts on the scale were first investigated to assess the quality of the scale. Negative items were recoded so that on the scale the scores of 5 always means positive and 1 means negative. The reliability analysis showed that the internal consistency of the 20-item scale was satisfactory where the Cronbach Alpha coefficient was found to be 0.82. The item total correlation coefficients for 18 items exceeded the desired value of 0.15. Two items were deleted from the scale. The Cronbach Alpha coefficient for the 18-item scale was found to be 0.85.

Although the sample size was small, the results of a factor analysis provided a four-factor model which explained around 58 % of the variance. The consistency of the factors with the conceptual categories for which the items were generated indicated the construct validity of the scale. The categories referred to usefulness, relevance for problem solving, individual & collaborative learning and creativity. Sample items for each category and corresponding factor loadings are presented in Table 1. The negative items which were recoded for calculations are shown in red.

For each participant a total score indicating how positive their perceptions were towards using KE result in their designs was calculated. The mean total score was 67.64 with a standard deviation of 6.9 where the minimum possible score was 18 and the maximum possible score was 90. Figure 1 shows the distribution.

Table 1. Sample Items, Categories and Factors

Categories	Sample Items	Factors 1	2	3	4
Usefulness	Evidence from KE results can help me create alternative designs.	0.811			
	KE results would help a designer for data-based decision-making.	0.751			
	KE results may be useful for preparing to design a new product that the designer has never encountered before.	0.434			
Relevance	KE results would provide solutions to sociological and cultural characteristics in design problems.		0.814		
	KE results may provide valuable information from scientific evidence for designers.		0.778		
Individual and Collaborative Learning	KE methodology could be taught to design students as a technical skill.			0.757	
	Interpreting KE results could be a part of design education.			0.622	
	Using KE results can be a similar practice like considering technical specifications for certain products such as medical tools or educational materials for children.			0.608	
Creativity	Exposure to KE results might cause an unnecessary mental barrier in the design process.				0.758
	Seeing the KE results would limit my ability to design creatively.				0.727
	Authenticity in the design process is not something that can be enhanced by scientific evidence from data.				0.643

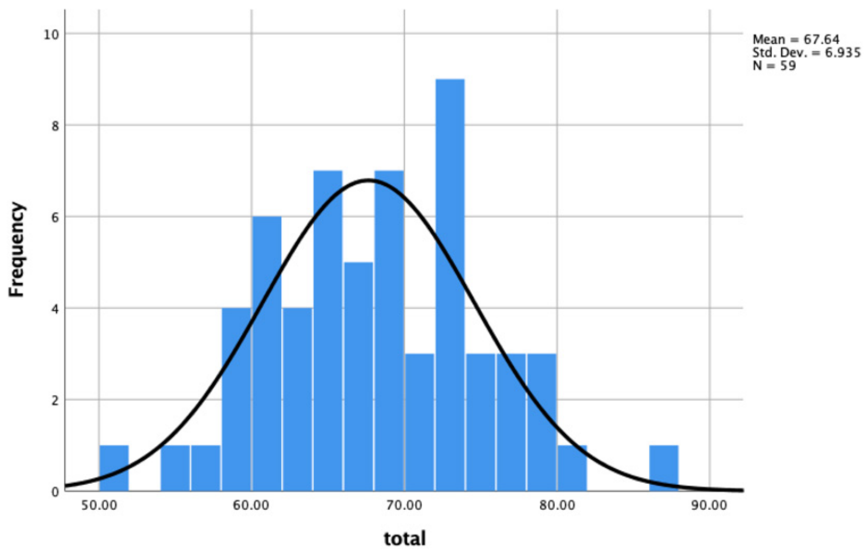

Figure 1. Histogram

The mean scores for each item were calculated. The mean of the item means was 3.8 and the standard deviation of the item means was 0.27, which showed that the attitudes of the expert designers was not found to be as negative as hypothesized to be in the beginning. The three items with the highest means (>3.98/5.00) were "KE results would help a designer for data-based decision-making.", "If KE results for a product are provided, I could think of using them for designing." and "Design teams can benefit from KE results for resolving conflicting ideas". The three items with the lowest means (<2.44/5.00) were "Authenticity in the design process is not something that can be enhanced by scientific evidence from data.", "Expert designers will not find KE results essential for their designs." and "Only novice designers may benefit from KE results, not experts".

The means of the total scores and mean of each item from the questionnaire which were investigated, indicated that the overall attitudes of experts towards using KE in their designs was found to be more positive than anticipated. Especially the means of the items regarding preconceptions for KE results limiting creativity of designers got lower scores indicating lack of evidence for these concerns.

4 CONCLUSION

A scale that can be used to assess the attitudes of designers towards using KE has been developed. [2] The designed questionnaire may be a tool to determine the willingness of individual designers in a team for using KE before starting with a design project. It can also be used for research purposes to identify the relationship between expert designers' attitudes and related characteristics such as creativity or design skills.

The results regarding the attitudes of the experts not being as negative as it was anticipated provided sufficient evidence to be optimistic for more expert designers to use KE in their design processes. On the other hand, there is still a concern for using KE results regarding the issue of 'design fixedness', a cognitive bias which prevents designers from interpreting objects in new ways rather than their prescribed versions (Duncker, 1945) which leads to the limitation of their creativity (Olteteanu ve Shu, 2017). Although this issue requires further research, as far as the opinions of expert designers are concerned, they seem to be willing to try using KE results for solving design problems at some point.

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[2] Please contact the authors for the complete scale.

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EXPLORING INDICATORS FOR HAPPINESS AND ITS EFFECT TO PEOPLE'S EMOTION USING LEIQ™

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ABSTRACT

Many assumptions were made about people's dissatisfaction with their daily lives, such as debt burden, social problems, unstable economic conditions, health problems, cost of living, lack of job opportunities, lack of educational support, and so on. The positive or negative emotional experience is distinctive between individuals or groups of people who share similar life experiences. Thus, the purpose of this study was to explore the emotional responses of a specific population to daily obstacles that may be related to the mentioned scenarios. The Lokman's Emotion and Importance Quadrant (LEIQ)™, which was built on axes of emotion vs. importance, was used in this study to discover the importance of the identified indicators to the people's happiness. The model is based on the idea that accurate strategies to improve people's quality of life can be devised by classifying indicators that contribute to people's emotions and understanding their importance to the people who interact with the stimuli. The findings of this study will eventually enable the identification of indicators that significantly influence people's positive or negative emotional states, which can then be used by stakeholders to devise effective strategies for future improvements.

Keywords: *Emotion; happiness; LEIQ™; quality of life; well-being*

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1 INTRODUCTION

Emotion is important because it is heavily associated to the quality of people's experiences in their daily lives. The emotion differs between individuals or groups of people who share common life experiences. The pursuit of personal happiness and a higher quality of life is, perhaps, a basic human desire. Hence, people strive for happiness and successful, long-lasting well-being. Happiness, also known as subjective well-being, used to be a prominent focus of research. It has then evolved to the "science of happiness" and is increasingly attracting the attention of many psychologists, economists, politicians, and neuroscientists (Mahadea, 2014). Social scientists and academics investigated happiness by examining the optimization of happiness and the characteristics that contribute to a happy existence. Interpersonal connections, for example, have a significant impact on human well-being. Thus, most scientists examine the influence of friendships, family relationships, and communities on happiness (Ahmad et al., 2021; Khairuddin & Mahmud, 2020; Lokman et al., 2018; Langeland, 2014), whereas economists examine the influence of consumption, wealth, and economic growth on happiness (Dutt & Radcliff, 2009).

Many assumptions were made about people's dissatisfaction with their daily lives, such as debt burdens, social problems, unstable economic conditions, health problems, cost of living, lack of job opportunities, lack of educational support, and so on. However, scientific evidence on the indicators of negative emotions and their significance for a specific population is lacking. Hence, this study was conducted to explore a low-income community's emotional responses and feelings in the face of daily challenges that may be related to the situations mentioned above. The study aims to provide an understanding of the issues this specific population has in their daily lives, and thus become a useful guide to community leaders and other stakeholders to strategize for improvements. The study provides opportunities for the people to express their positive or negative experiences with things they face in their daily lives, describing the causes that affected their feelings and how much they were important to them.

2 LITERATURE BACKGROUND

In psychology, it is widely accepted that people have emotional responses to their immediate surroundings. For example, in marketing, the pervasive influence of emotional response in various contents, such as advertising, product consumption, and shopping, has long been recognized by marketing research (Westbrook, 1987; Batra & Ray, 1986). According to Machleit and Eroglu (2000), in their study on emotional responses to shopping experiences, shoppers come to stores with specific goals and constraints, such as recreation needs, the presence of time constraints, and a budget limit - and affective reactions occur as they work toward meeting such goals. Previous research has shown that store environments can elicit emotional responses in customers (Machleit & Eroglu, 2000; Sherman, Mathur, & Smith, 1997).

Having said that, people's emotional responses are highly subjective. Some psychological scientists and scholars questioned whether feelings simply appear in consciousness, implying that generation is an active process that consumes cognitive resources (Kron, Schul, Cohen, & Hassin, 2010). Such complex cognitions are likely to interact with emotional response, which involves its own set of distinctive thoughts in the future (Leventhal & Shcerer, 1987). Furthermore, a type of emotion that may result in emotional responses strongly and routinely shapes people's decision making. Lerner, Li, Valdesolo, and Kassam (2015), for example, state that a person who is concerned about the potential outcome of a risky choice may opt for a safer option rather than a potentially more lucrative option. Such effects of emotional responses may eventually operate at both the conscious and unconscious levels.

Emotions play an important role in people's lives, both interpersonally and intrapersonally. As a result, emotional experiences and responses may have a significant impact on people's functioning, both positively and negatively. Causal analyses of past emotional experiences, according to Kassam and Mendes (2013), could have a significant impact on current emotional states. Reflective reasoning of a specific emotion, for example, can mitigate the negative effects of ongoing emotional experiences. As a result, it would have an impact on decisions made in the present and future.

Happiness and the experience of pleasant emotions are components of well-being. Emotional well-being also includes a cognitive assessment of overall life satisfaction (Langeland, 2014; Lamers, Westerhof, Bohlmeijer, Klooster, & Keyes, 2011). Furthermore, according to Langeland (2014), emotional well-being is a collection of indicators that reflect the presence or absence of positive feelings about life. Positive affect, happiness, and life satisfaction are all operationalizations of positive feelings or emotions. Happiness, according to Lokman, Kadir, Noordin, and Shariff (2014), is a mental or emotional state of well-being characterised by positive or pleasant emotions ranging from contentment to intense joy. However, positive emotions are one of the pillars of positive psychology. Positive emotional well-being can be viewed as both the experience of emotions and the regulation of emotions. Furthermore, emotional well-being includes positive subjective experiences of the past, present, and future, as well as contentment and satisfaction related to the past. Positive subjective experiences of the present include happiness, flow, ecstasy, and sensual pleasures (Langeland, 2014).

3 METHOD

Based on previous research on emotion and its impact on decision making, productivity, and well-being, this study employed the Lokman's Emotion Importance Quadrant (LEIQ) ™. LEIQ™ is a model developed on the axes of emotion vs. importance to allow classification of emotion, the indicators influencing the emotion, and the importance of the emotion to the people who interact with things in their daily lives. Classifying the indicators that influence the people's emotions and understanding their significance to the people is important so that suitable strategies for improvements can be devised.

This study required respondents to complete two phases of activities: i) Step One - LEIQ™, and ii) Step Two - Well-being Survey. Step One - LEIQ™ asked respondents to provide feedback on issues that affect emotions in their daily lives, both negatively and positively. Every respondent was given one LEIQ™ quadrant and was asked to quietly brain write the issues onto each quadrant of the empty quadrant, indicating whether the matters make them happy or unhappy. The data obtained from this process were then synthesized into patterns that make sense in related emotion, and then thematically analyzed to discover indicators that affect their happiness in their daily lives, as well as the importance of the indicators to the emotional responses. This enables the identification of which indicators significantly influence people's positive or negative emotional states.

Subsequently, every respondent was given one well-being Survey template, and they were asked to quietly tick and mark their choices, whether they are happy or not happy with the subject matters. The survey consists of 6 key areas concerning the public, including public transport, infrastructure, cost of living, education, safety, and anti-corruption, which were part of the focus in the country's national key result areas.

The respondents were invited among low-income groups in the country, in which the community of interest were purposively selected by the local government prior to the invitation. Members of the community (n=1793) physically attended the data collection session and were given a token of appreciation to compensate for their time commitment and cooperation.

4 RESULTS AND DISCUSSION

4.1 Analysis of LEIQ™: People's Happiness

The LEIQ™ quadrant was used in the study to discover people's emotions towards things they experience in their daily lives. The data was coded according to patterns and thematically analyzed. The resulting themes were then visualized into a word cloud according to each quadrant with four different parts (Figure 1), which are Q1 – Most Important Problems; Q2 – Problems but Less Important; Q3 – Happy and Important; and Q4 – Happy but Less Important. According to the data in Q1, financial, expensive goods, cost of living, money, and GST is among what matters most and bring negative effect to their well-being.

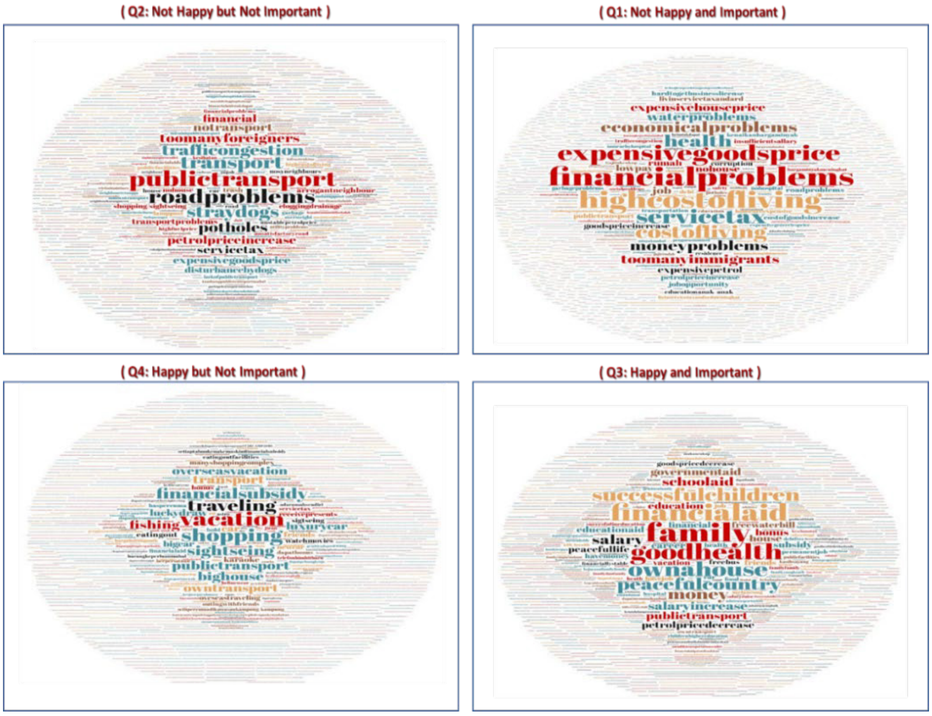

Figure 1. People’s Happiness vs. Importance

Meanwhile, as illustrated in Q2, public transports, damaged roads and traffic congestion show or to be the highest concern to the respondents but less crucial as compared to indicators articulated in Q1. On the other hand, as shown in Q3, family, cash incentive, good health and successful children are indicators that profoundly affect their positive well-being in their daily lives, while travel, holiday and cash incentive also have some significance to their happiness, as shown in Q4.

4.2 Analysis of People’s Well-being

The survey was based on public concern about public transportation, infrastructure, cost of living, education, safety, and anti-corruption, all of which were emphasized in the country's national key result areas. Descriptive analysis was conducted to understand the level of the people's experience, both positively and negatively, which affects their well-being in relation to these indicators.

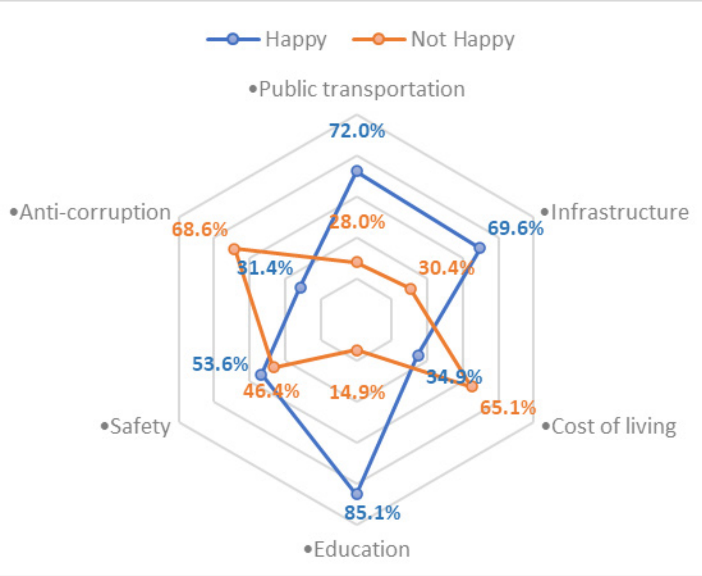

Figure 2. The people's wellbeing based on 6 key-areas.

Figure 2 shows that 68.6 percent of respondents negatively perceive the anti-corruption area, which ranks at the top of the list. On the aspect of the cost of living, 65.1 percent of respondents were negative, and 34.9 percent of respondents were positive. Education, on the other hand, had the highest percentage of positive respondents (85.1 percent) as compared to negative respondents (14.9 percent). When it comes to the public transportation area, there were 72 percent of positive respondents and 28 percent of negative respondents. There were 69.6 percent of positive respondents and 30.4 percent of negative respondents for the infrastructure area, and 53.6 percent of positive respondents and 46.4 percent of negative respondents for the safety area. These results provide insights to the state of the people's well-being and, in which could facilitate stakeholders' strategy for future improvements in each area.

5 CONCLUSION

The study employed the LEIQ^{TM} model to enable the classification of indicators that affect people's emotion, the influence of those indicators to people's positive or negative emotion, and the significance of these indicators to the people's happiness. A case study was done among low-income population to explore their emotional responses towards daily living experience that may be related to their well-being issues.

The LEIQ^{TM} model was adopted with careful attention to cooperative attitude and engagement among respondents and facilitated by moderators. The case study resulted large amounts of opinions and issues, and enabled the research to organize them thematically into their natural patterns, such as environment, welfare, and financial matters. These results could be used as a clue for decision makers to prioritize indicators that significantly influence people's emotion in the effort to elevate well-being and thus increase people's happiness and productivity be it at work or daily lives, and ultimately contribute to positive well-being at large. Further investigation and analysis could be proposed to provide opportunities to extend the findings, in which could contribute to accuracy and effectiveness of clues for future improvement strategies. Comparative research on higher income group is also recommended in order to provide solid foundation for scholarly discussion on similarities and differences of issues and importance, thus facilitate possible generalization of the findings.

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EXPLORING THE EMPOWERMENT OF CHINESE WOMEN'S DISCOURSE IN TIK TOK

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ABSTRACT

In the new media environment, women are no longer the recipients of information, but rather the producers and consumers of information. The media image of women has become more diverse. Tik Tok is a product of the rapid development of new media, where women are empowered in many aspects of production, performance, distribution and reception. In many Tik Tok videos, women express themselves, with topics ranging from beauty and dressing to work and even gender relations. While this is a somewhat new look compared to the past, Chinese women are still influenced by traditional culture and there is still a hidden power manipulation behind it.

The study of Tik Tok is relevant to the construction of equal gender relations in Tik Tok and other short social videos. At the same time, as the age group of Tik Tok users is young, it helps us to understand the contemporary media position of women in the social video sphere.

This study collects the participation of some active female users in Tik Tok on public issues, analyses the most popular female short videos posted by female users in Tik Tok, and examines the media image of female users in Tik Tok platform using a qualitative research approach, supplemented by quantitative research. In this way, we analyse whether women's right to express themselves is being realised unconsciously and whether there is a qualitative improvement in the expression of women's voices compared to the traditional media era.

Keywords: Tik Tok, media images of women, female empowerment

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1 INTRODUCTION

1.1 Research Background

With the popularity and maturity of mobile Internet, consumers' Internet-based content consumption and online social networking needs are increasing (Yuqing et al., 2012). The original graphic consumption can no longer meet users' needs, and video has become more preferred content. Short videos have currently become an important development direction for current information dissemination due to their low creation threshold, social attributes and strong interactivity, fragmented consumption and dissemination. Considered by the industry as a windfall in the Internet field, talents and funds are entering on a large scale. Tencent, Sina, Ali, Baidu and other major Internet giants have laid out to seize the high ground in the short video industry, relying on platforms and content. The number of short video users began to grow explosively as a result of the introduction of various short video APPs, such as Racer, Secapai and Xiaogaxiu. On 27 August 2021, China Internet Network Information Centre (CNNIC) released the 48th Statistical Report on the Development Status of the Internet in China. The report pointed out that as of June 2021, the size of Chinese short video users was 888 million, accounting for 87.8% of Internet users overall. The growth of short-form video has become the biggest bonus cake of the moment (Lu et al., 2002).

Since its launch in September 2016, Tik Tok has grown rapidly, attracting a large number of users in a short period of time (Wang et al., 2019). Although it was not well known in its early stages, in just nine months it has grown exponentially with over 100 million users and one billion daily plays. In the Spring Festival of 2018, Tik Tok's daily activity reached 65 million and even surpassed Alipay in the App Store download ranking at one point, becoming a phenomenon sought after by the post-90s and post-00s(Unni & Weinstein, 2021). The Mobile APP Index provided by Ariadata shows that as of November 2018, Tik Tok's monthly unique device downloads have reached 293.47 million units, successfully catching up with Racer and becoming the industry giant of short video APPs. According to The Economist, TikTok has become an indispensable companion for teenagers around the world when they are forced to stay home from school because of the epidemic(Zhang, 2021). As of March 2020, TikTok has been downloaded 115 million times and has over 1 billion users. And among the large group of users, female users have become the mainstay. QuestMobile has released the "2020 China Mobile Internet Spring Report". The report states that the size of Tik Tok users in China reached 518 million, with female users accounting for 57% of the total(Gan, 2020).

With the changing times and technological innovations, the media structure in China has undergone a radical change. Traditional media are in decline and new media are flourishing. Women have also changed dramatically in this media revolution, with female communicators no longer confined to professional women in media organisations. The birth of the Internet has lowered the threshold of communication. Women are no longer passive recipients of information, but active producers and consumers of information, and the relationship between communicator and audience has gradually become blurred. In the new media environment, the image of women has also become more diverse. As a result, some scholars have begun to look to the new media and have begun to analyse the image of women, women's discourse and the field of women's discourse in the new media environment. The widespread use of new media offers instrumental possibilities for the expression and widespread dissemination of women's discourse, which means that new media offers a form of 'technological empowerment' or new media empowerment for the new practices of women's discourse today(Döring, 2000).

The mass and lifestyle nature of short videos, as well as their interactive, consumable and audiovisual nature, offers the possibility for women to participate fully, empowering them in a number of ways, including production, performance, distribution and reception. Tik Tok is a product of the rapid development of visual culture and belongs to the field of visual communication. The issues that arise in the field of visual communication are not only a focus of attention in the field of communication, but also a growing concern for feminist scholars. In many Tik Tok videos, women express themselves, portraying more than just beauty or dependence on men in the traditional sense, with themes ranging from beauty and fashion to work and even gender relations. The body itself becomes not only a vehicle for short video narratives, but also one of the most important forms of narrative. Although this takes on a somewhat new look compared to the past, women are still influenced by traditional culture and there is still a hidden manipulation of power behind it.

1.2 Problem statement

The imbalance in the gender power structure of the traditional media era has been broken, providing an opportunity for the advancement of women's voices. The birth of short videos has further lowered the barriers to entry and provided a platform for women to express themselves(F. Yang, 2020). Tik Tok, the leading social short video, has attracted many female users and created many female celebrities. Short videos have a distinctly female participatory character. According to statistics, as producers and distributors, most of the people who upload short videos are post-00s, women. As an audience, women are more inclined to video. According to the survey, men are more inclined to use news and game apps, while women are more inclined to use consumer and video apps, so short videos are predominantly female at both the production-publishing and viewing-sharing ends, making them an important area for online feminist research. (J. Yang, 2020) .This situation is related to the lived-in nature of short videos. As short videos move from private to public space and from folk culture to public communication, their cultural tone is 'lived-in', which matches the strengths of women in related fields, thus making women highly compatible with short videos and forming a set of narrative and cultural mechanisms that effectively contribute to the construction and dissemination of short videos. These characteristics also make the female participation and empowerment approach of short videos different from, for example, women's literature and other women's literary arts(Shata & Seelig, 2021). However, Woolf's vision of autonomous female expression has not been fully realised on the Tik Tok platform. For female users, the limited scope of discourse and lack of self-expression persists, and the logic of 'beauty is justice' still prevails. The study of Tik Tok will not only enrich the findings of women and media studies in the field of new media, but will also have implications for the construction of equal gender relations in Tik Tok and other social short videos. At the same time, as Tik Tok is an emerging product in the new media industry and its users are young, feminist research on Tik Tok can help us understand the face of new age women and the status of contemporary women in the social video field.

1.3 Research Objective

The 'narrative' of short videos is in line with the little narrative of the French philosopher Jean-Francois Lyotard, which does not attempt to answer all social questions or play a decisive role in the organisation of society, but encourages fragmented knowledge and the parody of grand narratives(Sim S, 2001). It encourages fragmented knowledge and the parodying, appropriation and deconstruction of grand narratives, but also gives full play to individual creativity in an attempt to construct more egalitarian and richly diverse social connections, creating a real society that is interconnected, contradictory and diverse. It is through such small individual narratives that women empower short videos. The author intends to analyse the content and statistics of short videos on the Tik Tok platform, and to analyse the most popular Tik Tok female video numbers in ten genres, in an attempt to summarise women's participation and empowerment strategies in short videos, and to generate attention and discussion on related issues. This study explores the basic paths of women's full participation and empowerment in short-form video applications. We aim to construct three dimensions of women's empowerment strategies in short videos, mainly body narratives, relationship narratives and scene narratives, which embody the models of individuals, groups and societies respectively.

1.4 Significance of this study

In today's self-media platforms, "women's discourse" is no longer a term exclusive to academics, but is increasingly referred to by netizens. The rapid development of self-media has provided a platform for women's discourse to be fully expressed.

From a theoretical point of view, most studies of women's discourse in China have been conducted at the level of cultural institutions, analysing women's discourse from the perspective of female images in literature, film and television works and traditional media. Therefore, this study will analyse the female discourse behind female short videos on the Tik Tok platform in the age of self-media, using a combination of communication perspective and literary theory to provide a new perspective for the study of female discourse, which on the one hand can complement the relevant feminist theories. On the other hand, it is hoped that the study of women's discourse on the Tik Tok platform will bring inspiration to relevant women's movements and theories in reality.

From a practical point of view, most women in China aspire to have equal social status and voice with men. However, as feminist research in China started far behind the West, there is no complete theoretical system to support it, and no concrete practical experience to draw on. Therefore, this study analyses the phenomenon and current dilemma of women's discourse on the Tik Tok short video platform in the context of the self-media era, so that more people can pay attention to and understand the current situation of women's discourse in China and arouse women's sensitivity to Chinese women's discourse. Rather than laying the groundwork for women's discourse by weakening or devaluing men's legitimate right to discourse, it effectively alleviates the strong antagonism in the current online environment through the identification of hyper-gender consciousness, realises the true meaning of transgender identity, promotes every individual in the current society to face women squarely again, respects women's right to discourse expression, and provides feasible reference significance for women's discourse research.

2 FEMALE EMPOWERMENT STRATEGIES IN SHORT VIDEOS: BODY NARRATIVES, RELATIONSHIP NARRATIVES AND SCENE NARRATIVES

A study of the most popular female video numbers in each genre through Tik Tok data reveals some patterns. Each blogger posts thousands of short videos featuring herself in a video number, mostly following the same narrative strategy and maintaining an overall consistent narrative style. Generally, three narrative styles are used or overlaid: physical narrative, relationship narrative and scene narrative. These three narrative styles embody the individual, the group and the community respectively.

2.1 Body Narrative

The body narrative uses the body as a vehicle. Subject and object are intertwined through the medium of the body. The body is both the subject of the act and the narrative, and is also subject to the perceptions of the maker and performer and the scrutiny of the receiver, completing the narrative and the feedback of the meaning it carries in the process of being viewed. The interaction between women's 'body theory' and the media began in the 1970s, when it quickly became an effective form of symbolic coding in the mass media or cultural landscape. Today, women in short videos are expanding the expressive power of the body, using it as a vehicle to complete gender narratives, to fully explain the bodily concerns, identities or other subjective intentions of both genders, and to empower short videos through body narratives.

Firstly, women have a freer reign over their bodies and a richer range of physical expressions, which has led to more women's bodies being 'shown' rather than 'covered', resulting in more diverse images of women in the media. Unlike male culture, where the state of the body is determined by the needs of men, the state of the body is more often determined by oneself or the female audience, as the producers are also women, and the shots of female performers are less focused on the gendered breasts and buttocks, and more on the female face and the panoramic view of the female pose. Female audiences also prefer to see face make-up and full body wear, in line with the aesthetics of female producers and performers. Beauty bloggers are more typical in that they focus on the relationship between their own bodies and the bodies of their female audience, resorting to their own quest for beautiful bodies in an effort to make their female audience improve their image and reinvent themselves, guiding their female audience into hallucinatory projections of her body, realising the i-deal-ego and the 'ego-ideal' according to Lacan's theory of mirroring and gazing "The projection of i- deal-ego and ego-ideal is based on Lacan's theory of mirroring and gaze.

Second, women return to focus on the essence of women's lives, explore female subjectivity, and look at their bodies from more perspectives. For example, female bloggers in the knowledge and beauty categories in Table 1 show women's intellectuality and health. According to real-time data from Tik Tok, Ah Huai, the most popular female blogger in the beauty category at the moment, attracts a large number of fans by introducing the ingredients of skin care products as well as their efficacy, helping users to build healthy skin and establish the correct concept of skin care. The food and family life bloggers represented by "Li Ziqi" highlight the poetry and practicality of women through clothing and body language; "Grandma Wang who only wears high heels" she wears exaggerated pearl earrings, long pearl necklaces, hats and high heels in every appearance, showing her dashing and exquisite disregard for age through her clothing and temperament.

Table 1. An example of Top Female User Accounts From a Tik Tok

Name	Number of works	Number of likes	Number of fans
Ah huai	170	9,295,000	1,358,000
Yi Zhinannan	385	25,345,,000	2,823.000
Li Ziqi	772	220,000.000	52,966,000

Finally, women achieve absolute control over their own bodies in short videos and have the right to transform their bodies at will. Through case studies, I found that 'cross-dressing' is the most important tool in the narrative of women's bodies, i.e. the process of transforming the body from ugly (or ordinary) to beautiful by means of make-up, changing clothes and accessories. For example, "Little Orange", one of the top online beauty bloggers in terms of number of followers, has adopted the strategy of "national style cross-dressing", and its "Daji cross-dressing" video released on 11 October 2020 has received 4.055 million likes. The video "Daji in disguise", released on 11 October 2020, has received 405.5 million likes. The drama blogger "Xin Jiu'er" has adopted a dramatic "Chinese costume cross-dressing" direction. The blogger "Huang Sanqin" has also gained a lot of fans by combining "drama + beauty" and transforming herself from an ordinary passerby into a beautiful and sophisticated female boss. The "cross-dressing" narrative is also a common tactic among beauty bloggers. "The 'cross-dressing' video content is very popular with female audiences. The "drag" body narrative in short videos highlights the importance women place on their bodies and their confidence in them, but more importantly, the contrast between a woman's delicate make-up and her before and after body, with strong memorable music and simple gestures, pleases the female audience, allowing them to see their ideal female image and to have a It is a visual and aesthetic pleasure to learn how to make themselves beautiful and to provoke their own latent physical and psychological desires. It is all about sensuality and meeting the needs of the female audience through emotion.

2.2 Relational narratives

Sisterhood, an important theme in Western women's literature. It originally referred to the bond between women as a weapon to unite them against racial discrimination and class exploitation, to confront patriarchal culture and to build a female identity. As historical conditions and the situation of women in different social forms have changed, there is now less talk of solidarity and more of support. Support can mean agreeing with what someone thinks is right, or defending it. It also means acting as a support or foundation for weaker structures.

However, traditionally the most common sisterly relationships presented in our film and literature have been either adversarial, or "plastic Sisterhoods" in which false feelings can be dismantled by interests. In short videos, however, women are more often presented with a new narrative strategy based on supportive relationships. For example, the hilarious blogger "Crazy Sisters", which revolves around Zhang Xiaohua and Shao Yuxuan's daily routines of hilarity, eating and drinking among their girlfriends, uses Shao Yuxuan's first point of view to show their friendship as women who support each other despite their hijinks. As can be seen, there are two main ways of presenting the narrative strategy of the "supportive" relationship between the sisters. The first is that the protagonist is usually a strong, independent woman, i.e. the "big female protagonist" persona, who gives support to the relatively weak women. "The emergence of the female protagonist as a medium signifies the movement of women from a marginalised 'second nature' to the centre. Such a persona and storyline can satisfy the female audience's sense of self-worth in terms of gender, allowing them to experience a sense of release and comfort along with the storyline. Many people don't understand why the video is 'out of the loop', but it is actually influenced by the famous American sitcom 'The Broke Sisters', which portrays a very grounded, realistic, superficially mean but confident relationship with each other, full of equal love for women. Similarly, the drama blogger 'Wan'er's Treasure Sister' uses the daily routine of sharing a house as a creative point of reference, showing the relationships between multiple women with different personalities through a progressive 'break-in' model, exploring what true female friendship is. The premise of this narrative strategy is that the female subjects must have a strong relationship or emotional foundation with each other, and that each individual has a certain degree of independence.

The new mother-daughter relationships of today also follow this narrative strategy. For example, the hilarious blogger "Wen Jingling" is famous for her "100 ways to imitate your mother" and "100 ways to piss her off". She calls her mother "Sister Rong" and "Ms. Rong", and while Ms. Rong apparently "dislikes her daughter", mother and daughter are more like a pair of girlfriends who "dislike" each other.The daughter is not only on an equal footing with her mother, but she can even tease her mother in turn. Through the superficial teasing, the audience sees a very strong and deep bond between the women behind the scenes, who understand and support each other fully, and are a source of joy and emotional support for each other. It can be seen that female relationships have changed from the traditional narrative strategy of hostility to a relationship narrative strategy based on sisterly "support" in the short video; from the independent party supporting the weaker party, to both parties being independent and supporting each other, to the superficial "dislike" and even teasing of each other We see this in the short videos of women who are not only independent and supportive of each other, but are also superficially "disliking" each other and even teasing each other, but are also confident in their relationships. We see a new presentation of women's same-sex relationships in short videos, and we also see a growing trust between women, even across age, generation and class, and the possibility of genuine friendship.

In addition to Sisterhood, there are also relationships between female bloggers and members of the opposite sex in short videos, such as brother and sister, father and daughter, mother and son, husband and wife, and couples. These are grouped together and discussed together because they share a similar narrative strategy in that women are dominant in these relationships and are at the centre of the narrative. For example, the hottest video in this genre, "Big Wolf Dog Zheng Jianpeng & Yan Zhen Couple", creates a relationship between a husband and a wife by contrasting the image of a scruffy landlord and an exquisite landlady, creating a huge contrast between the husband and the wife, reflecting the family relationship of a strong woman and a weak man. Even the eldest daughter has a higher status than the husband. "Tall, short, fat and thin" is a female blogger from a middle-class family in Hong Kong. She is also the absolute centre of the family, often coming up with ideas to keep the whole family busy. The hottest blogger in the male cross-dressing category, "Superfluous and Mao Mao", has also borrowed this narrative strategy, with one person playing two roles, the female Mao Mao and the male Superfluous being the couple, but Mao Mao being the absolute subject of the video content. The video's main content is based on a small theatre that imitates women's mental activities and body language, giving voice to women and showing their charm. In this way we also see the respect, understanding and support of the male community for women, which marks a more equal and diverse society.

2.3 Scene narrative

Joshua Meyrowitz, a communication scholar, based on the media theories of Innes and McLuhan and Goffman's mimesis, introduced the concept of situation as a way to study the behavioural and psychological impact of "media scenes" on people. Situation has also become one of the characteristics of short videos. As mentioned earlier, the cultural underpinning of short videos is life, and most of the short videos produced are based on life scenes. Therefore, nature, home, school and workplace are the most popular settings for women's short videos, and accordingly, fields, scenic spots, living rooms, classrooms and offices are also the most popular scenes. Scene narratives have become an important dimension in the narratives of women in short videos. Scene narratives are more often used in the categories of food, travel, family life, drama, and funny. The most notable example is the short videos of women in the food category, represented by "Li Ziqi". In the same category, there are also "Peach Sister in Shu", "Pan Lou Lou", "Nostalgia" and "Chuan Xiang Qiu Yue". Whether they are set in the southwest of Shu, in the Dabie Mountains or at the foot of the Wuyi Mountains, the idyllic scenes of nature become an important strategy in the narrative, whether it is the pastoral style of the village or the unadorned earthen houses and stoves, they all present an original and authentic rural life. Every scene, including the mountains, streams, courtyards, lotus ponds and rice paddies, is imbued with a sense of life.

In addition, the city's "Aya Kitchen", which cooks breakfast for children, and "Pupu Kiki", which cooks food for the husband, are often set in the kitchen or living room of their homes, with all kinds of soft furnishings, tables, kitchen utensils, tableware and packaging items, all warm and lovely, seemingly They look like they are making food, but in fact they are showing an ideal state of 'home' through their scenes. The office is also a common scene in the city, and women give it a meaning outside of work, such as "Office Ono" making food in the office, conveying the idea that it's important to go to work and enjoy life first. In the above video, the scene is the main narrative, and through the scene narrative, the food becomes a poetic and pictorial picture of life, and the steaming meal carries the life, conveying a simple and moving, back-to-basics lifestyle and philosophy of life. The same narrative strategy is also found in almost all female travel bloggers. In a place with picturesque natural scenery and breathtaking human beauty, bloggers are conveying a philosophy and lifestyle through the narrative of scenes. One can find that the use of everyday, warm, beautiful and comfortable life scenes has become an important narrative dimension of female empowerment in short videos. The scenes and life are infused with each other, and the scenes reflect the quality of life and the concept of life, making short videos the best tool for women to "record the good life"; in turn, the rich life gives women unlimited sources of expression and materials, promoting the further practice of short videos for women. Of course, the above conclusions are drawn by looking at popular videos, and there may be some short videos that use other narrative dimensions, but because they are not popular and belong to a niche area, they are not studied. However, it can be said that narrative approaches based on bodies, relationships and scenes have become a fundamental strategy for female empowerment in short videos.

3 CONCLUSION

In summary, through the exploration of the issue of female participation and empowerment in short videos, it can be found that short videos have brought new space for women's full participation. Narrative is an important means of processing information, carrying expression and establishing communication in online society, and it is also a basic path for women's full participation and empowerment in short video applications. The main strategies for female empowerment in short video are body narratives, relationship narratives and scene narratives, which embody the three dimensions of the individual, the group and the society, or the close object, the close person and the distant view respectively. In short videos, women express themselves through narratives based on their bodies, relationships and scenes, creating a more diverse image of women in a 'small narrative', and a more harmonious relationship with their same-sex counterparts, supported and understood by men, and even dominant in both genders.

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EXPLORING THE KEER KNOWLEDGE LANDSCAPE OVER THE PAST DECADE

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ABSTRACT

The aim of this paper was to systematically explore the knowledge landscape of papers presented at KEER conferences over the last decade. We collected all papers published in conference proceedings between 2010 and 2020. We (i) used a text mining pipeline to extract, clean, and normalize keywords from the Title and Abstract fields, and (ii) created a co-occurrence network reflecting the relationships between keywords. The network was then characterized at different levels of granularity (static analysis vs. time slice analysis and whole network vs. node-level analysis). The exploratory analysis showed a stable expansion of the network over time. The cluster structure revealed several groups of keywords that did not change over time and reflected both domain-specific and method-specific topics of research in Kansei engineering.

Keywords: *Kansei engineering, science-of-science, knowledge mapping, network analysis*

1 INTRODUCTION

The field of Kansei engineering is well known and has been demonstrated in various case studies since its introduction in 1970. In the early 2000s, Kansei engineering has attracted great interest from researchers worldwide. The popularity of research on the consideration of user emotions and feelings in product design led to the establishment of organizations such as European Kansei Group (EKG) and the creation of a conference, namely Kansei Engineering and Emotion Research (KEER). The KEER conference has been held every two years since 2007 and is organised by the Federation of 4 Regional Kansei Research Associations. Thus, KEER is the first global Kansei association (JSKE, Taiwan Institute of Kansei, EKG, and MAKE). Each KEER conference includes about 100-170 papers, which is a large amount of valuable data. Kansei

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engineering relies primarily on established methods and techniques, but new topics are also important for the future of the field.

The objective of our research was to investigate the state of the art in KEER proceedings over the last 10 years (2010-2021). We focused on topics, applications, and tools that appear in complete articles (proceedings) available online. We used web search/text mining to explore the content. Later, we classified the result into thematic clusters. Through the analysis, we gained a deeper understanding of what research interests have emerged in the last decade related to the field of Kansei engineering academic development.

1.1 Knowledge landscape over past decade

The development of Kansei engineering and its research is still an ongoing process and the subject of interest of many researchers around the world. According to Lokman (2009) Kansei engineering (KE) is consisted of eight techniques: Type I: Category Classification, Type II: KE Computer System, Type III: KE Modeling, Type IV: Hybrid KE System, Type V: Virtual KE, Type VI: Collaborative KE, Type VII: Concurrent KE and Type VIII: Rough Set KE. Besides the general structure, KE types can be divided into computational and non-computational (Ahmady, 2008). Ahmady (2008) has grouped category classification (type I), Virtual KE (type V) and collaborative KE (type VI) as non-computational while KE computer system (type II), hybrid KE (type IV) are considered as computational. Each type of KE has its own specific complexity in extracting data on the semantics and product features side, but the main methodology consists of the same steps. Based on all KE types a common Kansei framework was developed by Simon Schütte (2005). In addition, Levy (2013) provided an overview of the history of Kansei engineering (KE) and explained a theoretical structure of three subfields describing the production of physical artifacts: KE, Kansei Science (KS), and Kansei Design (KD). According to Levy (2013), KS builds on brain science, particularly cognitive neuroscience and psychophysiology, and draws on related philosophies. The term Kansei design is used to characterize the KE work that leads to actual industrial products. This approach has been implemented at Toyota Motor Europe (Levy, 2013).

KE is applied in various product areas, such as consumer goods (e.g., cosmetics, food, fashion, automotive, electronics), digital industries, and services (Bidin et al.2018). Recent studies confirm that KE is strongly present in the automotive and electronics industries (López et al. 2021). To better analyse observed product parameters, KE studies often categorise the product by attributes or characteristics such as shape, size, colour, material, surface, and price. Products or services trigger different senses in users (smell, sight, hearing, touch). For this reason, we find the above product attributes (scent, visual, auditory or tactile sensation) explored with KE. Within similar academic fields often associated with KE, such as Affective and Emotional Engineering (Levy, 2013), there is no strict demarcation. Even the tools and techniques used to measure user feedback are widely used in the aforementioned fields. User perception of products in KE is studied with tools we find in other research fields (mathematics, computer science, psychology, mechanical engineering, etc.)(Schütte, 2006). However, capturing and evaluating user's feeling is still highly subjective. Therefore, tools that measure kansei should be suitable for processing uncertain and unstructured data (Nagamachi et al. 2006). A previous study found that the most frequently represented concept in KEER 2014 was "Kansei," followed by "emotion," "participant," and "product" at the same level (Omhover & Bouchard, 2014). It is not surprising that the three most important components of KE are represented at the same level. Since KE and its application is not a new method, we examine what themes emerge and what is trending. The goal of our research was to examine the popularity of KE research directions over the past 10 years.

We have examine the knowledge landscape and major research topics addressed at KEER conferences. To identify the individual topics and the relationships between them, we conducted a topic analysis of KEER proceedings from 2010-2020.

2 METHODOLOGY

In this section we present the data workflow and explain the computational methods. The work is generally based on three consecutive steps: (i) collection of the KEER corpus and pre-processing of the documents, (ii) extraction of keywords and their representation in the form of a network, which finally allows us to (iii) perform a cluster analysis and describe research topics consisting of closely related keywords/keyphrases.

2.1 Data collection

We have created a machine-readable corpus of all research papers included in the KEER Conference Proceedings from 2010 to 2020. The paper starts with basic metadata (i.e., author list, title, subtitle, abstract, and list of keywords) on a title page and continues with the main body of the paper following the IMRaD structure (i.e., introduction, methods, results, and discussion). In line with our previous experience in natural language processing, we used the abstract field of the paper for keyword extraction, where the abstract provides an optimal tradeoff between the runtime of the extraction process (i.e., lowest with full text and highest with title) and the accuracy of the extraction process (i.e., lowest with title and highest with full text). Although the papers in the proceedings are structured according to a common document template, we found a high degree of variation due to the different document styles and word processors used by the authors. Therefore, we made two assumptions to ensure that the document parser could correctly match the abstract: (i) the abstract field starts on the first page of each paper, and (ii) the abstract text is positioned between the first occurrence of the word "Abstract" and the first occurrence of the word "Keywords".

KEER conference proceedings are published online in PDF format. The PDF file was first processed using the command line tool "pdfseparate" to split the entire document into separate PDF documents, one for each conference paper. In the next step, we processed all the collected documents using the "pdftotext" tool to create a normalized plain text representation of a document. This allows us to extract the required (meta) data: (i) the unique identifier of the paper (composed of the publication year of the conference volume and the page number of the title page) and (ii) the text in the abstract field. Before further analysis, the free text was lemmatized using the English lemmatization list from the lexicon package in R.

2.2 Keyword extraction and co-occurrence network construction

The collected abstracts were further processed to extract meaningful keywords and keyphrases. For this task, we used the KeyBERT algorithm, a state-of-the-art keyword extraction method based on a deep neural network model. KeyBERT uses BERT embeddings to extract words and phrases that are most representative in a given abstract (Sharma & Li, 2019). Unlike classical methods that usually rely on simple frequency counting, KeyBERT uses contextual information during extraction. This processing step ends with up to five most representative keywords extracted from each abstract.

The keywords and keyphrases were then arranged into a co-occurrence network, a comprehensive yet easy-to-understand technique for representing knowledge in a given domain. The co-occurrence network consists of nodes and edges (links), the former referring to the keywords/keyphrases and the latter to the (undirected) relationships between them. A link between a pair of keywords/keyphrases is established if they both originate from the same abstract.

2.3 Co-word analysis and strategic diagram

In the third step, we explored the co-occurrence network in terms of cluster structure. We define a cluster as a research topic (i.e., research theme), consisting of tightly linked keywords. Formally, a cluster is a subnetwork of keywords only weakly connected to other clusters.

The topic analysis is based on the work of Callon et al. (1991), who proposed two measures, centrality and density, to map a specific research area. Centrality represents the relatedness of a given cluster of keywords to other clusters, while density refers to the interaction of keywords inside a particular cluster.

Considering both measures, we can draw a strategic diagram to represent the structural landscape of a given research area. In a strategic diagram, the x-axis denotes centrality and the y-axis refers to density. The plot is centered by the mean of both axis values, dividing the strategic diagram into four types of research behavior. Each cluster can thus be given a qualitative interpretation depending on which quadrant a particular cluster appears in. These types can be described as follows:

1. *Motor topics.* Clusters in quadrant I are characterized by high centrality and density. Such clusters are well defined and have been conducted over a long period of time by already well-formed groups of researchers.
2. *Niche topics.* Clusters in quadrant II exhibit low centrality but high density. Such clusters are characterized by high homogeneity (i.e., they have strong internal connections). However, they are isolated from other clusters (i.e., they have weak external links).
3. *Emerging or declining topics.* Clusters in quadrant III are defined by both low centrality and low density, and relate to either new (i.e., emerging) or disappearing research topics.

4. *Basic topics.* Clusters in quadrant IV have high centrality and low density and thus combine transversal and very general research topics. These clusters are important for a particular research community, but they are not well developed.

Data processing and statistical analysis was performed using custom Bash, Python, and R scripts. The programming code to reproduce the results is available from the authors.

3 RESULTS

In this section, we first present a global research landscape of KEER knowledge as extracted from conference proceedings. We then describe the basic features of the keyword co-occurrence network. Finally, we discuss the results of the strategic diagram.

The keyword co-occurrence network (2010-2020) consists of 5,941 nodes and 16,833 undirected edges (Figure 1). For visualization purposes, we prune the network and select only the 200 keywords with the highest frequency and limit the minimum frequency of the selected keywords to five keywords.

Next, we divide the network into two time slices. The network for the 2010-2015 period is shown in Figure 2, and the network for the 2016-2020 period is shown in Figure 3. Co-word analysis was performed for both time periods. Clusters with representative keywords are summarized in Table 1 and Table 2.

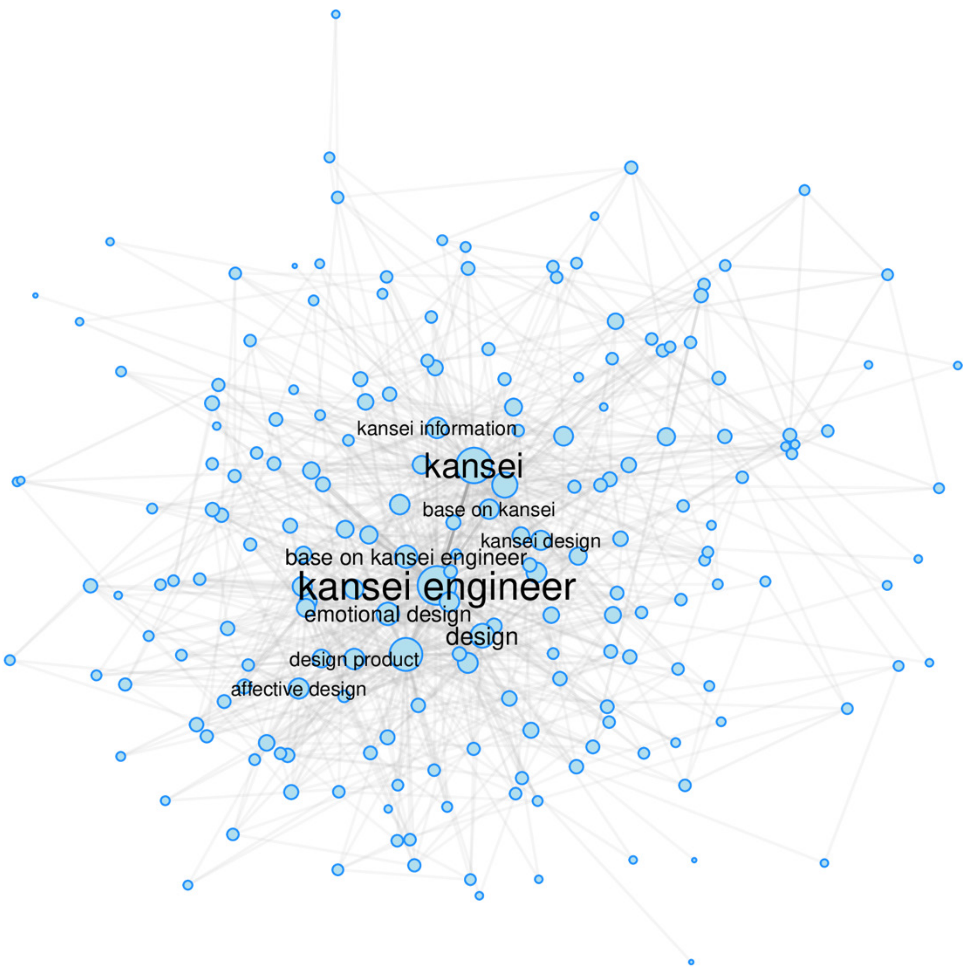

Figure 1. Keyword co-occurrence network generated from lemmatized keywords and keyphrases extracted with KeyBERT model from KEER conference proceedings (2010-2020)

3.1 KEER research topics in years 2010– 2015

On a strategic diagram in Figure 2, quadrant I contains a motor cluster called "Design". This cluster is characterized by high centrality and density. This means that the cluster relates to scientific topics that are well developed in this area and represent an engine of progress.

The quadrant II indicates research topics that will become driver topics in the future. In this quadrant we find three topics labelled “Traditional Japanese Craft”, “Fuzzy Inference” and “Tactile Feeling”.

The quadrant III contains a single research theme called “Robotics”. This cluster is characterized by low centrality and density. One could say that this theme is well developed. It is probably the research theme that was predominant in the earlier stages of development but is now considered mature.

The last quadrant IV could be described as a space of clusters with high centrality but low density. We find here designations such as: “Kansei Engineering”, “Kansei Information” and “Product Design”. These clusters are related to the fundamental themes represented in the KEER proceedings.

Figure 2. Strategic diagram summarizing the thematic clusters for the time interval 2010–2015

Table 1. Clusters by size and the most frequent keywords for the time interval 2010–2015

Cluster name	Cluster size	Frequent keywords
Kansei Engineering	495	kansei engineer, kansei, kansei word, kansei design, rough set, fuzzy, kansei factor, communication, impression
Product Design	271	product design, base on kansei engineer, kansei engineer system, emotional design, design process, product designer, design element, affective design, product development, design attribute
Kansei Information	263	kansei information, image retrieval, base on kansei, kansei evaluation, kansei model, kansei image, kansei quality, human kansei, neural network, retrieval system
Design	168	design, affective engineer, usability, affective, kansei information process, mobile phone, genetic algorithm, affective response, affective compute, color design
Traditional Japanese Craft	63	traditional japanese craft, kansei retrieval, virtual reality, kansei retrieval method, traditional japanese craft object, propose, japanese craft
Robotics	60	robot, human emotion, emotion, mobile robot, facial expression, face robot
Fuzzy Inference	28	fuzzy inference, fuzzy model, music, subjective criterion deviation, musical expression
Tactile	10	Tactile, tactile sense

Note: The extracted keywords are lemmatized.

3.2 KEER research topics in years 2016– 2020

On a strategic diagram evaluated from network partition 2016-2020 (Figure 2), quadrant I contains a single motor theme called “Virtual KE”. This cluster is characterized by high centrality and density. This means that the cluster relates to scientific topics that are well developed in this area and represent an engine of progress.

The quadrant II indicates research topics that will become driver topics in the future. In this quadrant we find three topics labelled “Robotics”, “Mobile & Web & Garment Design”, and “Usability”.

The quadrant III is empty. The last quadrant IV could be described as a space of clusters with high centrality but low density. We find here designations such as: “Kansei Word”, “Car Design & Service Quality”, “Product Design & AI”, and “Color Package & Design”. These clusters are related to the fundamental themes represented in the KEER proceedings.

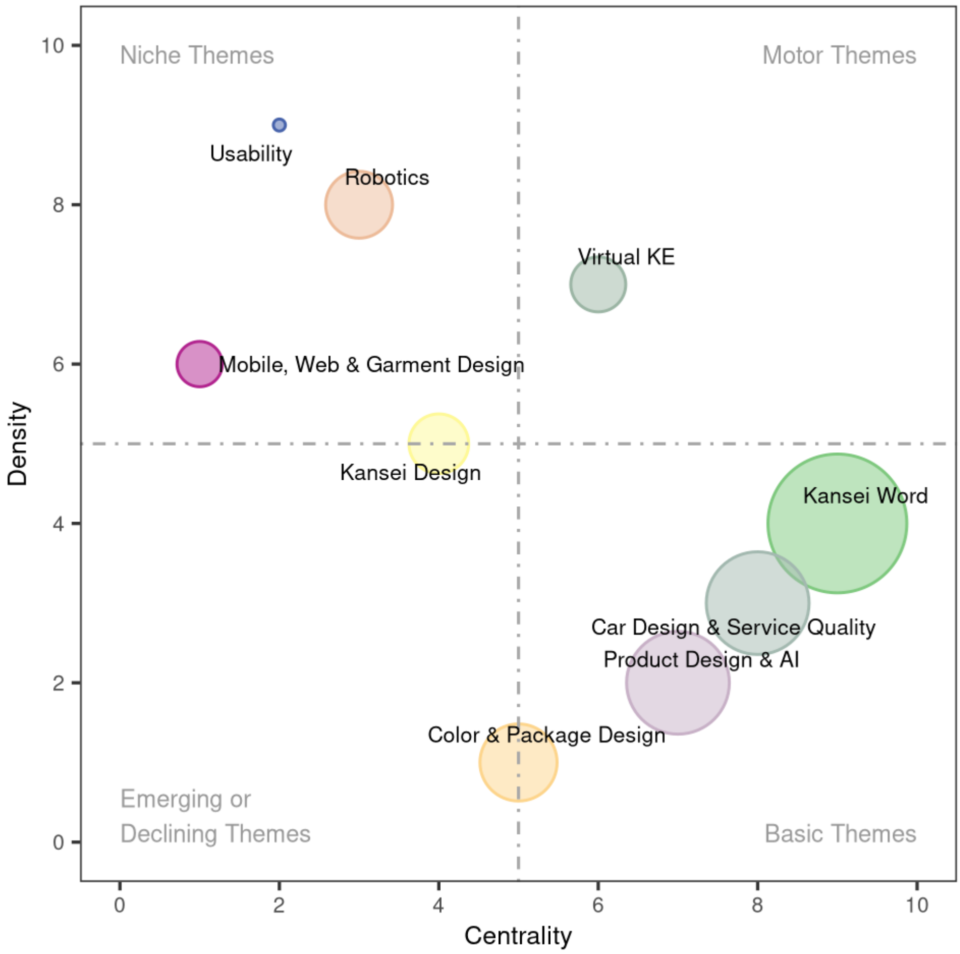

Figure 3. Strategic diagram summarizing the thematic clusters for the time interval 2016–2020

Table 2. Clusters by size and the most frequent keywords for the time interval 2016–2020

Cluster name	Cluster size	Frequent keywords
Kansei Word	282	kansei engineer, kansei word, kansei evaluation, kansei image, text mine, kansei attribute, kansei analysis, kansei adjective, user interface, aesthetic design
Car Design & Service quality	155	kansei, affective, customer satisfaction, kansei retrieval, kansei value, design product, car design, customer emotion, service quality, emotional satisfaction
Product Design & AI	155	product design, design, neural network, artificial neural network, product designer, product development, product model, interactive genetic algorithm
Color & Package Design	90	base on kansei engineering, color design, package design, kansei engineering system, kansei engineering method, kansei engineering approach, color, consumer emotion, product color design
Robotics	70	robot, kansei engineering methodology, emotion, user experience, human emotion, robot interaction,
Kansei Design	58	design element, kansei design, aesthetic, customer kansei, design process, kansei model, kansei factor
Virtual KE	51	affective design, service design, affective engineering, virtual agent, affective attribute, virtual learn environment
Mobile & Web & Garment design	39	emotional design, mobile learn material, cloth design, website design
Usability	21	usability, usability evaluation

Note: The extracted keywords are lemmatized.

4 CONCLUSION

Based on the results, we managed to identify the driving, niche, emerging or declining, and fundamental themes of KEER in the period 2010-2020. We have divided the strategic diagrams into half of the decade to better understand the consistency of each cluster. In the 2010-2015 quadrants II we find four themes labelled "Traditional Japanese Craft, Fuzzy Inference, and Tactile Feeling." Interestingly, there are different thematic clusters in 2016-2020, and the basic themes for quadrant II are related to Robotics", "Mobile & Web & Garment Design", and "Usability". Probably, the implementation of Kansei engineering in product types has changed due to technological development and global trends. We can find that the most important words that have been frequently used in the last ten years are "Kansei Adjectives, Kansei Evaluation, Kansei Attributes, Impression". We believe that these keywords are more frequently mentioned because they are the basis of Kansei engineering methodology. The broader application of Kansei engineering is apparently shifting to intangible products such as services and digital product design, with an emphasis on AI. According to our results, we assume that robotics-related topics will continue to play an important role in the future of Kansei engineering. Because our study was limited to KEER proceedings, a literature review of scientific papers that used KE would likely provide clearer information about the future direction of the discipline. The authors suggest conducting additional searches for scientific articles in relevant journals for the same time period.

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GENERATION OF PRODUCT DESIGN USING GAN BASED ON CUSTOMER'S KANSEI EVALUATION

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ABSTRACT

In recent years, deep learning has attracted much attention and various techniques have been proposed. GAN (Generative adversarial networks) is one such method. GAN uses images as the training set and learns to generate new images that are indistinguishable from the training set. In this study, A GAN-based design method that generates new products from the images of the customer's favorite products is proposed. The product images that customers evaluated as preferable are used as the training set of GAN. If the GAN fulfills its capabilities properly, the images generated from a customer's favorite product are more likely to be preferred by the customer. In the case study, the proposed method was applied to chair design. The generated chair images were first evaluated in terms of image quality, and then evaluated by subjects.

Keywords: *Kansei engineering, aesthetic design, deep learning, GAN (Generative Adversarial Network)*

1 INTRODUCTION

Due to maturation of science and technology, it becomes increasingly difficult to differentiate products in terms of performance, functional feature or price. Therefore, companies are required to differentiate their products in terms of subjective and abstract qualities such as aesthetic and comfort that are evaluated by customer's feeling, which is called "Kansei" in Japanese. The quality evaluated by customer kansei is called "Kansei quality" (Yanagisawa 2011).

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In the field of Kansei engineering (referred to as affective or emotional engineering), various methods have been developed to capture customer kansei and utilize it in product design. Questionnaire-based methods like semantic differential (SD) method (Osgood & Suci 1967) are widely used to quantitatively measure customer's impressions of products. On the other hand, various types of methods such as artificial neural network (Hsiao & Huang 2002; Kobayashi, Kinumura &Higasi 2015), fuzzy set theory (Hsiao & Huang 1998), interactive reduct evolutionary computation (Yanagisawa & Fukuda 2004), multidimensional scaling (Kobayashi, Kinumura &Higasi 2015) , rough set theory (Kobayashi & Niwa 2018; Kuramaru, Takanashi & Mori 2001; Ohki, Harada & Inuguchi 2012; Pawlak 1982; Yamada, Moroga & Uehara 2012), self-organizing map (Kobayashi & Niwa 2018), etc. are used to analyze the relationships between the results of customers' Kansei evaluation of existing products and their aesthetic features. In addition, with the recent development of deep learning, methods using deep learning have also been proposed. Ota et. al. proposed Kansei retrieval system to search for user's favorite clothing based on CNN and ANN (Ota, Takenouchi & Tokumaru 2017). Quan, Li and Hu (2017) proposed the Kansei engineering-based neural style transfer for product innovation (KENPI) framework. Dai, Li and Liu (2019) proposed the approach for automatic design scheme generation based on GAN (Goodfellow et. al. 2014). Schmitt and Weiss (2019) designed innovative chairs inspired by the chair images generated by GAN.

In this study, A GAN-based design method that generates new products from the images of the customer's favorite products is proposed. In the proposed method, the product images that customers evaluated as preferable are used as the training set of GAN. If the GAN fulfills its capabilities properly, the images generated from a customer's favorite product are more likely to be preferred by the customer. In the case study, the proposed method was applied to chair design. The generated chair images were first evaluated in terms of image quality, i.e., whether they looked like chairs or not, and how innovative they were compared to existing chairs, and then evaluated by subjects in terms of their preferences.

2 GAN

Generative Adversarial Network (GAN) were first proposed by Goodfellow et al. (2014). It contains two networks: one is a generator, and the other is a discriminator. The purpose of the generator is to learn to capture the statistical distribution of training data, to make samples from the learned distribution, and to make realistic images. The discriminator is intended to receive both composite samples and actual images and to distinguish them. As the generator and the discriminator are trained simultaneously and compete with each other, the generator is able to produce images that are indistinguishable from the training data to human eye.

Since GAN is one of the hottest topics in the research field of machine learning and various types of improved GANs, such as Cycle GAN, ProGAN (Progressive GAN) and Style GAN have been proposed to improve the quality of generated images and GANs have been applied in a wide range of research fields.

3 PROPOSED METHOD

The proposed method consists of the following steps. Their details are explained in the following sections.

Step.1 Collection of training data
Step.2 Questionnaire investigation
Step.3 Image generation using GAN
Step.4 Super resolution using SRGAN

3.1 Step.1 Collection of training data

Images of existing products of the same type as the design target are collected. To avoid affecting the training results of GAN, only images in which the products are arranged in the same orientation are collected, background of the images is retouched to white, and the images are resized to the same size.

3.2 Step.2 Questionnaire investigation

A questionnaire investigation is conducted to collect information on customer's preferences, or likes/dislikes, for product images prepared in Step.1.

3.3 Step.3 Image generation using GAN

GAN is performed using only the product images that the customer rated as "like". Any GAN methods can be used, but Style GAN is used in this study. The time required to train a GAN depends on the number of training data and the image resolution but is generally very long. In this study, low-resolution images of 64*64 are used due to limited computer resources and time available for computation. Instead of using low-resolution images, super-resolution of the generated images is performed in the next step. If there are no constraints on computer resources and time available for computation, a high-resolution image can be generated directly, and the next step can be omitted.

3.4 Step.4 Super resolution using SRGAN

The low-resolution generated images are super-resolved to high-resolution images. Any super resolution methods can be used, but SRGAN (Ledig et. al. 2016) is used in this study. High-resolution images of products of the same type as the design target are collected and used as training data for SRGAN. By using only product images of the same type as the design target, it is expected to produce a high-resolution image that well reproduces the characteristics of the same type of product being designed.

4 CASE STUDY

In order to examine the effectiveness of the proposed method, the proposed method was applied to chair design. Six undergraduate students participated as subjects. Because everyone has different preferences for products, the results of the six questionnaires were processed individually.

4.1 Step.1 and 2

4735 photos of chairs were collected from Google Image. The chairs in the images were oriented in the same direction and the background of the images was changed to white. Figure 1 shows examples of prepared chair images.

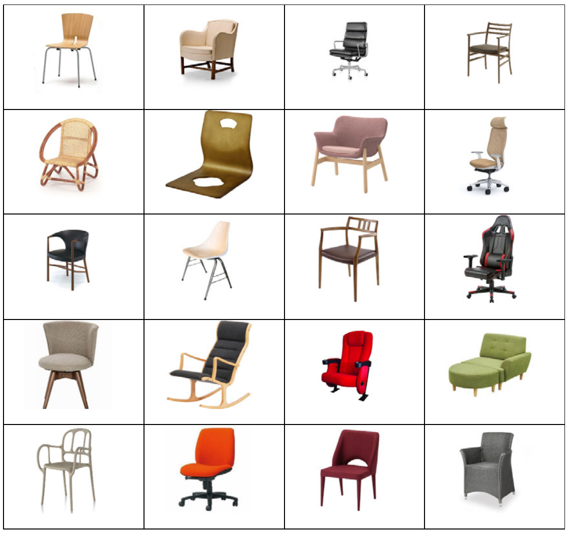

Figure 1. Examples of prepared chairs

Six subjects then rated their likes / dislikes of the collected chairs. Since GAN requires a very large amount of training data, i.e., preferences for product images, the survey system shown in Figure 2 was constructed in order to reduce the load on the subjects. The program randomly presents product images and allows subjects to enter “like” or “dislike” by two keys on the keyboard. Table 1 shows the questionnaire results.

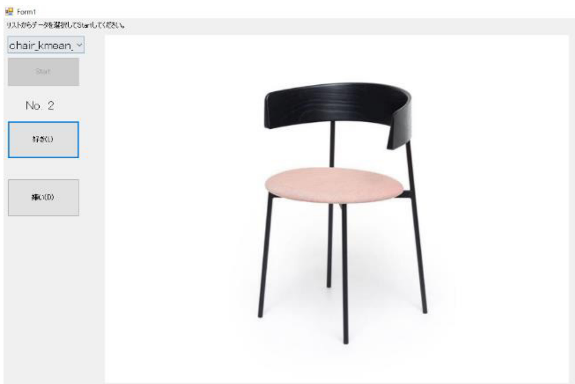

Figure 2. Survey system

Table 1. questionnaire results

Subjects	# of liked chairs	Percentage of liked chairs
1	1762	37.19%
2	2324	49.08%
3	1491	31.49%

4	3904	82.45%
5	1655	34.95%
6	1710	36.11%

4.2 Step.3 and 4

GAN was performed using only the product images that the customer rated as "like". Figure 3 shows the examples of generated chairs. 216 images were generated for each subject.

Figure 3. Examples of generated chairs

Generated images were then super resolved by using SRGAN. Figure 4 shows the examples of super resolved images. For comparison, the images upscaled by the traditional bicubic method were included in the figure.

Figure 4. Examples of super resolved images

4.3 Discussion

Obtained chair images were first evaluated in terms of image quality. Specifically, the obtained chair images are classified into the following four groups: New style of chairs, Normal chairs (same as training data), Unbalanced chairs (chairs without some parts), Not chairs. This classification was done manually by the authors. Figure 4 shows the chair examples of 4 groups. Table 2 shows the percentage of chairs belonging to each group.

Figure 4. Classification of obtained chairs

Table 3. Results of classification

Group	Percentage of chairs
New style	26.81%
Normal	47.66%
Unbalanced	5.53%
Not a chair	20.00%

Then, 20 chair images were randomly selected from those judged as new for each subject and they rated their likes / dislikes of those chairs. Table 3 shows their results. These results indicate that subjects are more likely to prefer chair images generated using images of their favorite chairs as training data than the images of randomly collected chairs. In other words, GAN generates images by capturing the characteristics of customer preferences. One concern in judging the validity of the results is the limited image resolution due to a processing capability problem. Such low-resolution images can represent the overall form of the chair, its structure, and its color, but they cannot represent detailed designs, such as fabric patterns and textures, or small parts. However, there are situations where customers rate their like / dislike for products using low-resolution images, e.g., when they are browsing the Web for a new chair. In such situation, the results are reasonable.

Table 3. Results of subjects' rating

Subjects	Percentage of liked chairs (obtained)	Percentage of liked chairs (original)
1	85%	37.19%
2	80%	49.08%
3	60%	31.49%
4	65%	82.45%
5	30%	34.95%
6	65%	36.11%

5 CONCLUSION

To design products that customers prefer based on the results of their kansei evaluations of existing products, a GAN-based design method was proposed. In the case study, the proposed method was applied to chair design. Chairs designed using the proposed method have a higher probability of being preferred by customers than randomly collected chairs. This result indicates that the proposed method designs products by the characteristics of customer preferences.

ACKNOWLEDGMENTS

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HARMONIZATION AND EVALUATION
TWEAKING THE PARAMETERS ON HUMAN LISTENERS

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ABSTRACT

Kansei models were used to study the connotative meaning of music. In multimedia and mixed reality, automatically generated melodies are increasingly being used. It is important to consider whether and what feelings are communicated by this music. Evaluation of computer-generated melodies is not a trivial task. Considered the difficulty of defining useful quantitative metrics of the quality of a generated musical piece, researchers often resort to human evaluation. In these evaluations, often the judges are required to evaluate a set of generated pieces along with some benchmark pieces. The latter are often composed by humans. While this kind of evaluation is relatively common, it is known that care should be taken when designing the experiment, as humans can be influenced by a variety of factors. In this paper, we examine the impact of the presence of harmony in audio files that judges must evaluate, to see whether having an accompaniment can change the evaluation of generated melodies. To do so, we generate melodies with two different algorithms and harmonize them with an automatic tool that we designed for this experiment, and ask more than sixty participants to evaluate the melodies. By using statistical analyses, we show harmonization does impact the evaluation process, by emphasizing the differences among judgements.

Keywords: *Automatically generated music, Melodies evaluation, Music and emotions*

1 INTRODUCTION

The capability of music to arouse various categories of feelings such as colors, feelings, or emotions (e.g., Juslin and Sloboda, 2011; Rodà et al., 2014; Murari et al., 2015; Rodà et al., 2018) has many applications. In the information technology field, a musical signal can contribute to the multimodal/multisensory interaction, providing the user with information through sonification. In this sense, sound design requires great attention and a deep understanding of the influence of musical parameters on the user's experience. In this field, the use of automatically generated melodies is very interesting, to have a large selection of inexpensive custom music (necessary to provide sonification to many events with different characteristics). Unfortunately, despite the large number of studies on the connotative meaning of music, very few are related to the repertoire of music automatically generated. This work introduces this study for generated melodies, investigating the effect of harmony.

There is an abundance of methods in which music can be programmatically generated, as the scientific literature on the subject testifies (Herremans et al., 2017; Tatar and Pasquier, 2019; Briot and Pachet, 2020; Carnovalini and Rodà, 2020).

Both artists and AI practitioners are interested in finding novel ways to generate music, for a variety of goals, and this has led to the design of many algorithms that are capable, to some extent, of generating musical material (Lamb, 2018). Most of these systems are focused on the generation of melodies, sometimes with the aim to imitate a particular style or composer.

This abundance of research on music generation is not as widely accompanied by research on how to evaluate if the quality of the generated material is satisfactory (Jordanous, 2013). While the most obvious way to assess this is referring to a musician or a musicologist who is expert on the kind of music that is being generated, often listening surveys asking to evaluate the musical outputs of an algorithm are used as a proxy of these expert evaluations. Such approach is often inspired by the Turing Test, although it should be noted that the Imitation Game envisioned by Turing does not really apply to this kind of evaluation (Ariza, 2009).

Despite others have underlined the risks of using such tests, since human listeners (especially if not experts (Soldier, 2002)) are not completely reliable and are subject to priming effects (Oore et al., 2018), to the best of our knowledge there is currently no study that tries to quantify just how susceptible humans are to the changes in how music is presented to them at the aural level. In other words, it is not completely clear if presenting two melodies in two different settings (such as a different arrangement) could change the preference between the two melodies expressed by the listener.

In this paper we propose a between-subjects study to evaluate if changing the aural setting (in this case, by harmonizing and arranging the melodies that need to be evaluated) has a significant effect on the evaluation of two algorithms for the generation of melodies. It is worth noting that while we choose two algorithms from scientific literature, the same process could simulate a test between generated tunes and human-composed ones.

1.1 Hypothesis

The main claim we wish to make and to prove is the following.

When presenting a set of computer-generated melodies in aural form to a human listener and asking them to make comparative statements on the quality of the melodies, adding harmonization and changing the instrumentation can influence the outcome of the experiment, even if the melodies remain the same.

Moreover, we are interested in the following question: does harmonization and instrumentation render the evaluation task of generated melodies more effective?

2 GENERATION OF MUSIC STIMULI

In this experiment we compare two different algorithms for melody generation: SuperWillow (van der Merwe and Schulze, 2010) and Melody-RNN (Waite et al., 2016), a melody generation algorithm from Google's open-source project Magenta[1].

The two algorithms have vastly different approaches to melody generation, one being based on Markov Chains, and the second on Long-Short Term Memory Neural Networks.

2.1 FF-Harmonizer

To test the assumption that varying the musical context of the melody will affect the evaluation, we designed a simple Harmonizer based on a Feed Forward Neural Network, trained on a lead sheet dataset (Simonetta et al., 2018), and applied it to the melodies generated by the systems described above. While for the scope of this experiment harmonization could have been manually added, we decided to use automatic Harmonization to better imitate the setting of computer-generated music.

FF-harmonizer takes an input melody of T bars and generates a corresponding chords sequence $Y = y_1, y_2, \dots, y_N$, in which N represents the length of the sequence. Each label is chosen from a set of 48 chords (we consider only triads in root position), specifically a triad chord is built for each degree of the chromatic scale (C, C\#, D, …, B), and declined in the four possible qualities: major, minor, diminished, and augmented. During the training phase each musical piece of the corpus is encoded in a sequence of vectors $\mathbf{X} = \vec{x}_1, \dots, \vec{x}_1, \vec{x}_N$ representing the notes of the piece through a many-hot-encoding. The corresponding output is a sequence of numbers $Y = y_1, y_2, \dots, y_N$ representing the chords, each notes vector $\vec{x}_i$ corresponds to a chord y_i. In the prediction phase, the melody to be harmonized is represented by a sequence of vectors **X**, the length of the which depends on the harmonization frequency. For instance, considering a melody of **T** bars, if the user wants to generate a chord for each bar, then the length of the sequence of input vectors will be **T**, but if the user wants a chord every half bar, then there will be 2**T** input vectors, as the model predicts a chord for each of the input vectors.

Figure 1. An example taken from a lead sheet from the dataset used to train the harmonization system.

[1] https://magenta.tensorflow.org

More specifically, consider the example song shown in Figure 1. Every file is loaded and parsed by the music21 library (Cuthbert and Ariza, 2010), which converts it to a specialized representation called a *Stream* object. Once the song is loaded, the following happens:

1. The algorithm finds the key of the piece and stores the tonic (i.e., G in the example);
2. The first chord is encoded, in this case G minor. This is represented by a number between 0 and 47, calculated by the sum of the distance d in semitones between the tonic of the piece and the root of the chord (in this case $d = 0$) multiplied by 4, and the quality of the chord (major = +0, minor = +1, diminished = +2, augmented = +3). The result of this operation in the example is the label: 4d + *minor* = 1;

The algorithm then computes the vector of notes below the chord considered, in this example G, Bflat and A. Each note is encoded as the distance in semitones from the tonic of the piece (i.e., G): distance(tonic, G) $\rightarrow d = 0$, distance(tonic, Bflat) $\rightarrow d = 3$, distance(tonic, A) $\rightarrow d = 2$. Then the vector of notes is filled using many-hot encoding: each vector position corresponding to values of d is set to 1, all other elements are left to 0. The result of this operation in the example is: [1,0,1,1,0,0,0, 0, 0, 0, 0, 0].

The encoding result for this example is:

$$
\begin{array}{l}
[1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0] \leftrightarrow 1 \\
[0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0] \leftrightarrow 29 \\
[1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0] \leftrightarrow 32 \\
[0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0] \leftrightarrow 12
\end{array}
$$

The neural network is then trained to predict the chord given this one-hot encoding. When harmonizing a melody, a similar encoding will be produced for the given melody segments, and the network will predict the most likely chord.

2.2 Audio Rendering

Both the generation algorithms and the harmonizer only output music in symbolic format (either Midi or MusicXML). This means that, for the listening-based questionnaires we will describe below, it is necessary to render the generated files in score notation as audio files. Moreover, the harmonizer module outputs chords annotations, but not a complete arrangement defining how those chords should be played, so that this additional step towards the final rendering must be taken care of.

To render the monophonic, non-harmonized files, we simply used MuseScore's export feature to turn the score files into .mp3 files, using the default Grand Piano as the instrument playing the melody, which is arguably a popular default rendering choice among researchers (Carnovalini and Rodà, 2020).

The harmonized files needed an arrangement, as discussed above. The same arrangement was used for all the files, having the melody played simultaneously by a violin and a flute, a cello playing the root of the chord for the duration of each chord. A rhythmic section of two guitars was also added, which would play the selected chord in open position (following a chart of open-chords positions).

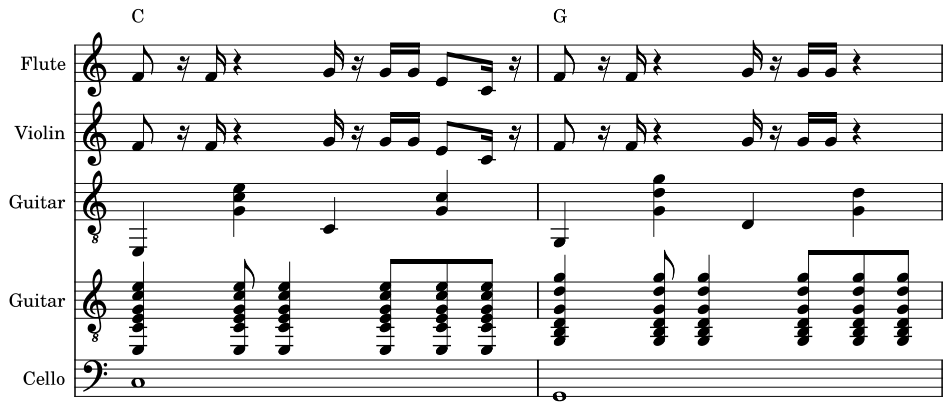

Figure 2. Two measures showing the output of the harmonization system, arranged for the "Group" modality used in the study.

One guitar would imitate fingerpicking by alternating low and high notes on the beats, and the other imitates strumming by playing all the notes of the chord following a typical folk rhythmic pattern. This instrument's volume was set to 40% while the other instruments were left at full volume. MuseScore export feature was again used for the generation of the .mp3 files, but in this case, it interprets the chords annotations by adding a piano playing the chord at the beginning of each measure, which was left as it helps immediately clearly establish the current harmony. Figure 2 shows one example of such arrangement over two measures harmonized by our algorithm.

3 EXPERIMENT

3.1 Subjects

Seventy-three responses were collected, of which twelve were discarded for failing the attention test or taking less than three minutes and a half to complete the survey (listening to all the melodic excerpts once takes about two minutes). The sixty-one remaining participants have an average age of 28.24 years (St. dev.: 10.85 years) and are divided in 41 males, 17 females, and three persons who did not specify their gender. Table 1 reports the responses to the musical experience question.

Table 1. Self-reported level of musical expertise of the participants.

Level of Expertise	Count
1. Nonmusician	6
2. Music-loving nonmusician	17
3. Amateur musician	8
4. Serious amateur musician	5
5. Semi-professional musician	15
6. Professional Musician	10

3.2 Method

Eight melodies were generated by the two systems, four melodies for each one, presented in Section 2. These eight original piano-only melodies were harmonized (group version) by following the above specified procedure. We will refer to these two versions of the same eight melodies as "modalities".

By means of a web interface, the users evaluate four melodies selected at random in one modality, and then the other four melodies in the other modality: the order of modalities is randomized (i.e., sometimes piano only comes first, other times the group version comes first) and the order of the melodies is randomized as well, again to avoid priming effects.

The users are asked to rank the first four musical excerpts based on their pleasantness/beauty, by dragging and dropping the html music player elements forming a leaderboard where the first element was the most pleasant/beautiful and the fourth was the least so.

The procedure repeats for the second set of four melodies, that use the modality that was not evaluated before. Note that in both modalities, the users evaluate two melodies for each algorithm.

At the end of the listening test, the users were asked to report their age and gender (but were offered the possibility not to respond) and to self-report their musical expertise by selecting the appropriate category among six (Zhang and Schubert, 2019). The participants had to agree to the informed consent before starting the test and had to respond to an attention check in the last page. Failing to do any of these two things resulted in automatic exclusion from the study. The time taken to respond to the questionnaire was also saved.

3.3 Results

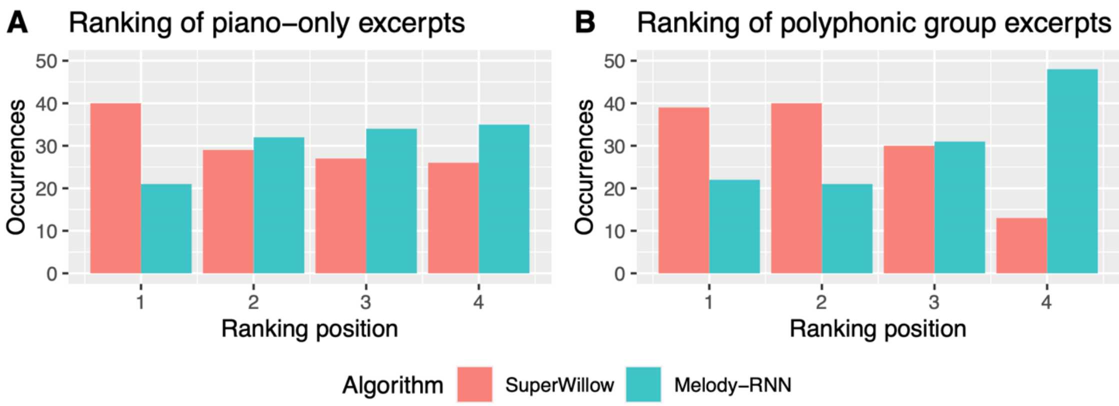

Figure 3. The results of the listening test, in aggregated form. A shows results for the piano-only excerpts, whereas B the results for the harmonized ones. They report the positional rankings, where the lower number means higher position in the ranking and thus more pleasing excerpt. Red bars are relative to SuperWillow excerpts, while blue bars to Melody-RNN.

Figure 3 shows the distributions of rankings for the two algorithms under different modalities. In all cases, the distributions are statistically different with 95% confidence according to a Mann-Whitney U test. In both the modalities the excerpts generated with SuperWillow were preferred by the subjects, i.e., the melodies generated by SuperWillow obtained globally a better (lower rank) position. More interesting, as Figure 3 shows, the difference between the algorithms is more evident when using the group modality. In the following section we try to assess whether the increase in difference is statistically significant.

To do so, a prediction model that estimates the evaluation based on the algorithm, the modality, and possibly the interaction with other features needs to be constructed. Since we consider the predicted value as ordinal rather than numerical, we used Cumulative Link Models (CLM), and used Analysis of Variance (ANOVA) to determine the importance of different factors.

The models we constructed try to predict the ranking of a piece based on the interaction between algorithm used, modality used, and musicianship of the evaluator. For this feature, the self-assessed level of musicianship was reduced to a binary value, distinguishing nonmusicians from musicians. The model was written as follows in R, using the function `clm` from the `ordinal` package (Christensen, 2019):

```
model = clm(ranking ~ algorithm*modality*musicianship)
```

The ANOVA underlines that the used algorithm and the interaction between algorithm and modality are strongly significant (p<<0.001). Moreover, the musicianship is also strongly significant (p<<0.001).

4 DISCUSSION

While the first result is that SuperWillow was preferred to Melody-RNN in our limited test set, that was not the goal of this work, and this result is not very significant since many other parameters would need to be considered to properly compare the two algorithms.

The more interesting results coming from the ANOVA analysis indicate that, while the difference between the algorithms is the main predictor (as could be expected from the difference in ratings of the two algorithms), the modality had indeed an effect on the evaluation, and that this effect varied depending on the algorithm. Musicianship is also impactful, as expected from scientific literature (Amabile, 1983).

Figure 4 shows the effect of the interaction between modality and algorithm on the ranking. We can see that the SuperWillow melodies are more likely to be in first position when harmonized, and the harmonized Melody-RNN excerpts are more likely to be in last position.

This suggests that the harmonization have not changed the global listeners' preference (SuperWillow was preferred in both the modalities), instead it rendered more evident this preference. If this result would be confirmed by further experiments (with more generation systems and musical pieces), it could imply a positive effect of harmonization and instrumentation in the evaluation process, given it contributes to obtain more clear results.

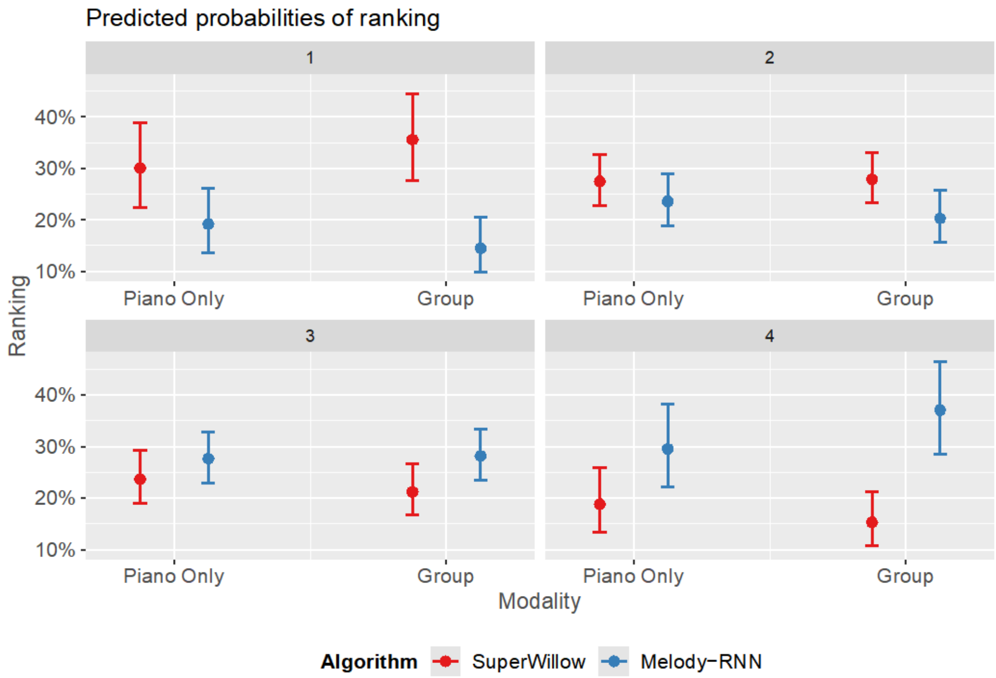

Figure 4. Interaction of chosen algorithm and modality. For each of the possible rankings (1 through 4) the probability of receiving that ranking is reported for both algorithms and modalities. The probability of receiving ranking 1 (lower ranking is better) grows with the harmonization for SuperWillow, but diminishes for Melody-RNN, and the opposite is true for ranking 4.

Of course, this effect could be also explained by the idea that certain melodies benefit from the harmonization process, while others are not really affected. One motivation could be that SuperWillow melodies sometimes include long notes, which can be dull-sounding when played monophonically on the piano, an instrument with a limited sustain, but are better perceived when played on sustain-heavy instruments like violin and flute along with an accompaniment that keeps the rhythm.

Obviously, this observation only applies to our example melodies, and different algorithms or different melodies could show different effects. Still, this observation supports the hypothesis that harmonization influences how melodies are perceived and evaluated.

5 CONCLUSIONS

In this paper, we designed an evaluation-by-comparison study to test whether harmonization and instrumentation can have an impact on the evaluation of computer-generated music, often used in the sonification of mixed reality systems. The study collected sixty-one responses from participants who evaluated melodies generated by two different algorithms for music generation which were presented both rendered as played only by a piano mono-phonically or by a small polyphonic group.

The results show that while the general comparison of the two algorithms was not changed by the presence of harmonization, it still influenced how the participants responded, affecting in different ways the evaluation of the melodies generated by the two algorithms. We observed that harmonization does not change the global trend of the preferences, but it makes the judgements clearer, supporting the conclusion that adding harmonization would be desirable when the evaluation of computer-generated melodies is required.

The main limitation of this study is the few systems (two) and melodies (eight in total) considered, numbers which were kept low due to the questionnaire fatigue, which was not negligible for a web-based survey as testified by the amount of failed attention checks. Nevertheless, it clearly shows the influence that the musical context (harmony and arrangement) can have on the evaluation of melodies. Researchers should be aware that such an effect exists and use caution when designing their evaluation methods.

ACKNOWLEDGMENTS

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IDENTIFYING THE PATTERNS OF CO-PRESENCE AND SOCIAL INTERACTIONS IN THE DWELLINGS OF CONTEMPORARY SRI LANKAN SUBURBS THROUGH THE VIRTUAL FIELDWORKS

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ABSTRACT

Co-presence is the idea that the presence of other actors shapes the individual behavior and creates the base for social interactions leading to a harmonious society. This paper discusses the structure of the observational means for the fieldwork of a research which clarifies the relationship between co-presence and social interactions while identifying patterns of co-presence in the dwellings of the contemporary Sri Lankan suburbs.

Sri Lanka is a multi-ethnic and multi-cultural nation. To identify the lifestyle, patterns of co-presence and social interactions of Sinhala Lower middleclass, which occupies the majority of the population and has the highest influence in the social dynamics of Sri Lankan society, this research has mainly focused on domestic places, in which a major part of their life is spent.

Due to COVID19 travel restrictions, onsite fieldwork was difficult. Hence two online field methodologies were developed as alternative fieldwork systems in this research, to clarify the patterns of co-presence and feelings related to them in creation of social interactions. The findings clarify that there are four main types of co-presence patterns which are related to functionality and frequency of co-activities of the co-presence occurrences. It was observed that among these types, co-presence occurrences with functional co-activities have less flexibility

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leading to limited social interactions while co-presence occurrences with non-functional co-activities have more flexibility leading to higher possibilities of social interactions.

Keywords: *Co-presence, Dwellings, Sri Lanka, Long-Distance, Field Study*

1.1 Introduction

The aim of this paper is to discuss the structure of the observational means for the field work and its findings, clarifying the relationship between co-presence and social interactions and the number of types of co-presence patterns and related feelings.

As the research was started amidst the COVID19 pandemic in 2020, the researchers from Japan were unable to visit the case study premises in Sri Lanka. Therefore, the researchers developed two types of long-distance online field study methodologies with special refence to two intensive case studies, which facilitated the level of observations and interviews needed for this study.

The Lower Middle Class, domestic place field studies were conducted in suburbs of Western Province, Sri Lanka namely Galle View Watta, Korosduwa, Wadduwa.

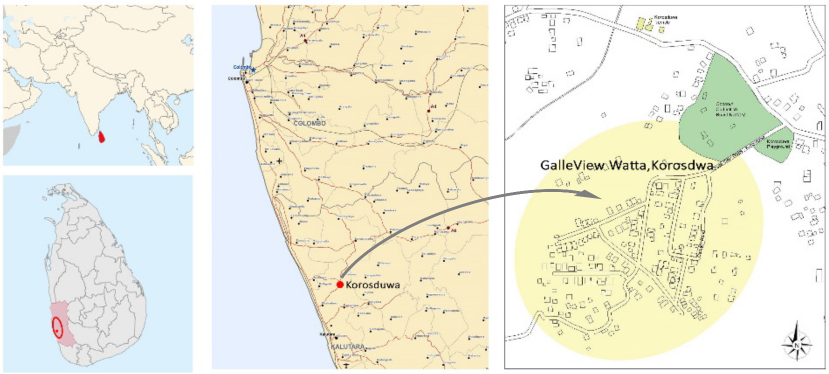

Figure 1. Selected Case Study Area
Source: Survey Department, Sri Lanka, Edited by Author

2 CASE STUDY 1 – FIELD STUDIES WITH METHODOLOGY TYPE 1

The main intention of this methodology was to observe the relationship between co-presence and social interactions. An appointed Technical Assistant (TA) recorded data from 6.00 SLST (9.30 JST) to 22 SLST (1.30 JST) on a selected day and the main researchers joined to the field studies via a Zoom meeting.

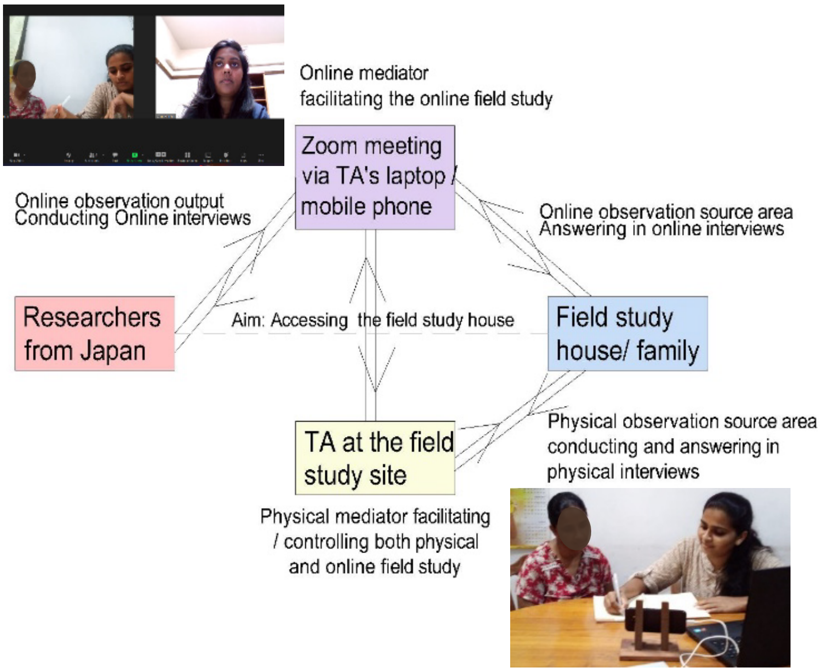

Figure 2. Pilot Study Online Field Study Observation and interview Data Collection System

2.1 Analysis of Pilot Study Data and Findings

Research findings identified two main types of co-presence: A. Co-presence with co-activities and B. Co-presence without co-activities.

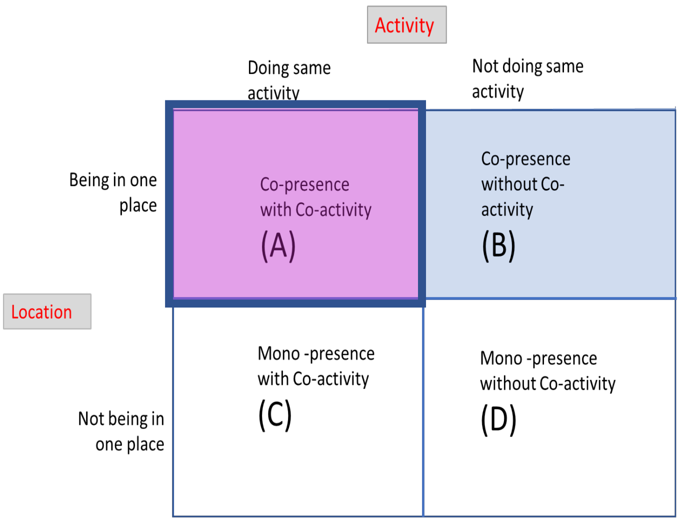

Figure 3. Identified Main Two Types of Co-presence

The detailed observations and interview data revealed that Co-presence occurrences with co-activities have higher levels of interactions, and this type has four more types of co-presence occurrences. The identified four types of co-presence types with co-activities are A1. Co-presence with functional and repeated activities, A2. Co-presence with not functional and repeated activities, A3. Co-presence with functional and not repeated activities, A4. Co-presence with not functional and not repeated activities.

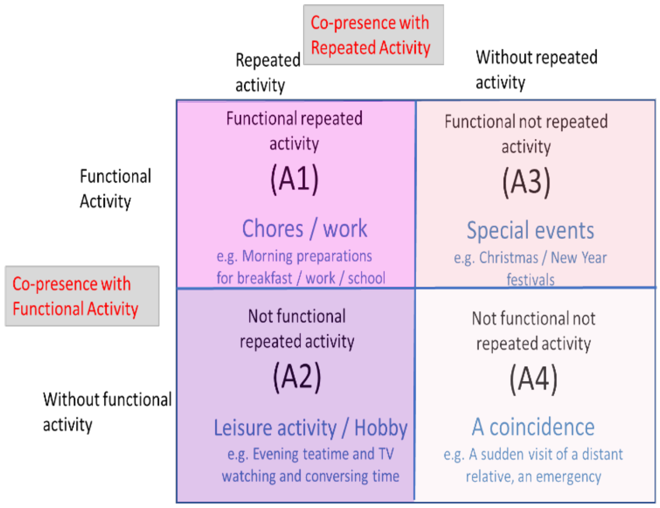

Figure 4. Identified Four Types of Co-presence with Co-activities

It was identified that co-presence types without repetition (A3 and A4 types) are rare in daily life and only co-presence types with repetitions (A1 and A2) can be observed in daily life. The observations and interviews show that co-presence occurrences without specific function (A2) create more possibilities of social interactions with feelings of joy and relaxation.

2.2 Advantages and Disadvantages of the Data Collection Methodology Type 1

In this method, from the interviews and online site observations, a general idea about the feelings in specific functions at different times were obtained. But since this methodology had no video recording facility, it was difficult to determine and analyze the feelings related to concrete activities, behavior of the members, body language and verbal communications.

3 CASE STUDY NO. 2 – FIELD STUDIES WITH METHODOLOGY TYPE 2

To understand the dynamism of creation of the types of co-presence patterns identified in the first case study, second type of online field study methodology was designed.

In these intensive case study three remote controllable, 360^0 CCTV cameras were used. Placements of CCTV cameras were No.1 at living room, No. 2 at kitchen, No. 3 (a) at dining area, CCTV no. 3 (b) at verandah. Online fieldwork and observations started from 6.00 SLST (9.30 JST) to 22.00 SLST (1.30 JST).

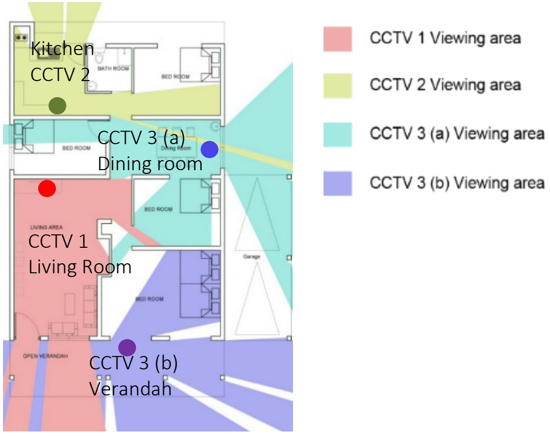

Figure 5. CCTV Camera Locations & Viewing Areas at Case Study No.2 House

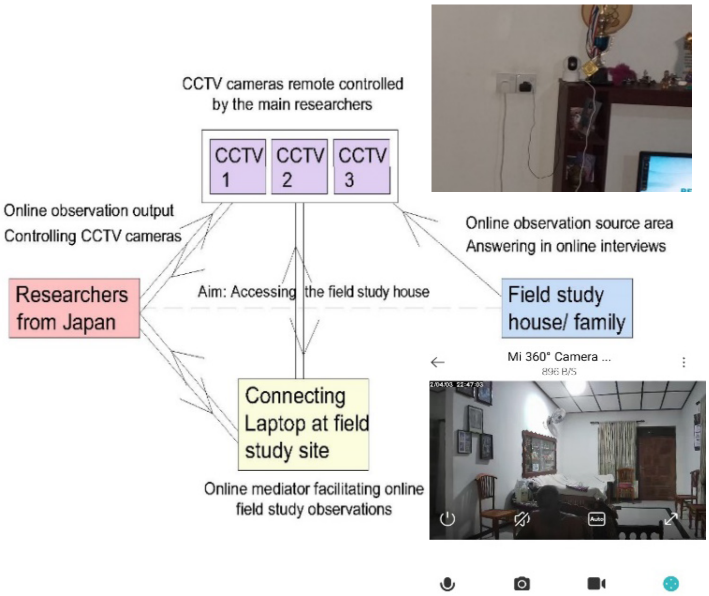

Figure 6. Case Study Online Field Study - Observation Data Collection System – Day 1

Family interviews were taken on the next day by the TA and the main researchers joined to the interviews via a zoom meeting.

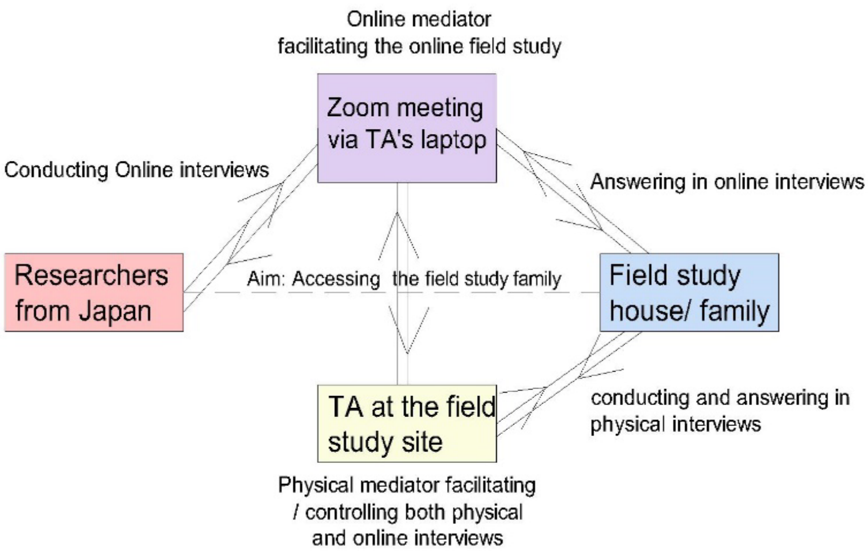

Figure 7. Case Study Online Field Study - Interview Data Collection System – Day 2

3.1 Analysis of Pilot Study Data and Findings

In the intensive case study analysis, the whole process from start to end of the co-presence occurrences were observed. From the video record observations and interviews, the feelings related to concrete activities, behavior of the members, body language and verbal communications during the co-presence type A1 and A2 were obtained and analyzed.

following behavioral patterns in each co-presence type were observed and identified.

- A1. Co-presence with functional and repeated activities - e.g., morning preparations of breakfast before going to school or work - body language and verbal communications are tensed and rapid and feelings are related to busyness and anxiousness with high focus on the task. These resulted limited social interactions.

Figure 8. Morning Cooking time on a weekday
(Case Study Family 2) – Day 1

- A2. Co-presence with not functional and repeated activities – e.g., evening teatime - body language and verbal communications are relaxed and free flowing, and feelings are related to joy, relaxing, and openness. These resulted high level of social interactions.

Figure 9. Early evening relaxing time / Teatime on a weekday (Case Study Family 2) – Day 1

3.2 Advantages and Disadvantages of the Data Collection Methodology of the Intensive Case Studies

The CCTV cameras allowed the researchers to obtain simultaneous, multiple viewing areas with remote controllability. This method was more effective as after some time the family members' awareness of the CCTV cameras reduced, and they started to behave freely. The detailed video recordings were used for the in-depth analysis of co-presence types, feelings, body language and verbal communications of the members and the level of social interactions during each occurrence.

4 CONCLUSION

This paper discussed the structure of the observational means for the field work of a research which clarifies the relationship between co-presence and social interactions while identifying patterns of co-presence in the dwellings of the contemporary Sri Lankan suburbs. In the field studies, two online field work methodologies were experimented.

In the first methodology, two main types of co-presence, namely co-presence with or without co-activities were identified. From co-presence with co-activities four other main types were identified. They are A1. Co-presence with functional and repeated activities, A2. Co-presence with not functional and repeated activities, A3. Co-presence with functional and not repeated activities, A4. Co-presence with not functional and not repeated activities. These four categories indicate that functionality and frequency of a co-activity are important aspects in creation of co-presence. Though the 1st methodology was able to identify these four categories of co-presence through observations and interviews, the methodology was not adequate to understand the dynamism of creation of these types of co-presence and related feelings resulting in social interactions.

Hence the second methodology with CCTV cameras was developed to understand the dynamism of creation of the types of co-presence patterns identified in the first case study with detailed video record observations to analyze the whole process of co-presence, related feelings, body language and the verbal interactions of the members leading to social interactions. The second methodology clarifies that co-presence patterns with specific functions (A1) result in limited social interactions due to the focused functions with feelings of anxiousness, busyness. Co-presence patterns without specific functions (A2) create more possibilities of social interactions due to the flexible activities with feelings of joy and relaxation.

From the second method, it was attempted to clarify why and how social interactions were generated from some copresence types and why and how social interactions were not generated from other co-presence types. The intensive case study number 2 shows that this second methodology is adequate to identify the sense of co-presence among members and their feelings at each co-presence occurrence leading to interactions. But to clarify and confirm these points in detail, a further developed future study with increased number of case studies are needed.

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IMPROVING THE USER'S EXPECTATION DISCONFIRMATION TOWARD THE TUMBLER BY REDUCING THE DIFFERENCES IN SENSORY DOMINANCE BETWEEN PRE-PURCHASE AND POST-PURCHASE EVALUATION

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ABSTRACT

Regardless of going online or physical shopping, expectation disconfirmation due to the discrepancy between pre-purchase and post-purchase evaluation may occur from time to time. Thus, this study takes the tumbler as an example and aims to explore the reasons behind, as well as finding a suitable solution. It is hypothesized that the change of sensory dominance in product interaction from purchase to real use might lead to expectation disconfirmation. More specifically, if the user-product interaction during purchase can be better designed to ensure the consistent sensory dominance with real use, there is a chance to avoid expectation disconfirmation. A set of five scenarios of user-product interaction was first proposed by investigating the daily-use behavior of tumbler users. 15 female participants with the experience of tumbler use were then recruited to experience the traditional product interaction during purchase first. After at least three weeks, they returned to experience the new manner of user-product interaction during purchase. Subsequently, each participant took a tumbler home to use it for four consecutive weeks, during which she was required to provide subjective responses at the end of each week. Results showed that there is no sufficient evidence that ensuring consistent sensory dominance during purchase with real use can avoid expectation disconfirmation. Nevertheless, the findings through interviews support the need for doing so.

Keywords: *overall satisfaction, intention of purchase*

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1 INTRODUCTION

Nowadays, online shopping has become one of the most popular ways of getting products that a consumer needs. Nevertheless, expectation disconfirmation may hence occur due to the discrepancy between pre-purchase and post-purchase evaluation (Oliver, 1980). Taking the computer mouse as an example, the limited richness of sensory stimuli associated with web browsing could require the consumer to imagine the haptic and auditory experiences by integrating his/her vision and long-term memory. Unfortunately, after adjusting the multimodal sensory experiences through richer interaction in real product use, the consumer often feels much less satisfied due to the inaccurate imagination (Lu and Yang, 2021). Moreover, the disconfirmation could be either positive or negative, depending on whether the perceived performance is better or worse than the expectation. From the perspective of kansei evaluation, it is intuitive that negative expectation disconfirmation should be avoided, in order not to make the customer feel disappointed after purchase. Positive expectation seems to be acceptable, yet the intention of purchase could be not strong enough if the expectation is below the customer's criterion of decision. So, no matter whether the disconfirmation is positive or negative, it should be excluded by properly designing the scenario of user-product interaction.

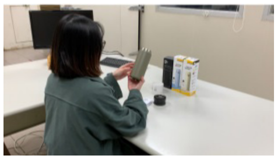
From the perspective of scenario design, it is not surprising that expectation disconfirmation could sometimes be observed even when buying products at a store. Although the multimodal sensory stimuli seem to be almost the same as those being experienced in real product use, the inconsistent scenario of user-product interaction might make a difference. More specifically, as the consumer is making a decision among few product samples, it is inevitable to rely on vision most to generate the overall satisfaction and intention of purchase. However, in daily use, the appearance of product may become less important as getting used to it (Schifferstein & Desmet, 2007). Instead, other sensory experiences such as the sense of touch would be of great concern since it is commonly involved in operations (Schifferstein, 2006). This is known as the shift in sensory dominance, due to the fact that the dominant sensory modality depends on the period of product usage (Fenko et al., 2010). For this reason, it would be beneficial to determine the dominant sensory experience in real use and package it in the scenario of user-product interaction during purchase.

Therefore, this study aims to investigate whether the consistent sensory dominance between pre- and post-purchase product evaluation may help reduce expectation disconfirmation. The tumbler was considered as the target product since the associated user-product interaction involves vision, hearing, sense of touch, and smell. Besides, consumers are usually not allowed to experience some interaction such as carrying, cleaning, and drinking with the product sample during purchase. As such a traditional user-product interaction prohibits the consumer from estimating the every-day scenarios of real use with the dominant sensory modalities, it could lead to expectation disconfirmation. If a redesigned scenario of user-product interaction at the store does prevent a significant lower level of satisfaction in real use, there would be evidence to support the hypothesis. It also helps understand what modalities of sensory stimuli play an important role of user evaluation at the different stages of product use. Based on the findings, the appropriate scenarios of user-product interaction that better resembles the real use could be identified for the long-lasting positive user experience.

2 METHOD

At first, behavioral characteristics of tumbler users during purchase and daily use were investigated through observation and interviews. This helps define the traditional manner of user-product interaction at different stages, as well as designing a new set of scenarios that resemble real use. As summarized in Table 1, there were five scenarios being considered in the new manner of user-product interaction during purchase. The purpose is to encourage the customer better imagine the routine use of tumbler after buying it by experiencing the multimodal sensory stimuli in detail. In contrast, the traditional manner often covers the scenario of "unboxing the tumbler" only. Even if the customer wants to experience more, it is limited to the case with no liquid inside the tumbler. As for the daily use after purchase, the interactions generally follow those scenarios presented in Table 1. However, there could be variations in "cleaning the tumbler" and "carrying the tumbler" due to the individual differences.

Table 1. The new set of scenarios of user-product interaction during purchase

Scenario	Features of interest	Sensory modalities experienced	Illustration
Unboxing the tumbler	appearance, texture, smell, weight, sounds, ease of handling	vision, hearing, touch, smell	
Cleaning the tumbler for the first time	cleaning procedures, smell, sounds, ease of disassembly and recovery, ease of handling	vision, hearing, touch, smell	
Everyday use of the tumbler	ease of drinking, ease of handling, leakage, smell, sounds, functions	vision, hearing, touch, smell	
Carrying the tumbler	weight, ease of handling, leakage	vision, touch	
Cleaning the tumbler after several times of use	cleaning procedures, smell, sounds, ease of disassembly and recovery, ease of handling	vision, hearing, touch, smell	

15 female participants with the experience of tumbler use ranging from 20 to 24 years old were recruited. Each participant was asked to perform the traditional user-product interaction

during purchase in a standardized laboratory environment first, i.e. stage 1. She can freely decide what to do with the product samples as if they are presented on the shelf at a store. In order to confirm whether there is expectation disconfirmation, semantic differential scales were presented to the participant to obtain her overall satisfaction and intention of purchase. Besides, the quantified importance of each sensory modality being perceived was also collected to help determine sensory dominance. After at least three weeks (for eliminating the learning effect), she returned to experience the new set of scenarios of user-product interaction during purchase (as shown in Table 1), i.e. stage 2. The same subjective responses were collected as in stage 1. Subsequently, the tumbler was given to the participant, so that she can experience the daily use for four consecutive weeks. During this period, i.e. stage 3, participants were required to turn in the same set of subjective responses at the end of each week. As the experience of four-week real use is completed, the participant returned again to have a final interview.

The paired t-test was conducted to find out the dominant sense at each stage. If the dominant sense in stage 1 or stage 2 is different from that of stage 3, there is a difference in sensory dominance the user-product interaction during purchase and real use. Moreover, the paired-t test was also conducted to analyze the difference in overall satisfaction between stage 1 (or stage 2) and stage 3. If there is a significant difference, expectation disconfirmation exists. As mentioned in section 1, it was hypothesized that there could be expectation disconfirmation between stage 1 and stage 3, due to the potential inconsistent sensory dominance in between. On the contrary, it was expected that consistent sensory dominance between stage 2 and stage 3 could be achieved through the scenario design, and hence contributing to the reduction of expectation disconfirmation.

3 RESULTS AND DISCUSSION

Results showed that the dominant sense has changed from traditional user-product interaction during purchase to real use. More specifically, vision is the only dominant sensory modality in stage 1, whereas vision, touch, and smell become equally dominant at the end of each of the four weeks in stage 3. In other words, by experiencing the traditional manner of user-product interaction, the participant may fail to pay as much attention to the texture, weight, and smell of the tumbler as how she will do in daily use. From this point of view, there is a chance that the participant overestimated or underestimated the performance of the tumbler in terms of the features associated with tactile and olfactory experiences. Nevertheless, no expectation disconfirmation was found between stage 1 and (at the end of the four week of) stage 3 (p-value = 0.581). There is only a slightly descending (but insignificant) trend of overall satisfaction through the four weeks compared to stage 1. If the observation lasts longer, e.g. 6 weeks or more, the participant's overall satisfaction might drop to a larger extent.

On the other hand, the dominant sense hasn't changed from the new manner of user-product interaction during purchase to real use. More specifically, vision, touch, and smell are found to be equally dominant both in stage 2 and at the end of each of the four weeks in stage 3. In other words, the five scenarios did help the participant consider the conditions of real use more carefully. Following this finding, it is intuitive that there is no significant expectation disconfirmation found in between (p-value = 0.610). In addition, the mean overall satisfaction in stage 2 (3.77) is significantly lower (p-value = 0.042) than in stage 1 (3.94). It seems that the consistent sensory dominance somehow calibrated the overestimated satisfaction.

Unfortunately, it seems to be not yet ready to prove the hypothesis. In other words, there is no sufficient evidence that ensuring consistent sensory dominance between user-product interaction during purchase and real use can reduce expectation disconfirmation. Nevertheless, in addition to the calibrated overall satisfaction mentioned earlier, some of the analysis results of interview support the need for doing so as well. More specifically, 13 out of the 15 participants were aware of the changes in sensory dominance from stage 1 to stage 3, and the sensory modalities that were considered less important during purchase (in stage 1) also became more important during daily use (in stage 3). In addition, among these 13 participants who were aware of these changes in sensory dominance, seven of them noticed the existence of expectation disconfirmation between stage 1 and stage 3 subjectively. From the perspective of satisfaction, those who were aware of expectation disconfirmation had a significantly lower level of satisfaction (p-value = 0.019) and intention of purchase (p-value = 0.022) at the end of the fourth week of real use than those who did not notice the expectation disconfirmation. Looking into the main reasons causing the decreasing overall satisfaction and intention of purchase after real use, the lack of critical haptic (e.g. handling the tumbler for a longer time, ease of opening the lid with liquid inside) and olfactory experiences (e.g. the odd smell due to stains of tea or coffee) in stage 1 does matter. In contrast, the interactions provided in the scenarios of stage 2 helped them consider these issues more easily.

However, some participants also indicated that the experience of smell during the new set of scenarios of user-product interaction in stage 2 did not exactly reflect what they really feel in daily use (in stage 3 or according to the prior experience). It is particularly not easy to experience the odd smell caused by the stains on the tumbler unless using it for a longer period of time. Thus, in user-product interaction during purchase, it would be beneficial to prepare a product sample being used for months to help the consumer better expect what will be experienced after purchase and real use. Besides, this also explains why the overall expectation after the four-week use is not significantly lower than that perceived during purchase. So, there is a stronger motivation to expand such a study to a longitudinal one spanning months. Moreover, although the standardized laboratory environment was built with high fidelity in terms of a real store, it would be of interest to clarify whether this could be a confounding factor in future studies. Of course, by extending to a wider range of target users of tumbler, the findings will be more persuading for the market.

4 CONCLUSION

This study takes the tumbler as an example to investigate whether reducing the differences in sensory dominance between pre-purchase and post-purchase evaluation may improve the user’s expectation disconfirmation. Results of 15 female participants showed that the dominant sensory modality has changed from traditional user-product interaction during purchase to real use, but it did not lead to expectation disconfirmation. Although the new set of scenarios of user-product interaction during purchase did ensure the consistency of sensory dominance and produce no expectation disconfirmation, there is no sufficient evidence to prove the hypothesis. Aiming at clarifying the detailed mechanism, it is worthwhile to continue with such a study by expanding the duration of observation and fine-tuning the scenarios of user-product interaction.

ACKNOWLEDGMENTS

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INFLUENCE OF MENTAL MODEL OF GUI ON USABILITY

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ABSTRACT

Applications operated on smartphones and other devices with a small user interface area on the screen and a large number of functions and contents will inevitably increase the number of operation procedures and make them more complicated. However, compared to the attention paid to information architecture and interaction in realizing intuitive user interfaces, less attention is paid to icons, and there are many examples where generic icons are used. Therefore, when icons and the functions they represent are different for each application, or when icons are unintelligible because of the distance between the user's mental model and the icons, the cognitive burden on the user is amplified, which may affect usability. We compared the usability of icons, one of the GUI elements, by focusing on their metaphors, and showed that the selection of metaphors that are in line with users' mental models has a positive effect on usability by improving the performance of task completion time and the number of errors. This study clarified the influence of the degree of congruence between the metaphor used and the user's mental model on the usability of icons, one of the GUI elements.

Keywords: *Mental Model · Metaphor · UI Design · Mobile app*

1 INTRODUCTION

In recent years, with the development of ICT technology, compact information communication terminals with touch interfaces such as smart phones have become widespread, and the service form dealing with huge amount of information has increased with improvement of communication technology. On the other hand, in an application operated by a smartphone or the like having a small user interface area on the screen, those having many functions and

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contents inevitably increase the number of operation procedures and become complicated. Also, with the expansion of the user layer, there is a demand for an intuitive user interface that can be operated without having advanced knowledge. In smartphones, tab-type navigation that facilitated access to frequently used functions became widely used. For this reason, techniques such as utilizing space on small screens and using GUI like icons to alleviate the cognitive burden are beginning to be generalized. However, as the IT environment rapidly changed from skeuomorphism to flat design, elements of the GUI were simplified, and buttons, icons and navigation that looked similar increased. Under such circumstances, information architecture, interaction, etc., have attracted attention in order to realize an intuitive user interface, and what is required of the GUI became more intrinsically central. Compared with the attention to inner objects (Information Architecture, Interaction, Kansei etc.) expressed in the GUI, an example in which a general-purpose icon is used without external attention to icons that only externalize elements and abstract elements stand out. When the icon and the function indicated by it are greatly different for each application, or the icon is far from the mental model of the user in the first place and it is difficult to understand, the icon that should support cognition rather than the cognitive burden There is a concern that it will amplify, so there is a need for research to clarify the influence that it has on usability.

This research aims to clarify the influence of usability on the icons which are part of the user interface, the degree of matching between the metaphor and the mental model owned by the user`s Kansei. In this case, we will conduct research on "music streaming service" among content distribution services that satisfy the requirements of clear user group and high information volume service.

Figure 1. Examples of the correspondence between metaphors and functions used in current services

2 PROBLEM WITH GUI TO SUPPORT INTUITIVE OPERATION

By using graphical elements such as icons and animation, GUI provides intuitive operation that is easy to perceive by providing familiar metaphor for users. As elements of the GUI, there are various things such as words, icons, animation, navigation, etc., but most of them are metaphors of substances and actions in the real world. It is easy to organize as the abstraction degree of the metaphor is similar to the user's past experience and memory, and it can be said to be intuitive.

For example, a user who perceived an icon using a trash can metaphor on the GUI as shown in Figure 2 has ever seen a garbage box of such a form in the past, or if it has used it, garbage You can understand the system's intention that you can throw away.

Figure 2. Example of an icon using the Trash Can Metaphor

However, since icons are visual information, recognition speed is fast, language problems are small, storage efficiency is excellent, but there are many problems caused by abstracting meaning. One of the problems is that the step of abstracting what you want to express is included in the icon, so the content that the user interprets from the metaphor varies from person to person. In addition, metaphor in GUI has supported intuitive operation by using metaphor modeling the real world, but in recent years there is a computer-specific meaning that there is no suitable metaphor in the real world, "Navigation menu" is often abstracted as shown in Figure. 3.

Figure 3. Icon that are highly abstract and do `not mimic anything in the real world

In addition, there are many cases where the metaphor of the icon showing the same concept differs. For example, it is an example in which there are two metaphors such as a gear and a knob to indicate the same "setting". This is because dependence on metaphor became noticeable as the width of expression of icons decreased since becoming a flat design. (Figure 4)

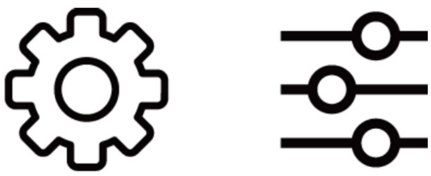


Figure 4. Examples of icons that represent the same concept but have different metaphors

Furthermore, since GUI design changed rapidly from skeuomorphism to flat design, it was not standardized and it was popularized with various metaphor, and even though services and OS still show the same concept, metaphor still differs A large number of examples of icons exist. As described above, it should have been an icon that should support the recognition by the user, but hindering the recognition may adversely affect the operation. However, the existence of the icon itself is still widely familiar and its advantages are also great, so it is considered that it should positively incorporate it. Therefore, understanding that the interpretation of the icon depends on the mental model of the user, and in the case where the designer uses the icon, it does not make a sensory selection from the vague correspondence relationship between the icon and the metaphor, and the environment surrounding the user Staying closer to the design, designing according to the mental model of the user is the first step to realize an intuitive user interface.

3 RESEARCH METHOD

In this research, as a logical study, we first discuss the importance of metaphor in user interface and the influence of development of ICT technology on user interface. We will conduct market research and experiments, and clarify mental models of users. Based on the result, a prototype is created and evaluated, then the influence of the metaphor on the usability on usability is clarified.

1) With regard to the main functions of the existing music service, extract the icon and identify the correspondence between the function and the metaphor

2) Visualize the mental model by having the metaphors recalled when word stimulus is given

3) Card sorting and labeling by the dichotomy on the icon and extract design elements

4) Survey questionnaire on mental model conformity degree

5) Consider and compare the GUI based on the above survey

4 SURVEY CONTENTS · ANALYSIS

4.1 Functional survey of existing services

Identifying functions and metaphors of existing music services from 166 services that are ranked higher in ranking from the AppStore genre "Music" and which can be regarded as continuing operation, we focus on existing functions in tab navigation I have identified key functions of music service.

Table 1. Key Functions of Existing Music Services Inspection (N = 166)

Top	138	Setting	32
Search	129	Download	21
Radio	84	History	6
Library	64	Raking	6
Browsing	59	Bookmark	5

In the results of Table1, the top four functions "Top", "Search", "Radio", "Library" are regarded as representative functions. Figure 5 shows the trends of extracting metaphors corresponding to each function from all services targeted for survey.

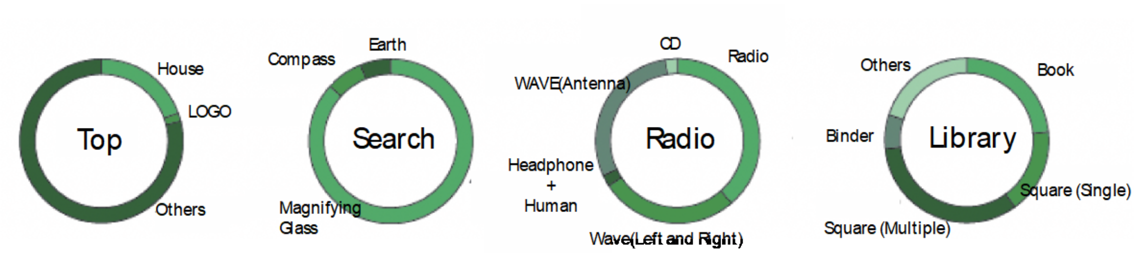


Figure 5. Correspondence relation between metaphor and function (N = 166)

From this result, "house" is the most metaphor representing "Top", "Magnifying glass" was the largest in "Search". Regarding these two, the metaphors are relatively uneven, and the metaphor of "Radio" is bipolarized into "Radio" and "Radio". On the other hand, "Library" was seen as "Book", "Square", "Binder", etc., and the variation was large. This is thought to be related to the abstraction level of the function, for example, the function itself as "Search" is a general and concrete word and the user is familiar with it, while the "Library" It is thought that it is caused by the fact that it shows the concept in service and is in the real world and there is no direct metaphor.

4.2 Extraction of metaphors to be recalled by word stimulus

Thirty-one subjects were asked to draw metaphors to remember when giving word stimuli. As a result, there was a tendency similar to metaphors used in existing icons. (Figure 6)

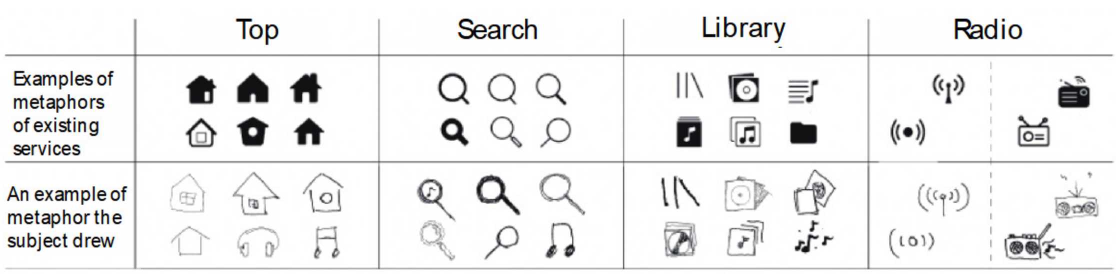


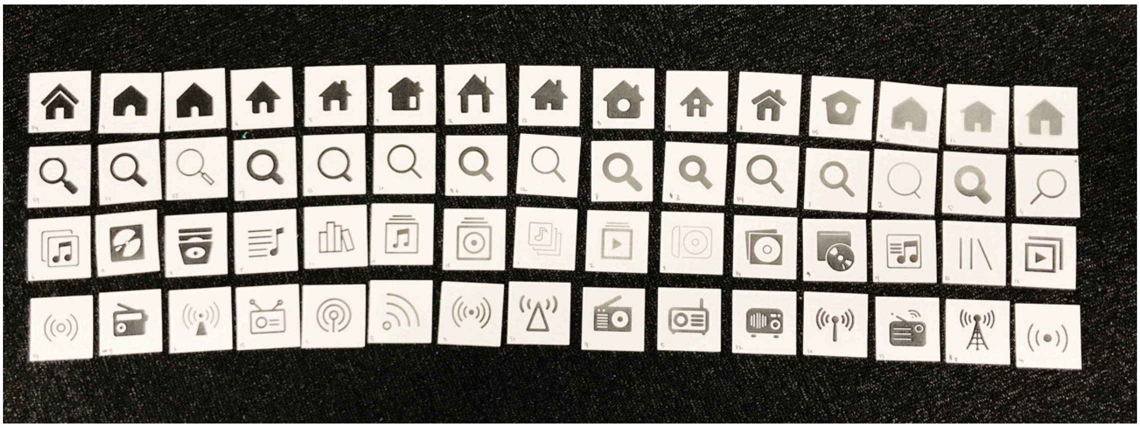
Figure 6. Extraction result of metaphors recalled from words (N = 31)

It seems that a similar tendency was observed because subjects were already in their 20s and men who are already familiar with existing services. However, among these trends, there is also a function with large metaphor variability, and it seems that such selection tends to affect usability by selecting it.

4.3 Extraction of design elements by card sorting

A total of 60 cards were sorted by 25 subjects, 15 each for the "Top," "Search," "Library," and "Radio" functions, without changing the flow of the experiment itself. This icons were extracted by the KJ method and used in the actual experiment. (Table 3)

Table 3. Card sorting result by dichotomy (N = 25)



	Top		Search		Library		Radio	
First level label	Presence of eaves	7	Line is thick or thin	16	Presence or absence of music notes	4	Radio or radio wave	21
	Presence or absence of chimney	6	Presence of handle expression	4	Presence of CD	4	Things with or without shape	2
	"Square" or "Round"	4	Handle direction is left or right	4	Presence of eaves	4	Presence or absence of radio wave expression	1
	"Blackish" or "White"	2	The tip of the handle is round or square	1	"Blackish" or "White"	4	Fill or line	1
	Are all bottoms grounded	2			Singular or Multiple	1		

	Top		Search		Library		Radio	
Second level label	Presence or absence of chimney	10	Presence of handle expression	10	Presence or absence of music notes	9	Presence or absence of tower expression	17
	Presence of eaves	9	Line is thick or thin	9	Presence of CD	9	Fill or stroke	16
	The top of the entrance is round or square	8	The lens is large or small	6	Singular or Multiple	6	Radio or electric wave	3
	Are all bottoms grounded	7	The tip of the handle is round or square	5	"Blackish" or "White"	5	The presence or absence of the radio antenna	3
	"Square" or "Round"	4	Handle is long or short	4	Fill or stroke	3	"legs" or "no legs"	2

The results of card sorting are shown in Table.3 for labels when bisected in the first and second hierarchies. The label in the upper hierarchy can be regarded as a large design element that influences the impression of the icon. For items that are painted with light gray in Table3, the part that is unique to that metaphor and that can be said of other general icons is the unfilled white part. Icons used when considering the influence of correspondence between functions and metaphor on usability are experimented using icons unifying these two design elements. By doing this, it is thought that the usability can be compared on the assumption that "difference due to design" is reduced and "difference by metaphor".

4.4 Mental model matching degree investigation

In order to classify low-mental model icons and high icons, two types of icons were prepared for 15 kinds of functions used in the music streaming service "Spotify", and 30 subjects were assigned a mental model by pair comparison the tendency was investigated. (Figure 7)

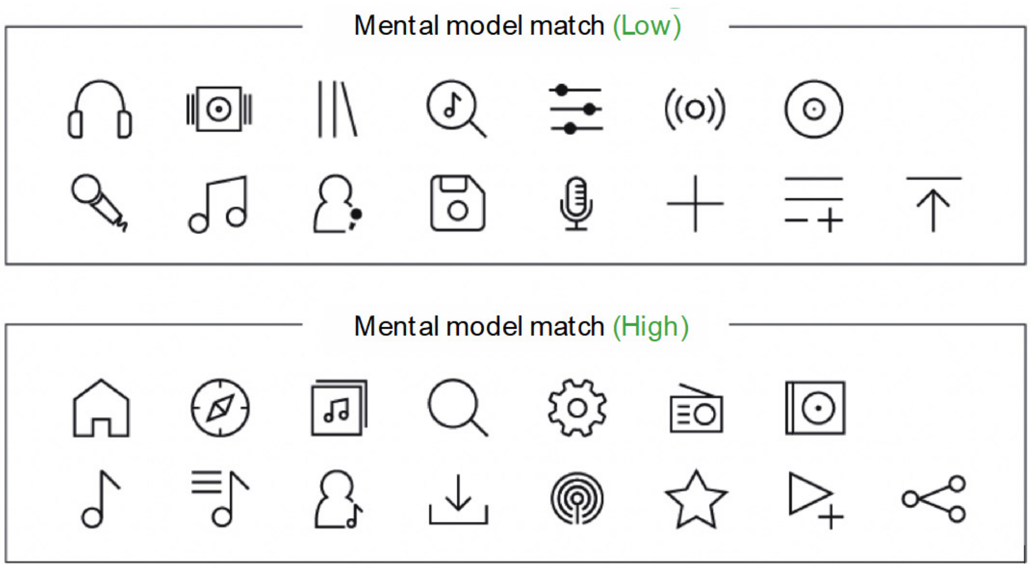


Figure 7. Mental Model Conformity Survey Result (N = 30)

4.5 Verification of the influence of difference in mental model matching degree on usability

In order to clarify the influence on usability due to mental model conformity degree, two prototypes were created based on the experimental result of Figure.7 and a verification experiment was carried out. With regard to the contents of the experiment, the tasks were of two different difficulty levels, and we measured the task achievement time and the number of errors in each prototype.

Table 4. Average task achievement time (N = 30)

TASK A(Mental model match Low)	TASK A(Mental model match High)
32.70s	29.87s
TASK B(Mental model match Low)	TASK B(Mental model match High)
60.50s	52.96s

Table 5. Average number of errors (N = 30)

TASK A(Mental model match Low)	TASK A(Mental model match High)
0.8	0.4
TASK B(Mental model match Low)	TASK B(Mental model match High)
1.2	0.4

From the experimental results in Tables4 and 5, it is better that the performance of task achievement time and error count is higher for each of the two tasks.

5 CONCLUSION

In this research, in order to clarify the influence of user's mental model matching degree on usability on GUI, as an example of "music streaming service", focusing on the icon which operates an application which is one of GUI elements in particular We conducted surveys and experiments. First of all, as a current status survey, we investigated the tendency of correspondence between metaphor and function for icons of existing services. There was a pattern corresponding to plural kinds of metaphor having variation and a pattern deviated to almost one kind of metaphor for one function. The cause was in the abstraction level of the function, and there was a tendency that the function was scattered more abstractly. Furthermore, even if the same metaphor is used, the design of the icon is different, so it was mentioned that equality of cognitive results can`t always be obtained if the metaphors are unified. In addition, to clarify the icons used in existing services so far, but in order to clarify whether they actually exist in the user's mental model or what kind of mental model they have, Experiments were conducted to draw metaphors to be recalled by giving word stimulus. As a result, there was a tendency similar to metaphors used in existing icons. It seems that a similar tendency was observed because subjects were already in their 20s and men who are already familiar with existing services. However, among these trends, there is also a function with large metaphor variability, and it seems that such selection tends to affect usability by selecting it. And in order to carry out the usability test to verify it, since it was touched at the investigation stage as well as the design of the metaphor as well as the design of the icon, the need to eliminate the influence of the design as much as possible from the icon used for this verification There is. As another experiment, prepare a card with an icon of an existing service for the purpose of clarifying which part of the icon is felt as a big design element, and label it into a dichotomous method and its dichotomous group Card sorting was carried out.

As a result, "outline shape of icon (round shape, rounded etc.)" and "color area inside icon" were extracted as elements which have a big influence on impression. Therefore, in the usability test, we thought that by using consistent icons for these two points, we can reduce the "difference due to design" from the difference in verification results and regard it as a "difference by metaphor". Based on that, we extract the icon in the user interface of the music streaming service "Spotify" based on the verification prototype used in usability story, and replace it with icons with high degree of mental model match and high icons for verification. Also, based on the results of metaphor corresponding to the function represented by the extracted icon based on the results of two previous experiments "Extraction of metaphor by recalling word stimulus" and "Extraction of design elements by card sorting", replacement I created an icon and conducted a questionnaire on "Mental model match degree preliminary survey" and selected a metaphor for comparison in usability test. In the final usability test, in the mental model "Prototype using icons with low conformity" and "Prototype using icons with high matching degree", two tasks are given, and "achievement time" "error number "Was measured.

The above results show that the selection of icons for operating applications, one of the GUI elements, can be improved by selecting a metaphor that is in line with the mental model of the user. The above results show that the selection of a metaphor that is in line with the mental model of the user has a positive effect on usability by improving the performance of task accomplishment time and the number of errors. performance of task accomplishment time and the number of errors, and that it has a positive effect on usability.

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INFLUENCE OF MULTIMODAL INTEGRATION ON SPATIAL PERCEPTION

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ABSTRACT

To design affective spaces that promote stabilized living experience and user well-being, it is necessary to consider and be aware of how multiple perceptual information interact and influence the way we perceive space i.e. multimodal perception. This study aims to gain an understanding of how sensory cues influence the emotional evaluation of the spatial design. We analyzed how the change in levels of spatial elements was emotionally perceived in the presence and absence of scent and color. The results from the study presented that both scent and color significantly affected the emotional response to change in levels of spatial elements in different ways. The findings suggest that (1) in the absence of both color and scent, the spatial elements interacted to affect the participants' moods related to being confused and feeling strained and tensed, (2) in the presence of a cool color (purple) and relaxing scent (lavender), spatial elements interacted to affect the participants' mood related to feeling strained and tensed, (3) in the presence of a warm color (orange) and stimulating scent (orange), spatial elements interacted to affect the participants' mood related to being unhappy. The findings of the study are worthy as they provide an insight into the influence of multimodality in spatial perception. They will help establish guidelines for incorporating perceptual information in spatial designs that provide stabilized living experience and enhanced individual well-being.

Keywords: *Multisensory Perception, High-Level Cognitive Functions, Visual-Olfactory Stimulation*

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1 INTRODUCTION

1.1 Multisensory perception in spatial design

It is a common conception and practice in environmental design and research to place emphasis on vision as a predominant sense or take a sense-by-sense i.e., unisensory approach, to evaluate how the change in one sensory stimulant (ex: olfactory) affects the affective response to another (ex: vision). However, any given environment is a complex multisensory structure that is experienced through the integration of multiple sensory information which influences our reactions and experiences within it. *The model of explaining the relationship of an innate subjective filter and the individual modification process by the experiences* by Kim et al. (2012) (Figure 1) presents the *kansei* process of how perceptual information obtained from sensory organs (eyes, nose, ears, etc) are integrated into the brain and is output as affective reaction such as emotion or intuition, which then act as the scale of the aesthetic and logical judgments [15].

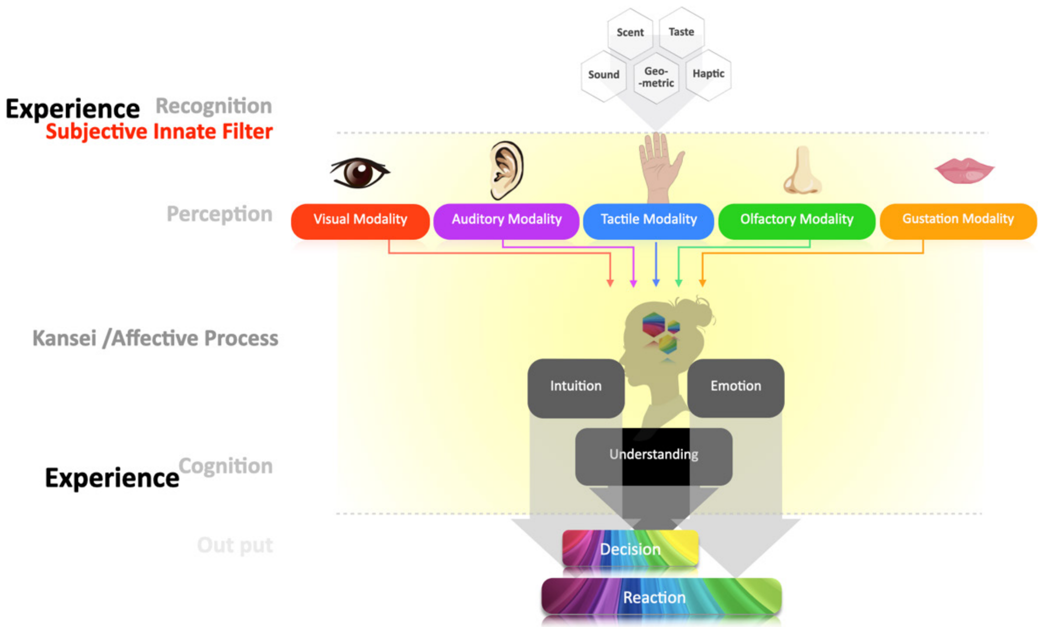

Figure 1. *The model of explaining the relationship of an innate subjective filter and the individual modification process* by the experiences by Kim et al (2012)

Nevertheless, there are insufficient findings on the extent to which our senses interact to affect our responses. Little consideration is given to the question of how the perceptual information from multiple sensory cues conjointly affects an individual's affective response in any given environment. A multisensory approach to spatial design practices will lead to the development of buildings and urban spaces that are matched to the users' social, cognitive, and emotional enhancement and well-being, rather than hindering it.

1.2 Purpose of the study

This study aims to gain an understanding of how sensory cues influence the emotional evaluation of the spatial design. For this purpose, we analyzed how the change in levels of spatial design elements (ceiling height, wideness) was emotionally perceived in the presence and absence of visual-olfactory cues (scent and color).

2 METHOD

Sixty-two native Japanese students (male:39, female:23, average age:21.1 SD:2) participated in the experiment.

2.1 Stimuli

Olfactory stimuli: Orange and lavender essential oils were selected and used as olfactory stimuli in the experiment [2,3]. The olfactory stimuli were presented by applying 0.05 cc (1 drop) of the essential oil on a mask. The participants wore the scented masks during the with scent *(orange scent/lavender scent)* conditions.

Visual stimuli: Nine types of VR (virtual reality) spaces with three levels of *ceiling height* (*lower, default, higher*) and *wideness* (*narrower, default, wider*) were prepared and presented in three color conditions (*no color, orange color, purple color*). A total of twenty-seven visual stimuli were produced by combining each level of the *ceiling height* and *wideness* in each color condition.

The visual stimuli used in the experiment were designed using Unity 2019.1.14f1, a cross-platform game engine, and were presented via Oculus Quest Head Mount Display (HMD). VR was used as a medium for visual stimuli in this experiment as it has been reported to be an effective tool for studying the emotional response to spatial conditions and has been widely applied in the psychiatric treatment of space-related phobia (ex: claustrophobia, acrophobia) [4, 5, 6]. The colors of the VR spaces were: greyish white (Hex Value: #f8f8f8) in *no color* condition, orange (Hex Value: #db9c7b) in *orange color* condition, and purple (Hex Value: #b0a3b6) in *purple color* condition. Greyish white was set by the authors, while orange and purple colors were selected from a previous study about the influence of wall colors on patients' recovery [7]. The size specification of the three levels of *ceiling height* and *wideness* are as presented in Table 1.

Table 1. Size specification of the three levels of the *ceiling height* and *wideness* of the VR spaces as set in Unity 5.5 (1m=1 Unity unit)

Spatial Design Element	Levels	Specification (m)
wideness	narrower	2.64×2.64
	default	5.282×5.282
	wider	10.56×5.282
ceiling height	lower	1.37
	default	2.4
	higher	4.2

The scale of measurement for wideness and ceiling height were set in Unity units (1 Unity unit = 1 meter). The default wideness level was set at 27.9 square meters, which is the standard floor space per person in Japan (Kanemoto, 1997) [8]. The default ceiling height was set at 2.4 meters, which is the average ceiling height used by housemakers in Japan [9]. The size setting for the levels other than those for the default levels was decided by the authors. In the case of the ceiling height element, the lower and higher levels were adjusted from the eye level in a seated position. As for the wideness element, the narrower and wider levels were set two times wider and narrower than the default level. This was done by checking the condition in the VR environment. The level of brightness was maintained the same in all the VR spaces.

2.2 Experiment method

The emotional evaluation was performed by using thirteen mood state evaluation phrases (Japanese), which were selected from previous studies on the influence of visual-olfactory stimulation on spatial perception [10,11]. The phrases were rated on a 5-point scale from 0 to 4 (0= not at all; 1= a little; 2= moderately; 3= quite a bit; 4= extremely). The evaluation phrases are as follows: *is confused, is unhappy, feel lonely, is worn out, feel strained and tensed, feel restless, feel panicky, feeling anxious, feeling nervous, feel stressed, feel refreshed, is not confident, feel gloomy.*

2.3 Procedure

The participants were assigned to one of the nine *scent-color* conditions, where they observed the nine VR spaces in the presence or absence of scent and color. The nine *scent-color* conditions are as follows: *no scent-no color, no scent-orange color, no scent-purple color, orange scent-no color, orange scent-orange color, orange scent-purple color, lavender scent-no color, lavender scent-orange color, lavender scent-purple color.* Before commencing the experiment, the participants were given a brief introduction to the experiment such as instructions on how to observe the stimuli and regarding the evaluation process. They were not informed about the presence or absence of scent and color to avoid biased impressions. They observed the VR spaces by freely turning around, looking in different directions, while remaining seated throughout the experiment. The stimuli were each presented to the participants for ten seconds in random order. The ten-second display duration was based on a previous study on impression evaluation of spatial conditions using fMRI that set the stimulus display time to 3000 milliseconds [12]. After this, the participants evaluated the evaluation phrases. This was treated as an inter-trial interval before they observed the next stimulus. The duration of the experiment per subject was twenty to thirty minutes.

2.4 Results

Two-way ANOVA was used for data analysis in this study to analyze how the change in levels of spatial design elements (ceiling height, wideness) was emotionally perceived in the presence and absence of visual-olfactory cues (scent and color). Significant interactions were reported in the *no scent-no color, orange scent-orange color,* and *lavender scent-purple color* conditions (Table 2). Data are reported as statistically significant at $p < .05$ and highly statistically significant at $p < .01$.

Table 2. Two-way ANOVA results for the significant interaction effect of ceiling height and wideness in *scent-color* conditions ($p < .05$*, $p < .01$**)

scent-color condition	evaluation phrase	independent variable	p-value
no scent-no color	*is confused*	*wideness[wider-default]*ceiling height[default-lower]*	0.0212*
	feel strained and tensed	*ceiling height[higher-default]*	0.0370*

		*wideness[default-narrower]*ceiling height[higher-default]*	0.0333*
orange scent-no color	*is confused*	*wideness[default-narrower]*	0.0026**
		*wideness[default-narrower]*ceiling height[default-lower]*	0.0066**
orange scent-orange color	*is unhappy*	*wideness[default-narrower]*ceiling height[higher-default]*	0.0413*
lavender scent-purple color	*feel strained and tensed*	*wideness[wider-default]*ceiling height[higher-default]*	0.0437*

No scent-no color condition: Significant interaction effect between ceiling height and wideness (p<.05*) (Figure 2, left) was reported for the evaluation phrase *is confused* (Table 4). A main effect of ceiling height (p<.05*) and significant interaction effect between ceiling height and wideness (p<.05*) (Figure 2, right) were reported for the evaluation phrase *feel strained and tensed*.

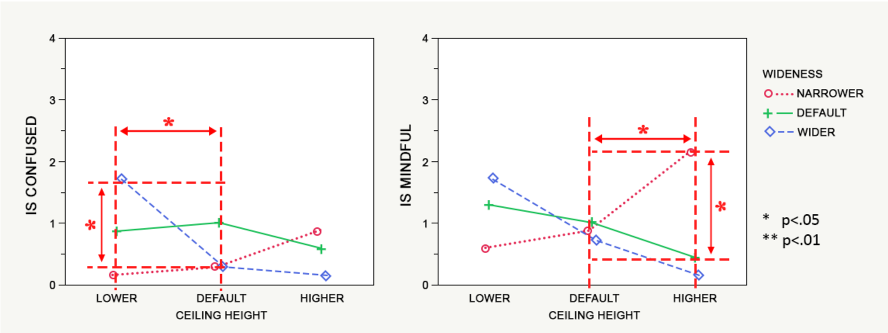

Figure 2. Significant interaction effect in the *no scent-no color* condition between *ceiling height* and *wideness* for the evaluation phrase *is confused* (p<.05*) (left) and *feel strained and tensed* (p<.05*) (right).

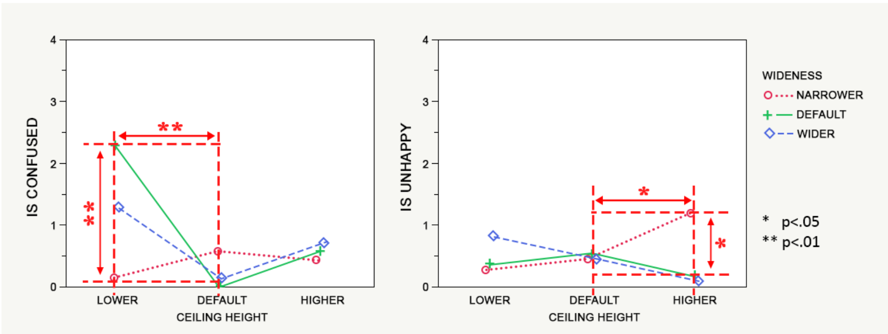

Figure 3. Significant interaction effect between ceiling height and wideness in the *orange scent-no color* condition for the evaluation phrase *is confused* (p<.01**) (left) and in the *orange scent-orange color* condition for the evaluation phrase *is unhappy* (p<.05*) (right)

Orange scent-no color condition: A main effect of wideness (p<.01**) and significant interaction effect between ceiling height and wideness (p<.01**) (Figure 2, left) was reported for the evaluation phrase *is confused*.

Orange scent-orange color condition: Significant interaction effect between ceiling height and wideness (p<.05*) (Figure 3, right) was reported for the evaluation phrase *is unhappy* in the orange scent-orange color condition.

Lavender scent-purple color condition Significant interaction effect between ceiling height and wideness (p<.05*) (Figure4) was reported for the evaluation phrase *feel strained and tensed* in the *lavender scent- purple color* condition.

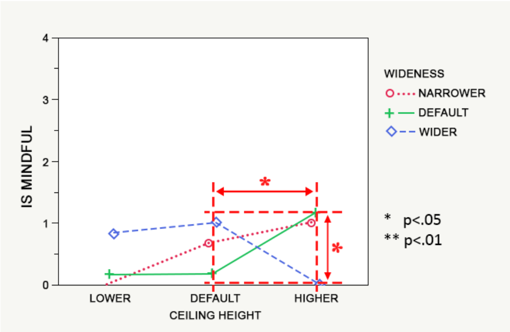

Figure 4. Significant interaction effect in the *lavender scent-purple color* condition between ceiling height and wideness for the evaluation phrase *feel strained and tensed* (p<.05*)

3 DISCUSSION AND CONCLUSION

This study aimed to gain an understanding of how sensory cues influence the emotional evaluation of the spatial design. We analyzed how the change in levels of spatial elements (ceiling height and wideness) was emotionally perceived in the presence and absence of scent and color. The results from the study presented that both scent and color significantly affected the emotional response to change in levels of spatial elements in different ways. The results present that:

(1) *No scent-no color:* The evaluation of *is confused* reduced greatly (*moderately* to *not at all*) in *wider* level of wideness as the ceiling height increased (*lower* to *default*). Conversely, there was only a slight difference in rating (*a little*) for the *default* level of wideness when the level of ceiling height increased (from *lower* to *default*) (Figure.2, left). The evaluation of *feel strained and tensed* increased greatly (*a little* to *moderately*) in *narrower* space as the ceiling height increased (*default* to *higher*). Conversely, the evaluation of *feel strained and tensed* decreased (*a little* to *not at all*) in *default* level of *wideness* as the ceiling height increased (*default* to *higher*) (Figure.2, right).

(2) *Orange scent-no color:* The evaluation of *is confused* reduced greatly (*moderately* to *not at all*) in *default* level of wideness as the ceiling height increased (*lower* to *default*). Conversely, the evaluation of *is confused* increased (*not at all* towards *a little*) in *narrower* level of wideness as the ceiling height increased (*lower* to *default*) (Figure.3, left).

(3) *Orange scent-orange color:* The evaluation of *is unhappy* increased (*not at all* to *a little*) in *narrower* level of wideness as the ceiling height increased (*default* to *higher*). Conversely, the evaluation of *is unhappy* reduced (*not at all* towards *a little*) in *default* level of wideness as the ceiling height increased (*default* to *higher*) (Figure.3, right).

(4) *Lavender scent-purple color:* The evaluation of *is feel strained and tensed* increased (*not at all* to *a little*) in *default* level of wideness as the ceiling height increased (*default* to *higher*). Conversely, the evaluation of *feel strained and tensed* reduced (*a little* to *not at all*) in *wider* level of wideness as the ceiling height increased (*default* to *higher*) (Figure.4).

3.1 Visual-olfactory integration in spatial perception

With most of our lives spent indoors, the space we occupy has a major role in our psychological behavior. Research works in the field of environmental psychology [13] have presented significant findings on how the environments affect individuals who inhabit them. The relationship between spatial design elements (ex: color, size, brightness, etc.) and user experiences is an important aspect of environmental design. Sakuragawa (2006) reported on how the users' perceptions and preferences were affected by the change in design features of a given space [14]. Ceiling height tends to influence users' aesthetic judgment and visual perception of the room [12] and the variation in the level of ceiling heights can affect the feeling of freedom and confinement within a given space [15]. Perception of an interior space can be influenced depending on the direction of illumination, and the type of light. Light is also reported to provide a sense of depth to the interior space [16]. Color has been reported to play an effective role in human emotions and perception in work and living environments [17]. Warm colors (such as orange) are associated with arousing, stressful and exciting moods, while cool colors (such as blue) are associated to calm, serene and comfortable moods [16]. Warm colors appear to be closer, and cool colors appear to be farther away [18].

Another sense which has been reported to effectively influence spatial perception is olfaction. It plays an active part in our daily lives and is strongly linked to the brain's emotional centers and has beneficial effects on people's mood, perception, and memory of environments. Lehrner et al. (2005) investigated the effect of ambient scents on mood improvement in a dental office and presented that ambient scents (orange and lavender) reduced anxiety and improved mood in patients waiting for their treatment [2]. Another study analyzing the effect of ambient scents on the waiting experience in a given environment presented that, orange scent elevated the evaluation of physical properties of the room such as brightness and height [3]. Gérard Brand and Jean-Louis Millot's (2010) study presented that, women have heightened sensitivity to scents and tend to be superior in terms of olfactory skills [19]. In recent years, it is widely used in retail spaces to improve the users' mood and impression about the product being displayed [20]. Environmental scents (ex: orange, lavender, ginger, mint) resulted in a mood enhancement of the customers in a retail environment, and also resulted in a positive evaluation of the environment and approach behavior [21]. Cho and Sai (2019) studied the interaction effect of the spatial design elements and scent on the psychological mood state. They reported that the presence of olfaction helped reduce the negative mood of the participants and improved positive mood states in deficit spatial conditions such as narrow spaces with low ceiling heights [10]. In another study on the influence of visual-olfactory stimulation on affective response to spatial design elements, they reported that spatial design elements interacted to affect emotions related to anxiety in the presence of orange scents and emotions related to decision making in the absence of an olfactory stimulus [11].

While there is growing interest in the significance of visual-olfactory stimulation in spatial perception, researchers mostly focus on how the condition of one sensory cue affects the evaluation of another and whether that interaction affects the users' mood, behavior, or performance. However, there is a lack of experimental evidence on how our perception of space changes when multiple sensory cues are simultaneously stimulated. The present study attempted to answer this question by analyzing how the change in levels of spatial design elements (ceiling height, wideness) was emotionally perceived in the presence and absence of scent and color. Emphasis was placed on scent and color since they are common interior and ambient features in spatial design. Gaining an experimental understanding of how these sensory cues affect the way we perceive spatial design will provide simple, minimal, and impressive ways to change the user experience of any given space. The findings of this study suggest that (1) In the absence of both color and scent, the ceiling height and wideness interacted to affect the participants' moods related to confusion, strain, and tension. (2) In the presence of a stimulating scent (orange), ceiling height and wideness interacted to affect the participants' mood related to confusion. (3) In the presence of a warm color (orange) and stimulating scent (orange), ceiling height and wideness interacted to affect the participants' mood related to unhappiness. (4) In the presence of a cool color (purple) and relaxing scent (lavender), ceiling height and wideness interacted to affect the participants' moods related to strain and tension. These findings are worthy as they add to the previous evidence of the effectiveness of visual-olfactory stimulation on the way we perceive space. Further research will provide deeper experimental knowledge about the relationship between multimodal perception and spatial design and will aid in the development of guidelines for affective spatial designs that will provide more stable living environments and positively impact improved individual well-being.

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INTEGRATING ANTI-FALLING FUNCTION INTO ELDERLY CLOTHING WITH HIGH SATISFACTION USING KANSEI ENGINEERING METHODOLOGY IN GUANGZHOU CITY, CHINA

A CASE STUDY OF PRODUCT SERVICE SYSTEM (PSS)

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ABSTRACT

Falls are one of the major health risks that affect the quality of life among elderly people, but the elderly people do not like to wear anti-falling clothing in their daily lives as the anti-falling clothing are inconvenient, uncomfortable and not beautiful for the elderly people to wear. The elderly clothing and anti-falling function have not been perfectly integrated. To prevent the elderly from being injured by falling and meet their pursuit of clothing, there is a need to integrate anti-falling function into elderly clothing with high satisfaction. This study aims to identify the integration strategies to meet the dressing effect that the elderly pursues in different scenarios using Kansei Engineering Type I. The design strategies for the elderly clothing with anti-falling function will be determined. A framework of integrating anti-falling function into elderly clothing with high satisfaction using Kansei Engineering Type I will be constructed, and the research framework will support the PSS design of elderly clothing at a later stage. The results of this study can support the improvement of elderly clothing performance.

Keywords: *Elderly clothing, Anti-falling function, Kansei Engineering, Product Service System (PSS)*

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1 INTRODUCTION

The world's population has been progressively aging (Chen et al., 2021). Population aging has become an increasingly serious social problem in the world (Su & Wang, 2019). By 2050, China is expected to have the largest group of citizens aged 80 years and over in the world, amounting to 90.4 million persons. Guangzhou, a large-sized Chinese city, faces the same problem, as its residents aged 60 years and over account for 17.27% of the population, which exceeds the national average (Su & Wang, 2019). Providing healthcare service to the elderly people to reduce living risks associated with their daily lives is increasingly being demanded (Wang et al., 2019).

According to the report from the World Health Organization (WHO), falls are the second leading cause of accidental or unintentional injury deaths worldwide. Each year an estimated 424,000 individuals die from falls globally, and 37.3 million falls that are severe enough to require medical attention occur each year (Jin et al., 2019). One-third of people over the age of 65 years who live in the community fall each year, this proportion increases to 50% by the age of 80 years (Zhu et al. 2018). The elderly population is at high risk of fall injuries, and the occurrence of falls often threatens the health of the elderly people and even their lives (Kang et al., 2021). Falls have been one of the main threats in elderly people’s life, almost 80% of reported accidents among elder patients are due to falls (Zhu et al., 2018). Hence, more and more researches are focused on preventing falls in elderly people. Anti-falling clothing is one of the functional products to prevent elderly people from falling, however, the anti-falling clothing specially designed for the elderly people are inconvenient, uncomfortable and not beautiful for the elderly people to wear in their daily lives (Zhu et al., 2018).

Clothing plays an important role in the overall personality of any individual, and the aesthetics is very important to the design of clothing (Sharawat & Hooda, 2018). Elderly people are demanding for a much higher level of functionality of clothing which tends to be more environmentally friendly, healthy, and technological. Clothing is part of the daily life of individuals and is concerned with the tasks of technical and aesthetic requirements (Chen et al., 2021). As for the clothing for the elderly found in the market today, they are manufactured in accordance with standards for young people, despite the elderly no longer having the same mobility, agility and body shape of the young (Vianna & Quaresma, 2015). Since the elderly clothing with anti-falling function are inconvenient, uncomfortable and not beautiful, elderly people are reluctant to wear anti-falling clothing in their daily lives.

The research and development of anti-falling clothing for the elderly people in China started relatively late, and the design of anti-falling clothing is not perfect at the present stage (Li & Wang, 2021). The specific needs of the elderly people for anti-falling clothing are not yet clear. Researchers have identified the design elements of integrating anti-falling function into elderly clothing. These design elements including style, material, color and pattern. However, the researchers did not identify the integration strategies of integrating anti-falling function into elderly clothing that can meet the dressing effect the elderly people pursue in their daily lives. Therefore, it is very necessary to conduct a further study of integrating anti-falling function into elderly clothing with high satisfaction. In this perspective, the aim of this study is to integrate anti-falling function into elderly clothing with high satisfaction.

1.1 The needs of the elderly on the daily clothing

Clothing plays an important role in the overall personality of any individual, the physiological and psychological needs of the elderly people on the clothing have begun to be concerned. Aging is a natural process that reflects a phase of human life when physical, cognitive and social changes begin (Chen et al., 2021). As a result, the clothing of the elderly people also need to be designed according to the physiological and psychological changes of the elderly people. Based on the analysis of previous studies, this study concluded that there are three main design needs of elderly people in the clothing design.

The needs of body changes: There are 3 common types of the somatotype on the elderly people in China: (1) the first kind is endomorph, whose bust, waist and hip are larger; (2) the second kind is an individual having a lean, slightly muscular body, without bouncy muscles but a little expanding waist; (3) the third is somebody whose abdomen is fat, who looks like a stone. Based on these physiological characteristics, the convenience and comfort as well as aesthetics of the clothing should be considered at the time of designing clothing for the elderly people.

The needs of behavior changes: The loss of muscle strength results in physical limitations, consequently, the elderly people's behavior becomes inflexible and slow (Wang & Xu, 2010). This is one of the causes of falls in elderly people. In this sense, the convenience and functionality of the clothing must be considered.

The needs of aesthetic changes: Individuals usually dress to match their role in society. The elderly people will match their clothing to their age. These aesthetic changes are reflected in the style, color and pattern as well as the fabric. Hence, the elderly clothing designer should consider the aesthetic needs of the elderly people.

1.2 The types of anti-falling clothing

Currently, there are several different types of anti-falling clothing for the elderly people already on the market. According to different anti-falling mechanisms, anti-falling clothing can be divided into two categories: airbag-related anti-falling clothing and pad-related anti-falling clothing. In China, there are two main brands selling airbag-related anti-falling clothing at present, their product categories include coats, vest, trousers, and waistband. For the pad-related anti-falling clothing, there is only one category, it is underpants. Several different brands are selling underpants. This study collected some anti-falling clothing for the elderly people from some online retail platforms, including TAOBAO.COM, TMALL.COM and JD.COM. According to different clothing styles, this study found 7 different types of the anti-falling clothing for the elderly people, including coats, vest, trousers, underpants and waistband, as shown in Table 1. These anti-falling clothing are different in style, way of wearing and fall prevention mechanism, the detailed clothing characteristics are shown in Table 2.

Table 1. The types of the anti-falling clothing

Types	Samples
Type 1: Coat	
Type 2: Vest 1	
Type 3: Vest 2	
Type4: Vest 3	
Type 5: Trousers	
Type 6: Underpants	
Type 7: Waistband	

Table 2. The characteristics of anti-falling clothing

Design elements		Characteristics
Type 1	Style	☑Coat □Vest □Trousers □Underpants □Waistband
	Color	□Black □White □Pink □Grey ☑Turquoise
	Protected part	□Hip ☑Head ☑Back ☑Shoulder
	Prevention mechanism	☑Emergency airbag □Fixed air cushion
Type 2	Style	□Coat ☑Vest □Trousers □Underpants □Waistband
	Color	□Black □White ☑Pink ☑Grey □Turquoise
	Protected part	□Hip ☑Head ☑Back □Shoulder
	Prevention mechanism	☑Emergency airbag □Fixed air cushion
Type 3	Style	□Coat ☑Vest □Trousers □Underpants □Waistband
	Color	☑Black □White □Pink □Grey □Turquoise
	Protected part	□Hip ☑Head ☑Back ☑Shoulder
	Prevention mechanism	☑Emergency airbag □Fixed air cushion
Type 4	Style	□Coat ☑Vest □Trousers □Underpants □Waistband
	Color	☑Black □White □Pink □Grey □Turquoise
	Protected part	☑Hip ☑Head ☑Back □Shoulder
	Prevention mechanism	☑Emergency airbag □Fixed air cushion
Type 5	Style	□Coat □Vest ☑Trousers □Underpants □Waistband
	Color	□Black □White □Pink ☑Grey □Turquoise
	Protected part	☑Hip □Head □Back □Shoulder
	Prevention mechanism	☑Emergency airbag □Fixed air cushion
Type 6	Style	□Coat □Vest □Trousers ☑Underpants □Waistband
	Color	☑Black ☑White □Pink □Grey □Turquoise
	Protected part	☑Hip □Head □Back □Shoulder
	Prevention mechanism	□Emergency airbag ☑Fixed air cushion
Type 7	Style	□Coat □Vest □Trousers □Underpants ☑Waistband
	Color	□Black □White □Pink ☑Grey □Turquoise
	Protected part	☑Hip □Head □Back □Shoulder
	Prevention mechanism	☑Emergency airbag □Fixed air cushion

1.3 The design methods of product design

This study aims to develop the elderly clothing with anti-falling function to fulfill the needs of the elderly people, so as to support the sales of the product and the sustainable development of the brands. In the scope of clothing design, the new population demand determines new consumption patterns that are characterized by the requirement for products and services that are appropriate for needs and expectation of these individuals (Neves et al., 2018). These specificities are associated not only with changes in taste and subjectivities, but also with physical and cognitive changes consequential of this stage of life (Neves et al., 2018). With the rapid development of scientific research and technology, the current retail business model is undergoing reform or optimization. A business model describes the rationale of how an organization creates, delivers and captures value (Osterwalder & Pigneur, 2010). Designing for the customer experience is crucial for developing new offerings, but providing new products or services alone is no longer enough, more than product ownership or service provision, customers always look for desired outcomes and value-in-use (Carreira et al. 2013). Nowadays, industrial companies are gradually shifted from a product-oriented business model towards a service dominant logic, and this business paradigm is known as Product Service System (PSS) (Zheng et al., 2019). A PSS is an integrated system of people, products, and services engaged in the pursuit of life cycle economic, social and environmental benefits while fulfilling customer needs through added value (Zhang & Haapala, 2011). Integrating business models, products and services together throughout the lifecycle stages, and creating innovative value addition for the system should be the focus of PSS design (Vasantha et al. 2015). Designing a PSS for the elderly clothing with anti-falling function is not only benefit for the elderly people, but also can support the healthy development of the society. Therefore, it is important to develop a PSS for the elderly clothing with anti-falling function.

Researchers have identified the design elements of integrating anti-falling function into elderly clothing, the design elements includes style, colour, material and pattern (Kang et al. 2021; Li & Wang, 2021; Zhu et al., 2018; He & Wang, 2020; Chen et al., 2021). However, they did not identify the detailed integration strategies that can meet the dressing effect the elderly people pursue in their daily lives. The customer experience is important for adding value to firms' offerings (Carreira et al., 2013). Analyzing customer experience can better identify the customer's needs. Theoretically, Kansei Engineering is a design method that can translate consumer impressions, feelings and needs on existing products or concepts to design solutions and parameters. It shows the way the impressions, feelings and needs of consumers are translated into product design (Lokman, 2010). Kansei is generally referred to sensitivity, sensibility, feeling and emotion (Nagamachi, 1992; Ishihara et al., 1993; Harada, 1998; Yoshikawa, 2000). Kansei Engineering methodology fulfill the need of this study to identify the unfulfilled needs or unmet requirements of the customer.

Since Nagamachi established the Kansei Engineering methodology in 1974, many researchers from different disciplines have contributed to the Kansei Engineering methodology. Currently, Kansei Engineering Type I is the procedure often used by many researchers. Category classification is a break down technique from a targeted concept of a new product to the associated subjective Kansei to the objective design parameters (Lokman, 2010). Schütte et al. (2004) proposed a model of the Kansei Engineering concept, as shown in Figure 1. The procedure of this model including 4 stages: (1) choosing the product domain, (2) semantic description and description of properties, (3) synthesis, and (4) test of validity and iterations.

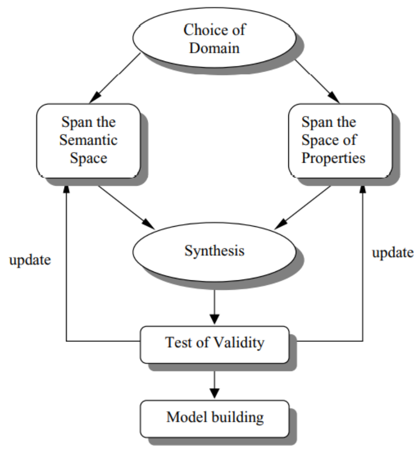

Figure 1. The procedure of Kansei Engineering Type I (Adapted from Schütte et al., 2004)

The design requirements of a PSS including: product element, service element, stakeholder network and supporting infrastructure network (Vasantha et al. 2012). To address the needs of designing a PSS, some researchers have developed Kansei Engineering methodology to incorporate some efficient instruments in PSS design in recent years. Carreira et al. (2013) incorporated the customer experience requirements and multidisciplinary inter-company design team to support the use of Kansei Engineering methodology. In addition, Sinclair et al. (2018) proposed a customer life cycle for the PSS design through a tool named Consumer Intervention Mapping. Yin et al. (2020) analyzed the stakeholder network and infrastructure network for the PSS design. Based on these studies, this study developed an extend Kansei Engineering methodology for PSS design, as shown in Figure 2.

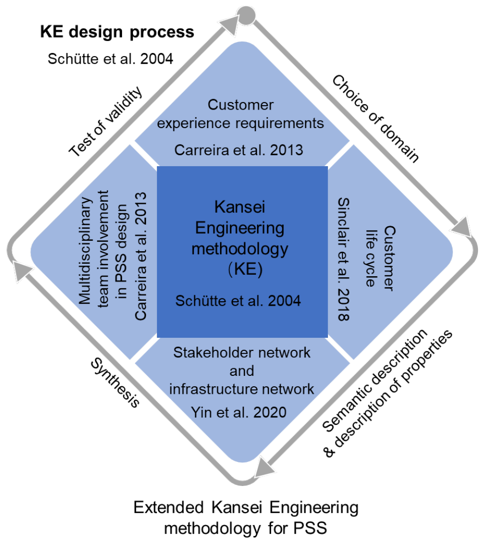

Figure 2. The extended Kansei Engineering methodology (Adapted from Schütte et al., 2004; Carreira et al., 2013; Sinclair et al., 2018; Yin et al., 2020)

2 METHODOLOGY

The extend Kansei Engineering methodology for PSS design needs to analyze product element, service element, stakeholder network and supporting infrastructure network in a customer life cycle. This study is only part of the PSS design, this part focuses on the analysis of product elements. The study presented here was conducted in May 2022. In terms of the procedure of Kansei Engineering Type I, the research design of this study including 3 phases: (1) choice of domain, (2) semantic description and description of properties, and (3) synthesis. For the test of validity, it will be carried out after all elements of the PSS design are analyzed, so the test of validity is not included in this study. A quantitative research method was used in this study, because the data of this study was collected through questionnaire survey, and the conclusion was reached through statistical data analysis of Kansei words.

2.1 Choice of domain

In the choice of domain stage, this study conducted a group discussion to define the Kansei domain of the analysis. This study is focuses on the analysis of product elements for elderly clothing with anti-falling function. Thus, the Kansei words were related to the characteristics of the product elements, and came from customer experience.

2.2 Semantic description and description of properties

Kansei is a Japanese term used to express one's impression towards artefact, situation and surrounding (Lokman, 2010). In this study, the Kansei refers to the expectations of elderly people for their clothing. Based on the summary of previous literature, the needs of the elderly for clothing include three aspects: (1) aesthetic needs, (2) sensory needs, and (3) behavioral needs. In terms of the needs of the elderly people, the expectations can be related to the needs. Therefore, this study sorted out the needs of the elderly people in their daily lives on the Internet according to the three aspects of needs. A total of about 200 Kansei words were collected, 30 words left after deleting the synonyms, as shown in Table 3.

Table 3. Collecting Kansei words for elderly clothing

Gender	Aesthetic needs	Sensory needs	Behavioral needs
Common	Fashionable Beautiful Youthful Energetic Decent Elegance Noble Neat Clean Simple Practical Tasteful Design Good quality Exquisite workmanship	Comfortable Soft Smooth Breathable Lightweight Fit Healthy Safety	Easy to put on Easy to take off Easy to move Easy to sit Easy to sleep Strong protective
Female	Feminine		
Male	Masculine		

2.3 Synthesis

Kansei measurement is the process of capturing consumer's Kansei. In this study, a questionnaire survey was conducted. The questionnaire survey used Likert scale, 5-rating scale. The range of each Kansei word was set from 1 to 5, whereby the 1 means the maximum value for the negative semantic, while the 5 means the maximum value for the positive semantic.

The participants were the people aged sixty-five and above. A total of 39 elderly people from Guanzhou city participated in this survey. Among the respondents, female elderly people dominated 56.41%, while male elderly people constituted 43.59% of the group. Respondents aged 65 to 69 accounted for 38.46%, 70 to 74 for 23.08%, 75 to 79 for 20.51%, 80 to 84 for 10.26%, and 85 and over for 7.69%. Respondents at each stage included both female and male.

Evaluation of Kansei gives opportunity for one study to investigate the similar meanings, structure and the concept in consumer Kansei. This study aims to identify the integration strategies of integrating anti-falling function into elderly clothing that can meet the dressing effect that the elderly people pursue in their daily lives. IBM SPSS Statistics 26.0 was used for data analysis in this study. In this study, descriptive analysis of Kansei word was carried out to understand the satisfaction of the elderly people with the design of the existing anti-falling clothing. Finally, according to the analysis results, the appropriate design strategies were determined to integrate anti-falling function into elderly clothing with high satisfaction.

3 RESULTS AND DISCUSSION

Table 4 shows the mean of the Kansei word of each elderly clothing. Figure 3 shows the satisfaction level of each anti-falling clothing. The mean value shows that these types of anti-falling clothing are acceptable to the elderly people, but have not reached the highest level of satisfaction. In order of satisfaction level from highest to lowest, the 7 types of anti-falling clothing are vest 2, vest 1, vest 3, waistband, coat, trousers, underpants. Vest 2 is ranked first, indicating that the satisfaction level of elderly people to vest style anti-falling products is the highest. That means vest is more favored by the elderly people. Compared with coat, trousers, waistband and underpants, vest not only has better anti-falling effect, but also has better aesthetics and convenience, so the combination of anti-falling function and vest design is more popular with the elderly. For the underpants, elderly people are not satisfied with its aesthetics, comfort and convenience. That means elderly people don't like to wear tight clothes all the time, they like loose clothes.

The value of "Strong protective" shows that the elderly people are most satisfied with the anti-falling effect of vest 3. Vest 3 not only protects the head but also the hips, indicating that elderly people think it is important to protect their head and hips when they fall. Hence, fashion designers should pay attention to protect the head and hips of the elderly people when designing anti-falling clothing, so that the elderly people can feel more secure.

The value of "Feminine" and "Masculine" shows that the styles of the 7 anti-falling clothing are considered masculine by the elderly people. Vest 3 has a higher level of satisfaction because it is designed according to gender. Elderly women and men have different aesthetic pursuits, therefore, fashion designers need to pay attention to product design according to different gender preferences.

Table 4. The mean of each Kansei word

No.	Kansei words	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
1	Fashionable	3.36	3.49	3.51	3.31	3.10	2.85	3.18
2	Beautiful	3.21	3.10	3.23	3.21	3.03	2.87	3.00
3	Youthful	3.49	3.28	3.31	3.26	3.28	2.97	3.05
4	Energetic	3.18	3.36	3.41	3.28	3.26	2.82	3.13
5	Decent	3.28	3.31	3.38	3.10	3.15	2.92	3.10
6	Elegance	3.03	3.13	3.28	3.00	3.10	2.82	3.23
7	Noble	2.95	3.08	3.21	2.97	3.08	2.74	3.13
8	Neat	3.13	3.21	3.36	3.08	3.10	2.97	3.13
9	Clean	3.21	3.26	3.33	3.13	3.08	3.03	3.00
10	Simple	2.95	3.31	3.38	3.18	3.08	2.95	3.23
11	Practical	3.23	3.41	3.46	3.41	3.26	3.00	3.21
12	Tasteful Design	3.13	3.41	3.51	3.33	3.28	3.08	3.26
13	Good quality	3.36	3.44	3.59	3.44	3.15	3.08	3.26
14	Exquisite workmanship	3.13	3.28	3.38	3.31	3.18	2.97	3.26
15	Feminine	2.74	3.18	2.85	2.82	2.85	2.69	2.62
16	Masculine	3.03	3.26	3.36	3.15	3.13	2.79	2.79
17	Comfortable	3.21	3.36	3.59	3.46	3.15	2.90	3.18
18	Soft	3.08	3.21	3.46	3.26	3.18	2.87	3.03
19	Smooth	3.21	3.26	3.26	3.31	3.15	2.90	3.00
20	Breathable	2.92	3.33	3.44	3.31	3.08	2.97	3.08
21	Lightweight	3.10	3.36	3.46	3.28	3.15	2.87	3.10
22	Fit	3.13	3.28	3.36	3.21	3.18	2.95	3.08
23	Healthy	3.26	3.31	3.41	3.26	3.15	2.92	3.10
24	Safety	3.23	3.28	3.44	3.33	3.21	3.00	3.10
25	Easy to put on	3.44	3.77	3.85	3.79	3.13	2.77	3.82
26	Easy to take off	3.41	3.59	3.72	3.74	2.95	2.69	3.92
27	Easy to move	3.33	3.69	3.85	3.82	3.15	2.74	3.77
28	Easy to sit	3.38	3.77	3.67	3.79	3.13	2.54	3.64
29	Easy to sleep	3.00	3.49	3.74	3.77	2.97	2.62	3.31
30	Strong protective	3.54	3.62	3.69	3.74	3.33	2.97	3.38
	Mean	3.19	3.36	3.45	3.34	3.13	2.88	3.20

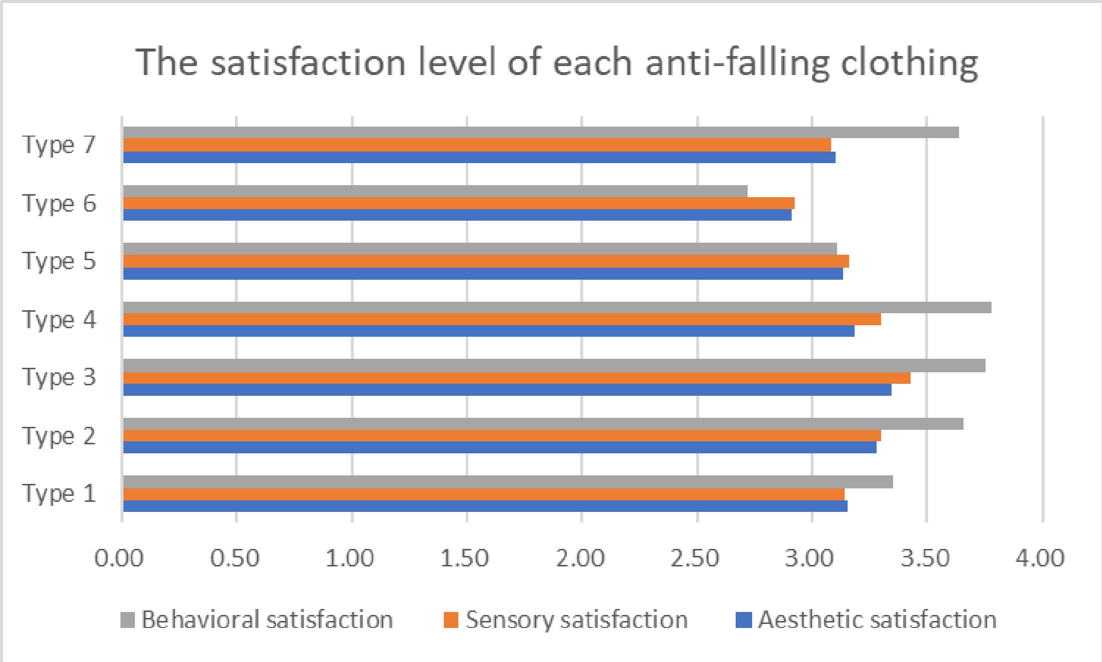

Figure 3. The satisfaction level of each anti-falling clothing

4 CONCLUSION

This study used Kansei Engineering Type I to identify the integration strategies for integrating anti-falling function into elderly clothing with high satisfaction. With the development of social economy and the improvement of living standards, the elderly people have a higher level of pursuit of clothing. Clothing with aesthetics and functions are more popular with the elderly people. When integrating functions into clothing for the elderly people, fashion designers should pay attention to maintain the comfort and convenience of clothing. This study identified some good integration strategies that can provide a reference for fashion designers when designing clothing for the elderly people. The research framework will support the PSS design of elderly clothing at a later stage.

The limitations of this study are that many individual factors of the elderly people were not taken into account for analysis in the questionnaire survey, such as their physical characteristics, living habits, professional background and so on. And the research results are the parts of PSS design. Future researches need to consider more design elements and the relationship between the elements to make PSS design more effective.

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This study aimed to show the way Kansei Engineering methodology targets elderly clothing to improve the clothing performance for the elderly people. The authors gratefully acknowledge the participants for their responses on the survey. The authors gratefully acknowledge the support of Faculty of Design and Architecture, Universiti Putra Malaysia for this study.

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INVESTIGATION OF AUTOMOTIVE LIGHT BLINKING PATTERN CONVEYING A DRIVER'S INTENTION TO YIELD

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ABSTRACT

This paper proposes a method of conveying a driver's intention to yield by blinking automotive lighting. Generally, headlight flashing indicates a driver's intention to yield to another driver or pedestrians in Japan. However, this signaling method can have several meanings, including warning other drivers of road dangers such as crashed cars, or informing other drivers of the presence of a pedestrian. There is a possibility of a misunderstanding, increasing the risk of accidents. Therefore, we have investigated an effective method for facilitating communication in traffic. This study focuses on nonverbal communication in which blinking lights convey the driver's intentions to others. In this study, visibility is not considered. Nine blinking patterns that changed the light colors, waveform, and blinking cycle were presented to fifteen healthy participants, and visual impressions were evaluated to identify the most suitable blinking patterns. These nine patterns indicate a driver's intention to yield to pedestrians and other drivers. The results indicated that a blue-green blinking pattern in which luminance changes with a triangular wave pattern with a one-second cycle was best conveyed the intention to yield.

Keywords: *driver's yield intention, automotive lighting, blinking pattern*

1 INTRODUCTION

This study was motivated by the evolution in recent years of automotive lighting as a signal to communicate with other traffic participants. In the near future, the traffic environment is expected to become more complex with the advent of self-driving vehicles. External Human Machine Interface (eHMI) has been proposed to replace the conventional communication (interaction) between the driver and surrounding traffic participants. Currently, there is no fixed design for eHMI, and target criteria are being discussed in automotive rulemaking forums such as UNECE WP29. Independence from language skills is one of the target criteria, and safety-conscious display contents are being considered. As some examples, there are road projection lamps and welcome lamps. The road projection lamp is a future lighting technology that projects information onto the ground to convey vehicle movement and information to other traffic participants. Its performance is being studied for implementation (Shibata, 2021). These are expected to be effective for facilitating communication in the traffic environment.

In this paper, we focused on “headlight flashing.” Headlight flashing in Japan is generally used as a sign to communicate a driver’s intention to yield to other drivers or pedestrians. However, it can have several meanings, including warning other drivers of road dangers such as crashed cars, or informing other drivers of the presence of a pedestrian. Therefore, drivers must guess the meaning of received headlight flashing depending on the situation. This creates the possibility of a misunderstanding, increasing the risk of accidents.

Nowadays, there are several types of automotive lighting (eg, sweeping, sequential, flashing). One research show pedestrians tend to cross sooner with a flashing signal compared to a sweeping signal. (Stefanie, 2019). Hence, we decided to identify a suitable blinking pattern to convey the intention to yield. Previous studies investigated the relationship between blinking frequency and light color, showing that a shorter blinking cycle correlates with a stronger feeling of tension for red, blue, green, and yellow colors. Conversely, the longer the blinking cycle, the stronger the feeling of relaxation (Yamashita, 2015). In this way, some studies have investigated relations between the blinking and light color and the receiver’s impression. However, few studies have investigated the blinking pattern to convey a specific intention. Therefore, this study focuses on nonverbal communication in which blinking lights convey a driver’s intentions to others.

This study aims to identify suitable blinking patterns of automotive lighting that convey a driver’s intention to yield. A blinking pattern consists of three elements: the light color, waveform, and blinking cycle. In this study, we set two steps of the experiment. The first step aims to identify one pattern that conveys yielding as a foundation pattern. Therefore, we experimented to select one of the blinking patterns they felt best conveyed the intention to yield. The second step aims to identify the relationship between the impression when blinking is received and each blinking pattern element. This paper describes the first step of this experiment.

2 EXPERIMENT

The first step of the experiment was conducted in a constant 650 lx illumination (Height from floor 1.1m) environment. Fifteen healthy participants sat in chairs spaced 2500 mm apart, and two lamps were installed at line-of-sight height (Figure 1). We provided nine blinking patterns (Table 1) that changed randomly the light color, waveform, and blinking cycle using the LED lamps (Figure 2). All blinking patterns except sample ④ have a constant chromaticity. Only sample ④ changed color (yellow → white → blue) with time. These blinking patterns were created by nine people who engage in developing an automotive lighting system, before the experiment. They were told respectively that create the blinking pattern that they thought could convey an intention to yield assuming the two scenes shown in Figure 3. Scene 1 shows communication between drivers, and Scene 2 shows communication between drivers and pedestrians. In both scenes, it is assumed that the front part of the vehicle illuminates when signaling.

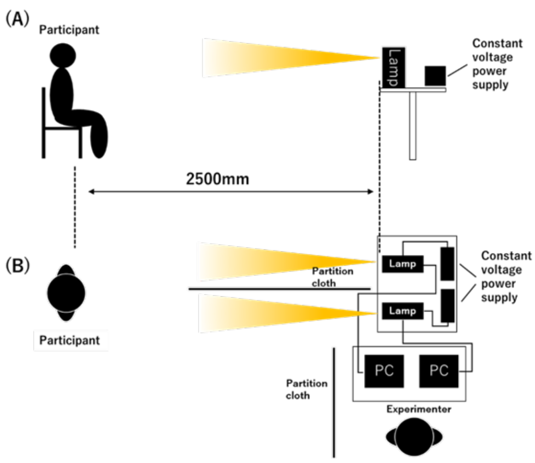

Figure1. Experimental environment: (A) Side view; (B) Front view.

Figure2. Apparatus: LED lamp, Constant-voltage power supply

Table1: Characteristics of each blinking pattern.

Sample No.	①	②	③
Waveform	Sine wave	Triangular wavex2 + 50%off	Sine wave+ 50%off
Time	1000ms	1500ms	1000ms
Chromaticity(x,y)	(0.24,0.18)	(0.19,0.73)	(0.23,0.11)
Sample No.	**④**	**⑤**	**⑥**
Waveform	B R,G	Sine wave	Triangular wavex2 + 50%off
Time	1000ms	1000ms	1000ms
Chromaticity(x,y)	Yellow→white→blue	(0.16,027)	(0.17,0.44)
Sample No.	**⑦**	**⑧**	**⑨**
Waveform	Trapezoidal waves x2 + 20%off	Trapezoidal waves x2 + 20%off	Trapezoidal waves x2 + 20%off
Time	2000ms	2000ms	2600ms
Chromaticity(x,y)	(0.25,0.18)	(0.15,0.15)	(0.18,0.76)

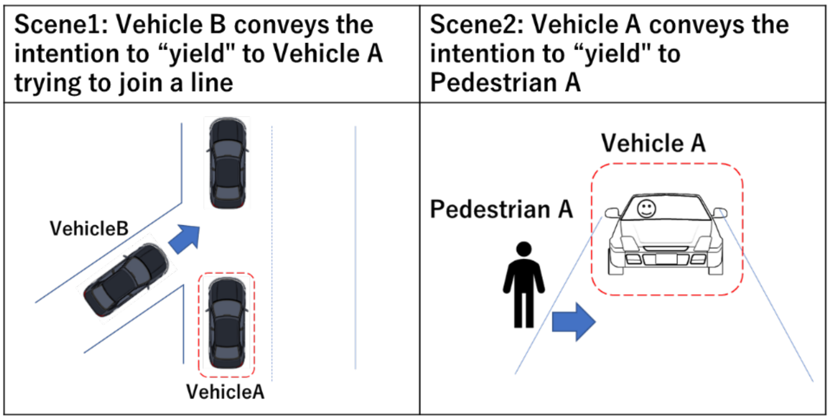

Figure 3: Assumed vehicle and pedestrian situations.

Visual impressions were evaluated by Scheffe’s method of paired comparison as modified by Nakaya (Takagi, 2014). Participants were asked to evaluate thirty-six combinations, comparing two different lighting patterns. Four blinking pattern combinations unrelated to the results were presented to familiarize the participants with the evaluation. Participants were asked to evaluate their visual impression of each of the following nine items on a 7-point scale by comparing the two types of blinking patterns: brightness, fast blinking speed, waveform rise rapidity, colors match the intention, glare, easily understood meaning, stands out, easy to see, and suitable.

3 RESULTS

This experiment aimed to identify a pattern that accurately conveys yielding as a foundation pattern. Therefore, we used the results of "suitable" and "easily understood meaning" item results in the overall evaluation. Also, we discuss the results of "colors match the intention", "easy to see" and "waveform rise rapidity", which were found to be strongly correlated with"easily understood meaning". Other item results were used for the discussion of evaluation trends.

The results of the impression evaluation by 15 participants are shown below. Figure 4 shows the results of the average degree of preference for "suitable," and Figure 5 shows the results of the average degree of preference for "easily understood meaning". For both items, samples ⑥ and ② were highly evaluated and showed significant differences from the other samples. However, the "suitable" category confirmed the combination effect, with a two-way interaction between the sample and the participants ($p<0.01$).

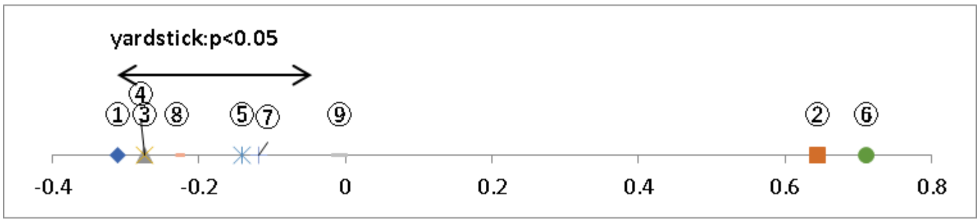

Figure 4: Average degree of preference: "suitable."

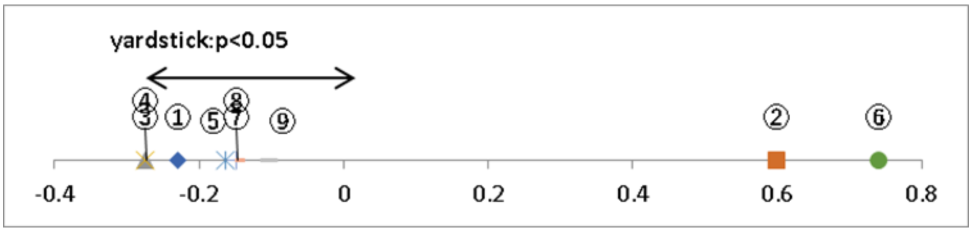

Figure 5: Average degree of preference: "easily understood meaning."

Blinking patterns with greenish colors were highly evaluated (Figure 6). However, the "colors match the intention" category confirms the combination effect, with a two-way interaction between the sample and the participants ($p<0.05$). According to the introspection survey results, this may be because the greenish color is similar to the blue of a traffic light in Japan, meaning "go." Therefore, this color was highly evaluated as a color for conveying that the signaling driver was yielding, so the signaled driver should proceed. For the waveform rise rapidity, sample ⑥ was the most highly evaluated (Figure 7). This flashing pattern is the fastest rising waveform of all the patterns and is considered highly rated because it closely resembles flashing headlights. Also, in terms of "easy to see", sample ② and ⑥ were highly evaluated (Figure 8).

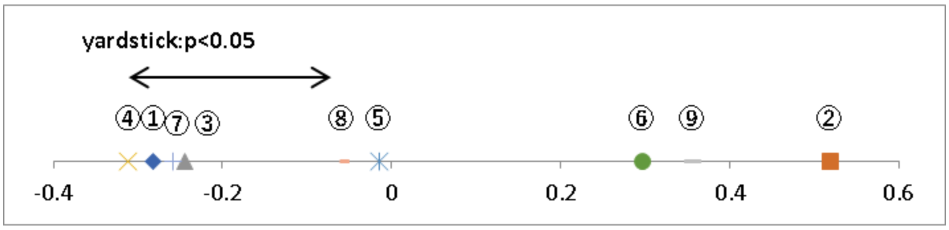

Figure 6: Average degree of preference: “colors match the intention.”

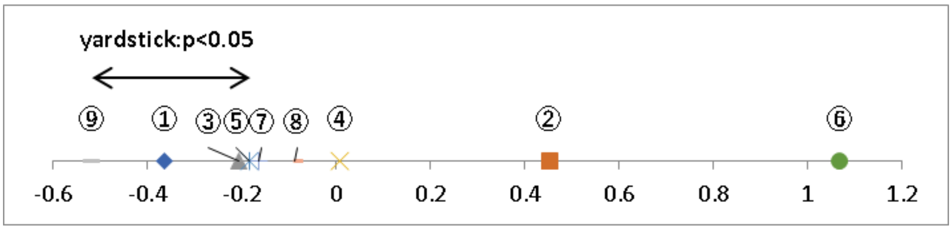

Figure 7: Average degree of preference: “waveform rise rapidity.”

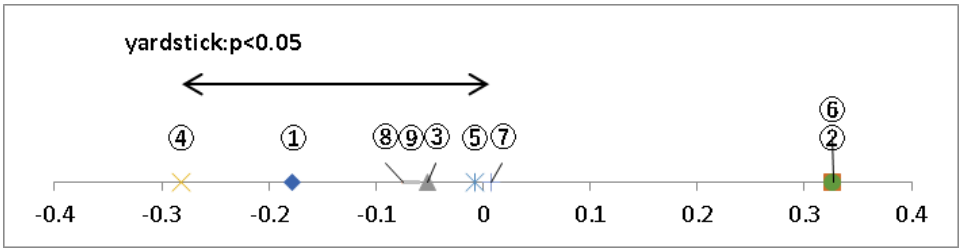

Figure 8: Average degree of preference: “easy to see.”

Based on these results, we chose a blue-green pattern with luminance changing in a triangular wave pattern with a one-second cycle (sample ⑥) as the blinking pattern that best conveyed the intention to yield. In this study, we give importance to nonverbal communication, and although there are some errors in chromaticity values between the samples used in the previous study and the blue-green emission pattern used in this study, the results are roughly in agreement with the previous study (Stefanie 2019).

4 CONCLUSIONS

We investigated blinking patterns' suitability for conveying a driver’s intention to yield by flashing their automotive lighting. We presented nine blinking patterns with different light colors, waveforms, and blinking cycles to fifteen participants and asked them to evaluate them based on visual impressions.

As a result, a blue-green pattern with luminance changing in a triangular wave pattern with a one-second cycle was chosen as the blinking pattern that best conveyed a driver’s intention to yield. This result is considered to be influenced by participants’ previous experiences, such as headlight flashing and traffic lights.

In this experiment, we investigated one of the suitable blinking patterns as a foundation pattern for the next step. Therefore, it is necessary to investigate the method of identifying the relationship between the impression when receiving the blinking signal and each blinking pattern element in the future.

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INVESTIGATION OF SYMMETRIC RELATIONSHIP BETWEEN EVALUATION OF SMOOTHNESS AND ROUGHNESS IN FABRIC SURFACE IMAGES

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ABSTRACT

The purpose of this study was to investigate the symmetry relationship between evaluation of smoothness and roughness of fabrics and the physical factors related to the evaluations, using a set of images obtained by photographing the surfaces of eight fabrics. These fabric surface images were created by setting the distance between the fabric and the camera at approximately 1 m and gradually reducing the distance for each of the eight fabrics. Based on these images, we conducted an experiment to evaluate the smoothness and roughness of fabrics on a seven-level unipolar scale. Results showed that the evaluation characteristics of fabric smoothness and roughness with consideration of the shooting distance of the fabric surface images differed for each fabric. Furthermore, analysis of the correlation between evaluation of smoothness and roughness of fabrics indicated that symmetry was not established between evaluation of smoothness and roughness of some fabrics.

Keywords: *Roughness, Smoothness, Visual, Shooting distance, Symmetry*

1 INTRODUCTION

In recent years, Internet shopping has become a popular option for many because of its convenience. In addition, its use is further increasing as a result of the restrictions on urban movement implemented in response to the global COVID-19 pandemic [Ministry of Internal Affairs and Communications, Japan, 2021]. However, previous studies have reported an advantage of vision over physical touch [Heller, 2017; Guest, Catmur, & Lloyd, 2002; Nishimatsu & Sakai, 1987]. Internet shopping can be considered a very useful sales method because its presentation technique leverages this visual advantage. In light of this, an important issue is the creation of images that facilitate human recognition of fabric textures and the establishment of a presentation method for such images.

In the previous study [Ishikawa et al., 2011], the relationship fabric texture evaluation and mechanical properties was investigated, and it was found that SMD (Mean deviation of surface roughness) [Kawabata, 1980], a mechanical property of the fabric surface, is an important characteristic of the feeling of the fabric texture. In addition, a study to identify evaluation words for fabric appearance and tactility revealed the importance of "smoothness" and "roughness" of fabrics [Ishikawa, Nakamori, Sasaki, Miyatake & Ayama, 2015]. On the other hand, several studies have reported on the symmetry of evaluation using semantically paired evaluation words [Ogino & Noguchi, 1996; Kato, Asahara, Moriyama & Ogiwara, 2021], but there has thus far been no discussion on fabric texture evaluation. In this study, we prepared a set of images of fabric surfaces and conducted experiments to evaluate the smoothness and roughness of fabrics in these images. In this report, symmetry is analyzed in words of oppositeness and correlation.

2 EXPERIMENT

2.1 Experimental Conditions

2.1.1 Creating Images

Eight different fabrics that fashion designers could identify were used (Figure 1). The shooting distance between the camera and the fabrics ranged from 0.2m to 1.0m, and shot in increments of 0.1 m. Nine patterns were used. In total, 72 fabric surface images were created. The camera type, lens, and shooting camera settings are listed in Table 1. The shooting environment included a photography booth (Figure 2) and D65 fluorescent lamps (FLR40S-D-EDL-D65/M, Toshiba, Japan) were placed on the left, right, and top of the booth to ensure uniform brightness throughout.

Table 1. Camera type, Lens and Camera settings

Item	Details
Camera type	Nikon D600
Lens	AF-S Micro NILLOR 60mm
Camera settings	ISO:100, Shutter speed:1/30, Aperture: F10.0

Figure 1. Fabric images

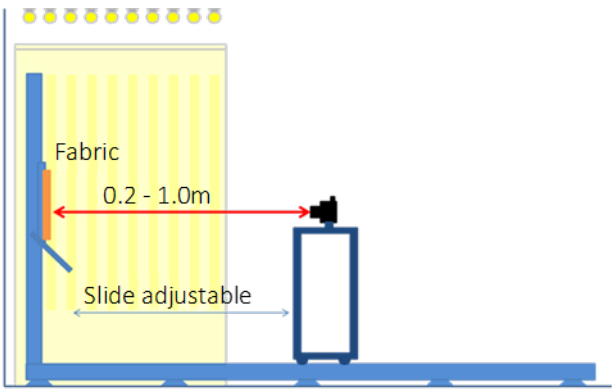

Figure 2. Photography booth for fabric

2.1.2 Evaluation Conditions

Figure 3 illustrates the evaluation conditions. The evaluation conditions consisted of a dark room, with the only light being the brightness emitted from the monitor. The distance from the monitor to the eye was approximately 72 cm. The evaluation scale was a 7-step unipolar scale (0 = no, 2 = slightly, 4 = usually, 6 = very) for roughness and smoothness, respectively. Participants were 10 male engineering students in their 20s.

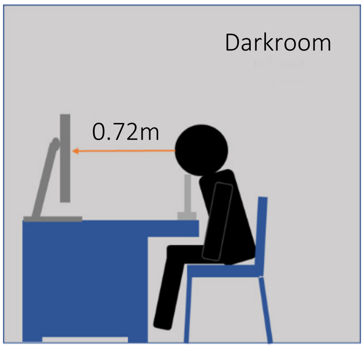

Figure 3. Evaluation conditions

2.2 Result and Discussion of Experiment

Figure 4 presents the relationship between shooting distance and smoothness/roughness evaluation values. As the shooting distance increased, the smoothness evaluation value increased, while the roughness evaluation decreased. Therefore, it is clear that a set of fabric surface images obtained by this imaging method can be used for quantitative assess smoothness/roughness. Further, it is clear that the evaluation characteristics of each fabric vary, although the trends of the evaluation characteristics are similar for each fabric.

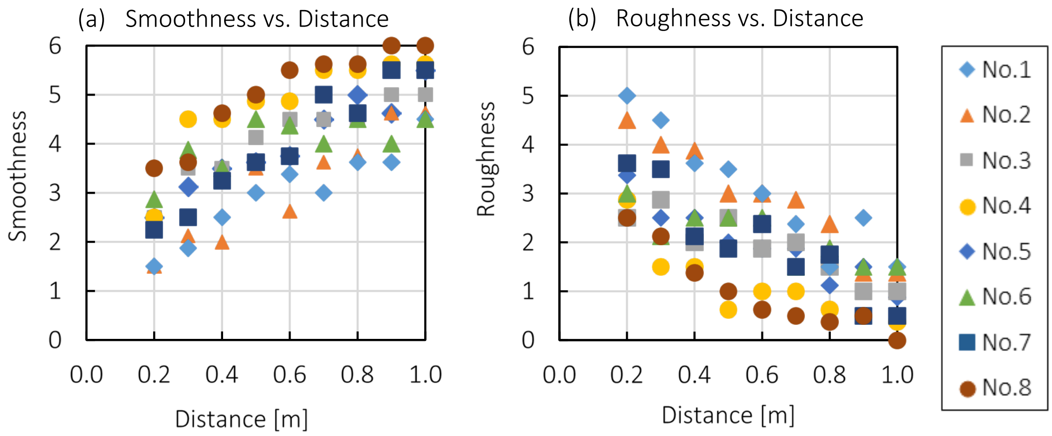

Figure 4. Relationship between shooting distance and evaluation value

Next, the symmetry relationship between evaluation of smoothness and roughness for the same image was examined. For the purposes of this study, symmetry was considered as the sum of the smoothness and roughness evaluations close to 6, and the absolute difference between the sum of the evaluations and 6 was calculated. The symmetry of No. 8 in Figure 5 was as high as approximately 0.9, and the symmetry of No. 5 was as low as approximately 0.72. Based on this, the results indicated that there may or may not be symmetry in the evaluation depending on the fabric type.

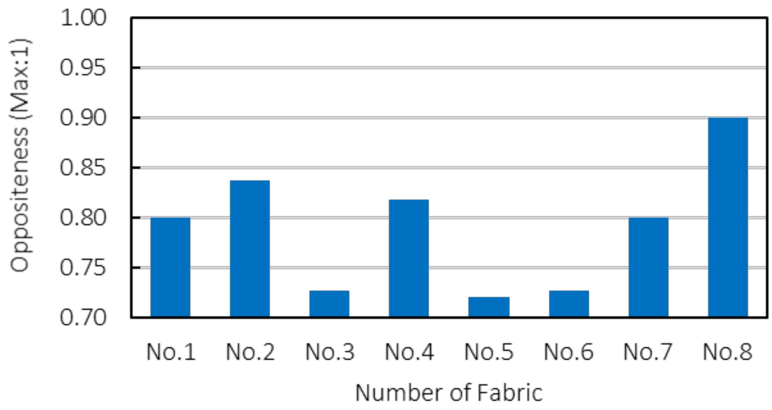

Figure 5. Oppositeness of smoothness and roughness for fabrics

3 ANALYSIS OF RELATIONSHIP BETWEEN SMOOTHNESS AND ROUGHNESS

The correlation coefficients between shooting distance, smoothness, and roughness were analyzed. Fabrics Nos. 1, 2, 3, 5, 7, and 8 which had high correlation coefficients between shooting distance and smoothness evaluation (Figure 6-(a)), tended to have high correlation coefficients between shooting distance and roughness evaluation (Figure 6-(b)). However, fabrics Nos. 4 and 6, which had low correlation coefficients between shooting distance and smoothness evaluation, tended to have low correlation coefficients between shooting distance and roughness evaluation.

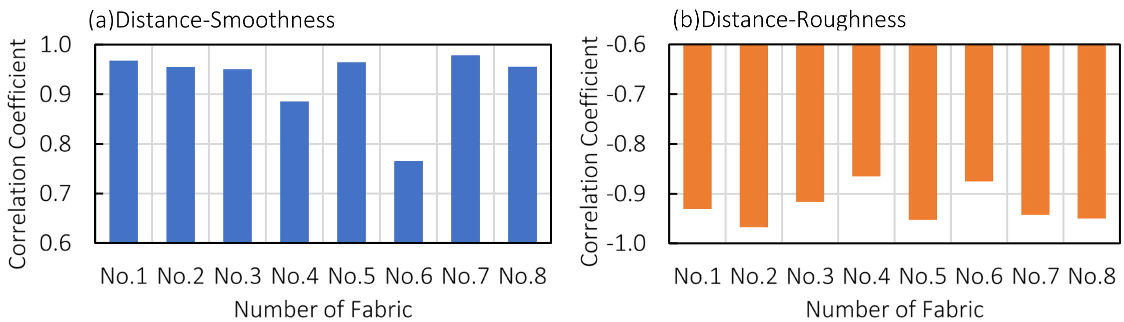

Figure 6. Correlation coefficient between shooting distance and smoothness/roughness evaluation

The correlation coefficients between evaluation of smoothness and roughness (Figure 7) were high for Nos. 1, 2, 4, 5, 7, and 8, suggesting a high correlation between the evaluation words. However, the correlation coefficients were low for fabric Nos. 3 and 6, suggesting a low correlation among the evaluation words. In other words, there were cases in which the correlation was not recognized, depending on the fabric.

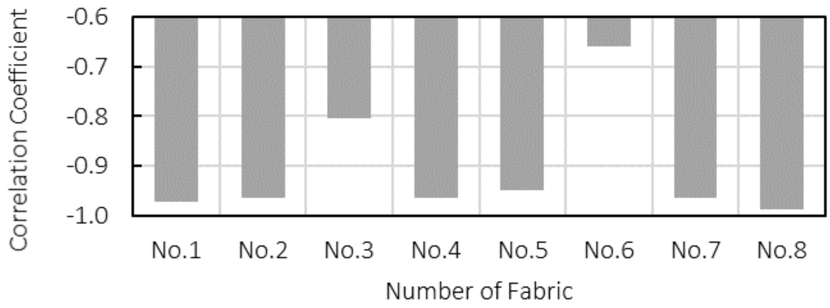

Figure 7. Correlation coefficient between evaluation of smoothness and roughness

Next, we analyzed the relationship between oppositeness (Figure 5) and the correlation between the evaluation words (Figure 7). Among Nos. 3, 5, and 6, which had low oppositeness, Nos. 3 and 6 also had low correlations, whereas No. 5 had low oppositeness but high correlations, suggesting that oppositeness and correlations capture different factors relating to making evaluations.

4 CONCLUSION AND FUTURE WORKS

The purpose of this study was to evaluate the smoothness and roughness of fabrics at seven unipolar levels using a set of images of eight different fabric surfaces and nine shooting distance conditions, and to examine the evaluation characteristics and symmetry between the evaluation words. The results revealed that the evaluation characteristics of smoothness and roughness of the fabric surface image with consideration of the shooting distance differed for each fabric. The fabrics with low correlation coefficients between the distance at which the fabric surface image was taken and the smoothness evaluation were almost the same as in the case of the roughness evaluation of the fabrics. Furthermore, the analysis of the correlation between evaluation of smoothness and roughness of a fabric indicated that symmetry between the smoothness and roughness evaluations could not be established in some fabrics.

It is suggested that future studies examine the differences in the evaluation characteristics of smoothness and roughness of fabrics and the effects of the physical sensation and visual characteristics of fabric surfaces, which are thought to influence the symmetry of smoothness and roughness evaluations.

Based on the above results, our final goal is to contribute to the development of next-generation online shopping sites that present images conforming to the evaluation of smoothness and roughness.

ACKNOWLEDGMENTS

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JAPANESE UNIVERSITY STUDENTS' BEHAVIOR WHEN READING ENGLISH: A QUESTIONNAIRE SURVEY AND FACTOR ANALYSIS

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ABSTRACT

This paper reports on a specific cognitive behavior often found when trying to understand a text not written in readers' native language. Our research group conducted a questionnaire survey to examine Japanese readers' cognitive behavior and awareness when reading English texts. We also conducted a factor analysis on this questionnaire to identify the behaviors often found when reading English. Participants were 56 Japanese students studying engineering at Chuo University. After reading the texts, a questionnaire consisting of 43 items was applied to the participants. We used exploratory factor analysis to identify the primary factors related to readers' cognitive behavior and awareness when reading a non-native language. As a result of the analysis, mainly based on the highest contributing factors, it was suggested that readers may have made substitutions into Japanese, their own words, when reading the English texts. In other words, when reading a non-native language, the reader may read the texts by replacing them with their native language rather than comprehending it in that language. Based on the results of our experiment, it is expected that the research on the cognitive supporting systems may help readers to understand non-native languages quickly and smoothly.

Keywords: *validating factor analysis, exploratory factor analysis, non-native language, second language, L2*

1 INTRODUCTION

This study examines cognitive behavior and attitudes during English reading comprehension to identify what Japanese students are doing and aware of when reading English as a non-native language. Characters and sentence structure are very different between Japanese and English. Due to the difference, almost all Japanese university students learn English as a second language (L2). However, they rarely use it daily, and few are proficient in reading English. So it is necessary to clarify how Japanese readers understand English texts. Furthermore, Japanese university students' cognitive behavior and attitudes when reading English texts have not been investigated. In contrast, the cognitive behavior and attitudes of Japanese university students when reading explanatory texts in Japanese have already been studied.

Our research group used a questionnaire survey and exploratory factor analysis to analyze cognitive behavior and attitudes when reading English. Inuzuka (2002) already utilized these methods. Therefore, we also adopted his research procedures in this study. Inuzuka (2002) clarified the factors comprising reading comprehension strategies through factor analysis of the results from a questionnaire on behavior and awareness while reading Japanese explanatory documents. Results of the questionnaire were classified into seven categories and summarized into three factors*: partial comprehension strategies*, *content learning strategies*, and *comprehension deepening strategies*.

We also referred to the following studies: Hsiao & Oxford (2002) and Yüksel & Yüksel (2012).

Hsiao & Oxford (2002) systematically reviewed the classification of L2 learning strategies and theories concerning their application. They conducted a confirmatory factor analysis of the data collected from 517 college learners who learned English as a foreign language. They revealed that Oxford's six-factor reading strategies and classification were the most consistent with learners' strategy use. The six factors used in this study were *memory*, *cognitive*, *compensation*, *metacognitive*, *affective*, and *social*.

Yüksel & Yüksel (2012) studied academic reading strategies among Turkish university students. Their study focused on the students' metacognitive awareness of three strategies used in academic reading: *global reading strategies*, *problem-solving strategies*, and *support strategies*. Their results showed that the participants usually used these strategies and were often aware of them.

2 METHOD

2.1 Participants

A questionnaire survey was conducted with 56 undergraduate and graduate students aged 20 to 29. The 56 participants included 39 males and 17 females, and no one was excluded from the analysis.

2.2 Procedure

This study chose the questionnaire reported in Inuzuka (2002) because it was written in Japanese. In addition, it was selected because Inuzuka assumed an explanatory document. The questionnaire contained 43 items concerning cognitive behavior and attitudes while reading English, rated on a 5-point scale, with 1 = *applicable* and 5 = *not applicable*. Table 1 displays the questionnaire item details.

Table 1. Questionnaire reading strategy items

1	Write down the important parts
2	Write comments and a summary of the content
3	Read with a paragraph-by-paragraph summary in mind
4	Read with a clear understanding of what is meant
5	Read while anticipating what is written next
6	Read while thinking about the important parts
7	Read with a concrete image in mind
8	Read while thinking about the text structure
9	Underline important text
10	Read by comparing the text with what you already know
11	Read while thinking about what each sentence simply means
12	Try to remember important words
13	Think about the title
14	Look for unfamiliar letters and words when reading
15	Repeat reading where you don’t understand the meaning or where it is difficult to understand what is meant
16	Read while thinking about what kind of questions a teacher would ask
17	Skim the whole book quickly to get a general idea of the meaning, and then re-read it
18	Write a paragraph-by-paragraph summary
19	Read slowly through the parts you don’t understand
20	Restate difficult phrases in your own words
21	Distinguish between what is important and what is not while reading
22	Take periodic breaks to recall what you have read
23	Adjust your reading speed based on how difficult the material is
24	Ask yourself questions to check how much you know
25	If you don’t understand something, think about where the meaning became unclear to you and start reading again
26	Think about whether the content is correct while reading
27	If you don’t understand something after reading it once, re-read it and try to understand it again
28	Concentrate on reading
29	When you find an unknown word, skip it and continue reading
30	After reading, ask yourself questions to check how much you understand

31	Read difficult sentences while rephrasing them in your own words
32	Think of specific situations to help you remember new words
33	Read while trying to connect what you are reading with what you already know
34	Memorize difficult words and content without understanding them
35	Draw simple tables and diagrams to summarize the content
36	Read while thinking about the meaning of each paragraph
37	Reading while thinking about where the words correspond to each other
38	Reading while paying attention to conjunctions (words like “but,” “and,” “that is,” etc.)
39	Read with concrete examples
40	Read repeatedly to memorize
41	Try to memorize important sentences without thinking about them
42	Predicting the whole picture from the context
43	Trying to read quickly

3 RESULT

We conducted an exploratory factor analysis and clarified what the respondents’ cognitive behavior and awareness when reading English texts. First, the number of factors was determined by parallel analysis using a screen plot, a graph of the eigenvalues of factors (Figure 1).

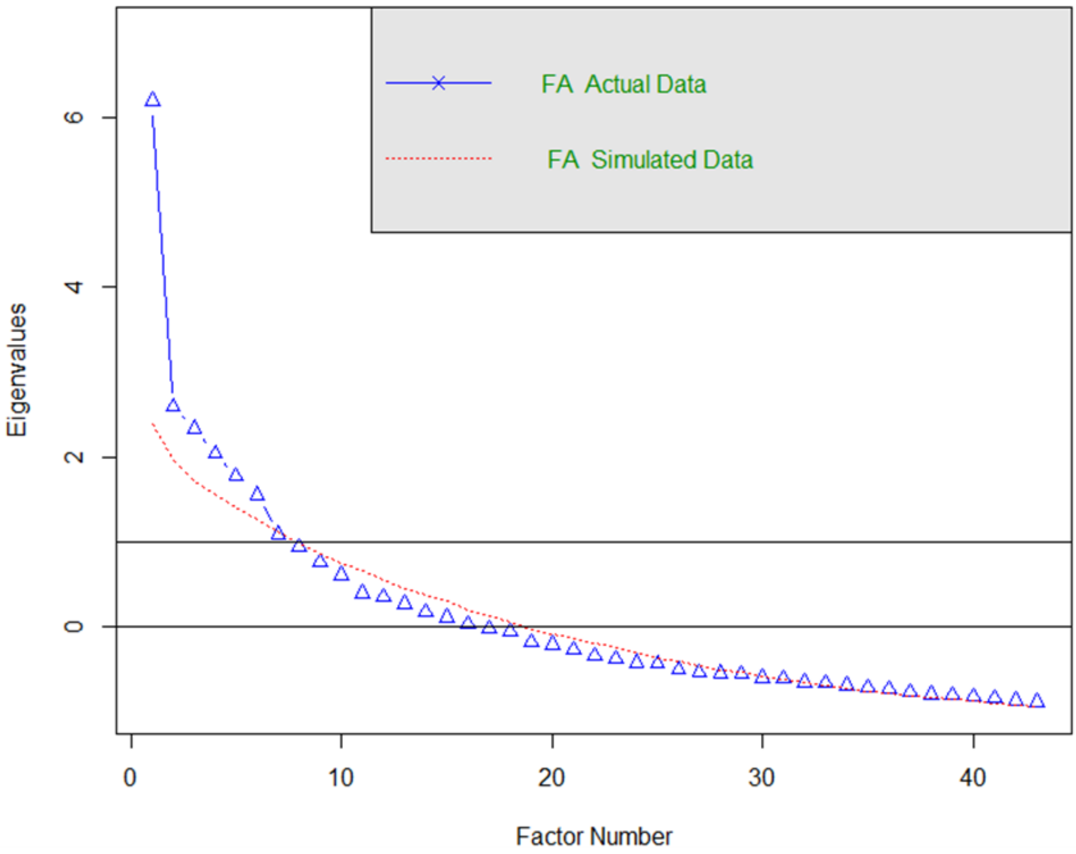

Figure 1. Graph of a screen plot

From the screen plot shown above, the number of selected factors is 6, which is larger than the eigenvalues of the randomly generated data.

The factor structure is represented in Figure 2, and the results of the factor loadings are summarized in Table 2.

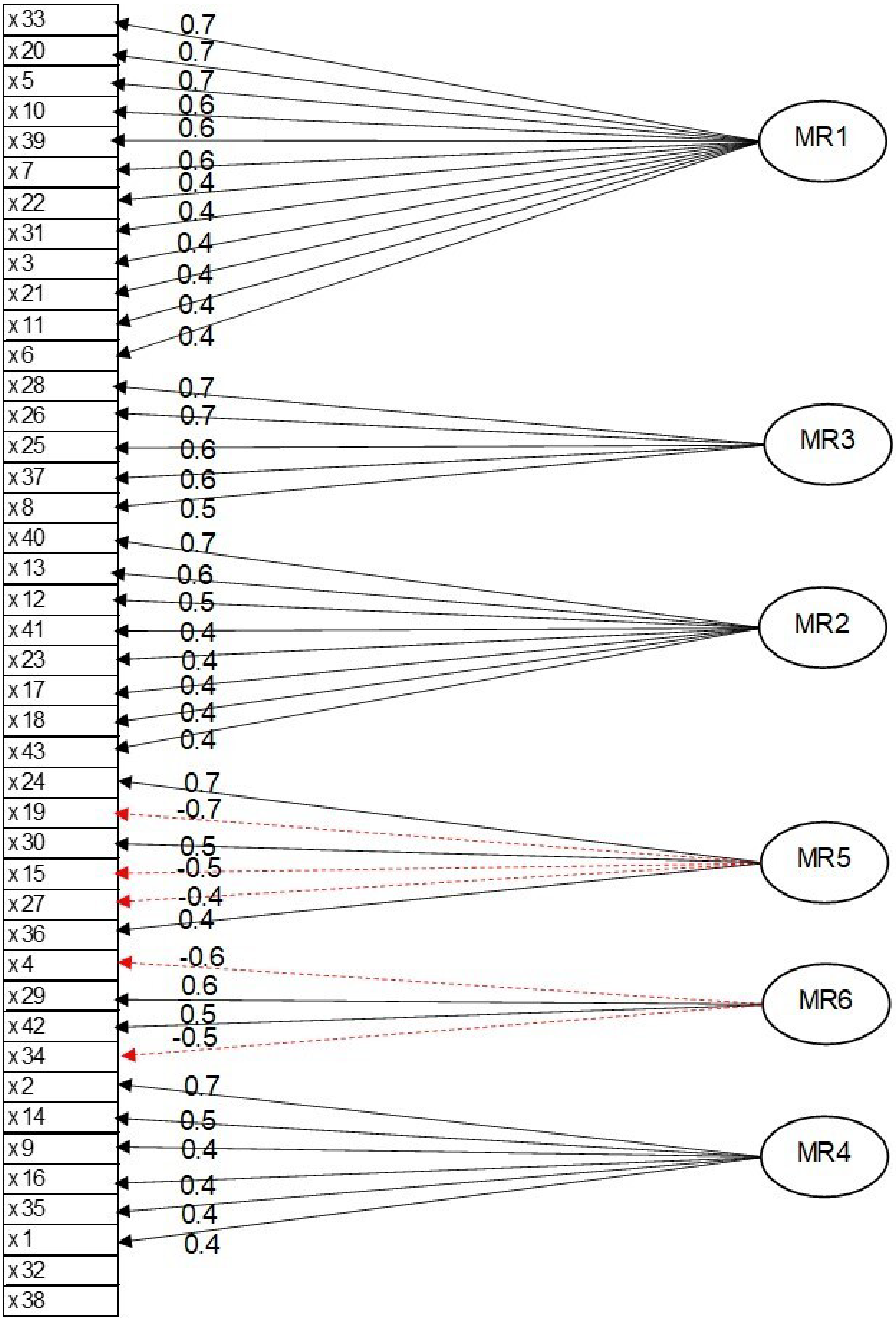

Figure 2. Factor analysis

Table 2. Factor loading

Factor	Questionnaire Item Number	MR1	MR3	MR2	MR5	MR6	MR4
MR1	x33	0.69		-0.13	0.11		0.22
	x20	0.68				-0.2	
	x5	0.67	-0.1			0.22	-0.22
	x10	0.6	0.16			-0.18	
	x39	0.6	-0.15				
	x7	0.58		0.23		0.15	-0.31
	x22	0.43					0.24
	x31	0.41	0.1	-0.11	0.11	0.22	
	x3	0.39	-0.15	0.17	0.28		-0.14
	x11	0.37	0.21		-0.11	0.33	
	x21	0.37	0.28			0.25	
	x6	0.36	0.22	0.11		0.12	-0.13
MR3	x28		0.72		0.13		
	x26		0.67				
	x25	0.3	0.56		-0.28	-0.37	
	x37	0.14	0.56	-0.17		0.35	0.27
	x8		0.54	0.3			-0.22
MR2	x40			0.75		-0.16	0.12
	x13		0.22	0.55		0.3	-0.12
	x12	-0.15	0.44	0.49			
	x41		-0.15	0.44		-0.15	
	x23		0.13	0.4	-0.17		-0.19
	x17		-0.13	0.39		0.29	0.35
	x18	0.1		0.36	0.35		-0.1
	x43	-0.17		0.35	0.32	0.29	

MR5	x24	0.22	0.23		0.72	-0.12	
	x30	0.2	0.25	0.17	0.55		0.21
	x36		0.28		0.39	0.34	0.15
	x27		0.17	0.17	-0.44		0.24
	x15		0.12		-0.51		0.39
	x19		0.17	0.13	-0.68		
MR6	x29					0.59	
	x42	0.11	0.33			0.52	-0.32
	x34			0.32	0.2	-0.49	-0.31
	x4	-0.13	0.41			-0.59	
MR4	x2				0.14		0.69
	x14	0.29		0.22	-0.12	-0.1	0.49
	x9			0.41		0.33	0.41
	x16	0.31	-0.14	0.35		-0.1	0.39
	x35	0.37			0.21		0.38
	x1	-0.21			0.38	0.18	0.38
Non-assigned	x38	0.12			0.23	0.28	
Non-assigned	x32	0.26		0.2	-0.12	0.19	

Table 3 also shows that the factor contribution for this experiment was 41%. Finally, each factor is compared with Inuzuka's factors. Figure 3 examines the factors reported by Inuzuka (2002): (A) *grasping the gist*, (B) *paying attention to structure*, (C) *clarifying meaning*, (D) *utilizing existing knowledge*, (E) *memory*, (F) *monitoring*, (G) *control*.

Table 3. Factor contribution

	MR1	MR3	MR2	MR5	MR6	MR4
SS loadings	4.11	3.05	2.73	2.74	2.6	2.46
Proportion Var	0.1	0.07	0.06	0.06	0.06	0.06
Cumulative Var	0.1	0.17	0.23	0.29	0.35	0.41

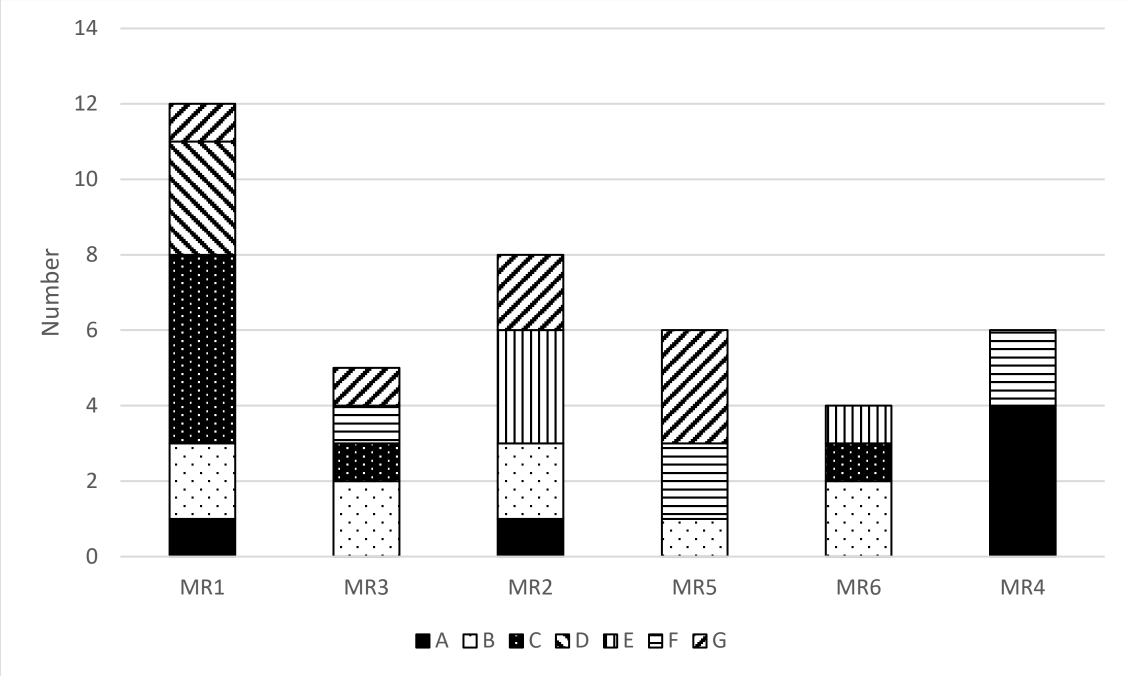

Figure 3. Breakdown of each factor

4 DISCUSSION

4.1 MR1

MR1 includes "putting words and sentences in the text into your own words" (clarifying meaning) and "using one's knowledge" (utilizing existing knowledge). In other words, the students read English while relating what is read to their terms and understanding.

4.2 MR3

While MR3 includes paying attention to structure, that is, to "read with attention to structure," it also contains items to check whether the user "understands the content." In other words, the participants are monitoring whether they know the text by focusing on the structure of the text.

4.3 MR2

MR2 includes memory for "important words and sentences in the text." The items related to the title summary and paragraphs indicate that the participants are trying to understand the text outline by focusing on the essential parts.

4.4 MR5

MR5 contains many metacognitive factors, such as monitoring and control. However, we found that the factor loadings for monitoring were positively correlated. In contrast, the loadings for control were negatively correlated. The idea is to keep reading without stopping on the parts that are not understood.

4.5 MR6

The factor loadings for "Read with a clear understanding of what is meant" were negative, while those for "Predicting the whole picture from the context" were positive. In other words, the participants understand sentences, not in detail but try to understand a total image in the context structure.

4.6 MR4

MR4 contains the highest number of factors reported in Inuzuka (2002). These elements relate to grasping the main points. This factor may emphasize the importance of getting the gist. Inuzuka (2002) suggested that the factor of grasping the gist had the highest contribution rate. However, in the present study, its contribution rate was low. Japanese students seem to place more emphasis on word comprehension when reading English texts.

5 CONCLUSION

In the exploratory factor analysis, we considered each factor with the number of factors set at 6. MR1, the factor with the highest contribution rate, suggested the possibility that the participants read while substituting Japanese for English when comprehending English sentences. Contrarily, grasping the gist, which had the highest contribution rate in the Inuzuka's study, was low at 0.06 in the present study.

Although the present paper omits the details of another study on validated factor analysis using the survey by Inuzuka (2002), Figure 3 shows a part of the comparison with Inuzuka's study. The comparison results suggest that Inuzuka's model does not fit well with the present one. This discrepancy in the models may result from differences in the reading strategy used for Japanese and English documents. For proper validated factor analysis, it would be desirable to use Japanese explanatory texts and increase the number of Japanese participants tenfold.

The following are possible strategies for our near future research:

1. The number of participants should be increased.
2. We must verify whether the model proposed in this study is more accurate than previous ones.
3. We must estimate the reader's state from eye movements during text reading.

We have the above plans to deeply clarify the reader's cognitive behavior and awareness during reading comprehension by studying the relationship between eye movements and the reader's state of comprehension. Furthermore, we believe such a study will contribute to developing the cognitive supporting systems that help readers to understand non-native languages quickly and smoothly. Through these studies, it is strongly expected to develop supporting technologies that will enable readers to continue reading texts easily.

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KANSEI ANALYSIS SHOWN IN A SINGLE MAP : MULTIPLE CORRESPONDENCE ANALYSIS OF DESIGN ELEMENTS AND KANSEI EVALUATION

A CASE OF LEATHER PATTERNS SIMULATED WITH 3D CG IN CHILDREN'S LOWER LEG ORTHOTICS

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ABSTRACT

In this study, we regarded the idea that supplementary variables and Multiple Correspondence Analysis are promising for analysis and visualize complicated relations in Kansei analysis. It could merge several different information tables and then project them into a map. Applying this advantage would make the overall view of Kansei. Design elements, samples, and associated Kansei words were shown in an MCA map. Leather patterns of children's lower leg orthotics are the objective of this Kansei evaluation. The leather surface was simulated with 3D CG with physically based rendering methods.

Keywords: *multiple correspondence analysis, multivariate analysis, 3D CG, surface, Kansei evaluation*

1 INTRODUCTION

1.1 Standard Kansei Analysis Methods

Since the beginning of the Kansei engineering in the early 1970s, invented by Prof. Mitsuo Nagamachi, Kansei Engineering has been involved in the development of many successful products such as MAZDA Roadster (Miata in the US, MX-5 in Europe and Asia), lighting devices, and home appliances from Panasonic, Milbon Deesse's Hair treatment products, Washer-Dryer from SANYO. Moreover, the methodologies of Kansei Engineering have been spreading to various

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industries. From car industries like Nissan, Mazda, FIAT and suppliers, home electronics industries like Panasonic, LG, and Samsung, cosmetics, food industries, and service industries such as hotels have intensively incorporated KE into their product planning and design process.

Several multivariate analysis techniques deliver Kansei structure and relations between design elements and Kansei evaluation. Following is the building procedure of Kansei engineering analysis and building Kansei systems.

(1) Selection of Kansei words

Select the Kansei words that are appropriate for what is intended. In the case of a house interior design, Kansei words are selected from interior magazines and books. Collected Kansei words are paired in the semantic differential (SD) 5-grade scale, like "beautiful [ ][√][ ][ ][ ] not beautiful". Most of the Kansei words are adjectives, but some words are uncommon jargon for specific domains. Thus, we call them "Kansei words" rather than adjective words.

(2) Assessment of the design components

The second step is to conduct a psychological experiment to collect subjects' Kansei. A semantic differential method questionnaire is made to evaluate products. Then, an experimenter presents slides, pictures, or real products to subjects for their assessment. These design element parameters (i.e., color, size, and shape of parts, components, or the whole design) are measured.

(3) Multivariate analysis of Kansei evaluation data

The next step is to analyze the latent structure of Kansei statistically. At first, Principal Component Analysis to find the correlational structure between Kansei words. Then, the implicit relations among Kansei words and physical attributes (i.e., color, size) are estimated. Hayashi's Quantification Theory Type I model has been used for this numerical estimation procedure. In these 20 years, we have often used Partial Least Squares regression as a computing method for solving the QT1 model (Ishihara, 2011).

(4) Development of Kansei Engineering System

The obtained relations among a component's design, features, structure, and the Kansei words are converted to rules that a computer uses for reasoning. An inference engine, graphics database, and graphics drawing engine are built for a complete system. Our Kansei engineering system can draw a design that corresponds to the user's Kansei from their input of Kansei words. We have developed various Kansei engineering systems, such as house interior, car interior design, and garment coordination.

1.2 Bourdieu’s Big-picture of social classes

French sociologist and public intellectual, Pierre Bourdieu (1930-2002) have published his monumental book, “La Distinction: Critique Sociale du Jugement” in 1979. This book revealed “social position” from quantitative data of different social surveys with multiple or single correspondence analyses.

Combining multiple survey data, “La Distinction” reveals social classes and distinctions between classes. A big-picture view of social classes in his demographics shows an integrated view. “Upper classes” include higher / middle level education lecturers, freelance professionals (Bourdieu take examples as doctor, lawyer, architects.), executive officers, officers at government or public offices, senior engineers, and businesspersons (of industry and commerce). Educators have the highest cultural capital but have lesser financial capital; Businesspersons have the highest financial capital and lesser cultural capital. Freelancer professionals have both financial and cultural capital to a higher degree.

In Bourdieu’s perspective, each individual has a position in a multidimensional social space. A person is not defined only by social class membership but by these different capitals. Thus, asking people about their lifestyles, such as hobbies, dining habits, kinds of preferred music, preferred art form, painters, reading newspapers, kinds of automobiles, and physical activities, reveals their social positions and capitals with multivariate analyses objectively. Bourdieu’s methodology of mathematical analysis of heterogeneous data shares insights with Kansei engineering data analysis. Bourdieu predominantly relied on Correspondence Analysis and Multiple Correspondence Analysis for his research and intellectual insights. These analysis methods are developed statistician team led by Jean-Paul Benzécri (1932-2019) at Paris University No.6, Pierre and Marie Curie University.

1.3 Correspondence Analysis

Correspondence analysis (CA) has been studied since the early 1970s (i.e., Benzecri, 1992) as a method to visualize the relations between rows and columns of a contingency table. The below lines are taken from our paper (Ishihara, Ishihara & Nagamachi, 2007).

The concept and procedure of the correspondence analysis are based on Pearson's chi-square test, which is the most popular method to test the relations between rows and columns in a table. In the process of the chi-square test, the expected value of each cell is calculated from the sum of the row, the sum of the column, and the grand total; i.e., The expected value of cell $_{ij}$ is *(sum of the row$_i$) * (sum of the column$_j$) / (grand total).*

The difference between the expected and the observed value is *(observed - expected)^2 / expected*. The total difference over all cells is a chi-square value. If it is more significant than a particular value with the degree of freedom, we reject the null hypothesis and conclude that the rows are significantly associated with the columns.

The difference table is *i*-dimensional in rows and *j*-dimensional in columns. The rows and columns are projected onto a smaller number of dimensional (i.e., 2-dimensional) space in the process of the correspondence analysis. Each row is projected onto a reduced dimensional space; each column is also projected onto another space with the same number of dimensions. When we normalize and superimpose the two reduced dimensional spaces, we can understand the relationships between items listed in rows and columns in the difference table.

In Kansei engineering, we have applied CA to solve the Quantification Theory Type 3 model of Chikio Hayashi (1954). (Ishihara, Ishihara & Nagamachi, 2007)

1.4 Supplementary Points

In correspondence analysis, variables and individuals (measured sample) those used for composing CA map space are called active variables and active individuals. In this application, a active individuals are samples (e.g. leather11w) and active variables are design elements (i.e., large_grain) as shown in table 1.

CA can deal with additional variables. They are not used for composing CA map space. Map dimension and space were fixed with active variables and active individuals. The positions calculated from additional variables are called Supplementary Points. Then, the supplementary points show the correlational relations of additional information with active variables or individuals. Positions of supplementary variables are computed with eigenvector matrices that correspond as rows or columns of the contingency table.

Table 1 shows the variables and samples in this research. Supplementary variables are Kansei words. The rightmost column is *cute*. Kansei evaluation values exceeding the average of overall evaluation +1 SD were noted as *cute*.

Evaluations below -1SD were noted as *not cute*, and evaluations between +-1SD were *Neither Cute*. Kansei analysis shown in section 3.2 has 26 Kansei words as supplementary variables. Then figure 8 shows spatial relations between samples, design elements as active points, and 26 Kansei words as supplementary points.

1.5 Multiple Correspondence Analysis

Correspondence analysis represents an association between two categorical variables. Multiple Correspondence Analysis (MCA) deals with a set of categorical variables. If these variables are on the same kinds of scale (quantitative/categorical) and have the same coding scheme, these could treat as a variable set (Greenacre, 2017).

An indicator matrix or Burt matrix is used for coding a set of categorical variables. The indicator matrix has 0/1 style coding. Burt matrix has a set of square contingency tables of all variables of the set. A submatrix of the Burt matrix has n-row n-column that represents n variation of a categorical variable. Mathematical properties of the 0/1 coded indicator matrix are well written in Husson, F, Lê, S. & Pagès, J. (2017).

As shown in Table 1, the design element table in this study has three-valued and five-valued variables (i.e., grainSmall / Large / emboss dots / nubuck). Kansei evaluation has been coded in three-valued. These are automatically re-coded into the Indicator matrix with the FactoMineR package (Lê, S., Josse, J. & Husson, F., 2008).

In this study, we regarded the idea that supplementary variables and MCA are promising for analysis and visualizing complicated relations in Kansei analysis.

It could merge several tables of different kinds of information, then projects them into a map. Applying this advantage would make the overall view of Kansei like Bourdieu's integrated big-picture view.

Table 1. Design element table for Multiple Correspondence Analysis. More Kansei evaluation columns are followed by the rightmost "*cute*".

Sample No.	sample	Shiny/ Matte	grainSmall/Large/embossDots/nubuck	pressed	Color Black	*Kansei "cute"*
1	leather1	matte	large_grain	pressed_grain	black	*NotCute*
2	leather1w	matte	large_grain	pressed_grain	dark_brown	*NotCute*
3	leather2	matte	small_grain	not_pressed_g	black	*NotCute*
4	leather2w	matte	small_grain	not_pressed_g	dark_brown	*NotCute*
5	leather3	matte	nubuck	not_pressed_g	black	*NeitherCute*
6	leather3w	matte	nubuck	not_pressed_g	dark_brown	*Cute*
7	leather4	matte	nubuck	not_pressed_g	black	*NeitherCute*
8	leather4w	matte	nubuck	not_pressed_g	dark_brown	*NeitherCute*
9	leather5	matte	small_grain	not_pressed_g	black	*NotCute*
10	leather5w	matte	small_grain	not_pressed_g	dark_brown	*NotCute*
11	leather6	matte	nubuck	pressed_grain	black	*NotCute*
12	leather6w	matte	nubuck	pressed_grain	dark_brown	*NotCute*
13	leather7	matte	large_grain	not_pressed_g	black	*NotCute*
14	leather7w	matte	large_grain	not_pressed_g	dark_brown	*NotCute*
15	leather8	matte	nubuck	not_pressed_g	black	*NotCute*
16	leather8w	matte	nubuck	not_pressed_g	dark_brown	*NeitherCute*
17	leather9	matte	small_grain	pressed_grain	black	*NotCute*
18	leather9w	matte	small_grain	pressed_grain	dark_brown	*NotCute*
19	leather10	matte	embossDots	not_pressed_g	black	*NotCute*
20	leather10w	matte	embossDots	not_pressed_g	dark_brown	*NotCute*
21	leather11	shiny	large_grain	not_pressed_g	black	*NotCute*
22	leather11w	shiny	large_grain	not_pressed_g	dark_brown	*NotCute*

2 METHODS

In this research, we have applied our virtual prototyping method (Matsubara et al., 2010) to evaluate sample variations of children's lower leg orthotics (Morinaga et al.,2019). Usually, children's shoes do not use leather, but for lower leg orthotics, leather is standard because of installing shafts and tolerance for torsions. Because children's lower leg orthotic is specially made for each patient, the patient and parents hope to have the orthotics along with their preferences. The leather has many variations on its surface finishing; then proper proposal based on KE is strongly needed.

At first, we scanned entire lower leg orthotics. HP Z 3D camera (HP Inc.) was used for the simultaneous scan of the shape and its textures. Then a new model was made by hand from the tracing of the scanned model. Manual tracing was done with Blender 2.6 (Blender foundation).

Leather surface variations were generated with Substance Painter 2017 (Allegorithmic Inc.). Variations of leather patterns, bump patterns, specular (surface glossiness), and colors were applied in 22 samples, as shown in Figure 2.

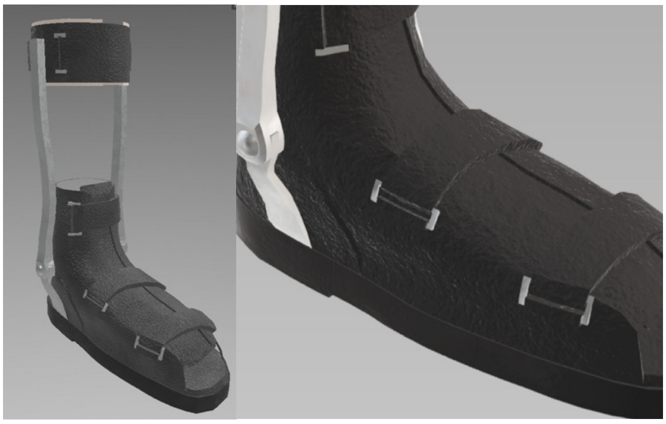

Figure 1. A model for Kansei evaluation on surface finishing.

Figure 2. Simulated leather patterns

Eight participants evaluated the samples (6 males and two females in their 20s and 30s). Sixty-six Kansei words were used for the evaluation. The principal component analysis extracted the Kansei structure.

3 RESULTS

3.1 Authentic Analysis Results

The principal component analysis results are shown in Figure 3 below. We consider first and 2nd PC. In the principal component loadings plot, at the + side of the 1st pc, there are *comfortable*, *casual*, *loveable* and *want to wear*. At the – side of the 1st pc, there is *plain*. PC first corresponds to attractiveness. We can find several polarized relations. In the direction of one to one-half o'clock, there are *cool, sophisticated, innovative, impressive*, and *urban*. At the opposite, seven and a half o'clock, there are *dull* and *coarse*. At two o'clock, there are *attractive, refined, beautiful,* and *good sense*. At eight and a half o'clock, there is *plain*. From 4 to 5 o'clock, there are *girlie, tender, light*, and *softly*. At ten and a half, there are *hard, massive,* and *masculine*.

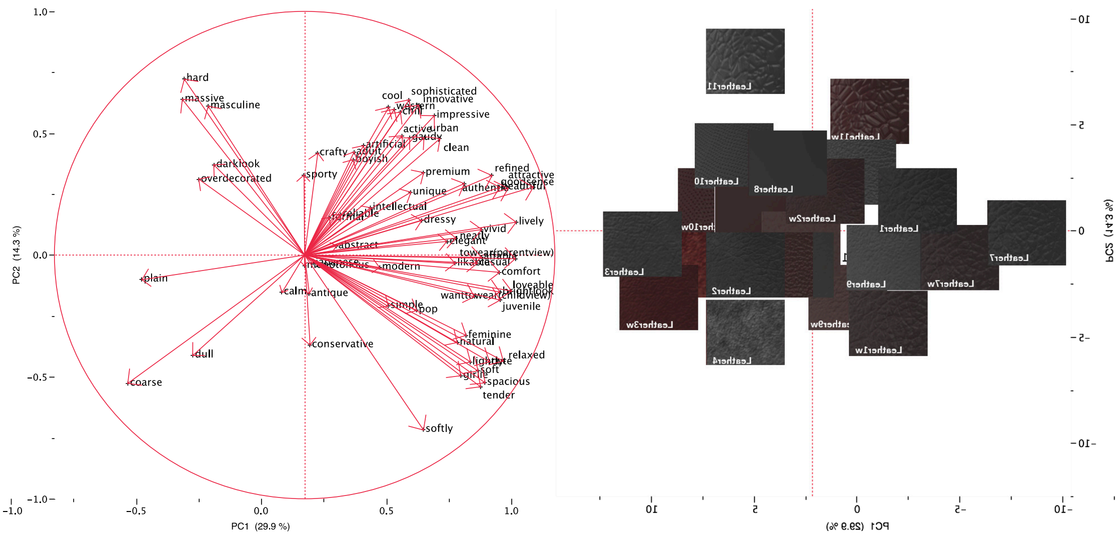

Figure 3. Principal component loadings of Kansei words (left) and principal component score of leather patterns (right)

On the right-hand side of the 1st pc, nubuck leathers (buffed surface to raise protein fiber) correspond to *juvenile, comfortable, lively* and *lovable*. *Feminine, soft, natural*, *cute* and *tender* were consistent with gray nubuck leather 4 and dark brown nubuck 4w.

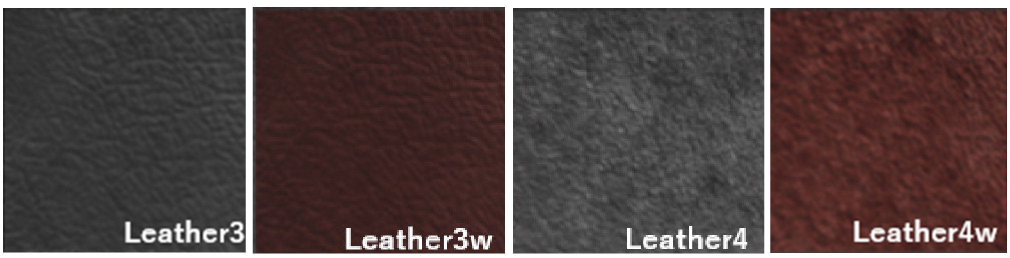

Figure 4. Nubuck leather as *juvenile, comfort, lively* and *lovable*.

Cool, western, innovative, and *gaudy* are placed in one o'clock direction. The corresponding leather is leather 11 and 11w that have a large pattern and glossy surface.

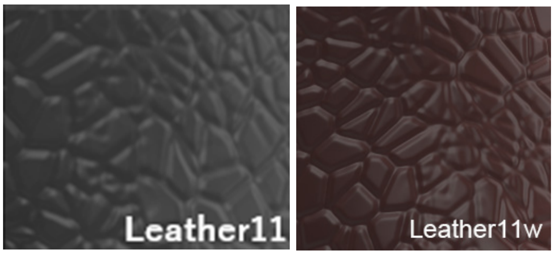

Figure 5. Glossy leather as *cool, innovative* and *gaudy*.

Refined, attractive, *good sense*, *comfortable* and *beautiful* at 2 o'clock direction tie with leather 10 and 10w. They have small bump dots in wavy alignment.

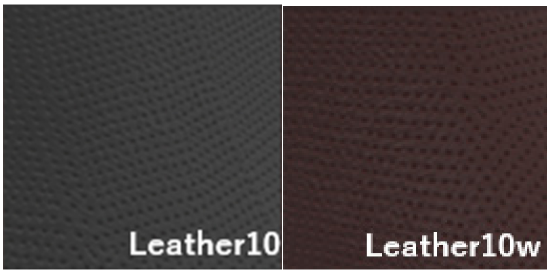

Figure 6. Dotted leather as *refined, attractive, comfortable* and *beautiful*.

3.2 PLS Regression Results

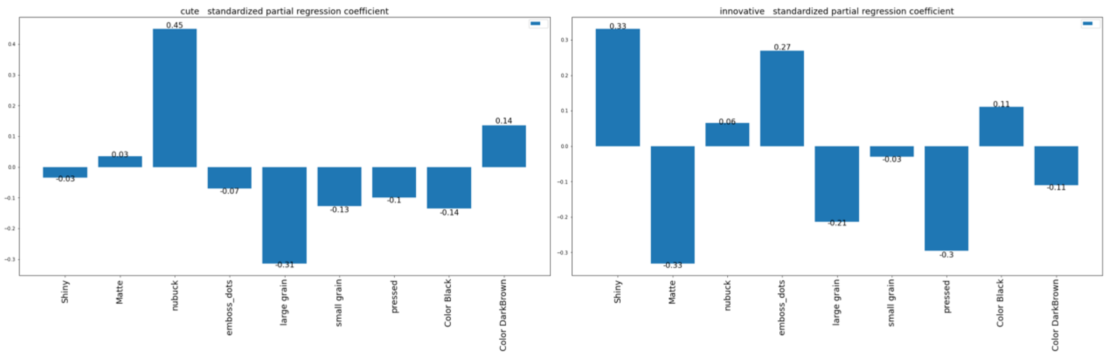

Figure 7. PLS regression analysis of design elements and Kansei, Left: *Cute*, Right: *Innovative*

Usually, we use PCA for Kansei structure analysis first, then use PLS regression for estimating associations between design elements and Kansei evaluation. Figure 7 shows the analysis results. These Kansei-design elements graphs would make for each of Kansei words; then, we have to be considered many bar graphs in Kansei engineering analysis.

3.3 Multiple Correspondence Analysis Results

Many beneficial relations could be read from an MCA map, shown in figure 8.

1. Color variation (black / dark brown) placed at the origin. Color has almost no relation to entire design element mapping and to Kansei evaluations. All varied color samples (shown in black, i.e., 10 and 10w) take the same position.

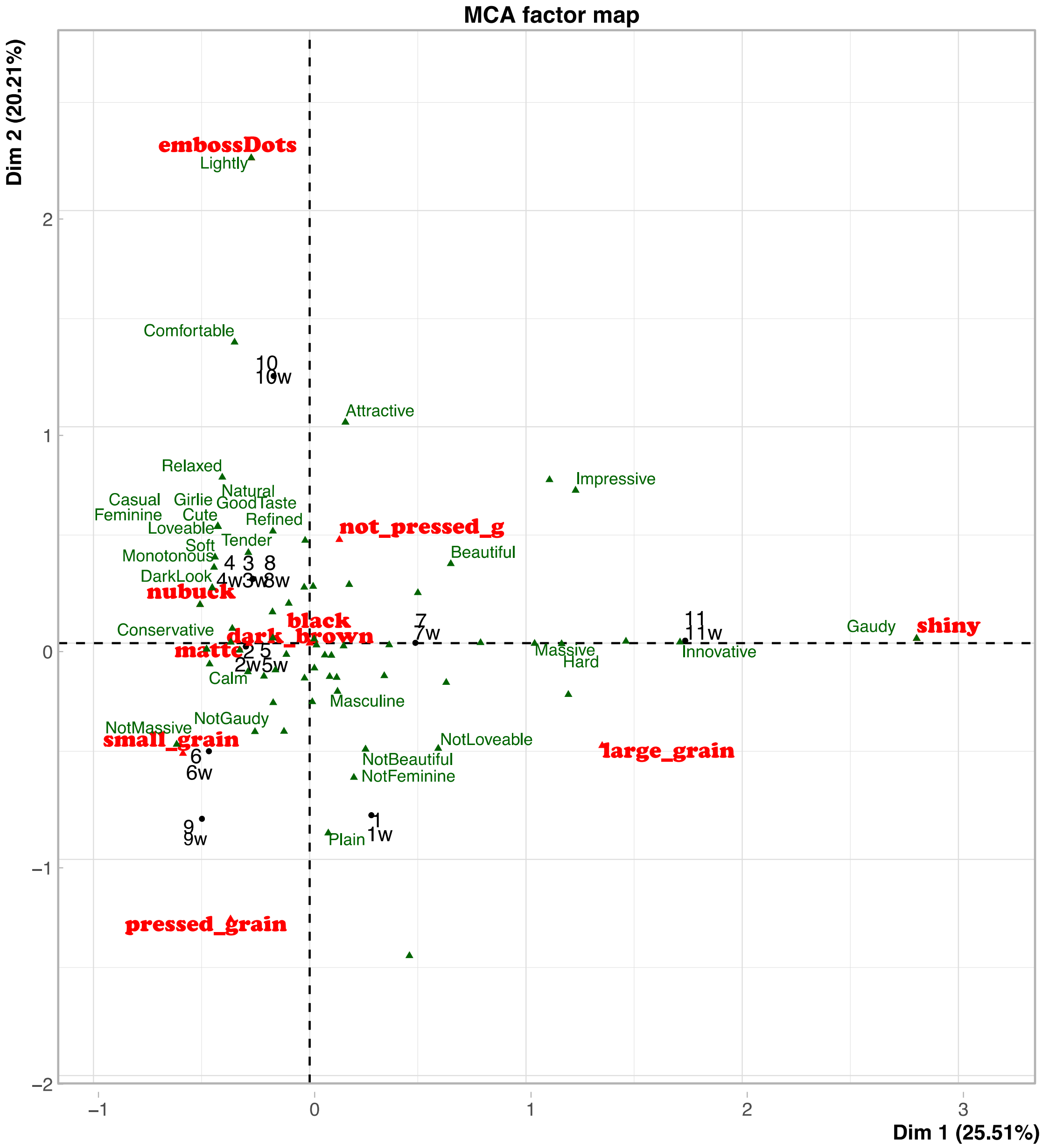

Figure 8. Multiple Correspondence Analysis results (red: design elements, black: samples, green: Kansei words (as supplementary points))

2. Design elements, Shiny and Matte, are alternatives to each other (in a logical sense). The position of two reflects exclusive coding. Shiny takes the position close to samples 11 & 11w; those two only are shiny patterns. Shiny is close to *gaudy* and *innovative*. Matte is close to Kansei, *conservative* and *calm*, and close to samples 2, 2w, 5,5w, 3,3w, 4,4w, and 8,8w.

3. Nubuck and not_pressed_grain samples are 3,3w,4,4w,8,8w, and *tender, soft, cute, natural, feminine, relaxed, casual,* and *monotonous*.

4. Pressed_grain samples are 9 and 9w, 1,1w and 6, 6w. 6 & 6w are also nubuck. Pressed_grain related with plain. Not_pressed_grain is the alternative and related to *beautiful, refined,* and *impressive*.

5. Although the nearest samples of Small_grain are 6 and 6w, consistent samples are 2,2w,5,5w, and 9,9w. Small_grain associated with *not_massive* and *not_gaudy*. Samples 6 and 6w would locate the inertia balance between Prosessed_grain and Not_processed_grain. Benzécri (1992) explained CA as the overall stabilizing process of dynamics, then local inconsistency in global consistency could happen.

6. Embossed_dots associated with 10 and 10w, and *comfortable*, *attractive*, and *lightly*.

Found relations from #1 to #5 in the above lines are compatible with PCA and PLS regression results. The relation embossed_dots and lightly are not revealed by PCA, but evaluation data of 10 has high on lightly. We consider that MCA has more sensitivity than PCA in some cases for expressing associations between Kansei and design elements.

4 CONCLUSION

Utilizing the methods of supplementary variable and MCA, visualizing complicated relations in Kansei analysis was achieved. Two different mappings (PC loadings for Kansei structure, PC scores for samples) and many bar graphs of Kansei and design elements are integrated into an MCA map. Integration of confounding and different kind of information and its visualization would contribute to showing the benefits of Kansei engineering to a broader audience.

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KANSEI ENGINEERING + USER EXPERIENCE DESIGN DRIVING INNOVATION IN HEALTHCARE

DELIVERING STICKY & INFECTIOUS EXPERIENCES

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ABSTRACT

In this presentation we will investigate how Kansei Engineering and User Experience Design come together to solve real problems in a large healthcare organization, transcending the boundaries between physical and digital solutions and contexts. We will investigate examples from industry and various methodology for driving collaboration and culture change. We will also discuss the value and, perhaps more importantly, the responsibilities that come with participating in the engineering of sticky and infectious experiences. Organizational structures and other enabling details will also be explored.

Keywords: *User Experience, healthcare, culture, strategy, innovation*

1 1 KANSEI ENGINEERING & UX: COMPARING, CONTRASTING, & COMBINING

At their core, User Experience Design (UX) and Kansei Engineering (KE) have a lot in common. They both have a structured, observation based, and an adaptive design iteration philosophy. More importantly, they both focus on how products feel and are experienced, differentiating them from simple physical fit and function (Rintoul, 2014; Nagamachi, 1999, p273).

However, even with a high degree of commonality, there are critical differences. It is in this space where we can find synergies between the two methodologies. For example, KE comes from the engineering world, utilizing techniques such as applied mathematics, and evolutionary computational processes (Nagamachi, 1999, p274). KE principles blend the psychological feelings a product or service evokes and help guide product feature decisions to maximize the positive impact and minimize the negative feelings. (Guo, Liu, Liu, Wang, & Wang, 2014).

UX, by contrast, is a branch of design that bleeds into the product space. This sometimes comes from information technology groups, and sometimes from marketing. It focuses more on design heuristics, best practices, applied psychology, and a more humanities-based method (Nielson & Norman, 2022).

Another distinction is that KE focuses on a feature-out approach, analyzing the feature level building blocks as a means of predicting the outcome of feature collections on the overall feeling of a product experience. Whereas UX focuses on the journeys, workflows, and personas involved in the overall design, accessibility, and usability of a system. At Fresenius, we are attempting to take a “best-of-breed” approach, merging the qualities of each methodology to best serve our users.

For example, in our journey map studies, we do not simply aggregate descriptive statistics from demographic data. Rather, we use feelings as the key set of features, differentiating moments in a narrative. To do this, we utilize feeling taxonomies, along with other objects / situations / people / places taxonomies, to normalize the feelings and situations expressed through organic open-ended interviewing. This affords an opportunity for creating data models without artificially restricting data collection to surveys. In this case, we view the moments in a journey as akin to the features in a product. Here we mine for the “moments that matter” and try to elicit the proper Kansei for each.

In our design practices, we focus on how we want our users to feel and not just on what we want them to do. This extends both the boundaries of UX and KE by moving into a space of proactive affective systems approach to product/service design. Additionally, when we communicate findings to engineers, and other stakeholders, we employ techniques leveraging immersive storytelling, rather than simply providing spreadsheets of data of report conclusions.

This is the key to creating “magical” experiences. Here we define “magical” as a delightful, engaging, valuable, awe inspiring, personalized, and surprising pattern of interactions that create sticky and infectious experiences, cultivating deeper engagement and curiosity. Here we use “sticky” and “infectious” as defined by Malcolm Gladwell in his book The Tipping Point: How Little Things Can Make a Big Difference (2000). To bring the next level healthcare disruption, we must deliver magical experience to everyone touched by products or services so that they want more and will spread the word in their network.

These techniques become critical imperatives for healthcare as this is where empathy is a palpable driving force (Lamothe, Rondeau, Malboeuf-Hurtubise, Duval, & Sultan, 2016). The world of healthcare contains environments of high emotion, and it requires humanistic solutions to navigate rich human objectives, such as treatment compliance, pain and stress management, and emergencies. This is a problem space where humans need to be understood and engaged as humans, not items on a production line.

2 PROMOTING THE KE BASED APPROACH AS A FORCE FOR CULTURAL CHANGE

Healthcare product and service delivery is ripe for disruption as evidenced by the number of startups challenging the established healthcare enterprises (Joseph, 2021). Technology is a disruption agent as evidenced by the M&A of niche providers by established enterprises (Joseph, 2021). Personalizing healthcare is key as one size fits all does not meet the expectations (Morgan, 2021). Delivery of healthcare products and services aimed at the emotional aspects of end users can make a difference (Birks & Watt, 2007; Nightingale et al., 2018).

Our disruption: Afford delivery of healthcare product/service experiences as a story to maximize the end users' Kansei at each step. Our contention is that the experience continuum must extend all the way from service provider to service consumer, given the significant personal context and connection that infuses the service delivery, especially in dialysis. Therefore, for sustainable sticky and infectious experience delivery, we must consider the Kansei of everyone touching the product or service delivery: patients, physicians, nurses, vendors, and employees.

Technology has an anchor role in this disruption. The digital and physical worlds are coming together in truly unprecedented ways. Thus, infusing KE principles into designing and delivering magical experiences across the engagement continuum will make a huge difference.

Our inspiration is Disney's Imagineering process and objectives: deliver magical experiences to guests across Disney's worldwide properties and enterprises, creating "The Happiest Place on Earth" (Lipp, 2013, p. 1). To build a healthcare organization to adopt this vision, we propose a core set of roles:

1. The Empath: Responsible for understanding the emotional/psychological aspects of a proposed solution and how to elicit and translate feelings expressed, turning them into the requirements for a targeted outcome.
2. The Tactical Designer: An expert in designing products/services with specific features associated with end user's Kansei to make it sticky and infectious. This role focuses on the accessibility, cognitive, and usability needs of the end user and translates requirements into actionable product definitions. They aim to maximize the end user's Kansei to make the product and/or service desirable, attractive, and valuable.
3. The Storyteller: Envision the overall story arc of how the entire narrative of end user interaction with solution fits together. They understand the interconnections between the different journeys and own the blueprint for how the feelings are choreographed into a meaningful signature experience. They are the strategic big-picture thinkers who are imparting a higher layer of Kansei across the entire ecosystem.
4. The Data Scientist: Discovers of repeatable patterns from observational data and the master craftsman of the Kansei process. This person provides the critical data-driven insights that will convert the business desires into actionable requirements through the lens of a system of features and feelings.

You will notice that the first three competencies are derived from canonical UX practices, while the fourth is integrated from the KE domain.

3 THOUGHTS ABOUT THE DIGITAL/PHYSICAL MELD AND KE

The concept of a story arc is the core component that anchors magical experiences. A story arc has worlds and experiences blended to maximize a coherent overarching Kansei. This creates an opportunity to make reality malleable, allowing for a magical experience to emerge across the healthcare product or service, extending possibilities beyond the boundaries of typical constraints. As we breakdown domain barriers and obey the laws of physics, we create a digital/physical meld where we suspend reality as we know it, allowing magical experiences to happen.

This meld is orchestrated by the core group with support from the entire organization as it takes several iterations before all the components come together purposefully for delivery. This kind of transformation will require enterprise buy-in and years of maturation before it is fully realized. This requires significant investment as multiple story arcs need to be formulated, tested, refined, and integrated into the product and service delivery. However, the investment an organization makes to such a disruption will help retain its valuation and contribute to staying at the cutting edge of continual improvement and creative destruction (Adler, 2019).

4 WHERE TO GO FROM HERE: THE SEEDS OF A VIRAL IMMERSIVE EXPERIENCE

As stated, achieving the magic requires the connection of multiple narratives across user stories; each playing a part in defining different sides of the same larger ecosystem. This transcends people, contexts, the digital and physical spaces, and weaves a lattice of intersecting journeys with a singular emergent outcome. Where we take it next will be a human-centric bubble, containing a shared story made by human hands, for human consumption, utilizing all the technologies, feelings, and expressions that make us unique as people, and bring us together under a single vision of an experience.

We are culminating these thoughts into the creation of a “Center for Magical Experience” (CMX) within Fresenius, bringing this disruptive thinking into product and service delivery experience engineering. The core idea for the CMX is to build an idea factory for engineering magical experiences throughout our organization.

Our CMX is very similar to Disney’s Imagineering, GoogleX, and MIT Design Lab where new and creative ways to bend the reality are explored. The key difference in our context is the focus on the sticky and the infectious, as we encourage the adoption, retention, and socialized spreading of the moments we create, increasing each encounters’ desirability and social reinforcement.

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KANSEI EVALUATION OF HANFU STYLE DIVERSITIES BASED ON USER PERCEPTION AND ACCEPTANCE

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ABSTRACT

On the rise of China-chic, diverse trends have surfaced in the *Hanfu* development because of revivification and innovation. Understanding the perception and acceptance of potential users is vital for *Hanfu* development as it develops genuine confidence in their national identity and traditional culture. This study investigated and discussed the Kansei aspect of perception and acceptance of users in the appearance and structure of *Hanfu*. The study aims to grasp of characteristics of *Kansei* to identify the diverse style of *Hanfu* images to help designers understand the market needs of *Hanfu* products style and improve the attractiveness of a product. Two types of *Hanfu* were selected for evaluation. All data were gathered and analysed using semantic differential methods, descriptive statistics, factor analysis and hierarchical clustering analysis. Results revealed two kinds of *Hanfu*: S01 can be categorised as practical and modern traditional *Hanfu* images, whereas S02 represented original and adequate fashionable *Hanfu* images. Finally, this paper is the first empirical research in *Hanfu* using the *Kansei* engineering method from users' perception and acceptance.

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Keywords: Hanfu; Kansei evaluation; Design; diversity; perception

1 INTRODUCTION

On the rise of China-chic, diverse trends have surfaced in the *Hanfu* development because of revivification and innovation. The *Hanfu* has evolved over several historical dynasties, providing modern individuals with more options (F. Week et al.,2021). The most popular styles mainly include Han, Tang, Song and Ming dynasties. For example, the Tang style often utilises bright colours that users feel fresh and lively. Contrastingly, the Ming dynasty is known for flamboyant and elegant styles. *Hanfu* is traditionally worn for special occasions but is now worn as part of daily fashion. Modern enthusiasts style it by mixing it with contemporary pieces to create a new look (Mengxia, 2021). For instance, the designer styles a Ma Mian skirt of the Ming dynasty with a T-shirt or a blouse to satisfy enthusiasts who want to wear *Hanfu* daily. Therefore, wearing diverse styles of *Hanfu* became a popular trend and expressing individuality.

On the other hand, the eye-catching revivification and innovation of *Hanfu* are because the consumption of traditional Chinese culture and lifestyle has become a resonance of the times. The *Hanfu* has provided a way that embraces Chinese culture and expresses a sense of national and personal identity (Xiaodie et al., 2020). As the main force of the national tide, the younger generation has increasingly recognised *Hanfu*, which highlights traditional culture, and the *Hanfu* market has ushered in an explosion. According to the China Business Industry Research Institute data (MS&DToCHfI, in 2020), in 2020, the number of *Hanfu* fans in China is 4.225 million, and the size of the *Hanfu* market is 6.36 billion yuan. In 2021, the number of *Hanfu* fans in China was estimated to be 5.176 million, and the market size of my country's *Hanfu* industry will be about 10.5 billion yuan in 2021. Due to the increase in consumers and the enlargement of the *Hanfu* market, consumers have higher requirements for *Hanfu* products. According to Qianzhan Industrial Research Institute from Tmall.com, Chinese *Hanfu* consumers mainly consider appearance (style and structure) when purchasing *Hanfu* (Guan, 2020). Thus, understanding the perception and acceptance of the appearance and structure of potential users is vital for *Hanfu*'s development. It can help *Hanfu* designers design more popular *Hanfu* products in appearance (style and structure) and expand the *Hanfu* consumer market.

Given consumers mainly consider the appearance and structure of *Hanfu*, designers need to consumers what style and structure know would like to wear or buy. This study investigated and discussed the *Kansei* aspect of perception and acceptance of users in the appearance and structure of *Hanfu*. This study selected two representative *Hanfu* samples of revivification and innovation from the Tmall platform. This study chose two *Hanfu* samples by qualitative research analysis based on the far-leading sales volume and outstanding style design on Tmall. Ninety-seven questionnaires were distributed to potential consumers and *Hanfu* amateurs at Questionnaire star (Chinese-Wen Juanxing) from December 2021 to January 2022. All data were gathered and analysed using semantic differential methods, descriptive statistics, factor analysis and systematic cluster analysis. The study aims to grasp of characteristics of *Kansei* to identify the diverse style of *Hanfu* images to help designers understand the market needs of *Hanfu* products' style and improve the attractiveness of a product.

Considering users' consumption intention in Hanfu (Yin,2020) is essential. Remarkably, it is indispensable that consider combining the cultural significance behind the elements of Chinese traditional Hanfu design (Bin & Jingxin, 2021). Most previous publications studied cultural value or innovation inheritance side using qualitative research, but only very few covered the Kansei aspect of perception and acceptance of users in the appearance and structure of Hanfu. This paper is the first empirical research in Hanfu using the Kansei engineering method from users' perception and acceptance.

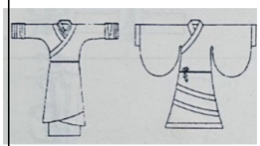
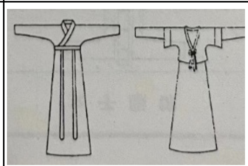
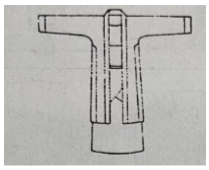
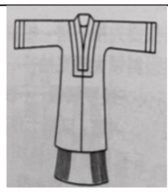
2 LITERATURE REVIEW

2.1 The definitions of Hanfu

Hanfu (Wikipedia) is the traditional style of clothing worn by the Han Chinese. It includes a completed set of clothing categories and styles. *Hanfu* has multiple components: upper garment, lower garment, full-body cloth, outer garment, and inner garment. Thus, the appearance style of *Hanfu* is composed of various clothing categories. The definition of *Hanfu* in Wikipedia that is referred to the “traditional Han costume". Xing (2014) proposed that the definition of *Hanfu* is the traditional or ethnic costume of the Han nationality that has unique characteristics of Han culture, which is obviously different from the traditional clothing or ethnic clothing of other ethnic groups. Shaoying (2014) extended the definitions of *Hanfu* under the diversified background of modern *Hanfu*. She defined ‘*Hanfu* as the namely national costume of Han Chinese people. The succession of *Hanfu* elements in fashion is called modern Han-style fashion. Today's *Hanfu* does not belong to the types of traditional *Hanfu* in essence, and it is free creation with retaining the verve of *Hanfu* and drawing lessons from *Hanfu* characteristics(Hu, 2014). Na (2019) pointed out the new definitions and characteristics of *Hanfu*: *Hanfu* refer to the clothing that appeared and became popular in the 21st century and borrowed from the traditional costumes of the Han nationality in history before the late Ming and early Qing dynasties. *Hanfu*'s style component can be roughly divided into three categories: upper and lower garments, deep clothes and upper garments and lower trousers. The core features of mainstream styles are plane cutting, cross-collar and right-sided (the collars are stacked on the left and right, and the shape looks like the letter “y”), rope knots (no buttons and zippers, tied with ropes), upper and lower garments, wide robes and oversized sleeves (generally referring to dresses, with narrow sleeves in daily life), robes, cuff edges, etc. Xing (2019) argued that *Hanfu* could be divided into two concepts: “traditional Han costume” and “modern Han costume”. The concept of “traditional Han costume” refers to the Han nationality costumes before the late Ming and early Qing dynasties, the costumes are distinctive and distinct from other ethnic costumes and express the national character. However, the definition of “modern Han costume” refers to the Han nationality clothing style reconstructed by people in modern society based on “traditional Han costume”. “Modern Han costume” inherited and retained the characteristics and verve from characteristics of “traditional Han costume. In the current context, the “modern Han costume” retains the traditional national clothing structure and adds recreative embroidery patterns and waist or shoulder accessories, which is more of a manifestation of identification with traditional clothing culture. In other words, “modern Han costume” is an inheriting and innovation of Han traditional costume and culture. According to the previous literature review and contemporary young generation understanding of Han costumes, the definitions of *Hanfu* were concluded that *Hanfu* is namely the national costume of Han Chinese people, which includes the crucial characteristics: (1) retaining the verve of "traditional Han costume" from diversified costume style, (2) innovation and inheriting the Han national costume and culture.

Hanfu is a term of description for garments wearing the state of the Chinese Han people. *Hanfu* has experienced more than 3,000 years of history, including all the traditional clothing classifications of the Han nationality. *Han traditional costumes* carried on Chinese etiquette culture and refer to conventional clothing and accessories that are different from other ethnic groups (Xing, 2014). According to record, Han traditional costumes witnessed prosperity and decline as the common growth of the Chinese nation (Ding al., 2020). From the Yellow Emperor's accession to the throne to the end of the Ming Dynasty and the beginning of the Qing Dynasty, each succeeding dynasty produced own distinctive costume images, reflecting the socio-cultural environment of the times (M.Z.,2017). To conveniently understand the appearance and structure of the traditional Han costume, this study outlined the evolution of Hanfu in major dynasties in **Table 1.** The images in **Table 1** presented appearances of the final wearing state of traditional female Han costumes, not the structure. The structure details may reference components, apparel categories and style in **Table 1**.

Table 1. The Evolution of Hanfu in Major Dynasties

No.	Dynasty	Components	Apparel Categories	Style	Female Clothing (Image)
1	Han	Full-Body Cloth, or Upper and Lower Garments	Deep Clothing (Shenyi, Chinese) Includes “Cured Gown” and “Straight Gown”, Robe (Pao, Chinese)	Simple, Quaint	
2	Tang	Full-Body Cloth, Inner Garment, or Upper and Lower Garments	Robe (Pao, Chinese), Open Cross-Collar Shirt, a Long Silk Scarf (Pibo, Chinese), Tube Top	Gorgeous, Free, Beautiful, Exquisite	
3	Song	Full-Body Cloth, Inner Garment, Outer Garment	Robe (Pao, Chinese), Beizi, Which Were Usually Regarded as Shirt or Jacket and Could Be Matched with Ru (a Jacket), Overcoat, a Long Skirt, and The Beizi	Delicate, Elegant. Natural	
4	Ming	Full-Body Cloth, Inner Garment, Lower Garments and Outer Garment	A Long Skirt, Pleat Dress, Half-Sleeved Garment	Gorgeous, Beautiful， Metaphorical	

(Source: Miao Aili & Kuang Lu, Atlas of Chinese and Western Costumes in Past Dynasties, Guangdong Science and Technology Press, 6 (1996), Chapter on the Evolution of Chinese Costumes in Past Dynasties: p33-34)

Following the development of society, diverse trends have surfaced in the *Hanfu* development. The popular styles of *Hanfu* were mainly inspired by Han costume in Tang, Song and Ming dynasties. However, the design of *Hanfu* caused arguments because of the diversity styles. One is that *Hanfu* lacks a unified design standard, making it challenging to be routine. The complicated design and wearing process make it difficult to appear in people's daily lives life. Wearing *Hanfu* is inconvenient because the wide cuffs and long skirts affect daily activities, which is opposite in line with modern people's pursuit of simple, convenient and comfortable lifestyles. Another is that revivalists and reformists have different points of view on design of *Hanfu*. The revivalist believes that the design of *Hanfu* needs to follow the traditional structure appearance and retain its characteristics. Some scholars of Han culture think that inheriting the conventional structure in styles of Han costume would be better to reserve the Han apparel culture (Fercility, 2020). Lately, the *Hanfu* styles had changed to diversies trends because of human oriented concept, the growth of new materials, the development of new craft technology and new style integration (Chen, 2021). Among the young females, the modern Han apparel is one of the individual identification clothes that being used as modern clothing (Ding al., 2020). The practical, modern, individual and adequate were the prioritized preferences as their daily wear. In contrast, the reformists think *Hanfu* should be practical and modernised to form the concept of innovation *Hanfu* (Shanshan, 2019). In the diversified modern society, the *Hanfu* design must realise the modern reconstruction (Xing, 2019). The existing debate is surrounding two topics: inheritance the traditional structure of appearance and innovation design that integration the Han culture (Zhenzhen, 2020). Thus, evolution of *Hanfu* style has gradually formed two main styles: revivification and innovation.

Hanfu really provide a way to concern Chinese culture and expresses a sense of national and personal identity (Min, 2021). The influence from daily lifestyle and national identify throughout the years is an important factor in *Hanfu* development aspect. With this situation, the Chinese (Han) people wore traditional Han costume or modern Han apparel to express their unique Chinese identify (Breward, 1995). In the development of *Hanfu* diversity process, wearing *Hanfu* become a fashionable trend for expressing individuality, cultural confidence by the young generation in China. In addition, the *Hanfu* movement promoted the development of contemporary *Hanfu*. Contemporary young generations intended to build a pure, utopian social vision and an idealized historical era through the revivification and innovation of *Hanfu* (Carrico, 2017). Under the cyberspace, Chinese young generation pursues cultural reflection and identity in the “virtual community”. Therefore, the *Hanfu* movement provided an opportunity of the reflection and national cultural identity for the Han youth group. In contemporary social, the young generation is the main pillar of *Hanfu* consumption group, which expressed their inheritance and identification of traditional culture by wearing *Hanfu* (Jun, 2017) (Xing, 2014).

Nowadays, competition for *Hanfu* products is very cutthroat in market (Perihao al., 2019). Understanding young customer perception and acceptance in *Hanfu* style diversities that is crital for creating satisfied *Hanfu* products. Effective value of *Hanfu* products can generate competitive product advantages (Xu, 2017). Therefore, to make *Hanfu* with more competitive advantages, companies and designers need to determine which kind of *Hanfu* style that young users need to satisfy their potential market needs. Creating a new product that get to the heart of what consumers really want will allow good and worthwhile products to enter the market (Pourabedin, 2018).

2.2 Kansei engineering

Kansei engineering (KE) is a technology that integrates *Kansei* into engineering realms to create products that meet the needs and desires of consumers (Nagamachi, 2002). KE collects *Kansei* and emotional experience from consumer perception and matches how the *Kansei* is related to the product's physical characteristics. KE seeks to improve human well-being by investigating physiological and behavioral factors that lead to satisfaction. KE research started at Hiroshima University around 1970 (Schütte al., 2004). In recent years, much more study has been undertaken on KE research in different fields (Schütte,2005; Jindo& Hirasago, 1997; Guo al., 2016; Shaari, 2015). KE Type I is one of the types in *Kansei* engineering methods (Nagamachi, 1999). It deconstructs a specific product concept into a more detailed concept, which is then expanded to several levels and construed in terms of the physical characteristics of the product development. For example, the most well-known example is the creative application of *Kansei* engineering Type I in the Mazda car design, and the KE Type I played a crucial role in the design of Wacoal's brassiere success. KE Type I has been extensively researched in product development. It can be described as the technology of translating a customer's sensation and image for a product into design elements (Lokman, 2010). This study targets KE Type I to evaluate *Hanfu* diversity. To determine diversities in the current *Hanfu* styles, it should relate to the user experience. Semantic differential (SD) is a type of a rating scale designed to measure the connotative meaning of objects, events, and concepts, the connotations are used to derive the attitude towards the given object, event or concept (Min, 2021). Therefore, this study can collect the *Kansei* Words associated with user experience using semantic differential methods. *Kansei* analysis usually uses data analysis, and the analysis commonly performed to analyse the consumers *Kansei* includes descriptive statistics, factor analysis and systematic cluster analysis.

3 RESEARCH METHODOLOGY

Given the urgence of understanding and evaluating *Hanfu* style diversities (revivification and innovation) from user perception and acceptance, the first question in this research is to what users experience in appearance from the revivification and innovation styles? The second research question is, how to create products that meet the needs and desires of consumers by experience? To answer these questions, determining the research direction during this study, identifying the diversified characteristics of the revivification and innovation styles in *Hanfu* appearance and structure, then determining *Kansei* words using the SD method. The research methodology design is as follow shown in **Figure 1**.

As the young generation is the main pillar of *Hanfu* consumption group, this study investigated design students and amateurs were interesting in *Hanfu* fashion that aged between18 to 28 years old. The study aimed to examine perception and acceptance of young *hanfu* users that experience in appearance and structure in the revivification and innovation styles, and selected two representative *Hanfu* samples of revivification and innovation from the Tmall platform by qualitative research analysis. These two samples have been chosen based on the far-leading sales volume and outstanding style design on Tmall. The questionnaires were measured using 5-piont Likert scale, ranking from 1(strongly disagree) to 5 (strongly agree). The questionnaire designed a set of questions to conduct a survey of *Hanfu* diversity charaterics based on the identified Kansei words that described the *hanfu* style. 97 (N>96) questionnaires were distributed to potential consumers and *Hanfu* amateurs at Questionnaire star (Chinese-Wen Juanxing) from December 2021 to January 2022.

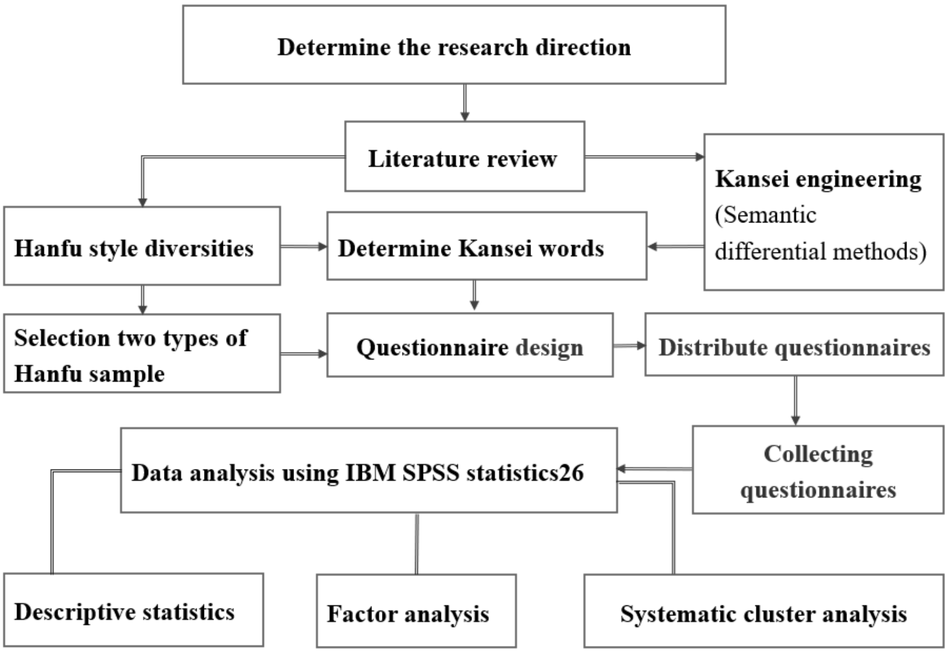


Figure 1: Research methodology

This study calculated the sample size by using the formula:

N = Z2 ×P× (1- P) / d2

N = sample size
Z=Z statistic for a level of confidence (eg:1.96 for 95%)
P=Expected proportion
e= Precision

In generally, where the population is unknown, the sample size can be derived by computing the minimum sample size required for accuracy in estimating proportions by considering the standard normal deviation set at 95% confidence level (1.96), expected proportion (50%=0.5) and the precision (0.05= ±5). Despite the questionnaire of this study has only 18 questions, but participants are required to spend a lot of time focusing on answering questions based on the two *Hanfu* samples. Therefore, this study increased the precision to 10%. Finally, this study required minimum sample size will be around 96 for the population with a 95% confidence level, a 50% expected proportion and a 10% precision. In order to make the analysis more accurate, this study will increase the sample size to more than 96 young students.

The target was to collect as much as possible information and Kansei experience of young generation wearing *Hanfu*. The data then was evaluated by using a few statistical analysis such as descriptive statistics, factor analysis and systematic cluster analysis.

3.1 Selection of Hanfu Samples and Its Visual Assessments

This study selected representative *Hanfu* samples of revivification (S01) in **Figure 2** and innovation *Hanfu* sample (S02) in **Figure 3** to investigate and discuss the *Kansei* aspect of perception and acceptance of users in the appearance and structure of *Hanfu*. These two samples have been chosen based on the far-leading sales volume and outstanding style design on Tmall, and two sample's brands ranking is location in the top 2 of *hanfu* brands in the 2020. According to qualitative analysis that we found both S01 and S02 draw on the appearance and structure of *Hanfu* in the Ming Dynasty. In appearance, S01 could be intuitively recognised that the design followed the traditional structure appearance and retain its characteristics in the Ming Dynasty. The style structure of the Ming system was followed: a top with a stand-up collar and a placket is matched with a MaMian skirt. For S02, its style was closer to fashion style from appearance perception. The pattern used the elements that were most popular among young people and was innovatively designed in combination with the patterns of the Ming Dynasty. The colour design was also boldly combined with popular colours. In terms of style structure, although the style formed the upper and lower garments, the structural has been innovatively styled and restructured. The skirt of the lower garment used the multi-pleated design elements of the MaMian skirt. In the qualitative analysis, S01 was regarding as a sample of revivification *Hanfu*, and S02 was marked on a sample of innovative *Hanfu*.

Figure 2: The image of traditional Han costume (S01)
(Source: TMALL, Brand: Returning to the Han and Tang Dynasties (*Chonghuihantang,* Chinese)

Figure 3: The image of modern Han apparel (S02)
(Source: TMALL, Brand: More than Thirteen (Shisanyu, Chinese)
https://m.tb.cn/h.foti4z2?tk=7rJb26FmpXX

3.2 Selection of Kansei Characteristic

Hanfu costumes carried out diverse characteristics in style from the perceptual perspective of aesthetics. Chinese scholar Zie C. studied Hanfu aesthetics from the perspective of sensibility and culture in "History of Chinese Costume Aesthetics". He points out that Hanfu costumes reflect the aesthetic mentality and cultural features. Given the aesthetic form of Confucian-dominated and complementary to Taoism, Chinese people focused on combinations of rationale and emotion in traditional costume. As a result, Hanfu costumes expressed diverse styles in their historical evolution, which included not only the characteristics of solemnity, humility, and wealth but also leisure, plainness, and moderation. **Table 2** lists the dominant Kansei words from the perspective of perceptual characteristics to describe the aesthetic styles of Chinese costumes in Major historical Dynasties (Zi e. 2001).

Table 2: Kansei words in *Hanfu* costumes of Major historical Dynasties

No.	Dynasty	Kansei Words	Characteristic
1	Pre-Qin	Practical, Exquisite, Natural, Handy, Solemnity	Diversity
2	Qin and Han	Suitable, Humility, Natural, Handy, Beautiful	Diversity
3	Wei and Jin	Personal, Both Dignified and Graceful	Diversity
4	Sui and Tang	Leisure, Dignified, Graceful, Gauzy, Wealth	Diversity
5	Song	Elegant, Moderation, Simple, Fresh, Plainness	Diversity
6	Ming	Retro, Mundane, Graceful, Plainness	Diversity

Despite Hanfu having different costume images in diverse dynasties that reflect the style characteristics of various forms and different characteristics, it has never left the norms of traditional ideology and culture off, such as "Heaven and Man Are United as One" and "The five elements" (Yunbi. 2021). For example, the Upper and Lower Garments of Hanfu embody the concept of "Heaven and Man Are United as One". In addition, Hanfu follows “The five elements” that link the Five Colors (white, blue, black, red and yellow) with the Five Elements (wood, fire, earth, metal, and water). In the current Hanfu revival movement, the design of Hanfu is guided by the traditional ideology and culture. For example, it was taking the shape of the Ru skirt as a reference, adding embroidery patterns and waist and shoulder accessories that conform to the aesthetics of Hanfu, and forming a modern revivification of Hanfu. The design of Hanfu can frequently express its beauty through specific *Kansei* words (such as delicate, light, elegant, fresh, traditional etc.) that reflecting the classical and placid aesthetics characteristic.

This study investigated the perception experience of *hanfu* style from potential users and amateurs by using a dozen of *Kansei* words from the questionnaires. This *Kansei* evaluation is significant in terms of matching the *Hanfu* appearance with human feelings (Shaari et al., 2001). This experiment is to establish the suitable demand for wearing and feeling situation in styles of *Hanfu* by using Kansei words. The evaluating words are chosen from hundreds of keywords, with approximately 18 terms reflecting both *Hanfu* visual appearance features. The *Kansei* words are adjective words with its lowest ranking of 1 until the highest of 5 points by Likert scale (Taherdoost, 2019). **Table 3** shows the collected *Kansei* words of *Hanfu*'s style in SD. This table shows the 18 adjective words attributes that been selected by the *Hanfu* designers. Each keyword was based on users own experience of *Hanfu* when they wore and appreciated the *Hanfu* image. In appearance observation of **Figure 2** and **Figure 3**, both showed that respondents had enough interest in S01 and S02. By using SD methods obtained the expressed image words for two samples such as beautiful, cute, elegant, well-made, particular, traditional, good-looking, gorgeous, etc.

Table 3: The Collected Kansei Words of Hanfu's Style in SD

Category	*Kansei* Words	Category	*Kansei* Words
Style /Appearance	1.Beautiful	Style /Internal Structure	12.Good-Looking
	2.Cute		13.Practical
	3.Gorgeous		14.Considerate
	4.Classica		15.Original

	5.Particular		16.Creative
	6.Fresh		17.Adequate
	7.Popular		18.Convenient
	8.Innovative		19.Traditional
	9.Modern		
	10.Elegant		
	11.Well-Made		

4 RESULTS AND DISCUSSION

This study analysed the data by using SPSS 26.0 to evaluate the *Hanfu* style diversities from user perception and acceptance. To begin with, this study performed descriptive analysis and a reliability test of the questionnaire, and then the descriptive analysis expounds frequency and percentage from respondents. Next, the reliability test looks upon the score from Cronbach s coefficient alpha test. The obtained Cronbach's Alpha was 0.978, this value is far greater than 0.6, thus this study can continue to do future analysis. To solve the research problem of this study, factor analysis and cluster analysis were used to evaluate *Hanfu* style diversities based on user perception and acceptance.

4.1 Descriptive Analysis

97 usable questionnaires were collected from young consumers aged 18 to 28 years old at HIE. There were no missing data in the responses because the information was gathered through an online survey. Of the 97 respondents, 57 (58.8 %) were between the ages of 20 and 21, while 32 (33 %) were between the ages of 22 and 23. A total of 24 male (25.8 %) and 72 female (74.2%) responded. The respondents' education level was high, with 97 (100 %) of them being HIE undergraduates. **Table 4** displays the basic demographic information of the respondents.

Table 4： Basics Information of Descriptive Analysis (N=97）

		Frequency	Percentage
Gender	Male	25	25.8
	Female	72	74.2
Age	18-19 years	3	3.1
	20-21 years	57	58.8
	22-23 years	32	33.0
	24-25 years	3	3.1
	over 26 years of age	2	2.1

4.2 Reliability Analysis

The reliability analysis report of Hanfu style diversities was shown in Table 5. The correlation is 0.710, which is greater than 0.3. The Cronbach’s Alpha total is 0.978, which is greater than 0.7. The results indicated that survey questions for Hanfu samples had a good consistency. Thus, all questions were reserved.

Table 5. Reliability Statistics and Correlation Analysis

	Appearance	Structure	Dimensionality	Cronbach's Alpha	Items
Appearance	1.00		Total	0.978	19
Structure	.710**	1.00	Appearance	0.967	11
			Structure	0.950	8

**means the correlation is significant at the 0.01 level (two-tailed, Pearson correlation)

4.3 Factor analysis

The respondents who were used to define the subject were 25 males and 72 females. The differences between the factors that affected the total concepts of both clothes were derived by factor analysis. For S01, this study calculated the most significant two factors, as shown in **Table 6.** The two factors of S01 have a cumulative contribution of 68.988%. Factor 1 contributed a rotation load squared and variance percentage of 35.792%; the Rotation load squared and variance percentage of Factor 2 is 33.196%. Regarding S02, the cumulative contribution is 77.828%. Factor 1 of S02 contributed a rotation load squared and variance percentage of 41.742%; the Rotation load squared and variance percentage of Factor 2 is 36.087%. Therefore, this study can confidently use factor 1(appearance) and factor 2(structure) to construct Kansei evaluation of two *Hanfu* samples in style diversities.

Table 6 presented values obtained by the factor analysis using selective Kansei adjective words to identify style diversity and user perception and acceptance. 18 Kansei adjective words were examined by confirmatory factor analysis to investigate the subjective words of the visual appearance of both S01 and S02. Participants had different perceptions of two *hanfu* samples through this observation on appearance and structure.

The result implied that S01 was strongly experienced by human feelings because of its beautiful (FL=0.878>0.6) and convenient look (FL=0.811>0.6), but S02 was strongly perceived as a gorgeous (FL=0.858>0.6), beautiful (FL=0.839>0.6) and innovative (FL=0.802>0.6) image. As shown in **Table** 6, S01 was judged as a “beautiful, cute, elegant, convenient, practical” look. S02 was considered a “gorgeous, beautiful, innovative, fresh, original, considerate, modern” representing the visual image.

Table 6: Analysis result from *Kansei* evaluation

S01	Factor 1	Factor2	S02	Factor 1	Factor2
Adjectives	Appearance	Structure	Adjectives	Appearance	Structure
Beautiful	0.878		Gorgeous	0.858	
Cute	0.754		Beautiful	0.839	
Elegant	0.752		Innovative	0.805	
Well-made	0.716		Fresh	0.799	
Particular	0.703		Elegant	0.797	
Traditional	0.679		Good-looking	0.748	
Good-looking	0.678		Particular	0.739	
Gorgeous	0.650	0.518	Creative	0.729	0.525
Popular	0.631		Original		0.822
Convenient		0.811	Considerate		0.797

Practical		0.797	Modern		0.765
Considerate		0.760	Adequate		0.735
Adequate		0.742	Practical		0.717
Original		0.725	Well-made		0.713
Creative		0.674	Traditional		0.663
Rotation Load Squared and Variance Percentage	35.792	33.196	Rotation Load Squared and Variance Percentage	41.742	36.087
Cumulative%	35.792	68.988	Cumulative%	41.742	77.828
KMA	0.935		KMA	0.946	
Barth's spherical value	1127.322		Barth's spherical value	1567.658	
df	105		df	105	
Sig.	0.000		Sig.	0.000	

4.4 Hierarchical clustering analysis

Using SPSS.26.0, this study applied hierarchical clustering methods. Using mean euclidean distance analysed 18 *Kansei* words in appearance and structure of two *Hanfu* samples. The clustering method adopts the between-groups linkage, the average distance between all indicators between the two *Kansei* words is the smallest, and the two *Kansei* words are merged and then merged step by step. The clustering results are shown in **Figure 4** and **Figure 5**. According to the results of cluster analysis (Figure 4), when the inter-class distance is 20, the study styles are divided into four categories. One category is considerate, convenient, practical, original, the second category is creative, adequate, belong structure design category, the two categories are the rationality of structure category. The third category is fresh, good-looking, particular, innovate, cute, modern; the other category is popular, traditional, gorgeous, elegant, classical, beautiful, well-made (These two categories belong the appearance). *Kansei* evaluation of *Hanfu* S01 in terms of appearance and structure is that it pursues a gorgeous style on the basis of following the traditional style and appearance while retaining the original lovely style, reflecting the innovative characteristics, and the style in structure is practical and convenient. Overall, respondents like the practicality and modern style of *Hanfu*.

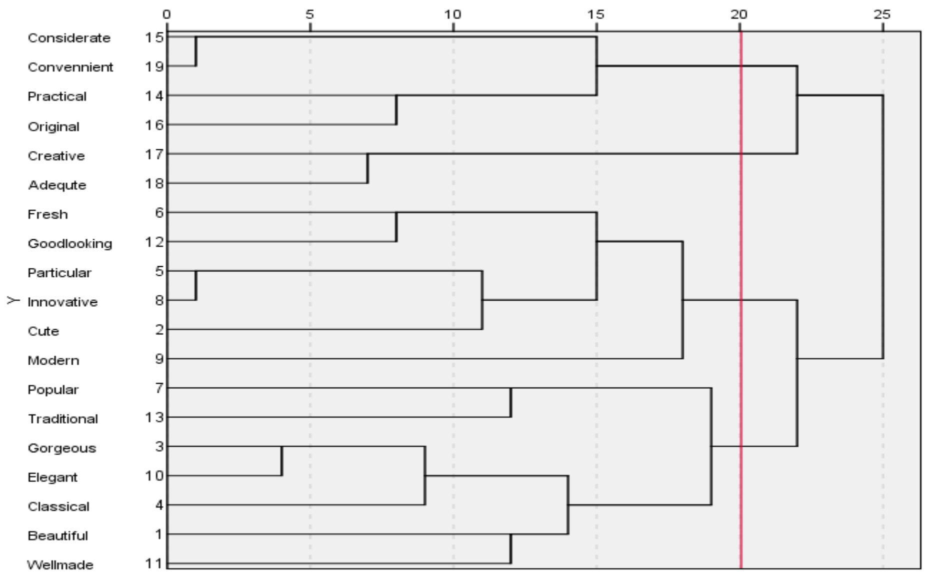


Figure 4： Result of clustering analysis of S01 by SPSS

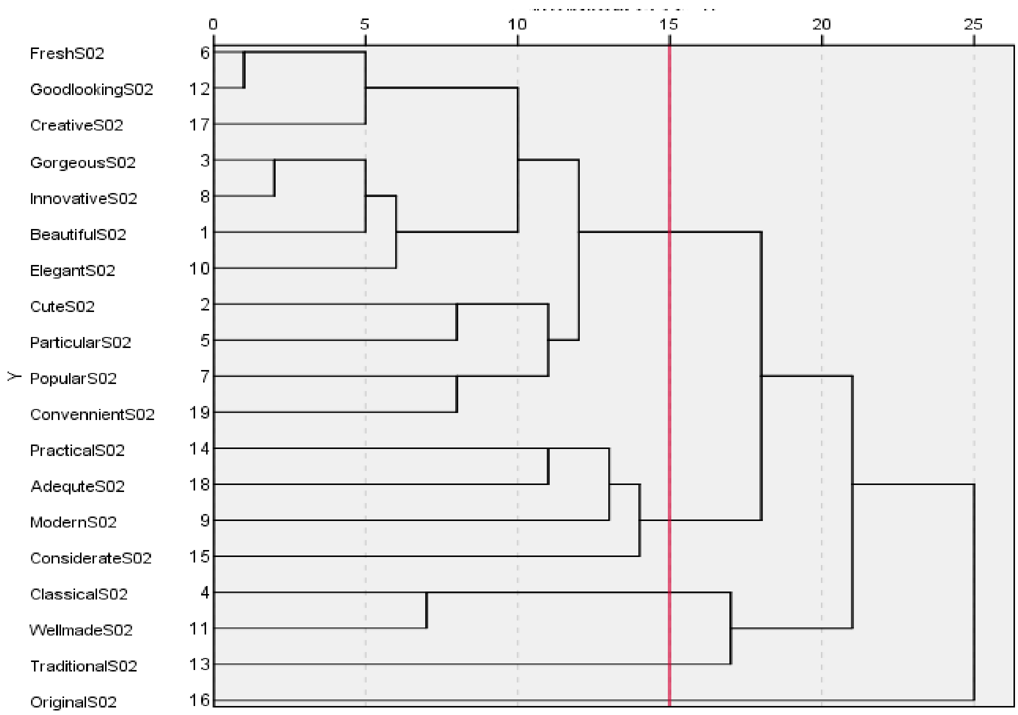


Figure 5: Result of clustering analysis of S02 by SPSS

In **Figure 5,** shown the result from *Kansei* words of S02 clustering analysis closely linked each other as it represents the important needs of users about the S02 *Hanfu* sample. The *Kansei* adjective for appearance and structure of S02 had been identified as original and adequate-popular, beautiful, modern, classical, and traditional. It had been identified as contemporary Han apparel suitable for daily wear. Through *Kansei* words evaluation, "appearance and structure of style diversities" are closely linked perception and acceptance of users together that resulted in the desirable express of *Hanfu* are obtained by image observation and wearing experience that can represent the need to representations of *Hanfu* cultural identity.

5 CONCLUSION

This evaluation process presents that Kansei act as the adjective, and relationship media between Hanfu style are essential in identifying appearance and structure. Obtaining their emotions from the Hanfu and following needs and choices. In this paper two samples appearance images (S01 and S02) have observed to identifying style diversities desire from traditional Han costume and modern Han apparel.

There are two main categories being identified in literature review the Hanfu. Firstly, traditional Han costumes - from the Yellow Emperor's accession to the throne to the end of Ming dynasty and the beginning of Qing Dynasty, each succeeding dynasty produced its own distinctive dress codes, reflecting the socio-cultural environment of the times. The most popular styles mainly include Han, Tang, Song and Ming dynasties. S01 represents Ming dynasty style of modern and practical formal clothing. Secondly, modern Han apparel. Since the Revolution of 1911, inherits the Han traditional costume style and expresses the Han cultural characteristics and the Han national emotion and cultural identity based on inheriting the "traditional Han costume ". It is now being worn as part of daily fashion. Modern and original design in S02 had shown the feeling and image regarding the innovation appearance of the clothes. The elements of beautiful, cute, modern, gorgeous, particular, classical, fresh, popular, and innovation were strongly expressed by the respondents, as the current societal needs in Hanfu diverse style.

The results elucidate that two Hanfu samples strongly had "modern feeling" features in the design. Traditional hanfu elements are being considered as the main influence factors in social and cultural development to fulfil users' desire for Hanfu cultural identity. It was predicted that the revivification and innovation styles were used on distinct occasions to express Chinese (Han) cultural identity. It has been understood that emotional satisfaction is an important factor in clothes design. User perception and acceptance gained from these efforts should ultimately facilitate the development of Hanfu innovation design requirements.

Finally, the research also had its limitations. The questionnaire focused on design students and amateurs at the Hunan Institute of Engineering. Further studies may expand the survey participants to distinct cities that can further improve the reliability of the study.

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KANSEI EVALUATION ON WEB-BASED GEOGRAPHIC INFORMATION SYSTEM: A MALAYSIAN CASE ANALYSIS

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ABSTRACT

In the discipline of design science, the integration of cognitive, semantic and affective elements is crucial in the conception and development of designed products. Affective elements in IT artefacts have gain researchers interest, but little attention was given to Geographic Information System (GIS). This paper presents a research attempt to identify emotional response towards web-based GIS, and determine design influence to the emotion by applying Kansei Engineering (KE). The method involved ten selected web-based GIS specimen, 10 Kansei words as descriptors of emotional responses which was organized as a 5-point Semantic Differential (SD) scale to form a Kansei checklist. 50 participants were asked to rate their emotional responses toward the specimens into the Kansei checklist. Principal Component Analysis (PCA), Factor Analysis, and Partial Least Square (PLS) analysis were used to enable the research to achieve its objectives. The research discovered that the semantic structure of Kansei that shaped by the response was spaciousness and intenseness, and the significant Kansei concepts are formal and eye-catching. The PLS analysis have assisted the research to understand the significant influence of design to Kansei responses. These results provide cues for designers to design future web-based GIS with embedded emotion.

Keywords: *Emotional UX, Geographic Information System (GIS), Kansei Engineering (KE)*

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1 INTRODUCTION

User experience (UX) and user interface (UI) are critical aspects of user satisfaction in system design. The goal of Geographic Information Systems (GIS) is to provide users with information about data distribution in the form of geospatial data. People can now interact with geographic data via the internet and gain benefit from the GIS. The use of diverse media as a user interface (UI) for Geographic Information Systems (GIS) shows how UX on GIS are becoming more important. On another note, emotion was once thought to be a completely functional process in which users' emotional responses had no bearing; thus, emotional design requirements were ignored. Recent advancements however, have demonstrated the significance of emotional design, with several research identified emotion as having a significant impact on user satisfaction.

An initial investigation into user experience with web-based GIS reveals that the information delivered is boring and repetitive, less informative, and rigid, resulting in user dissatisfaction with information access, despite the fact that the information presented is critical to the users. Using the Kansei Engineering (KE) approach, this study investigated Kansei responses and evaluated web-based GIS in an attempt to provide cues for incorporating users' emotion into UX design.

2 RESEARCH BACKGROUND

Geographic Information Systems (GIS) is a multidisciplinary system that combines integrated data with geographical data (Hamidi, 2012). This study is a part of the study implementation to design emotion embedded web-based Palembang City regional asset mapping in Indonesia. Past research on GIS in the region include mapping potential disasters in Palembang City with parameters for fire disasters, floods, and natural disasters (Andriani & Indrayani, 2015), and the use of Fuzzy Analytic Hierarchy Process in GIS for Raskin distribution (Leni, Azro, & Robinson, 2019). Other research have looked into detecting crime (Munthe, 2021), mapping the distribution of traditional Samarinda souvenir shops (Annugerah, Astuti, & Kridalaksana, 2016), and web-based mapping of Palembang City's regional tourism potential.

In relation to asset mapping, Salam and Fahmi (2017) have studied on regional assets, particularly on the Regional Asset at Cirebon City's Badan Pengelolaan Keuangan dan Aset Daerah (BPKAD), which focuses on producing spatial data that depicts regional assets in the form of social and public infrastructure (Salam & Fahmi, 2019). Another study is on the Utilization of GIS in Regional Tourism Development, which began with data input and progresses through the stages of map creation, data manipulation, file management, query analysis, and output visualisation (Purnaweni & Riwayatiningsih, 2017). However, it was argued that more advancement is required before GIS can provide more necessary information about Regional Tourism Potential (Purnaweni & Riwayatiningsih, 2017).

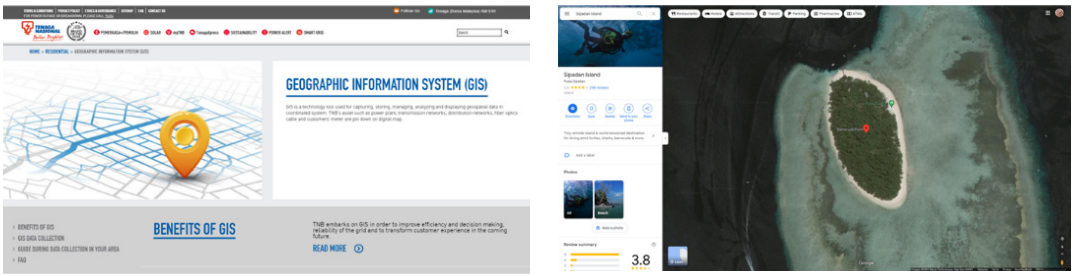
Emotional measurement is a growing area of research. As the interaction between social, cognitive, and biological processes in emotion becomes more tractable, emotional concepts are now being researched comprehensively using theories and methodologies that require collaboration among social, cognitive, developmental, clinical, and neuroscientists (Cacioppo &

Gardner, 1999). However, in GIS, it was argued that affective/emotional outcomes should be given more attention.

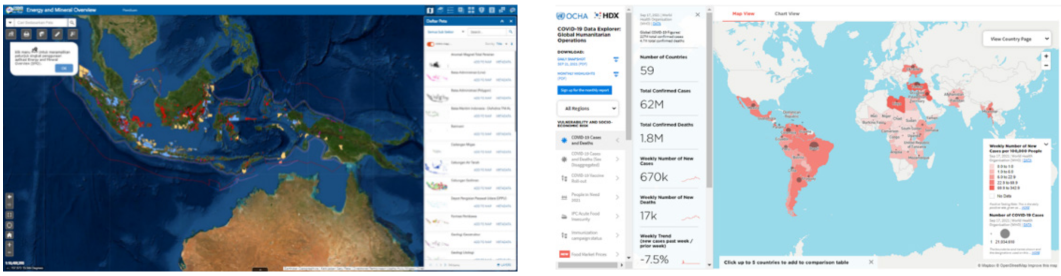
Past research adopting KE in Indonesia has been found to focus on the design of e-Learning interfaces (Griha, Isa, & Hadiana, 2017), mobile commerce (Hadiana, 2016), and Android based academic information systems design (Mud'is, Busro, Faizin, & Ali, 2019). Kholil (2017) suggested a design that translates the concept of beauty and cuteness feelings into 47 design components organised into five sections: Header, Footer, Left Sidebar, Right Sidebar, and Body. Hadiana's research on mobile e-Commerce was inspired by the lack of user viewpoint consideration during the design process, which contributed to a lack of consumer interest in mobile business (Hadiana, 2016). The objectives of the study was to apply the KE methodology to uncover implicit demands based on customer emotions and how they connect to the design of e-Commerce mobile applications, with the aim of producing recommendations for e-Commerce mobile application design. On the other hand, Mud'is et al. (2019) developed an academic information system employing KE methodology, using 17 Kansei terms, 12 Android-based specimens, and 35 participants. The final product is a Kansei Elements for Android-based Academic Information System Design matrix with 40 sub-groups and 105 design elements, grouped into five primary groups: Linear Layout, Menu Button, Button Type, Image View, and Toolbar. Motivated by the success of similar research in the region, this study adopted the KE methodology to develop a mapping of the region's assets using GIS modelling and UX/UI design that takes into account users' emotions.

3 THE METHOD

The study collected two types of data: emotional responses (Kansei) of GIS users to Web-based GIS user interface (UI) and Web-based GIS design elements (DE). Web-based GIS samples were chosen based on visible design differences and analysed using predefined specimen identification rules. To classify DEs and attributes, such as colour, typography, and map attributes, a DE versus specimen matrix was used. This matrix was then used as the specimen analysis instrument. Based on the results of the analysis, ten specimens were finally determined to be valid specimens using KE rules. Figure 1 depicts examples of web-based GIS specimens.



(a) (b)



(c) (d)

Figure 1. Example of web-based GIS UI

Purposive sampling was done among post-graduate students in Klang Valley, Malaysia. The study recruited subjects based on rule specified in KE to undertake specific target users (Lokman & Nagamachi, 2009), i.e., GIS users, as evaluation subject in the study. Accordingly, fifty users with prior experience using Web-based GIS were recruited and participated as respondents in the Kansei evaluation procedure.

The Kansei evaluation consisted of four steps; i) The specimen and its URL were presented to the users; ii) the users were given a few minutes to familiarise themselves with the specimen; iii) the users were required to rank their emotional responses to the Kansei checklist; and iv) the steps were repeated for each specimen. The study employed the Kansei words identified by Novianti et al. (2022), and these words were organised into a 5-point Semantic Differential (SD) scale to develop a Kansei checklist. The order of the KWs in the checklist was randomised to eliminate bias. Multivariate analysis was then performed on the averaged evaluation data to determine the significant Kansei that was shaped by the subject's emotional responses to the specimens, as well as to discover the relationship between Kansei responses and the Web-based GIS DEs.

4 THE RESULT & DISCUSSION

The research analyzed the Kansei semantic structure for Web-based GIS by principal component analysis using the averaged evaluation result from the Kansei evaluation session. The result shows that the first principal component (PC1) (eigenvalue: 13.55, contribution ratio: 67.8%) can be represented as spaciousness concept, and the second principal component (PC2) (eigenvalue: 2.53, contribution ratio: 12.6%, cumulative contribution ratio: 80.4%) represented as intenseness concept from the evaluation. Together, the first two principal components represent most of the data structure, which means the structure of Kansei Words are highly influenced by the first two principal components. The remaining principal components have very less influence to Kansei structure and can be ignored. The study then identified semantic structure of Kansei Words from the analysis result. The structure is illustrated by PC Loadings (Figure 2).

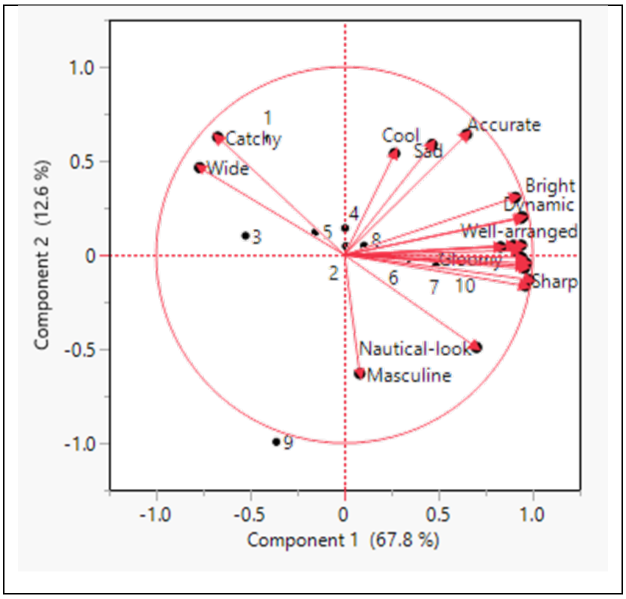


Figure 2. The Kansei semantic structure.

Figure 2 shows PC loadings for the first and second principal components from the evaluation result. The research could observe that Web-based GIS with high score on the first principal component is having high characteristic of spaciousness and so in the contrary. On the other hand, the research could observe that websites with high score over the second principal component is having high characteristic of intenseness and so in the contrary. Thus, PCA performed to the evaluation result has enabled the study to identify Kansei semantic structure, and the mapping of Web-based GIS accordingly. The result enables the research to conclude that Kansei structure on Web-based GIS has two components, which are spaciousness and intenseness. In addition, blending and balancing these two components are the basis for new concept of Web-based GIS design.

4.1 The significant Kansei

The research discovered the significant concept of Kansei by the use of Factor Analysis (FA). Table 1 shows result of FA after varimax rotation (used to simplify variable interpretation.

Table 1. Factor contribution table

Factor	Variance	Percent	Cumulative Percent
1	9.7922	48.96	48.96
2	4.2356	21.18	70.14
3	2.2934	11.47	81.61
4	1.6319	8.16	89.77
5	1.3079	6.54	96.31

It is evident from the table that the first factor explains 48.96% and the second factor explains 21.18% of the variables. Both factors represent 70.14%, a majority of the factor contributions. This shows that Factor1 and Factor2 have dominant influence to respondents' Kansei. The proportion of variability explained by the third factor and the rest are minimal (<2.5) and can be considered as insignificant.

Table 2 shows factor loading results in ascending order, which enable the observation of the significant Kansei. Variables that have high score are perceived as significant factors in Web-based GIS design. The research set approximately 0.85 as the reference score.

Table 2. Factor loading

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Fresh	0.921797	0.069002	0.022344	0.198772	0.251336
Rigid	0.898904	0.325417	0.228969	0.088489	-0.05803
Simple	0.893238	0.409242	0.126659	0.090095	-0.04933
Calm	0.888128	0.384539	0.087299	-0.18802	-0.04769
Bright	0.877795	0.17307	0.216897	-0.24824	0.239716
Formal	0.856964	0.2187	0.232627	0.118885	0.156123
Gloomy	0.848903	0.393167	0.287578	0.013256	-0.04676
Sharp	0.840253	0.491209	0.155256	0.061816	0.112064
Prestigious	0.836279	0.46966	0.097497	-0.18052	-0.01246
Dynamic	0.812784	0.337964	0.308567	-0.23079	0.153396
Informative	0.721226	0.343403	0.474428	0.256487	0.229322
Well-arranged	0.697488	0.400794	0.474158	-0.07936	0.293465
Natural	0.676487	0.47378	0.529747	-0.01783	0.05182
Accurate	0.579337	-0.00974	0.490371	-0.59142	0.086239
Nautical-look	0.302955	0.935463	0.081146	-0.00142	-0.00899
Sad	0.218158	-0.02249	0.943729	-0.13908	0.143272
Catchy	-0.31683	-0.91137	0.020733	-0.24176	-0.0694
Masculine	0.108333	0.105901	-0.0578	0.923662	-0.11909
Cool	0.147104	-0.03396	0.167403	-0.14616	0.9600
Wide	-0.42805	-0.8829	-0.06444	0.030851	0.079687

The tables shows that the Kansei concept is structured by 2 factors. The first factor consists of fresh, rigid, simple, calm, bright, and formal. The research labels this factor as the concept of formal. The second factor consists of nautical-look, catchy, and wide. The research labels this factor as the concept of eye-catching.

It can be observed from the FA result, the concept of Kansei in Web-based GIS is structured by two factors; formal and eye-catching. These two factors explain 70.14% of the total data, and considered to be indicators to the design of Web-based GIS that embeds a targeted Kansei concept. This suggests that Web-based GIS should include these two concepts in order to the desired result.

4.2 Relationships between Kansei and Web-based GIS DE

Partial Least Square (PLS) analysis was performed to identify relationships of emotion and DEs. The results were used to discover influence of DEs in each Kansei. In the research, three sets of data were used for this analysis, and they were; 10 sets of Kansei responses by 50 subjects, 10 Web-based GIS specimen, and the DE matrix. The investigation of DEs in the earlier phase of this research has resulted 8 design attributes and 40 values. For PLS analysis purposes, all these elements were converted into dummy variables. Table 3 shows instance of the PLS scores.

Table 3. Instance of PLS scores

DEs	Simple	Informative	Dynamic	Natural	Calm
Body Bg Colour: DarkBlue	-0.0039	0.0049	-0.0172	-0.0069	-0.0163
Body Bg Colour: Blue	0.0267	0.0294	0.0307	0.0349	0.0272
Body Bg Colour: White	-0.0008	-0.0240	-0.0023	-0.0161	0.0080
Body Bg Colour: Gray	-0.0202	0.0033	-0.0042	0.0006	-0.0184
Body Style: One Column	-0.0022	-0.0135	-0.0081	-0.0231	0.0004
Body Style: Two Columns	0.0017	0.0179	0.0105	0.0248	-0.0005
Body Style: Three Columns	0.0006	-0.0086	-0.0048	-0.0051	0.0002
Body Bg Style: Solid	0.0202	-0.0033	0.0042	-0.0006	0.0184
Body Bg Style: Picture	-0.0202	0.0033	-0.0042	0.0006	-0.0184
Body Font Style: SansSerif	-0.0484	-0.0496	-0.0507	-0.0408	-0.0491
Body Font Style: Serif	0.0484	0.0496	0.0507	0.0408	0.0491
Body Font Colour: Black-Blue	-0.0058	-0.0210	-0.0163	-0.0103	-0.0061
Body Font Colour: White-Blue	0.0267	0.0294	0.0307	0.0349	0.0272
Body Font Colour: White-Red	0.0484	0.0496	0.0507	0.0408	0.0491
Body Font Colour: White-Black	-0.0683	-0.0595	-0.0593	-0.0668	-0.0646

In order to determine influence of DEs to Kansei, PLS Range for each Kansei were calculated. The calculation of Range enables the identification of design influence, based on the higher score as compared to average range value. The results were then sorted based on descending order to show highest to lowest influence of DE to each Kansei. Table 4 shows the sorted result for influential DEs for formal and eye-catching concept.

The result suggests that to design a formal Web-based GIS, designer must set priorities to DEs according to the higher to lower order influence, e.g., body font colour and style, top menu background colour and shape, map style, and so on. On the other hand, to design eye-catching Web-based GIS, designer must set priorities to DEs according to the higher to lower influence, e.g., top menu position, map colour, body font colour, footer font colour, dynamic map auto focus, and the rest follows.

Table 4. The significant DE to Kansei

FORMAL			EYE-CATCHING		
1	0.1034	Body Font Colour	1	0.1586	Top Menu Position
2	0.1016	Body Font Style	2	0.1361	Map Colour
3	0.0935	Top Menu Bg Colour	3	0.1118	Body Font Colour
4	0.0917	Top Menu Shape	4	0.1096	Footer Font Style
5	0.0898	Map Style	5	0.0993	Map Dynamic Auto Focus
6	0.0889	Top Menu Position	6	0.0840	Top Menu Bg
7	0.0872	Left Menu	7	0.0821	Top Menu Shape
8	0.0872	Left Menu Picture Size	8	0.0750	Map Source Data Info
9	0.0872	Google Earth	9	0.0747	Main Menu Ads
10	0.0864	Header Font Style	10	0.0737	Map Style
11	0.0854	Map Source Data Info	11	0.0678	Header Position
12	0.0807	Footer Font Colour	12	0.0659	Top Menu Style
13	0.0802	Map Colour	13	0.0657	Left Menu Picture
14	0.0782	Map Dynamic Auto Focus	14	0.0657	Left Menu Picture Size
15	0.0774	Map Search Field	15	0.0657	Google Earth
16	0.0739	Top Menu Style	16	0.0569	Map Zoom Scroll
17	0.0643	Header Style	17	0.0569	Map Zoom Button
18	0.0598	Main Menu Ads	18	0.0541	Body Font Style
19	0.0570	Left Menu Font Colour	19	0.0526	Header Font Style

5 CONCLUSION

This paper has described the outcome of Kansei evaluation in web-based GIS. The research has successfully identified the significant concept of Kansei in web-based GIS, and the significant influence of DE to the respondents' Kansei using PCA, FA, and PLS analysis.

PCA has enabled the research to identify the Kansei semantic structure and specimen that corresponds to the semantic space. FA on the other hand has resulted the significant concept of Kansei in web-based GIS as formal and eye-catching. The research observed that Kansei responses to Web-based GIS is characterized by spaciousness and intenseness, and this provide cues that new concept of web-based GIS should blend and balance these two components. Additionally, PLS analysis has enabled the research to determine significant DEs and their influence to Kansei responses. This provides cues to designers to design and develop future web-based GIS with a targeted emotion.

Although there were some limitations due to limited samples, the result of the study provides valuable insight into the body of knowledge in emotional UX, and design strategies for web-based GIS. The limitations however, opens door for future research such as by employing larger sample size, as well as comparative cultural aspects in order to enrich the findings and enhance the generalizability of the identified DE and its influence to the Kansei of web-based GIS users.

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KEYWORD VERIFICATION OF VIDEO EXPRESSION NECESSARY FOR REGIONAL PROMOTIONAL VIDEOS

TEXT MINING USING AWARD-WINNING FILMS FROM THE JAPAN WORLD'S TOURISM FILM FESTIVAL

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ABSTRACT

Due to the Corona situation, teleworking practices and relocations have increased, as people realize that they can do their jobs from any location. People have been relocating and buying land in remote and rural regions, away from the risks associated with the ongoing pandemic and inner-city living. The author of this paper has made several promotion films, documenting the initiatives of local people in the mountainous rural Ashimi district of Fukui Prefecture, and has been researching to verify and describe the results of these video expressions by comparing them to similar projects from different regions both in Japan and around the world. This paper researched the works of Japan World's Tourism Film Festival, which the author was also involved in managing, and used text mining to find keywords required to improve and objectively verify results.

Keywords: Text Mining, Tourism Film, Visual Expression Method.

1 INTRODUCTION

There are many marginal settlements in Japan today, including in the Ashimi area of Fukui Prefecture, which is the focus of this study. One such settlement is the Ashizumigama Charcoal Kiln, which is a local business attempting to help accommodate people relocating to the area, utilize local resources, and promote regional branding. The business engages in the sale of charcoal products, firewood, and shiitake mushrooms, placing a strong emphasis on protecting the local natural environment and forests in a sustainable way while at the same time increasing sales. While involved in the activities of this district, the author has been documenting the way of life that makes the most of local resources and has been conducting research into how best to archive their efforts through video images to find the best methods of expression for regional promotional videos.

In a previous study, the author aimed to research the different methods of video expression that would be useful for individuals or organizations involved in regional branding and promotion. As a result, it was interesting to note that even though the length of the two videos, the method of video expression, and the setting of the advertisement itself were the same, there were significant differences in viewer ratings and number of views, and the author wondered if these differences were related to other factors.

The fact that the title of one work included the name of the product, while the title of the other work was drawn from the words of the person interviewed in the video was considered by the author to be a factor that prompted a large difference in viewer ratings and interest in the video. However, it was difficult to quantify the qualitative elements for the disparity which led the author to search for methods of verifying which factors would give the viewers a favorable impression and increase viewer ratings.

Therefore, in this study, we examined 40 films nominated from 201 films submitted to the Japan World's Tourism Film Festival (JWTFF) held in March 2022, along with 47 films nominated from 1542 films submitted to the international competition to determine what sort of keywords were used in the production of regional promotion films that were worthy of nomination. To verify what keywords were used to create the regional promotion videos that were worthy of nomination, a text mining analysis was used to examine them.

2 METHODS

The method of this study is an analysis using a user-local text mining tool (User Local, 2022).

First, regarding text mining, "Text Mining Techniques and Trends" (Ogi, 2015) begins, "What is text mining? Although it is commonly stated that there is no clear definition, it essentially means mining (information excavation) texts (sentences) and quantitatively analyzing texts with qualitative characteristics. This technology is called that because "data" in data mining corresponds to "text". At its core, it is realized by a combination of natural language processing, statistical analysis, and data mining technologies." Since around 2001, there have been several text mining studies in Japan.

Furthermore, IT Trends (IT Trend, 2022) indicates that the data collected has been studied since the 1960s, when computers were adopted as the backbone of business support systems. Data mining originated in the 1960s when computers were accepted as mission-critical systems to support corporate operations, and data analysis was used to create "hypotheses" for solving business problems (The History and Evolution of Text Mining, 2022). Text mining, on the other hand, has fundamentally altered conventional wisdom by eliciting "insights" before hypotheses. Machines are now able to grasp and translate natural language because of advancements in AI and deep learning technology. Siri and other AI assistants, search engines, and chatbots that use natural language processing are all examples.

According to the developer (Higuchi, 2017), KH Coder is a well-known text mining software in Japan. Higuchi states, "KH Coder is a free content analysis (quantitative text analysis) and text mining program. It was designed to perform quantitative analysis on a variety of Japanese text-type data, including free-text descriptions in questionnaires, interview transcripts, newspaper articles, and so on. It can show lists of words in text files, concordances, and conduct other searches and statistical analyses."

When studying text mining for the first time, the author tried utilizing this KH Coder, but after preparing and preprocessing the text data to be verified, the chart diagram of the "co-occurrence network," which reveals the links between texts, which KH Coder is good at, was not retrieved properly. This most likely happened due to the author being trained in how KH Coder worked. However, some preparation was required to perform morphological analysis based on keywords and automatically re-analyze the text mining based on specific elements of voice and text, which the author believed required a significant amount of preprocessing effort.

As a result, the author chose to use the aforementioned user-local text mining tool for the research and analysis of this study because it was straightforward to grasp.

Figure 1. User Local AI Text Mining

2.1 Source data for analysis

The original data used by User Local was an Excel document containing the titles, synopses, production backgrounds, targets, and goals of 40 films nominated from 201 films submitted to the Japan section of the JWTFF in March 2022, and 47 films nominated from 1542 films submitted to the international section.

Excel sheets comprising the titles, synopsis, production background, targets, goals, and other information for 47 regional promotion videos selected from 1542 videos submitted to the International Competition were used.

2.2 Pretreatment

The text data for the text mining study included 908 words or 18,728 characters for the Japanese sector and 7,897 words or 48,899 characters for the foreign area, as shown in Table The original Japanese data was exported to CSV data from Excel, with extraneous symbols (underbars, special parentheses, etc.) and coined words that could be separated eliminated, or concatenated as a single sentence preprocessed. Because the foreign component was written in English, specific coined words were checked, but no additional preparation was required, so the Excel data was converted to CSV.

Table 1. Text Mining Number of Source Data

	International	Japanese
Words	7,897	908
Characters	48,899	18,728

2.3 Analysis Method

Based on the previous study "Factor Analysis of Film Evaluation Using Text Mining and Network Analysis," the author hypothesizes that the evaluation of films nominated for this year's Tourism Video Festival will be influenced by the factors that affect the evaluation of films nominated for regional promotional films (Ogawa, 2022). The author believes that by focusing on nouns and adjectives in the provided materials, they may extract the characteristics that influence the nominated films' evaluation. By doing so, the author will clarify the evaluation criteria for the works chosen by the film festival jury and consider their video expression approaches.

3 RESULTS

Table 2 shows the content visualized by text mining in the user's local area. This investigation will focus on word clouds, word frequencies, and co-occurring keywords.

Table 2. Types of analysis visualized

Type	Details
Word Cloud	Several words with high scores are selected and illustrated with a size corresponding to their value. The color of the words differs according to their part of speech, with blue representing nouns, red verbs, green adjectives, and gray moving words.
Word Frequency	The table shows the frequency of words that appear in a document. The size of the "score" shown for each word indicates how characteristic the word is in a given document. Usually, the more often a word appears in a document, the higher the score, but words such as "say" or "think" that appear frequently in all documents will have a lower score.
Co-occurring keywords	The figure shows a line connecting words that have similar patterns of occurrence in a sentence. The larger the number of occurrences of a word, and the stronger the degree of co-occurrence, the thicker the line is drawn.

3.1 Results of analysis by Word Cloud

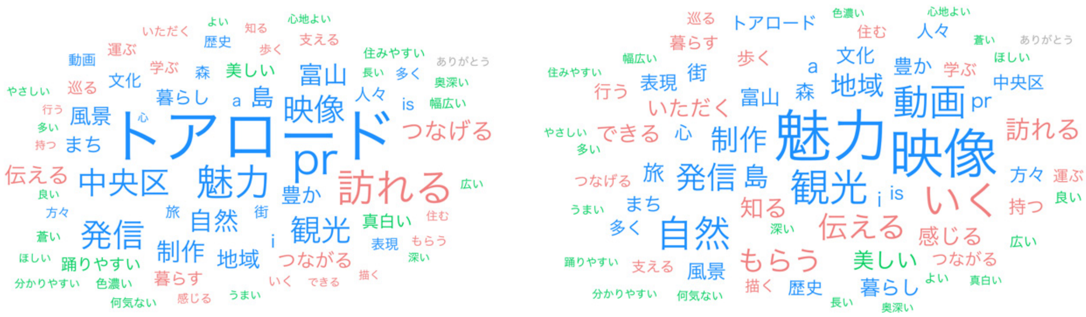
The first step is to examine the word cloud's results. The word cloud is set up so that distinct results are displayed in order of score and frequency of occurrence.

The score (user local, 2022) is a number that represents the word's "importance.", "Words that appear frequently in general papers are given less weight since they are not important" according to text mining, while "words that do not appear frequently in general documents, but solely in the document under study, are given more weight." Words that appear infrequently in general papers but frequently in the document under study, on the other hand, are given additional weight. The TF-IDF approach is a statistical process that is used to extract these distinguishing words. The "score" is a value that takes into account not only the number of occurrences but also the degree of importance when using this method. A high-scoring word is one that characterizes the text.

The top parts of speech of the words exhibited in the order of score and frequency of incidence in the international section (Figure 2) were predominantly verbs in the order of score and nouns in the order of frequency of recurrence. Nouns are the most commonly used parts of speech in titles, synopses, and production objectives, among other things. The words "unique" and "different" stood out on the Word Cloud, and they were prominently shown in both score order and frequency order. The next most prevalent adjectives are “natural”, “new” and “local” which appear to be linked to the increased focus on nature and local cities following the Corona Disaster.

By Score By Frequency

Figure 2. Word Cloud International Section Results



By Score By Frequency

Figure 3. Word Cloud Japan Section Results

The majority of the components of speech in the Japan section (Figure 3) were nouns, both in score order and frequency order. Place names like “Toa Road”, “Chuo-ku” and “Toyama” stood out in scoring order, as did terms like “attraction”, “video”, “PR” and “sightseeing” all of which communicate the sense that the video production is a tourist attraction marketing. Furthermore, when compared to the international portion, the word cloud had more adjectives in off-center regions.

3.2 Results of analysis by Word Frequency

The word frequency analysis findings can be obtained as a CSV file from UserLocal, and Table 3 summarizes the top 50 most often occurring terms and their parts of speech. The top five words in both the international and Japanese categories are words related to the tourism video festival's objective, such as images and films, although “people” in the international area and “attraction” in the Japanese section are the most distinctive words. In terms of nouns, the international section had “culture”, “life”, “event”, “time”, “year” and “day” whereas the Japanese section had “nature”, “travel”, “island”, “life”, “town”, “landscape”, “history” and proper nouns. As a result, many of the visual expressions connected with these keywords may have been chosen for video works made in Japan.

Table 3. The top 50 most frequently appearing terms and their parts of speech

International								Japanese							
No.	part	word	count	No.	part	word	count	No.	part	word	count	No.	part	word	count
1	noun	people	33	26	verb	take	16	1	noun	魅力	48	26	noun	a	12
2	noun	film	30	27	noun	island	15	2	noun	映像	45	27	noun	表現	12
3	noun	video	29	28	noun	one	15	3	noun	観光	31	28	verb	いただく	12
4	noun	campaign	28	29	verb	see	15	4	noun	自然	30	29	verb	感じる	12
5	noun	tourism	27	30	noun	sauna	14	5	noun	動画	29	30	verb	できる	12
6	noun	world	27	31	noun	cannes	14	6	verb	いく	26	31	Adjective	美しい	12
7	noun	culture	25	32	noun	adventure	14	7	noun	発信	24	32	noun	is	11
8	verb	make	25	33	noun	region	14	8	noun	制作	22	33	noun	方々	11
9	noun	city	24	34	verb	want	14	9	noun	島	20	34	noun	心	11
10	noun	place	23	35	Adjective	natural	14	10	noun	地域	20	35	noun	トアロード	10
11	noun	destination	21	36	Adjective	new	14	11	verb	伝える	18	36	noun	中央区	10
12	noun	experience	20	37	noun	australian	13	12	verb	もらう	17	37	noun	人々	10
13	noun	life	20	38	noun	australia	13	13	noun	旅	15	38	noun	歴史	10
14	noun	nature	19	39	noun	area	13	14	verb	訪れる	15	39	noun	多く	10
15	noun	event	19	40	Adjective	main	13	15	noun	富山	14	40	noun	世界	10
16	noun	time	19	41	Adjective	local	13	16	noun	暮らし	14	41	noun	東京	10
17	verb	find	19	42	Adjective	different	13	17	noun	街	14	42	noun	my	9
18	noun	holiday	18	43	noun	territory	12	18	verb	知る	14	43	noun	日常	9
19	verb	show	18	44	noun	u	12	19	noun	pr	13	44	noun	体験	9
20	noun	year	17	45	verb	look	12	20	noun	風景	13	45	noun	大阪	9
21	Adjective	unique	17	46	verb	go	12	21	noun	豊か	13	46	verb	歩く	9
22	noun	audience	16	47	noun	tourist	11	22	noun	i	13	47	verb	行う	9
23	noun	day	16	48	verb	promote	11	23	noun	文化	13	48	verb	持つ	9
24	verb	visit	16	49	verb	focus	11	24	noun	森	13	49	noun	奄美大島	8
25	verb	experience	16	50	verb	create	11	25	noun	まち	12	50	noun	people	8

Furthermore, there was only one adjective in the Japan portion of the top 50, the word "beautiful" therefore the author looked at the ratio of nouns to adjectives in the worldwide and Japan categories again, and the findings are displayed in Table 4. In the Japan segment, adjectives occurred only 2.1 percent of the time, indicating that nouns and verbs appear to be the primary components of Japanese tourism videos. The effect on the spectator is a topic for further investigation, but the findings of this study clearly illustrate that the approach to tourism video creation in Japan and other nations is vastly different.

Table 4. Differences in adjective occurrence rates

	International section	Japan section
Noun	*1,075*	*1,469*
Verb	343	267
Adjective	*350*	*31*
% Adjectives	***32.6%***	***2.1%***

3.3 Results of analysis by Co-occurring keywords

Figures 4 for the international section and 5 for the Japanese segment illustrate the results of the co-occurring keywords.

First, the international section's co-occurring keywords were organized into seven major groups. The most common group included the nouns “people”, “place”, “film” and “time” which led to the verbs “make”, “find”, “show” and “get” while adjectives such as “natural”, “local”, “real” and “beautiful” were displayed as related keywords. By connecting the keywords in this group, they can be regarded as keywords that provide suggestions for video titles and expressions.

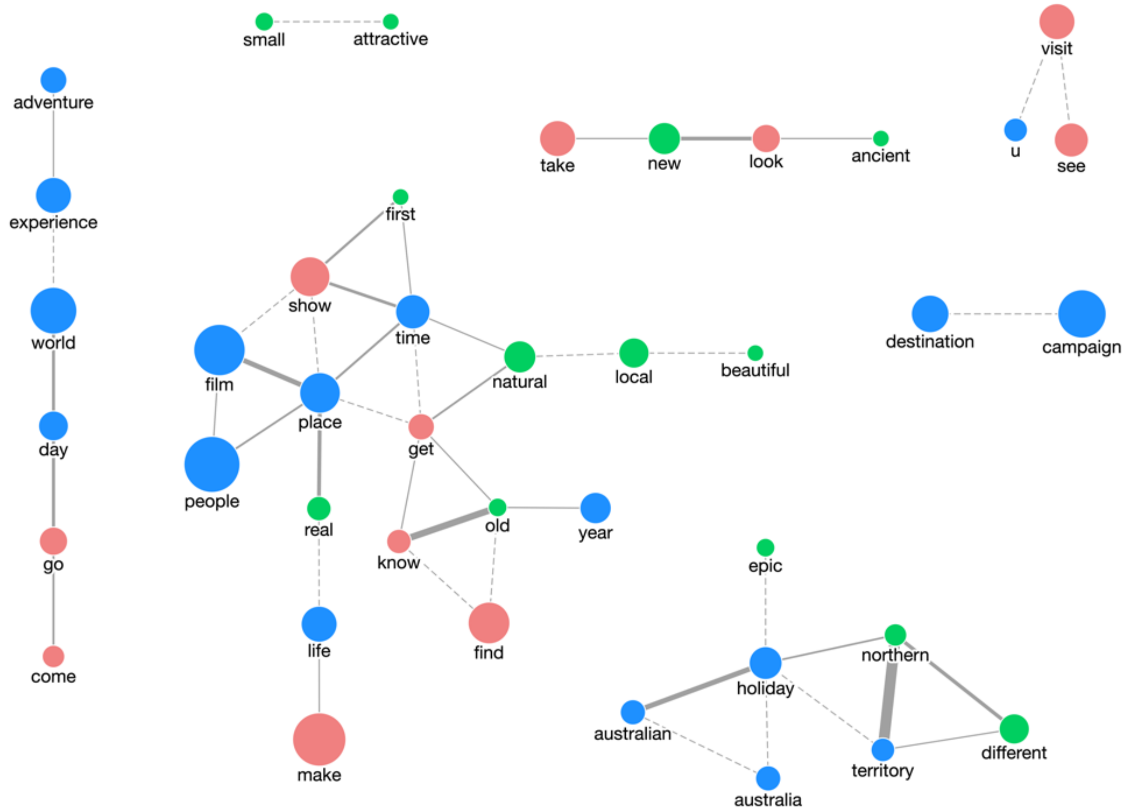


Figure 4. Co-occurring keywords International Results

For example, “If you come to this location, you will meet someone” (Matsubara, 2020), the title of a regional promotion film produced in a marginalized hamlet that is also the author's research base, earned the Grand Prize in the 2nd SDGs Creative Award. “People” are the “place” in “this place” and the “someone” in “you can meet someone”.

Similarly, the words used in the title of (Matsubara, 2022), another interview video produced in the previous study, were conceived without using specific place names or activities, with the goal of making viewers imagine what happens, what they see, and what they feel when they arrive at that location.

“Northern” and “territory” are strongly co-occurring words, as indicated by the thick gray line linking the co-occurring keywords. This is because the phrase “northern territory” appeared multiple times in the text detailing the summary and goals of one video production, and it was a keyword that should have been pre-processed as a single word. As a result, the author believes that this group included the related nouns “Australian” and “Australia” as well as the name of the region. Because the other groups were merely linearly related, it's safe to believe that the keywords with the highest frequency of recurrence were linked to the phrases that accompanied them.

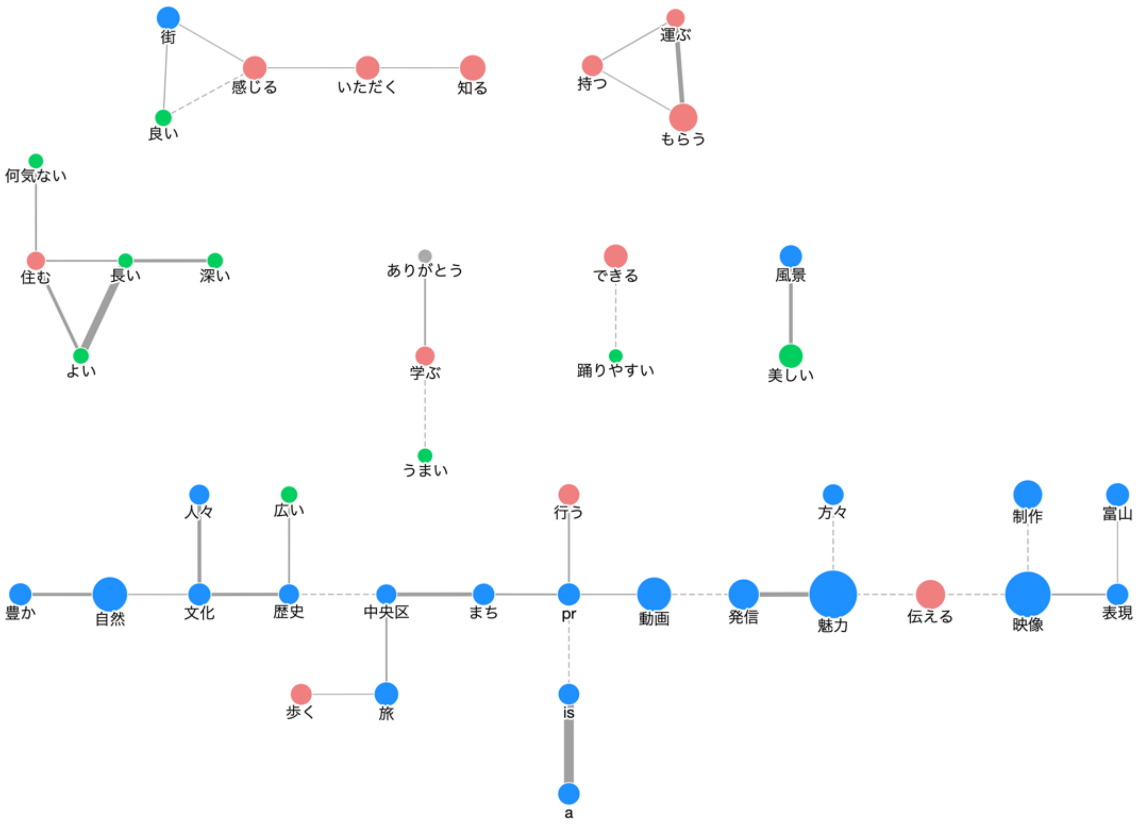


Figure 5. Co-occurring keywords Japan Results

In the Japan section, like in the international section, the results of the co-occurring terms were organized into seven primary groupings. However, in contrast to the international section, most of the keywords in the Japan section were connected by linear relationships, with nouns like “attraction” and “transmission” connected to the verb “convey,” nouns like “image” and “expression” connected to the verb “convey” and nouns like “city” + “PR”, “city” + “place name,” and “culture” + “history” and “culture” + “people” connected to the verb “culture.” The terms “culture” and “people” become increasingly linked to “culture” and “people.” Some sentences derive from keywords like “feel the good things about the town” and “let people know the excellent things about the town” which are associated with the adjective “good” in the group where the verbs “feel”, “receive” and “know” are coupled with the noun “town.” It's possible that grouping co-occurring keywords into noun-centered, verb-centered, and adjective-centered groupings is a feature of the Japanese language, but further research on this is required in the future.

4 CONCLUSIONS

In this study, using text mining analysis as a validation approach, the author investigated whether keywords can be identified in regional promotion videos submitted to the Japan World's Tourism Film Festival.

The adjectives “unique”, “different”, “natural”, “new” and “local” shone out on the word cloud in the international section, perhaps due to the heightened attention to nature and local cities in the aftermath of the Corona Disaster. Nouns like “people”, “location”, “film”, and “time” were the most common co-occurring keywords, leading to verbs like “create”, “discover”, “show” and “get” as well as adjectives like “natural” and “local”, “real” and “beautiful.”.

The bulk of keywords in the Japan section were nouns, but location names and terms like “attraction”, “video”, “PR” and “tourist” stood out, confirming that the film is a promotional film targeted at luring tourism. Furthermore, as compared to the international section, the word cloud was distinguished by the presence of adjectives in off-center places. Many co-occurring keywords were thought to be expressed in terms of notions such as “city” + “PR” + “conveyance” with nouns such as “attraction” and “transmission” leading to verbs such as “conveyance” and nouns such as “image” and “expression” leading to verbs such as “conveyance”.

Based on these findings, the author concluded that, in comparison to the rest of the world, current Japanese tourism videos appear to express the producers' desire to “transmit the attractiveness” and “how to make people feel and know the city's attractiveness” as well as specific place names as video expressions. The results of the international section, on the other hand, point to a more specific image of a trip to “make”, “find”, “show”, and “get” in a “unique and different”, “natural”, “new”, “local”, “real” and “beautiful” location, and it appears that the tourist images in the sightseeing video are meant to evoke this intention.

Professor Tsuyoshi Kigawa, the JWTFF's representative, and Mr. Katsunosuke Honda of Honda-ya Honten, a JWTFF judge, a producer of Japanese heritage, and a regional producer of Cool Japan for the Cabinet Office, spoke at a talk session (JWTFF, 2022) and said, “Although the technology for photographing beautiful places and attractive parts of the region has improved, what strikes me about going there is what you can learn and notice.” He explained, “The technology for capturing gorgeous landscapes and attractive features of the region is developing, but what strikes me as interesting is what you can learn and see when you visit, which makes me want to visit. It makes you want to inquire further. It inspires you to go exploring. Rather than leaving the answers on the visuals, it leaves a lasting impression. The visuals left me feeling as if I could go there and find out for myself.” His assessment of the Japanese section was as follows. “Showa-era tourism was about seeing,” Mr. Honda continued. “Tourism during the Heisei era was all about the experience. Tourism during the Reiwa era is all about discovery.” He underlined the importance of creating images that reflect changes in tourism. “I believe that by understanding and perfecting traditional culture and traditional performing arts, and sprinkling them into the visuals, we can create images that only Japan can create and that will be enjoyed by people all over the world,” he continued. He also gave us some tips on image expression that we should consider in the future when it comes to Japanese tourism images.

Keywords like “tradition”, “culture” and “performing arts” specified by Mr. Honda were positioned behind linearly related nouns in the text mining survey done at the time, and this was reflected in the visual manifestation of the Japanese regional promotion. This is why the terms “culture” and “entertainment” were nominated for prizes and won. This shows that text mining of keywords in visual expressions will be helpful when considering visual expressions in future regional promotion videos.

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MALE AND FEMALE FACIAL ATTRACTIVENESS PREDICTION

AN IMAGE-BASED APPROACH USING CONVOLUTIONAL NEURAL NETWORK-BASED MODELS

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ABSTRACT

In recent years, significant research has been conducted on the use of deep learning for prediction of facial attractiveness. These studies are expected to have various applications such as recommendation systems and face beautification. Therefore, it is crucial to improve the prediction accuracy. In this study, to improve the accuracy of facial attractiveness prediction, several convolutional neural network-based models were built using sex-specific datasets. Then, their accuracies were compared. The results showed that VGG19 and VGG16 had the highest accuracies for the male and female face datasets, respectively. A detailed confirmation of the factors necessary for prediction is expected to contribute to the construction of models based on human perceptual characteristics. These models maybe utilized in various engineering applications.

Keywords: Facial attractiveness, Deep learning, Convolutional neural networks

1 INTRODUCTION

Recently, in the field of machine learning, research on facial image analysis has gained momentum. In particular, research that uses deep learning to construct models to predict facial attractiveness has attracted considerable attention (Saeed & Abdulazeez, 2021), and is expected to be utilized in various engineering applications. For example, facial beautification (Liang et al., 2014) and face editing (Liang et al., 2015) are in increasing demand to create resumes and profile photographs. To improve the editing accuracy of these tools, their internal models must capture various facial features, such as morphological characteristics, texture, and

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gender differences. In the field of psychology, it is known that sexual dimorphism affects attractiveness (Johnston, 2006; Jones et al., 2015; Russell, 2009). Moreover, in deep learning analysis, it has been pointed out that the essential features for predicting facial attractiveness can differ depending on the gender of the person In the image (Sano, 2022). However, in most previous studies on facial attractiveness prediction, models were trained either on a mixed dataset containing images of males and females (Liang et al., 2018; Xu et al., 2017) or on a dataset containing only the images of females (Xie et al., 2015), and the consideration of gender differences of people in these images is insufficient. If a highly predictive model that considers these factors can be constructed, the model can be used to extract the features important for facial attractiveness. This is expected to contribute to understanding facial attractiveness features that have not been elucidated in psychological research. Furthermore, since these techniques will lead to various engineering application studies, it is important to study the models.

Therefore, in this study, the factors necessary for gender-specific modelling were examined using several commonly used convolutional neural network (CNN)-based models, with model building performed separately for images of males and females.

2 PROCEDURE

2.1 Dataset and metrics

In this study, first, the images of males and females were split into separate datasets to identify gender differences. Subsequently, models were built for each of these datasets. The benchmark database SCUT-FBP5500 (Liang et al., 2018) (Figure 1), which contains 2750 male and 2750 female facial images labeled according to their attractiveness by 60 raters, was used as the dataset. For both models, 2200 randomly selected images were used as training data during the training phase and the remaining 550 images were used as the test dataset. All validations were performed using a five-part cross-validation method to reduce bias resulting from data partitioning. The Pearson correlation between the image label values and the prediction results was used to measure the prediction performance.

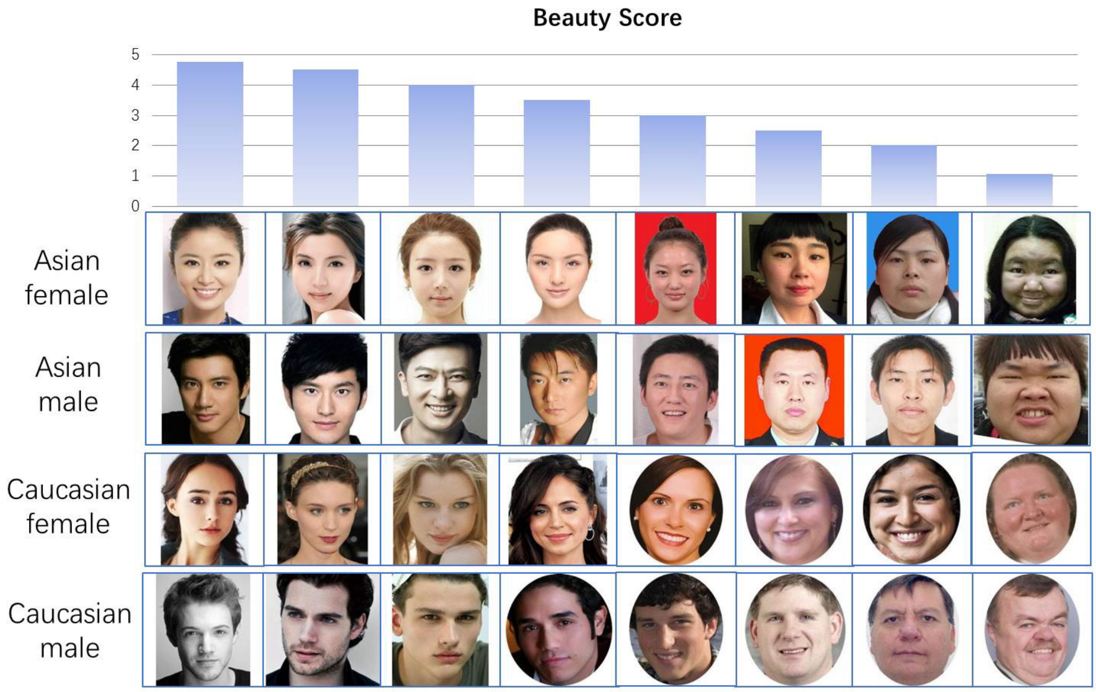

Figure 1. Sample images from SCUT-FBP5500.

2.2 Methods

The model uses a CNN-based method. CNN is a neural network structure with an added operation called convolution and is an excellent model using images as input. The CNN-based methods used for validation were a simple CNN, ResNet50 (He et al., 2016); DenseNet121, DenseNet169, and DenseNet201 (Huang, 2017); and VGG16 and VGG19 (Simonyan, 2014). For each model, the batch size and number of epochs were fixed at 160 and 500, respectively, for the training. Moreover, for the methods other than the simple CNN, the prediction accuracy was improved by using the weights of the neural networks that were pretrained by ImageNet as the initial values.

3 RESULTS

The average model accuracies for the male face dataset were 0.768 for CNN, 0.816 for ResNet50, 0.825 for DenseNet121, 0.841 for DenseNet169, 0.807 for DenseNet201, 0.836 for VGG16, and 0.844 for VGG19. Whereas those for the female face dataset were 0.744 for CNN, 0.804 for ResNet50, 0.801 for DenseNet121, 0.817 for DenseNet169, 0.783 for DenseNet201, 0.855 for VGG16, and 0.846 for VGG19. Table 1 presents the detailed results.

Table 1. Correlation coefficient results.

model	sex	1	2	3	4	5	average
CNN	male	0.784	0.741	0.780	0.782	0.755	0.768
ResNet50	male	0.844	0.825	0.801	0.783	0.827	0.816

DenseNet121	male	0.847	0.821	0.825	0.774	0.859	0.825
DenseNet169	male	0.843	0.858	0.835	0.855	0.815	0.841
DenseNet201	male	0.868	0.822	0.836	0.651	0.858	0.807
VGG16	male	0.797	0.841	0.852	0.853	0.836	0.836
VGG19	male	0.808	0.852	0.843	0.861	0.858	0.844
CNN	female	0.775	0.725	0.732	0.761	0.728	0.744
ResNet50	female	0.807	0.802	0.800	0.827	0.786	0.804
DenseNet121	female	0.719	0.827	0.824	0.814	0.818	0.801
DenseNet169	female	0.813	0.826	0.843	0.825	0.777	0.817
DenseNet201	female	0.846	0.819	0.796	0.643	0.810	0.783
VGG16	female	0.869	0.851	0.848	0.844	0.864	0.855
VGG19	female	0.852	0.848	0.859	0.844	0.829	0.846

4 DISCUSSION

The validation results showed that VGG19 and VGG16 were the most accurate models for the male and female face datasets, respectively. This may be because VGG started learning with the weights from ImageNet as its initial values, which increased its accuracy based on the characteristics common to image recognition. Additionally, the simple and deeply layered model structure of VGG may be suitable for prediction. However, because this validation was conducted only to confirm the accuracy of the models, critical predictors were unclear. In a previous study, Sano (2022) reported that for the prediction in the case of men, the important area was that around the eyebrows. Whereas in the case of women, the area around the eyes was considered important. It will be necessary to confirm the differences in what features the constructed models have learned internally depending on the male and female images. In future we aim to confirm the details of the factors that are essential for prediction using morphological information, such as the facial landmark information. An in-depth understanding of these factors and a thorough examination of those models that give more consideration to human perceptual characteristics may be utilized in various applications such as face editing.

5 CONCLUSION

Several CNN-based models were built using sex-specific datasets and their accuracies were compared. The results showed that VGG-based models had the highest accuracy when trained using the male and female face datasets separately. A detailed confirmation of the factors important for prediction is expected to contribute to the construction of models based on human perceptual characteristics. These models can then be utilized in various Kansei engineering applications.

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MATERIAL DERIVATION AFFECTS THE PERCEPTION OF SUSTAINABILITY IN POLYMER PRODUCTS

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ABSTRACT

There is an increasing demand for "natural" products by consumers, businesses, scientists and product developers. Trends suggest that the term *natural* may be colloquially understood to be a plant-based material or ingredient. This study investigates whether this trend could apply to polymers by declaring the derivation of the polymer as a plant or as petroleum. Because polymer materials do provide environmentally positive attributes for products in relation to other materials, such as lightweighting, durability, and lower fabrication energy requirements, it may be helpful to understand the influence of a polymer's derivation on the perception of a polymer product's sustainability. The goal of this study is to assess peoples' relative perceptions of the sustainabilities of polymer drinking cups when the base materials from which the polymers were derived are exposed. A set of six injection-molded drinking cups was given to research subjects to analyze. Each cup is made of a different polymer. The polymers have derivations including petroleum, corn, sugar and trees. Participants evaluated the cups on six qualitative design strategies for sustainability, including natural-ness. This paper compares the perceived sustainable attributes of the cups, and which attributes were most strongly influenced by revealing the derivation of the polymers.

Keywords: *sustainable polymer selection, sustainable design strategies, natural materials*

1 INTRODUCTION

Sustainable design plays an essential role in negating and reversing the effects that consumption has had on our natural and built environments. Concern about sustainable development and climate change has caused people to attend to and alter the ways they live to

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support environmental goals and ensure that future generations can meet their own needs (Pew Research Center, 2020; United Nations, 1987). Product designers invested in this movement aim to design products that are both perceived to be sustainable by consumers and are measured to be sustainable by scientific metrics.

One observation in this environmental movement is that the demand for more “natural” products in peoples’ health and homes is increasing (Mintel, 2021a and 2021b). While this trend may be caused by the desire to be more sustainable, natural materials are not necessarily less environmentally impactful. Moreover, “natural” is an ambiguous, broad and minimally regulated category. Dictionary definitions for natural refer to having the characteristics of nature or coming from nature (Brittanica, 2022; Merriam-Webster, 2022), a definition which ultimately applies to every material humans have harnessed. Science journal articles and books refer to natural materials predominantly as substances that come from plants or animals (Kumar, 2020; Lee, 2014; Muthu, 2020; Patwa, 2018; Ritchie, 2014; Willför, 2008), but notably also include minerals (DeMouthe, 2006). The US Food and Drug Administration requested comment on the use of the term “natural” as related to food in 2015 (The Federal Register, 2015), prompted by requests for more specific regulation of the word in food product descriptions. No new FDA requirements have yet come to fruition resulting from the comments collected. Consumers, scientists and regulators don’t have consistent definitions or even understandings for “natural” material attributes or requirements, but collectively use the term “natural” as one that is important to define the materials we use.

Product designers also do not have a succinct definition of a natural material, despite the fact that selecting natural materials is one of the principal strategies for sustainable product development (Graedel, 1995). Just like consumers, scientists and regulators, product designers assume that the materiality of a product is an indicator of that product’s overall sustainability (Ashby, 2009). The material an object is made of is not the sole indicator of a calculated environmental impact, however. The Okala (White, 2013), Sustainable Minds (Sustainable Minds, 2022) and Eco-indicator 99 (PRé Sustainability, 2000) Life Cycle Assessment tools for products weigh the materials used in a product, but also weigh the fabrication techniques, transportation of the product, the energy consumed in the product’s lifespan and the end of product life. While quantitative sustainability measurements can be conducted through Life Cycle Assessments (LCA), the perceptions that consumers and designers have of material sustainabilities are not necessarily the same as what is calculated in an LCA. For example, assuming comparable size, an aluminum water vessel may be perceived to be more environmentally friendly than a high density polyethylene (HDPE) water vessel despite the fact that an LCA may indicate that an aluminum vessel would have a higher environmental impact than an HDPE vessel (Muenchinger, 2013). Gaining a deeper understanding of user attitudes towards sustainable products can assist the success of environmentally conscious new product design (Hojnik, et al., 2019).

Studies of consumer perception of product sustainability have indicated that natural-ness is a driver of whether a product is considered sustainable as a whole (Muenchinger, 2014; Muenchinger, 2013) and that materials in products categorized as “natural” were warm, rough, heavy, and not transparent or reflective (Karana, 2012). Polymers do not instinctively fit into any of the descriptors of the Karana study, and are a primary material category for consumer products. Understanding the emotional relationship that polymers do or can have with the descriptor “natural” would benefit designers, marketers, and even consumers in combined efforts to be more environmentally conscious in product choices. Because Kansei studies quantify the emotional responses people have to attributes of products (Nagamachi, 1995), and tease out perceptions that consumers may not know they have (Kang, 2011), a Kansei study was conducted to examine the effect of participants knowing the derivations of polymers used to make drinking vessels. The hypothesis is that the more plant-based polymer derivations would skew the perception of “Natural” to be stronger, and that the overall perceived sustainability of the material would be higher than for petroleum-based polymers. The goal of this study, as of other Kansei studies (Nagamachi, 2002) is to guide designers in developing products that consumers emotionally connect with as having latent environmentally friendly attributes.

2 METHODS AND MATERIALS

Two hundred seventy-six people participated in the Kansei cups ranking exercise, all associated with the University of Oregon. Two hundred seventy participants self-identified as students, fifty-seven percent self-identified as male and forty-two percent self-identified as female. Participation in the study concluded prior to a lecture about measuring sustainability and similar research studies in perceptions of sustainability. Financial compensation was not provided to the participants.

2.1 Cups

The cups used in this study were fabricated specifically for this research. They were made from six different polymers: high density polyethylene (HDPE) derived from petroleum, HDPE derived from sugar, polypropylene (PP) derived from petroleum, a composite of 30% cellulose derived from trees plus 70% PP derived from petroleum, polylactic acid (PLA) derived from corn, and a co-polyester (PES) derived from petroleum. They were all fabricated through injection molding using the same tooling. The cups are shown in Figure 1.

Figure 1. Six cups pictured left to right: HDPE sugar, HDPE petroleum, 30% cellulose/70% PP composite, PES from petroleum, PLA from corn and PP from petroleum.

While the vessels are made of different polymers, there is a goal to have the objects in the study be as similar as possible. All materials are their natural color; no colorants were used.

There are, however, noticeable physical differences in the cups due to the natural color, densities and shrink rates of the different materials. The PLA and PES cups are both transparent, but the PLA has an amber tint and the PES has a purple tint. The petroleum-derived HDPE is brighter white than the sugar-derived HDPE. The composite cellulose/PP is opaque amber with embedded lighter flecks. The weights of the cups range from 77g (both HDPE cups) to 108g (PLA), a 29% difference. Because the polymers have different shrink rates, the heights of the cups are slightly, though visibly different from polymer to polymer. The tallest cup is the PES at 96mm, and the shortest is HDPE (sugar) at 93mm, a 3% difference.

The impact factors for both the material and for the injection molding process (Okala impact factor for injection molding is 0.72 points/lb) are multiplied by the weight of material of the object to determine the total Okala Impact Factor points for the object. These impacts, for the materials and the product totals, are provided from lowest to highest total impact in Table 1.

Table 1: Cup materials, weights, Okala Impact factors and total points

Material	**Weight in g (oz)**	**Okala Material Impact Factor in points/lb**	**Okala Impact Factor, Material + Manufacture (injection molding)**	**Percentage increase in Impact from HDPE (petroleum)**
HDPE (petroleum)	77.1 (2.72)	1.7	0.411	0
HDPE (sugar)	77.7 (2.74)	1.7	0.414	0.73
PP	72.0 (2.54)	1.9	0.416	1.2
Cellulose/PP	88.2 (3.11)	1.9 (use PP)	0.50	22
PLA	108 (3.80)	1.9	0.622	51
Co-polyester	101 (3.55)	3.6	0.959	133

The cup with the lowest Okala impact is HDPE (petroleum). The cup with the largest impact is the co-polyester cup, which has a 133% larger Okala impact over the HDPE (petroleum) cup.

The cups were provided to the participants as a six-sample set with both a group-identifying letter (A-P) common to the set and a material identifying number printed on the bottom of each cup. The names and derivations of the materials were provided to study participants, such as “High Density Polyethylene (HDPE) derived from sugar”.

2.2 Word Pairs

Participants in this study were asked to rank each cup on six word pairs designed to target qualitative strategies of sustainable design. The word pairs are: *Delicate – Durable; Lasting – Degradable; Raw – Finished; Harmless – Toxic; Natural – Artificial; Recyclable – Waste*. These word pairs were constructed to address historic sustainable material selection strategies (Graedel and Allenby: 240) (Lewis and Gertsakis: 86-87). These word pairs have been successful in determining feelings of sustainability towards products in previous studies (Muenchinger, 2012; Muenchinger 2013b, Muenchinger 2014).

3 RESULTS

Each cup is summarized by the average rankings in Figure 2. For each of the word pairs the more environmentally friendly word of the pair is positioned at the "1" side of the ranking on the 1-7 scale and the legend on the right presents this word. There is a general trend that the cups made from polymers derived from plants are perceived to be more sustainable than the cups made with polymers derived from petroleum. Clearly, all of the polymer cups are perceived to be Durable.

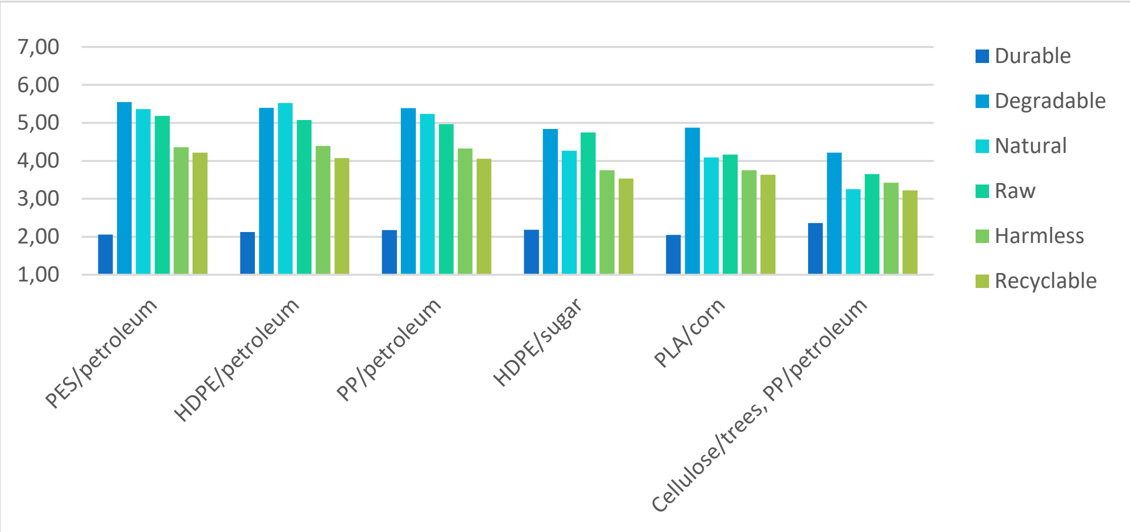

Figure 2. Average sustainability rankings of six polymer cups

4 DISCUSSION AND CONCLUSION

Visual representation of the data shows trends in perceptions of petroleum-based polymers compared to other polymer derivations, and perceptions of durability. The data in Figure 2 also suggests that the Cellulose/PP composite cup is perceived to carry the most complete set of characteristics associated with sustainability. For statistical significance comparing response data from the petroleum-based and sugar based HDPE cups, the Cellulose/PP composite cup, and durability factors of all cups, an alpha level of .05 was used.

4.1 HDPE: Petroleum-derived compared to Sugar-derived

The most direct comparison of cups for material derivation are the two HDPE cups. As is appropriate for cups made of the same polymer, they are the most similar of all the cup samples in weight, dimensional size, color, tactility and opacity. The average rankings of the HDPE cups are shown in Figure 3 for direct comparison.

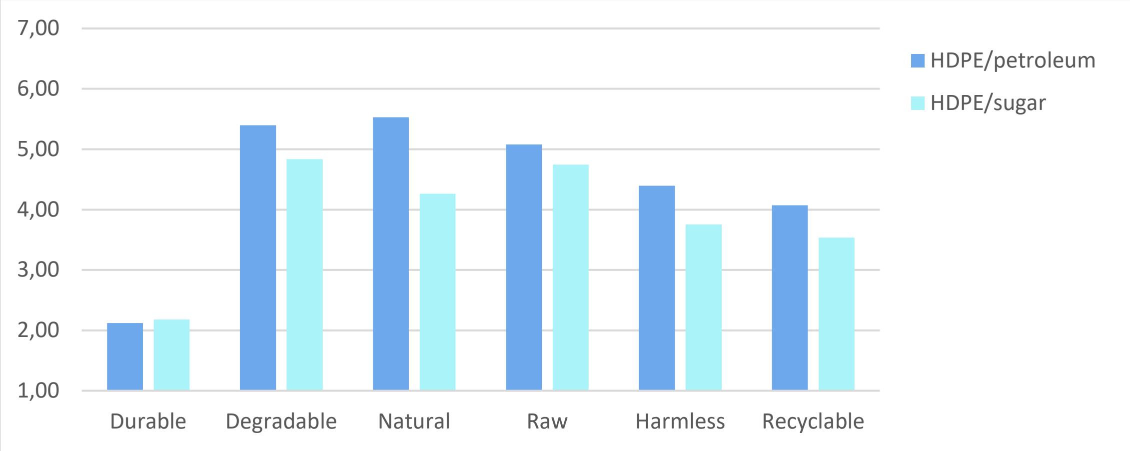

Figure 3. Average sustainability rankings of cups made from HDPE derived from petroleum and sugar

Five of the six word-pair rankings (Degradable, Natural, Raw, Harmless and Recyclable) show the sugar-derived HDPE cup to be perceived as more sustainable. Despite the variability of the responses, as indicated in the whiskers of the box plots in Figure 4, the perceived differences between the two cups in these five categories are statistically significant differences. The durable ranking, however, shows the petroleum-based HDPE cup to be perceived as more durable. This difference is not statistically significant, suggesting that the selection of a sugar-derived HDPE material would not negatively affect the perception of the product's durability.

Box plots of the data in Figure 4 show that the mean rankings for three of the six word-pairs (Degradable, Natural and Harmless) are lower for the sugar-derived HDPE cup, indicating stronger perception of sustainability. The responses are most tightly grouped, showing strongest consensus, that the HDPE cups are durable, not degradable, and not raw. Interestingly, it was common for the HDPE cup derived from petroleum to not be considered natural, while responses for the sugar-derived HDPE cup were more widely dispersed, yet provided a lower average ranking compared to the petroleum-derived cup and a significantly stronger overall perception of sustainability on that natural ranking.

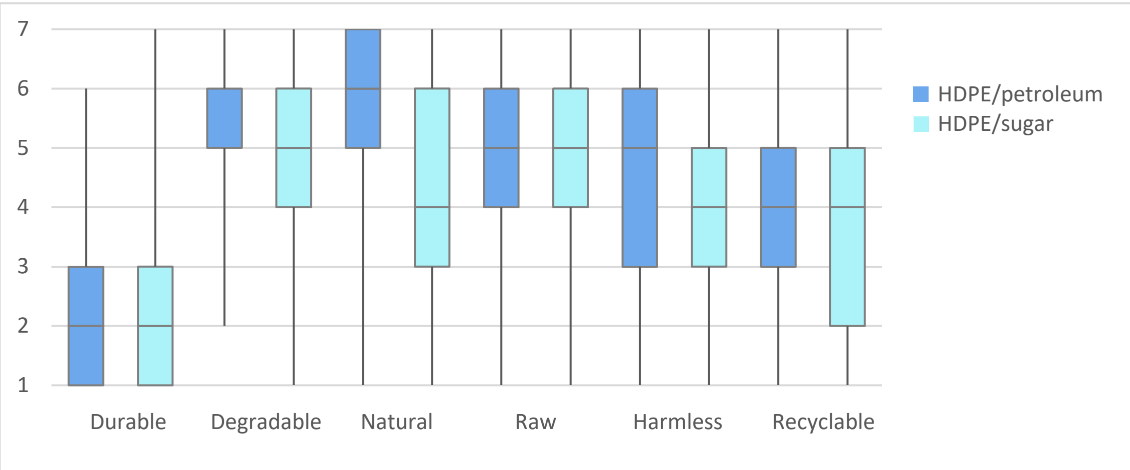

Figure 4. Box plot sustainability rankings of cups made from HDPE derived from petroleum and sugar

It is notable that the derivation, the stated difference between the two cups, influences perceptions of sustainability strongly. While the derivations are different, the molecular structure of HDPE is ultimately the same in each of these cups. Sugar-derived and petroleum-derived HDPE cups would be equally “degradable” and “recyclable.” The “raw” term is as elusive as the “natural” term in definition and regulation, but it may be helpful to know that the sugar-derived HDPE cup does have a stronger perception of rawness. The “harmless-to-toxic” word pairing is meant to relate to the cup product, not the loaded environmental and social issues associated with mining and farming for material resources. As such, the two HDPE cups are equally “harmless.” The perception of the sugar-based HDPE cup’s natural-ness makes intuitive sense, as there are noted trends that natural materials are plant-based. The cups look the same, feel the same, smell the same, and they sound the same when tapped on a table. The senses do not provide enough information to influence perceptions of sustainability. Knowledge about the material derivation of the polymer is the source of the differences in perception. Therefore, describing the product’s material as sugar-derived strengthens the perception of sustainability of the product.

4.2 Cellulose/Polypropylene composite

As seen in the general trends in Figure 2, the Cellulose/Polypropylene (PP) composite cup has the most sustainable rankings for five of the six word-pairs: Degradable, Natural, Raw, Harmless and Recyclable, compared to all of the other cups. Similar to the comparison between sugar-derived HDPE and petroleum-derived HDPE, the Cellulose/PP composite is perceived to be more sustainable than its peers. This is a statistically significant difference in comparison with all other cups in every category, with the exception of Durable, with every other cup. This composite is derived from 30% wood material, and 70% petroleum material, which is considerably less material from a plant-based and/or renewable resource than the other two plant-derived polymers: sugar-derived HDPE and corn-derived PLA, which are 100% plant-derived. Therefore, it must not be the derivation of the cup’s material that is the driver of these perceptions.

The most obvious differences between the Cellulose/PP composite cup and the other cups are visual. It is a definitive opaque amber color, and the color is non-uniform. Qualitatively, it is not as shiny or reflective as the HDPE and PP cups. It is the median cup of the sample set in weight. Qualitatively, the tactility seems less lubricious than the HDPE and PP cups, perhaps toothier or fuzzier than the PES cup, and softer than the PES and PLA cups. Similar to the results in the Karana study, this cup is warmer and rougher compared to its set-mates, and is not transparent or reflective. The Cellulose/PP cups look and feel more like they’ve been made with a material that has grown though changes in seasons or weather, rather than one that has been perfectly mass manufactured.

4.3 Durability

Both the PLA and PES cups are perceived to be significantly more durable than the Cellulose/PP cup, but those are the only statistically significant differences the data show in perceived durability between the various cups. Two physical properties could prompt this difference in perceived sustainability: the mass of the cups/materials and the color and transparency of the cups/materials.

4.3.1 Mass

The two cups with the most mass, the PLA and the PES, had the biggest impression of durability. These two cups are heavier than the others by over 12 g, with PLA 50% heavier than the lightest PP cup, and PES 40.3% heavier than the PP. The cup perceived to be least durable, however, is the Cellulose/PP cup, which is not the lightest weight, rather is right in the middle of the set. The PLA cup is 22% heavier than the PP/Cellulose, and the PES is 15% heavier than the Cellulose/PP. It is interesting that the PES cup is petroleum-based, the PLA cup is corn-based and the Cellulose/PP cup is a mix of petroleum and plant, or more specifically, petroleum and trees. Based on these observations, it is hypothesized that the weight has a stronger influence on the perception of durability than the material derivation.

4.3.2 Color and transparency

The Cellulose/PP cup is the only cup of the set of six that has an inconsistent, mottled visual texture. The Cellulose/PP cup is opaque, like the two HDPE cups, and it has an amber hue. The PLA cup also has an amber hue. The PLA cup is transparent, as is the PES cup. As the two transparent cups are perceived to be the most durable, transparency is hypothesized to influence the perception of durability. It is notable, however, that this seems counterintuitive, as a widely known transparent material: glass, is known to fracture easily compared to other materials. As the Cellulose/PP cup is the only visually textured cup, inconsistent color may negatively influence the perception of durability.

Based on the direct comparison of the two HDPE cups, exposing a plant-based base material used to make a polymer does positively impact the perception of sustainability of the end product. This is a benefit to selecting and supporting the plant-based polymer industry in an effort to create, produce and sell more sustainable products. As there is no statistically significant difference seen by exposing plant-based polymer derivations in the perception of durability, which is an undoubted characteristic of polymer products for sustainable goals, there is not a downside apparent from this study. Other characteristics of color, visual texture and tactility should also be considered in polymer products when considering a consumer’s perception of sustainability. Visual texture and tactility may be affected by in-mold texture application in injection-molded parts. Warm colors, or colors associated with plants may also affect the perceived sustainability of a product, and may be added as colorants to base polymers. In maintaining the goal of developing truly sustainable products, the qualitative strategies of exposing a plant-based material, application of texture and inclusion of color should be used in combination with quantitative metrics, such as LCA’s to ensure that products are developed to have the least impact on our environment.

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MODELLING EMOTIONAL VALENCE AND AROUSAL OF NON-LINGUISTIC UTTERANCES FOR SOUND DESIGN SUPPORT

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ABSTRACT

Non-Linguistic Utterances (NLUs), produced for popular media, computers, robots, and public spaces, can quickly and wordlessly convey emotional characteristics of a message. They have been studied in terms of their ability to convey affect in robot communication. The objective of this research is to develop a model that correctly infers the emotional Valence and Arousal of an NLU. On a Likert scale, 17 subjects evaluated the relative Valence and Arousal of 560 sounds collected from popular movies, TV shows, and video games, including NLUs and other character utterances. Three audio feature sets were used to extract features including spectral energy, spectral spread, zero-crossing rate (ZCR), Mel Frequency Cepstral Coefficients (MFCCs), and audio chroma, as well as pitch, jitter, formant, shimmer, loudness, and Harmonics-to-Noise Ratio, among others. After feature reduction by Factor Analysis, the best-performing models inferred average Valence with a Mean Absolute Error (MAE) of 0.107 and Arousal with MAE of 0.097 on audio samples removed from the training stages. These results suggest the model infers Valence and Arousal of most NLUs to less than the difference between successive rating points on the 7-point Likert scale (0.14). This inference system is applicable to the development of novel NLUs to augment robot-human communication or to the design of sounds for other systems, machines, and settings.

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INTRODUCTION

1.1 Background and introduction to Non-Linguistic Utterances (NLUs)

Non-Linguistic Utterances (NLUs) for communication from machine to human have been popularized in fiction, for example in the Star Wars movies where the robot R2D2 communicates with his human counterparts using squeaks, beeps, and other robotic sounds. This has inspired scientific research to try to understand whether there is any real communicative capability behind these sounds (Bethel & Murphy, 2006). NLUs are also used in daily life, for example in train stations to indicate passing a turnstile or an approaching train. Although these are one-way signals. NLUs are sounds that contain no discernible words, aren't musical, and exclude laughing or onomatopoeia. They are used to convey information, affect, or to communicate. (Yilmazyildiz et al., 2016)

R2D2, WallE, cartoons and movies where robots use squeaks, beeps, and whirrs to communicate are enjoyed by audiences, who might not fully understand an actual message but can go along with the context and generally understand what is being conveyed. The character pose and design, and context of the situation also assist in conveying the intended message.

Since the 1970's, NLUs have been used in psychology, where researchers have explored how tones can be used to communicate affect (Yilmazyildiz et al., 2016). Mavridis (2015) also argues for the importance of affect in robot human communication. Affect is communicated in both the semantic content of an utterance as well as the prosodic content. Also, across different cultures, affect can be understood and communicated differently. Language-independent communicative capabilities would allow robots to communicate with a wider range of people, suitable for settings such as tourist attractions and multi-cultural societies.

1.2 Overview of the current state of related work

NLUs and other SFUs have been successfully interpreted in terms of affect and emotional expression. Previous research has investigated whether NLUs can successfully convey emotion or affect. Reasons for using NLUs include, natural language programming is costly and difficult, not all applications require natural language communication, programming for multiple languages adds additional complexity (R. Read & Belpaeme, 2012, 2016; Yilmazyildiz et al., 2016). NLUs provide two main benefits: they are not linked to any language, and they can communicate a message in a very short time (Luengo et al., 2017).

Komatsu (Komatsu, 2005) explored how to communicate positive, negative, agreement and disagreement using NLUs. He found that sounds with rising frequencies were interpreted to be positive while those with falling frequencies were found to be negative, as in 'earcons' (Blattner et al., 1989) for computers and mobile phones.

Read and Belpaeme (2012) found that children were able to readily interpret NLUs in terms of their affect (happy, sad, angry, scared). However, they were not always consistent amongst each other when considering a given utterance. They (R. Read & Belpaeme, 2016) also found that adults interpreted NLUs in terms of their affect categorically, and that subtle changes between the NLUs did not result in subtly different interpretations.

The Keepon robot used NLUs to communicate with pre-verbal children with some success. Not using natural language makes designs easier to implement and suitable for the morphology of the robot (Yilmazyildiz et al., 2016). Read and Belpaeme (2014) recommend that NLUs be used alongside other more standard means of communication to augment functionality, as opposed to replacing them.

1.3 Machine Learning and speech emotion classification

Researchers have used machine learning methods to analyze mainly the linguistic parts of speech, but also non-linguistic components, to model the emotional meaning. In general, combinations of techniques for both feature extraction (Mel Frequency Cepstral Coefficients (MFCCs), spectrograms, pitch, intensity) and emotion classification using machine learning methods like Convolutional and LSTM neural networks, as well as Random Forest, have tended to outperform standard or non-machine learning oriented approaches. (Chen et al., 2020; Iliou & Anagnostopoulos, 2009; Issa et al., 2020). Previous work was done to model NLUs for communication in dialogue using their dialogue parts, and prosodic trends for dialogue part factors were established (Khota et al., 2019, 2020).

1.4 Objectives

The objective of the current research is to model the Valence and Arousal of NLUs, to evaluate candidate sounds for public facing social robots or similar agents that make use of such sounds.

This paper describes a novel inference model relating the features of NLUs to their affect.

2 MODEL DEVELOPMENT

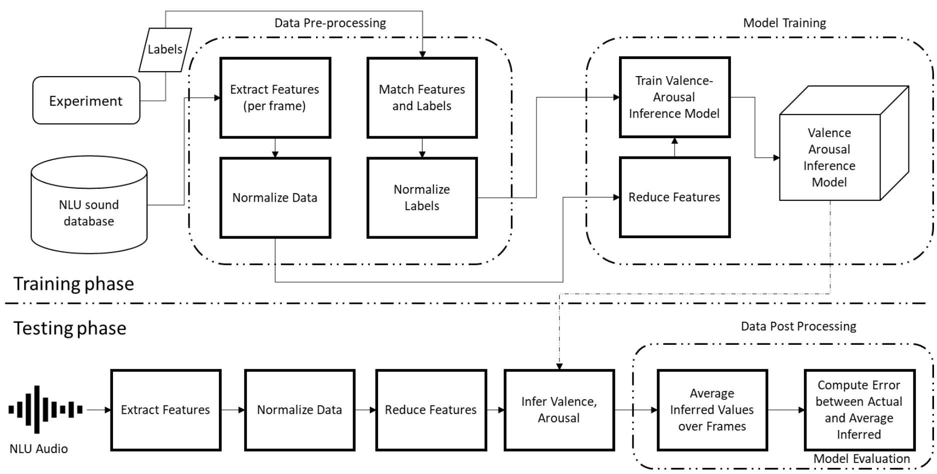

Figure 1: Proposed model

Figure 1 shows the method for developing the model. Firstly, audio files are labelled in experiments according to their Valence and Arousal. Next, important features are extracted from each audio file, and together these data are preprocessed, including being normalized, before being split into training and test datasets and input into a machine learning model which is trained on the training data set to infer Valence and Arousal on the testing data set. Inferences are collected per frame of audio data (described in section 4) and averaged over the number of frames per audio file to compare predicted and actual Valence and Arousal per audio file.

3 EXPERIMENT

3.1 Sound data sources

Sounds from popular media draw from many different sound designers who may have used various methods to generate and record sounds. This selection is intended to make the dataset agnostic in terms of generation method, potentially removing some influence from specific methods, recording sources, software, tools, or instruments.

The sounds used in experiments were gathered from popular movies, TV shows, and videogames. These sources were intended to explore the sample space and involve a wide range of sounds in terms of their source character, timbre, context, mode, as well as pitch, amplitude, and other prosodic properties. Table 1 shows the movies, TV shows, and videogame sources used, as well as the number of sounds from each, many of which are children's shows, or popular science fiction. A total of 560 NLUs were used. The sounds were extracted from lossy MP4 sources. The bitrate of all audio files is 768kbps except for the sounds synthesized (Khota et al., 2019, 2020) from PureData (*Pure Data — Pd Community Site*, n.d.), which are 705kbps.

Table 1. Sound data sources

Source	No. of Sounds	Character Type
Aladdin	21	Animal
Castle in the Sky	5	Robot
Dark Star	7	Robot
District 9	8	Alien
E.T.	40	Alien
Gremlins	4	Other
Guardians of the Galaxy	4	Alien
How to Train your Dragon	6	Animal
Ice Age	2	Animal
Monsters Inc	19	Other
My Neighbor Totoro	6	Animal
Shrek	6	Animal
Silent Running	8	Robot
Spirited Away 2001	12	Other
Star Wars Episode 4: A New Hope	75	Robot
Tangled	9	Animal
The Emperor's new Groove	15	Animal
The Iron Giant	17	Robot
Toy Story	6	Other
Treasure Planet	11	Other
Wallace and Gromit	1	Robot
WallE	31	Robot
Synthesized Sounds from Pure Data	29	Other
Blues Clues and You: TV Series	10	Other
Bucket's Quest Star Wars Resistance: TV Series	5	Robot
The Muppets Dr Bunsen and Beaker: TV Series	13	Other
Curious George: TV Series	21	Animal
In the Night Garden: TV Series	12	Other
Pokémon Journeys: TV Series	13	Other
Scooby Doo: TV Series	7	Animal

Star Wars Episode VII: The Force Awakens	37	Robot	Star Wars Rebels: Video Game	66	Robot
Surfs Up	3	Animal	Star Wars Jedi Fallen Order: Video Game	31	Robot

About half the sounds come from characters that are robots. 17% were from animals, 9% by alien characters, and others from various other imaginary characters.

3.2 Experiment process

The experiment proceeds as follows, after starting the experiment program: The sounds are played in random order for the subject. Each time a sound is played, the subject must rate it in terms of Valence and Arousal. Each of these is rated on a seven-point scale where a Valence rating of -3 is the lowest, representing a negative emotional state. -2 is a negative valence, -1 is a slightly negative valence. 0 is a neutral valence, 1 is a slightly positive valence, 2 is a positive valence, and 3 is the most positive valence, representing a positive emotional state. Arousal rating of -3 is the lowest arousal rating, representing a very low level of excitedness or energy. -2 is a low level of arousal, and -1 is slightly low arousal. 0 represent a neutral level of arousal. 1 is slightly high arousal, 2 is high arousal, and 3 is the highest level, representing an extremely energetic or excited state. The subject can repeat each sound as many times as necessary and, once satisfied with the ratings, proceeds to the next sound. Once all sounds have been rated, the experiment ends, and the rating data is saved into a text file. The sounds were labelled according to Russell's Circumplex model of affect (Posner et al., 2005)

3.3 Statistical analysis

A total of 17 subjects participated in the experiment, with each subject rating batches of 140 files each, 5 unique batches totaling 560 sounds. Results from the labelling experiment showed that most NLUs were rated to be slightly negative Valence and slightly high Arousal, as shown in figure 2. The ratings appear to be normally distributed for both Valence and Arousal.

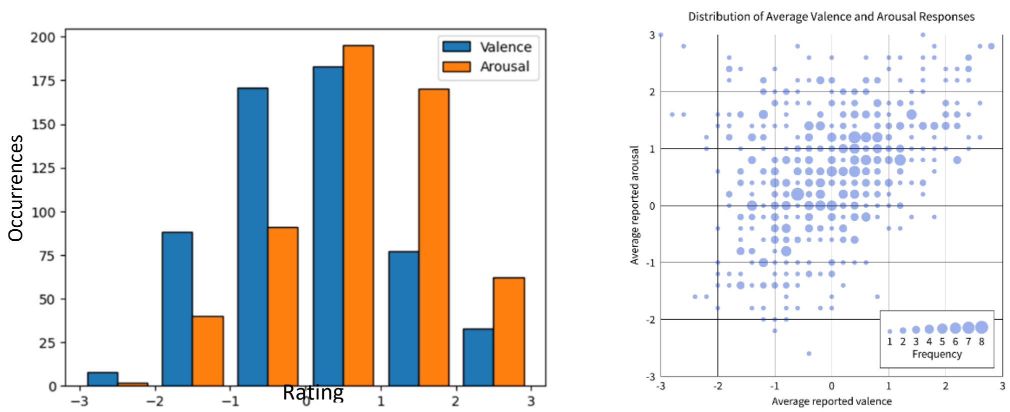

Figure 2. Valence and Arousal ratings data distribution and bubble scatter plot

To assess the reliability of the rating data, each batch of 5 ratings per file was analyzed for inter-rater agreement. Two measures were used to gauge inter-rater agreement. First, the standard deviation of ratings between all 5 raters was computed, for both Valence and Arousal, and the average of these values was calculated to be 1.18 for Valence and 1.12 for Arousal, indicating that subjects were generally within just over one rating point for a given evaluation. Next, Krippendorff's Alpha was calculated for the 5 raters and for Valence and Arousal was found to be 0.36 each. Since Krippendorff's Alpha does not consider the interval nature of the rating scale, this result shows that there is reasonable agreement between the raters.

4 MODEL EXECUTION

4.1 Audio feature extraction

Three audio analysis packages extracted various audio feature sets from the audio files: pyAudioAnalysis, openSMILE Low Level Descriptors and openSMILE Functionals.

The pyAudioAnalysis audio feature library (Giannakopoulos, 2015) contains 136 frame-based audio features. Each sound file is separated into frames by defining frame length in seconds and frame step (difference between starting point of successive frames) in seconds. The 136 features are calculated based on these window sizes such that each audio file has 136 features per frame. Features include: zero crossing rate, energy, energy entropy, spectral centroid, spectral spread, spectral entropy, spectral flux, spectral rolloff, Mel Frequency Cepstral Coefficients (MFCCs), and chroma.

The openSMILE (open-Speech and Music Interpretation by Large-space Extraction) toolkit (Eyben et al., 2015, 2016) was developed to create a standardized freely available feature extractor for problems within the audio analysis domain. It is made up of two main feature sets, The first being Low Level Descriptors (LLDs), which are frame-based in that they are calculated over discrete frames or sections of the audio file. These include zero-crossings, signal energy, loudness, cepstral features such as MFCC and PLP-CC, as well as fundamental frequency, jitter, shimmer, chroma etc. The second feature set are functionals, which are calculated over the duration of the audio file. These include extreme values, means, moments, peaks, segments, coefficients of Discrete Cosine Transform (DCT), rise and fall times, etc.

4.2 Factor analysis

Factor analysis was performed on the normalized openSMILE Functionals and the pyAudioAnalysis features to reduce the dimensions before applying the machine learning models described in the following sections. 35 factors were used for the pyAudioAnalysis feature set and 12 factors for the openSMILE Functionals features set, based on the scree plot and eigenvalues (of greater than 1). As for the openSMILE Low-Level Descriptors features (22 features) the best performance of the model was achieved without using factor-transformed data.

4.3 Random forest machine learning model

A Random Forest Machine Learning model was trained and used to infer valence and arousal on a test data set. Firstly, the factor-transformed (except for openSMILE LLDs) dataset was split into training and testing data, and the Random Forest classifier was trained on the training data. The trained Random Forest model was then run on the test dataset to infer the Valence and Arousal values for each frame of audio data. The results were averaged over the number of frames per audio file to relate the predictions back to the original labels obtained from experiments, in which the subjects had assigned Valence and Arousal ratings per audio file. The model was trained and tested with various combinations of the input parameters, namely, frame length, train-test split, and number of factors, and also with all 136 features.

The key metric used to evaluate a given model was Mean Absolute Error (MAE):

$$MAE = \frac{\sum_i^n |\hat{y}_i - \bar{y}_i|}{n}$$

Where MAE is the Mean Absolute Error, $\hat{y}_i$ are the predicted values for Valence or Arousal, $\bar{y}_i$ are the actual values for Valence or Arousal, n is the number of items in the test data set.

4.4 Transfer learning Mel spectrogram neural network model

A transfer learning Neural Network Mel Spectrogram based model was also used and results compared to the main model described in this work. Such techniques have been used in speech emotion recognition (Shor et al., 2020). In the current work, Mel Spectrograms were generated for each of the 560 sounds. The InceptionV3 Neural Network (Szegedy et al., 2015) was used to classify the sounds. The InceptionV3 Neural Network is a freely available Neural Network trained to recognize images trained on the ImageNet database, which contains around 14 million images in 20,000 categories. The network is pre-trained and its weights frozen, as per the transfer learning method. The results of the Neural Network model are included alongside the Random Forest model results in the current work.

5 RESULTS

Results of the audio feature random forest model, as well as the Mel spectrogram neural network model, are shown in Table 6. In the table, the transfer learning neural network model is referred to as TLNeuralNet and the simple sequential neural network model as NeuralNet. The openSMILE features are listed as follows: openSMILE Functionals after factor analysis are openSMILEFuncFT, openSMILE Low Level Descriptors are openSMILELLD. The pyAudioAnalysis features after factor analysis are called pyAudioFT.

Table 1. Model execution results: Mean Squared Error (MAE) – results with lowest MAE are in bold

Model Type	Feature Set	MAE Valence	MAE Arousal	Factors/Features	Train/Test Split
TLNeuralNet	Mel Spectrograms	0.147	0.161	N/A	0.9
NeuralNet	openSMILEFuncFT	0.136	0.106	12	0.9
Random Forest	pyAudioFT	0.121	0.105	35	0.9
	openSMILEFuncFT	0.116	0.101	12	0.9
	openSMILELLD	**0.107**	**0.097**	22	0.9

Figure 3 shows scatter plots of actual vs predicted values produced by the model for Valence and Arousal. The Valence, the correlation is 0.63 and for Arousal 0.75.

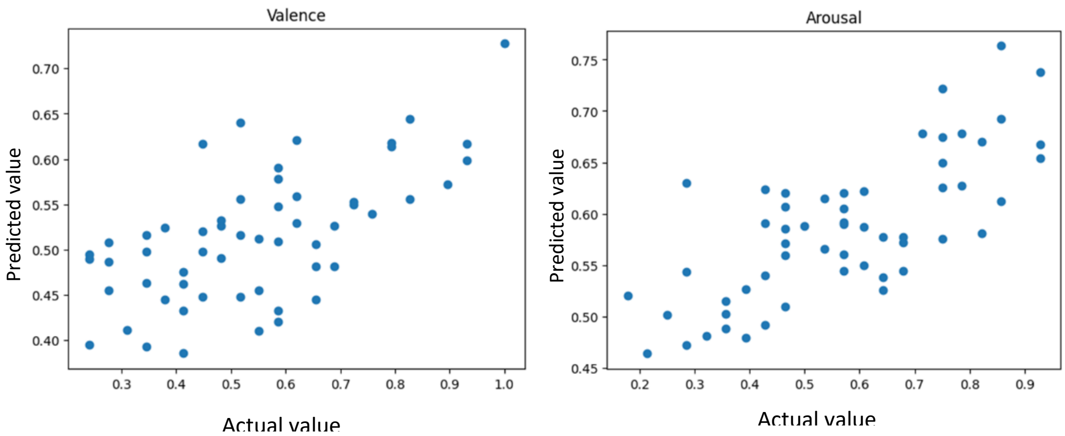

Figure 3: Actual vs predicted values of Valence and Arousal: scatter plots

6 DISCUSSION

The lowest average error achieved for Valence was 0.107, and for Arousal 0.097, both from the Random Forest model and using the openSMILE LLD Feature Set with 22 Features and a 90/10 Training Test split. The Random Forest model performed best. However, a simple sequential Neural Network using the openSMILE Functionals produced comparable results. The Mel-Spectrogram Transfer Learning InceptionV3 model performed worse, possibly due to the spectrograms containing too much information that was not useful for the neural network, and there being only 560 spectrograms. The model might yield better results with more sounds/spectrograms. Considering the original 7-point rating scale, a difference of one rating point would be equal to 100/7 = 0.14. Therefore, it can be deduced that the model is able to predict the Valence and Arousal of most sounds tested with an accuracy within one rating point difference along that scale.

The difference between the three feature sets was almost negligible. Combining features from each feature set might improve results. Regarding the openSMILE LLD feature set and pyAudioAnalysis feature set models, a frame-based method was used whereby results were averaged over the number of frames per sound as a post processing step to establish the predicted values of Valence and Arousal per sound and compare them to the actual rating data. Accounting for the contribution of each frame to the sound might also yield better results.

The model is slightly better at inferring the Arousal of a sound than its Valence. Arousal results also had higher correlations between predictions and actuals, as seen in figure 3. This result is not surprising since Arousal is mostly related to the amplitude and rhythm of a sound, whereas more factors make up Valence. Some experiment participants also commented that they found it easier to assess the Arousal of each sound than its Valence. The model was run multiple times and the average MAE for each sound each time it occurred in the test data set was computed using the absolute value of the difference between predicted and actual Valence and Arousal. This value was averaged over the number of model runs and used to indicate whether a given sound was able to be successfully classified by the model or not. Sounds with higher average MAE were analyzed and the most common characteristics were; sounds too long and/or containing too many utterances, containing too much background music, or containing speech.

7 CONCLUSIONS AND FUTURE WORK

A model was developed to infer Valence and Arousal of NLUs from popular media sources. The model predicted the Valence and Arousal of an NLU within one rating point on the 7-point scale used in the experiment. This system can be used to evaluate candidate sounds for sound design contexts such as social public-facing robots or interactive agents, for commercial and industrial settings, public spaces such as train stations, or in media and entertainment. Possible applications also include machine sounds such as those used in smart devices or even hospital machines.

In future, the modification of the model such that results are weighted in terms of each frame's contribution to the audio file may improve results. Weighting by frame for features extracted at a frame level might better relate the model back to the original experiment context in which sounds were evaluated by audio file. Future work will also focus on expanding and developing the model in terms of exploring wider ranges of sounds. Increasing the number of sounds used could lead to better model results and more suitability to deep learning methods. For example, Generative Adversarial Networks could be used to create sounds to augment the dataset, and to validate the model by creating novel unseen sounds to test it. Sound generation with support from this type of model would lead to useful applications and systems to generate sounds for specific interaction scenarios. This model is the first of its kind to use machine learning to accurately relate the features of Non-Linguistic Sounds to their affective dimensions. In the future, the aim is to use the current model to develop a sound design support system for social robots, entertainment, and other media that use such sounds.

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NEGATIVE ATTITUDES TOWARDS ROBOTS VARY BY THE OCCUPATION OF ROBOTS

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ABSTRACT

The "negative attitudes towards robots scale" (NARS) has been widely applied in the field of robot-human interaction. However, the various occupations and roles of robots have not been discussed when studying negative attitudes towards robots. This study explores whether the occupation of robots could influence people's negative attitudes towards them. For the first time, two types of robots that may be widely used were used in a NARS-related study. We conducted online questionnaire research, covering three separate parts: negative attitudes towards robots, negative attitudes towards service robots, and negative attitudes towards security robots. The results of the online survey collected from 114 participants (54 females and 60 males) highlighted differences among the scores of people's negative attitudes towards service robots and the negative attitudes towards robots or security robots. People showed the lowest negative attitudes towards service robots. There were no significant differences between the negative attitudes towards robots and security robots. This study supports the hypothesis that people show different levels of negative attitudes towards different types of robots in terms of occupational division. These results provide a helpful indicator for the study and design of robots in various occupations in the robotics industry.

Keywords: *robot design, NARS, robot occupation*

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1 INTRODUCTION

Anthropomorphic robots are becoming increasingly popular throughout modern society as an important aspect of robotics. Researchers are gradually refining the design and study of robots, including their production, definition, anthropomorphic perception, social categorization, and emotional experience. It is necessary to determine how people recognize and perceive robots. Some researchers have suggested that the way robots are perceived may depend on basic psychosocial processes, such as social categorization (Fiske et al., 2007).

Occupation, an important social classification, is also a pivotal topic in robotics research. Studies of robots across different occupations within various domains have identified several outcomes related to social classification and robot occupation. The "negative attitudes towards robots scale" (NARS) has been widely used in robot-human interaction studies (Nomura et al., 2006). The effects of gender stereotypes and negative attitudes towards robots on gender appearance preferences vary with human occupation. For some people in certain specific occupations, there was no association between stereotypes, negative attitudes, or gender preferences for robots playing roles in their own fields (Nomura & Suzuki, 2022). It has been demonstrated that people project gender stereotypes regarding human society onto robots with gendered characteristics. When confronted with robots, humans can socially categorize robots based on their "male" or "female" characteristics. The results show that people tend to perceive heterosexual robots as more trustworthy, reliable, and attractive (Siegel et al., 2009).

Robots with male names were perceived to be more suitable for security roles, whereas robots with female names were more suitable for healthcare roles. This suggests that non-appearance factors of gender characteristics also influence people's preferences for robots with different occupations (Tay et al., 2014). Several studies on robots across various professions have found that high anthropomorphism has positive effects — for example, the addition of human forms and interactive features to service robots can promote positive emotional responses from older users (Zhang et al., 2010). However, people's trust in robots does not always increase with anthropomorphism, as it is highly context-dependent (Roesler et al., 2020).

Furthermore, a robot’s task may influence the active response and engagement of the participants (Rau et al., 2010). A cross-cultural study identified factors influencing attitudes towards robots, such as culture, prior exposure to robots through media, and personal experiences of emotions towards robots (Haring et al., 2014). These findings show that there are still uncertain and complex relationships and influences between the robot's occupation and task, the user's personal characteristics, and the user's emotions towards the robot.

Social categorization of robots with different occupations is likely to lead to different negative attitudes towards them; however, there remains a lack of research in industry and academia on attitudes towards robots with different occupational attributes, with a paucity of understanding concerning what attitudes people will have when faced with anthropomorphic robots with different occupational attributes. To clarify these questions, this paper will examine how robot occupation affects people's negative attitudes towards robots when they answer the NARS questionnaire. Service and security robots — as common classes of anthropomorphic robots —

are likely to be widely used in the future. This study uses these two occupations as robotic occupations. Negative attitudes towards robots, service robots and security robots will be revealed and discussed for different age and gender groups.

2 METHODS

2.1 Participants

Questionnaires were distributed and collected online. Two age groups — 20-30 and 60-70 — and two genders — male and female — were selected as the target subjects. A total of 240 questionnaires were collected. After removing subjects who had experience in designing, building, or using robots, in addition to those who failed to answer the trap questions correctly, 114 valid sets of participant data for those aged 20-70 years old (M = 46.29, SD = 19.93) were selected. Valid data sets included 26 women aged 20-30 years (M = 25.38, SD = 2.51), 27 men aged 20-30 years (M = 24.96, SD = 2.82), 28 women aged 60-70 years (M = 64.32, SD = 3.19), and 33 men aged 60-70 years (M = 64.91, SD = 3.52).

2.2 Measurements

The NARS questionnaire was selected as the primary measurement instrument (Nomura et al., 2006). In this study, service and security robots were selected as the control robot occupations. We made changes based on the NARS to adapt the new questionnaire to the two occupations of service and security robots. The original English version of the NARS (α = 0.803) was revised by three experts, back-translated and proofread by two experts who have proficiency in both English and Japanese. Ultimately, two completed scales were produced: the NARS service robots scale (α = 0.847) and the NARS security robots scale (α = 0.889). We used a web-based questionnaire platform for subject recruitment and collection. Each subject completed the NARS questionnaire separately for the robot, service robot, and security robot. No robot image was shown on the questionnaires, and only the types of robots are different on three NARS scales.

3 RESULTS

Reliability tests were conducted for NARS1 (negative attitudes towards interactions with robots), NARS2 (negative attitudes towards the social influence of robots), and NARS3 (negative attitudes towards emotional interactions with robots) of the three NARS questionnaires, all of which measuring a high degree of reliability ($\alpha > 0.7$). After conducting an RM one-way ANOVA (analysis of variance), we found that there was a significant difference among NARS-service robots, NARS, and NARS-security robots ($F(2, 226) = 6.466$, $p < 0.05$, $\eta^2 = 0.054$) (Figure-1(a)). Tukey's multiple comparison test revealed that the mean value of NARS-service robots was significantly lower than that for NARS ($p < 0.01$, 95% CI [0.4715, 2.493]) and NARS-security robots ($p < 0.05$, 95% CI [-2.116, -0.094]). However, we did not observe a significant difference in participants' negative attitudes towards robots and security robots.

As per the Friedman test, we did not find significant differences in NARS1 for the three different robot occupations. The Friedman test revealed that there was a significant difference between the NARS2 values of service robots (M = 13.21, SD = 3.91) and the NARS2 value of robots (M =

14.34, *SD* = 1.9; *F*(2, 226) = 9.40, $p < 0.01$, $\eta^2 = 0.077$) (Figure-1(b)). Dunn's multiple comparisons test showed that the NARS2 score of the service robots was significantly lower than the NARS2 of the robots (p = 0.0025). The Friedman test showed a significant difference between the NARS3 scores of the security robots (*M* = 10.72, *SD* = 2.32), robots (*M* = 10.04, *SD* = 1.90), and service robots (*M* = 10.04, *SD* = 2.21; *F*(2, 226) = 10.35, $p < 0.01$, $\eta^2 = 0.084$) (Figure-1(c)). Dunn's multiple comparisons test showed that the NARS3 of security robots was significantly higher than that for robots ($p < 0.01$) and service robots ($p < 0.01$). According to the results of the two-way ANOVA, no interaction effect was found among robot occupation, subject's gender, and subject's age.

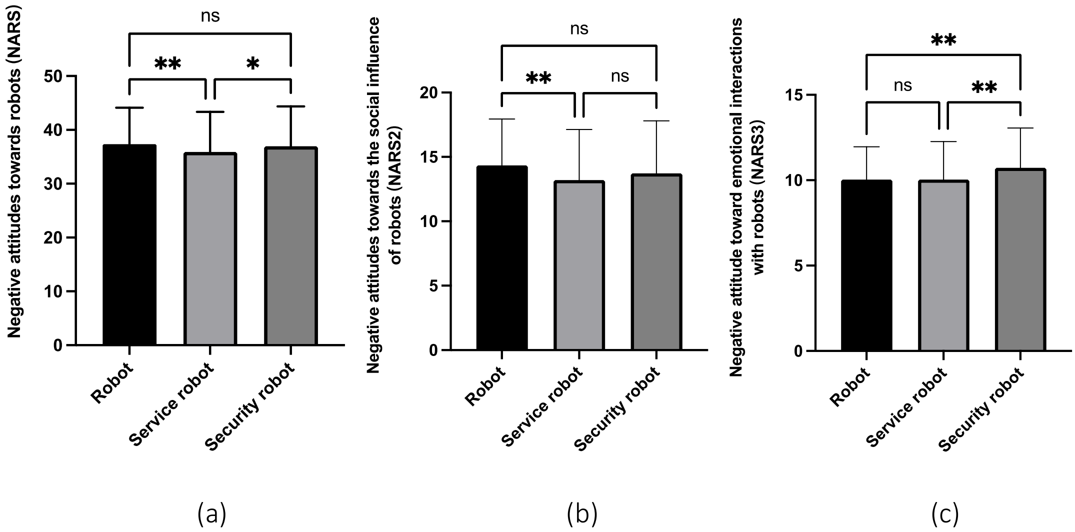

Figure 1. Negative attitudes towards robots, service robots, and security robots. *p<0.05, **p<0.01.

4 DISCUSSION

Some researchers have suggested that the gender and personality of social robots interact with their corresponding role stereotypes in influencing users' perceptions of social robots (Tay et al., 2014). The robot occupations in our study had highly differentiated occupational characteristics and task categories. The occupational attributes of robots and people's occupational stereotypes may also influence the NARS results. The effects of gender stereotypes and negative attitudes towards robots on gender appearance preferences were discussed (Nomura & Suzuki, 2022). This study's groundbreaking finding that negative attitudes towards robots change with robot occupations has important value for research related to robot occupations. Researchers may not be able to use the original NARS to address robotics research in various types of occupations and usage scenarios. Some researchers have also found that personality dimensions affect how individuals perceive the robots with which they interact (Kaplan et al., 2019). This implies that the subjects' personalities may also influence the results of the NARS, especially NARS1 and NARS3. Therefore, repeated measures and screening of subjects should be considered in NARS-related studies.

Compared to security personnel, service workers have stronger emotional interaction attributes in their occupational stereotypes and assume that they consider service robots to be consistent with the occupational stereotypes of service workers in human society; it is easy to understand that service robots have significantly lower NARS3 than security robots (Koenig & Eagly, 2014). The highly negative attitude towards emotional interaction with security robots, along with the lowest negative impression of service robots, may be related to the bias against the occupation itself (Tay et al., 2014). This study attempted to examine robot occupation, subject age, and gender using the NARS instrument; however, no interaction was found. This may be due to the insufficient number of valid subjects, or may be indicative that no interaction exists, and that no definite conclusion can yet be reached. The present study did not find significant results related to NARS1, demonstrating the need to expand the subjects and introduce more diverse robot occupations as a research goal. In studies related to NARS, researchers have suggested that both identity threats and realistic threats significantly increase negative attitudes towards robots (Huang et al., 2021). Robot occupation as an important element of identity was purposefully explored in this study, and we will conduct more in-depth research in the future regarding the link between perceived threats and robot occupation.

5 CONCLUSION

This study has found that people's negative impressions of robots change with the robot occupation. Users' negative impressions of service robots are significantly lower than those of robots and security robots. This study reveals, for the first time, that negative attitudes towards robots vary with the robot’s occupation. This study provides important guidance for future research and the design of robots for diverse occupations.

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NOVELTY INDEX FOR CURVED SURFACE USING KL DIVERGENCE AND ITS EFFECTIVENESS ON INDUSTRIAL PRODUCTS

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ABSTRACT

It is said that the relationship between "novelty" and hedonic response is expressed as an inverse U-shape. The latest studies about perception emphasize "novelty" as a factor of emotion and quantify "novelty" by assessing the difference in amount of information using Kullback-Leibler (KL) divergence. In this study, we proposed a novelty index of closed surfaces using KL divergence focusing on their curvatures. To calculate novelty index, we firstly calculated Gaussian curvature of each vertex in the shape. Then, we defined occurrence probability distribution which represents probability that a vertex has a certain curvature. The KL divergence expresses the difference between the occurrence probability distributions of the standard shape and the target shape. To confirm the effectiveness of the proposed index, we conducted the cognitive experiment using the shape samples of an automobile generated by particle swarm optimization method. The coefficient of determination between the proposed index and sensory evaluation values of "difference" were very high which support the applicability of the index. Furthermore, the consideration of location information increased the correlation with sensory evaluation. This suggests the possibility to evaluate an industrial design requirement quantitatively and contributes to develop the automatic shape generation in product design.

Keywords: *novelty, curvature, KL divergence, industrial products*

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1 INTRODUCTION

Recent development of computational technologies has enabled partially automation of the design process (Singh & Gu, 2012). Generative design is one of those computation-based design methods to realize multiple shape generation (Caetano, 2019, Lin & Lee,2013, Singh & Gu, 2012). However, conventional generative design methods evaluate the physical constraints (e.g., stress, stiffness and mass) (Shea, 2005, Sato, 2007), and few methods focus on the perceived "aesthetic liking". Hence, designers need to choose and refine a final design from the proposed design (Lin, 2013). If the method to evaluate the "aesthetic liking" of shapes could be developed, generative design can be performed without designers and causes a large impact on design industry.

In the industrial design field, many researchers have pointed out "novelty" influences the "aesthetic liking" of products. Hekkert (2003) conducted a cognitive experiment for industrial products and concluded "novelty" affect "aesthetic liking". Creusen (2015) insisted the "typicality" with a touch of "novelty" is preferred. Liu et al (2020) emphasized that "novelty" of utilitarian products increases and decreases preference when they are promotion-focused and prevention-focused, respectively. Berlyne (1970, 1971) insisted that moderate level of "novelty" is preferred.

This study aims to propose an index of "novelty" for industrial products, which is important for development of design evaluation in generative design. We, therefore, quantify "novelty" of closed surfaces and conduct a sensory evaluation experiment on "difference from the basic shape" using the automobile shapes, verifying the effectiveness of the proposed index.

2 PROPOSITION OF NOVELTY INDEX

2.1 Related works

The recent research on human perception provides effective guidelines for novelty index. Friston quantified the information content obtained by perceiving an object in the outside world by the Kullback-Leibler (KL) divergence (Friston, Kilner, & Harrison, 2006). Furthermore, Yanagisawa (2019, 2020) defined the "novelty" as the information content gained in the brain after perceiving sensory stimuli and proposed free-energy model of emotion potential. In this theory, "novelty" is formulated as the KL divergence of the posterior distribution from the prior distribution.

Previous researches indicate that curvature represents the overall shape feature quantitively and has the major influence on design evaluation (Ujiie, Kato, Sato & Matsuoka, 2012, Kato & Matsumoto, 2020). We, therefore, emphasize that curvature is effective to evaluate "novelty".

We decided to calculate the novelty index as the KL divergence of probability distributions defined by curvature of typical shape and that of input shape, respectively.

2.2 Proposition of novelty index

This study proposed Gaussian curvature KL divergence as an index of "novelty". This index calculates the difference between probability distributions of standard shape and target shape using KL divergence. Note that, we utilize the occurrence probability vector as a probability distribution. The calculation of Gaussian curvature KL divergence is described as follows.

1. The Gaussian curvature K is calculated at each sample point on the sampling surface, and the dimensionless Gaussian curvature K' is calculated by multiplying K by the square of the maximum diameter D of the curved surface shape.
2. Quantize K' by setting parameters (deviation E and number of states V) and assign K' of each sample points to each state s_i.
3. Occurrence probability of state s_i $(i \in \{1,2,\dots,V\})$ p_i is calculated as:

$$p_i = \frac{N_i}{N} \tag{1}$$

   where, N_i and N are the numbers of vertices of state s_i and of all vertices on the surface, respectively. Then, the occurrence probability of the target and standard shapes can be expressed as the vector $\boldsymbol{p}^{\text{target}} = p_i^{\text{target}}$ and $\boldsymbol{p}^{\text{standard}} = p_i^{\text{standard}}$, respectively.
4. Gaussian curvature KL divergence $D_{\text{KL}}(\boldsymbol{p}^{\text{target}} \parallel \boldsymbol{p}^{\text{standard}})$ is calculated as:

$$D_{\text{KL}}(\boldsymbol{p}^{\text{target}} \parallel \boldsymbol{p}^{\text{standard}}) = \sum_{i=1}^{V} p_i^{\text{target}} \log_2 \frac{p_i^{\text{target}}}{p_i^{\text{standard}}} \tag{2}$$

5. In Eq. (2), we assume that p_i^{standard} is greater than zero if the corresponding p_i^{target} is greater than zero. If p_i^{standard} does not satisfy this property, we replace $\boldsymbol{p}^{\text{standard}}$ in Eq. (2) with the following equation (McDonough et al., 2011).

$$\boldsymbol{p}^{\text{standard}'} = (1-\varepsilon)\boldsymbol{p}^{\text{standard}} + \left(\frac{\varepsilon}{V}\right)\boldsymbol{e} \tag{3}$$

   where, ε is a parameter ranging from 0 to 1 ($\varepsilon = 0.0001$ is used in this study); $\boldsymbol{e}$ is a of ones.

3 COGNITIVE EXPERIMENT

3.1 Experimental conditions

This study conducted the experiment to confirm the correlation between the proposed index and human cognition. The conditions of the experiment are described as follows:

- Participants: 42 university students in their twenties (34 men and 8 women), including 24 general students and 18 students from automobile club with high interests on automobiles.
- Sample shapes: 37 sample shapes are generated by deforming standard shape (MAZDA MX-5, 3rd generation) using PSO shape generation method in order to realize wide range of “novelty” (Fig.1).
- Evaluation method: the sensory evaluation for “difference from the standard shape” based on the seven-point Likert scale (1: “strongly disagree”, 2: “disagree”, 3: “slightly disagree”,

4: "neither agree nor disagree", 5: "slightly agree", 6: "agree", 7: "strongly agree"), profiles of participants and evaluation criteria.

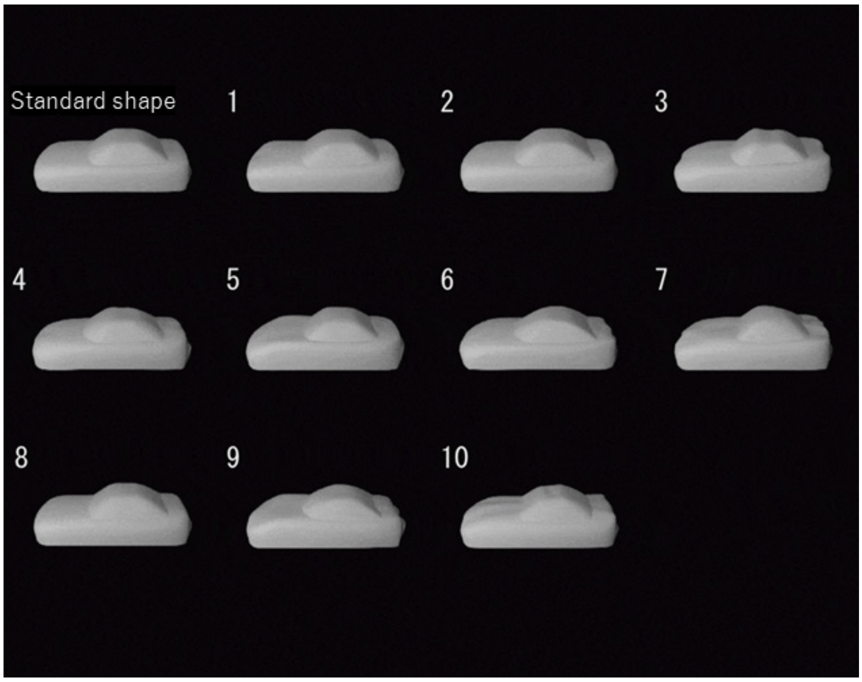

Figure 1. Examples of sample shapes

3.2 Results and discussions

The relationship between proposed novelty index and sensory evaluation values about "difference from the standard shape" is shown in Fig.2. The coefficient of determination R^2 in logarithmic approximation is 0.81 which confirms the correspondence between D_{KL} and the sensory evaluation values.

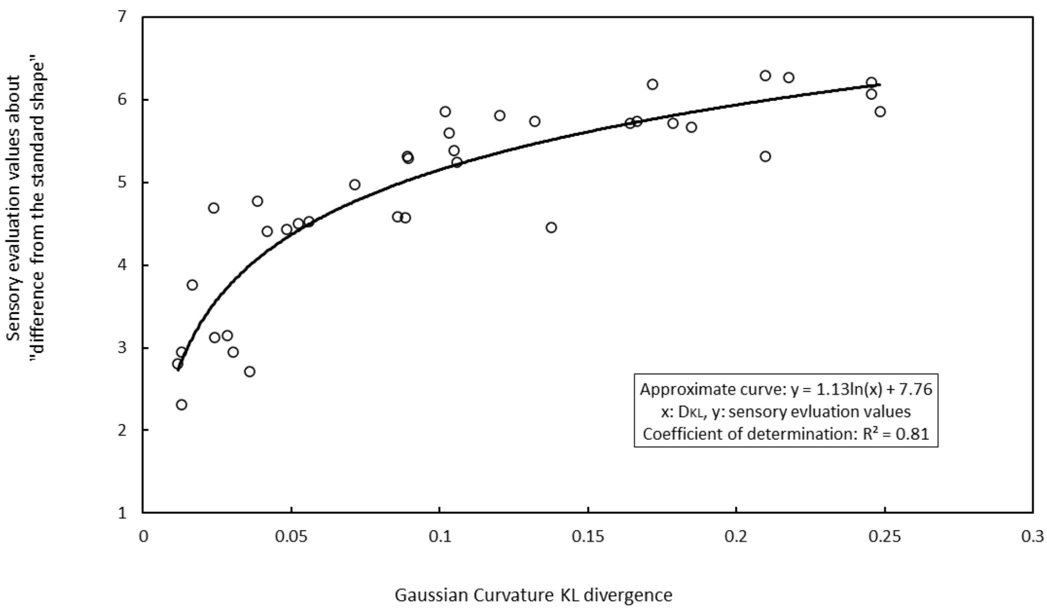

Figure 2. Relationship between Gaussian Curvature KL divergence and sensory evaluation values about "difference from the standard shape"

The result of questionnaire about the evaluation criteria shows that lots of participants focused on the roof and bonnet to evaluate the shapes. Moreover, several studies indicated that participants place importance on the evaluation from a familiar direction of the product in case of industrial products (e.g., the front side of the car) (Okano, 2020). Therefore, we considered to refine our novelty index to take into account of location information by adapting occurrence probability matrix described with quantized Gaussian curvature (V states) and quantized location information (M parts) to probability distributions of KL divergence. This index can also be weighted with correspondence to each part of shape, implying to be used as an index that reflects high influence on the difference of front part. The advanced Gaussian curvature KL divergence is defined as follows:

$$D_{\mathrm{KL}}\left(\mathbf{P}_{M\times V}^{\mathrm{target}} \parallel \mathbf{P}_{M\times V}^{\mathrm{standard}}\right) = \sum_{i=1}^{M}\sum_{j=1}^{V}\left(K_i \times p_{ij}^{\mathrm{target}} \log_2 \frac{p_{ij}^{\mathrm{target}}}{p_{ij}^{\mathrm{standard}}}\right) \tag{4}$$

where $\mathbf{P}_{M\times V}^{\mathrm{target}}$ and $\mathbf{P}_{M\times V}^{\mathrm{standard}}$ are $M \times V$ matrix of occurrence probability in target shape and standard shape, and K_i is the weighting coefficient, respectively. The relationship between this advanced index with weighting coefficient $K_i = 1$ at whole area and sensory evaluation values about “difference from the standard shape” is shown in Fig.3. The coefficient of determination R^2 in logarithmic approximation is 0.86. The same relation with weighting coefficient $K_i = 10$ at the front part of shape is shown in Fig.4. The coefficient of determination R^2 in logarithmic approximation is 0.87. These results signify that the consideration of location information and weighting by degree of attention enhance the correlation with sensory evaluation.

As an industrial contribution, this novelty index is effective as evaluation method of products and also has the applicability for the advanced generative design method which automatically generates aesthetic shapes evaluating the “novelty” of industrial products. Designers can choose the target value of this index, which corresponds to the preferred level of novelty.

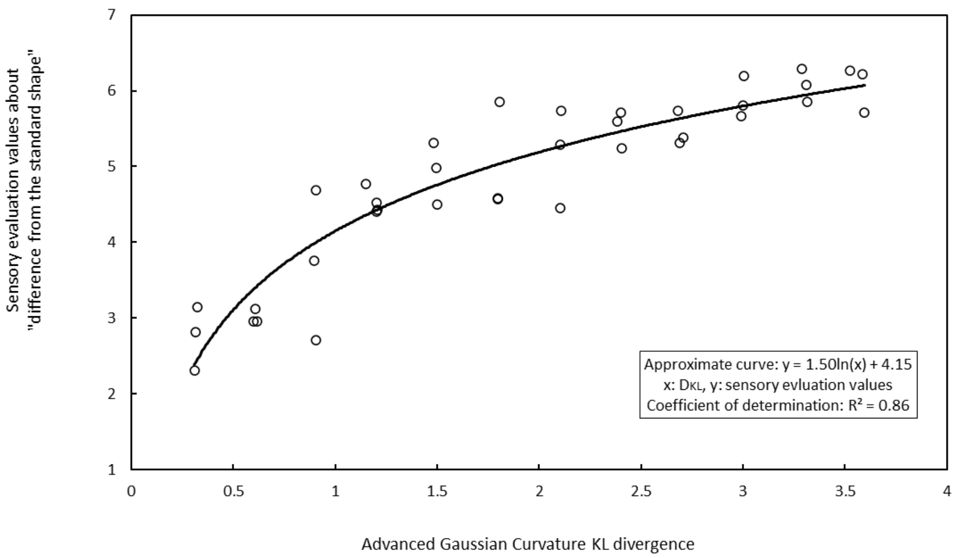

Figure 3. Relationship between Advanced Gaussian Curvature KL divergence (K=1) and sensory evaluation values about “difference from the standard shape”

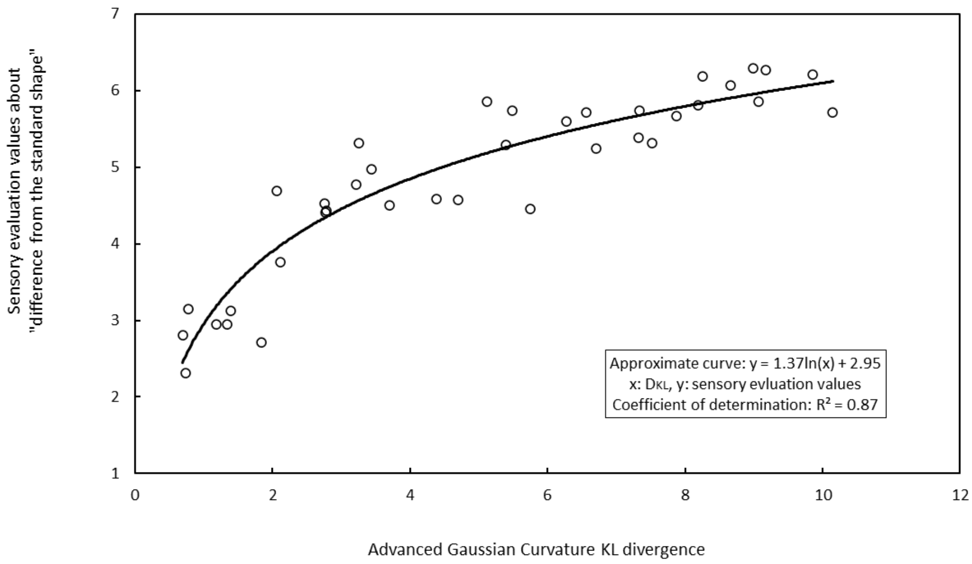

Figure 4. Relationship between Advanced Gaussian Curvature KL divergence (K=10) and sensory evaluation values about "difference from the standard shape"

4 CONCLUSION

This study proposed Gaussian curvature KL divergence as a novelty index of curved surface shape. Using this novelty index, we conducted a cognitive experiment using the shapes of automobiles which confirmed the effectiveness of proposed index with the coefficient of determination 0.81. Furthermore, consideration of location information provides better correlation with sensory evaluation. The future study should analyze the relationship between "novelty" and "aesthetic liking" and propose integral index of "aesthetic liking".

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"OTOGI BOX": A CUBIC HAPTIC INTERFACE FOR PRESENTING A STORY THROUGH TACTILE COMMUNICATION

THREE-DIMENSIONAL STORYTELLING THROUGH TACTILE STIMULATION

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ABSTRACT

Haptic technology provides users with an experience that is unattainable via audiovisual information alone. Researchers have previously attempted to synchronize tactile information with video to enhance the multimedia experience, although their studies were based on the assumption that visual information is present. Tactile stimuli usually act as additional information for a story and do not normally arouse people's imagination regarding a story; a door opening, water dripping onto the floor, or someone walking across the floor is usually presented through visual information. This study proposes the "Otogi Box," a cubic haptic storytelling interface using tactile stimuli. The haptic interface provides a whole new user experience, letting them feel the story unfold in their hands. The interface independently vibrates each of its faces based on the audio signals providing various touch sensations that fit a specific story. We present "Dwarf's House" as a demo story, wherein users feel a dwarf realistically entering and exiting the box. For instance, the right face vibrates as if a door is opening when the dwarf opens the door on the right side of the house. The basic storytelling capabilities of the interface was tested through a user evaluation. The results revealed that the proposed interface could effectively present a

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simple story through tactile sense without any visual information, and enabled stimulation of users' imagination in a unique manner.

Keywords: Haptic interface, storytelling, tactile stimuli

1 INTRODUCTION

With recent progress in virtual reality technology, active research is being conducted on haptic interfaces. Presenting tactile stimuli effectively conveys information to a wide range of users, including those with audio and visual disabilities. This approach also provides an experience that cannot be solely obtained using audiovisual information.

Several studies have attempted to present tactile information synchronized with video to enhance multimedia experiences. Systems proposed in these studies present haptic stimuli that express the impact forces received by characters appearing in movies or haptic stimuli considered appropriate for user experience in a video from the first-person perspective (Ablart, Velasco, & Obrist, 2017; Danieau et al., 2012, 2014; Lemmens, Crompvoets, Brokken, van der Eerenbeemd, & de Vries, 2009). These studies additionally presented first-person tactile stimuli with fixed stories presented in videos to make the viewing experience more immersive. However, no attempts were made to allow users to imagine scenes or understand the story content without visual information.

This study aims to realize an experience that appeals to the user's sensibilities by developing a method that conveys the story using tactile communication—without presenting visual information. We provide a new experience, allowing users to imagine stories through their tactile sense. Additionally, we considered that storytelling through tactile sensing could enhance user sensitivity and imagination (Higashimoto, 2020).

In dramas and movies, there are many cuts from a bird's-eye view—i.e., not from any of the characters' points of view—to convey the story; similarly, the third-person omniscient point of view is also used in novels. Therefore, it is necessary to present the tactile stimuli from a third-person perspective rather than a first-person perspective when conveying a story through tactile communication.

Moreover, to activate tactile stimuli from a third-person perspective, it is necessary to present tactile stimuli three-dimensionally on a haptic interface that allows users to make contact during the presentation of the content without spatial restrictions. The appropriate tactile stimuli should be placed at the appropriate positions along the story three-dimensionally to express what happens in the story. Accordingly, we developed the “Otogi Box,” a palm-sized cubic haptic interface that can be grasped with both hands and has a mechanism for vibrating each face independently. The name "Otogi Box" comes from the Japanese term "Otogi-Banashi," which refers to legends and old tales told to children and are figuratively unrealistic fantasy stories. We also developed a storytelling method using the tactile sense by changing the places where the tactile stimuli are provided. The main contribution of this study is to provide a whole new experience allowing users to imagine stories through their tactile sense by providing a 3D expression of tactile stimuli in the users' hands. This experience appeals to users' sensibilities.

2 RELATED WORK

"Dialogue in the Dark" is an exhibition in which people are guided by the visually impaired and enjoy communication in "100% pure darkness," using senses other than their sight (*Dialogue Social Enterprise: Dialogue in the Dark,* 2022). Visitors can imagine their location or what they are touching and communicate with other participants through touch, interacting with surrounding objects, making sounds, and listening. The "1-2-Switch" computer game (*Nintendo Co. Ltd. 1-2-Switch™,* 2022), developed for Nintendo Switch (*Nintendo Co. Ltd. Nintendo Switch,* 2022), contains several games wherein the user listens to sounds and feels vibrations without any visual information. This type of interactive media allows people to enjoy communication and games rather than narrative content by using senses other than their vision.

In previous research, tactile information was added to make reading experiences more exciting and memorable (Yannier, Israr, Lehman, & Klatzky, 2015; Alam, Rahman, & Saddik, 2013). However, the contents of the stories were conveyed in a non-tactile manner.

3 METHOD

We propose a cubic haptic interface, where each face of the interface vibrates independently and presents various tactile sensations to communicate events in the story to the users through their hands.

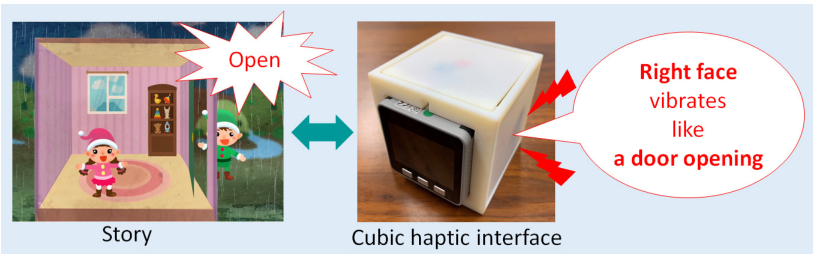

Figure 1. Schematic illustration of the proposed method

Our proposed method allows three-dimensional changes in the location where tactile stimuli are presented through the cubic haptic interface and tells a story through tactile communication. We present "Dwarf's House," a story demo where users feel as if a dwarf actually enters and leaves the box. The cube-shaped haptic interface corresponds to a dwarf's house, and the appropriate face vibrates with the appropriate vibration pattern according to the events in the story. In a scene where a dwarf outside the house opens the door on the right side of the house and enters it, the right side of the box vibrates, which corresponds to the door opening; the bottom then vibrates, which corresponds to the dwarf walking inside the house (Figure 1). By presenting tactile stimuli this way, we believe that users would feel as though the dwarf had actually entered the box.

We developed the “Otogi Box,” a cubic haptic interface with an authoring system (haptic editor) used by content creators. The content creator can edit the vibrating face and pattern on the story timeline using the haptic editor. The cubic haptic interface provides particular stimuli according to the content created using the editor.

3.1 Otogi Box

This study explores the possibilities of three-dimensional storytelling with tactile stimuli employing a device that a user can handle without spatial restrictions.

The interface of the “Otogi Box” has an electric circuit, including a microcomputer (M5Stack) (*M5Stack: Modular rapid ESP32 IoT Development Board,* 2022). The circuit receives signals that control the vibrators attached to the inside of the interface—instructing which face to vibrate and the vibration type—through wireless communication (Bluetooth or Wi-Fi) with a computer.

The proposed cubic interface is equipped with a mechanism that facilitates the independent vibration of each face so that the user can instantly identify the vibrating face. In our previous studies, we determined that it is difficult to identify intuitively and accurately the vibrating face of an ordinary plastic box if the vibrator is attached to the inside of one face because the vibration also propagates to the other faces. Therefore, we devised and evaluated a structure that suppresses such propagations (Azuma, Handa, Shimizu, & Kondo, 2017). This proposed interface also follows the previous structure, has 74 mm edges, is made of resin, has an inner box integrated with an outer frame and plate-like parts, and fits in the palms of both hands. Each plate-like part constitutes a cube face and is supported by the inner box via a gel bush with a silicone stick (Figure 2). Thus, the propagation of vibrations to the other faces is suppressed by ensuring no direct contact between the faces and reducing the movements of each face that are transmitted to the inner box by using an elastic body to connect the faces.

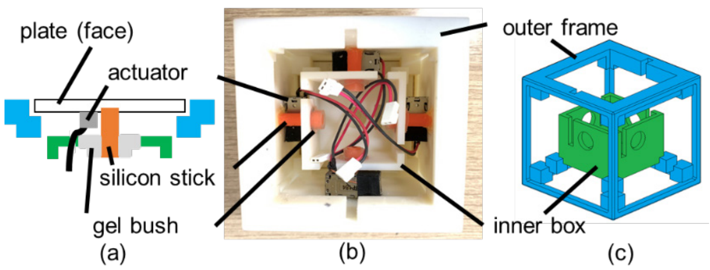

Figure 2. “Otogi Box.” (a) Structural schematic of each face of the cube. (b) Interface without the electric circuit. (c) Structure of the integrating inner box with the outer frame

A HAPTIC™ Reactor (*Alps Alpine Co Ltd: HAPTIC™ Reactor Vibrational Feedback Device,* 2022), which vibrates when a sound signal is input and produces various tactile sensations, was used as the actuator attached to each cube face. The sound files to be input to the actuators were recorded on the microSD card attached to the microcomputer module. Additionally, an audio power amplifier that amplifies the signal output for vibrating the actuator (a HAPTIC™ Reactor) is mounted on the electronic circuit, including the microcomputer module. The interface has a built-in lithium polymer battery to operate these components.

3.2 System

We developed an authoring system (haptic editor) that enables story creators to edit tactile information presented by the “Otogi Box” on a story timeline. When presenting their story, the story creators can choose which face to vibrate and the vibration type (audio signal) in each part of the story. For instance, in the "Dwarf’s House" demo story, the right face of the interface vibrated, corresponding to the door opening when the dwarf opened the door on the right side of the house. Creators can present various tactile stimuli through various audio signals. Moreover, they can play back the assigned audio signal and confirm the appropriateness of the tactile sensation during editing. The operation screen has a user-friendly interface and allows editing of tactile information on the timeline of the existing video to convey the story even while watching the video (Figure 3). The edited result is output and saved in a project folder. Multiple projects can be created for the same video, considering the target user, such as those with visual and hearing impairments. When creators run the project, the “Otogi Box” can be controlled according to the edited result.

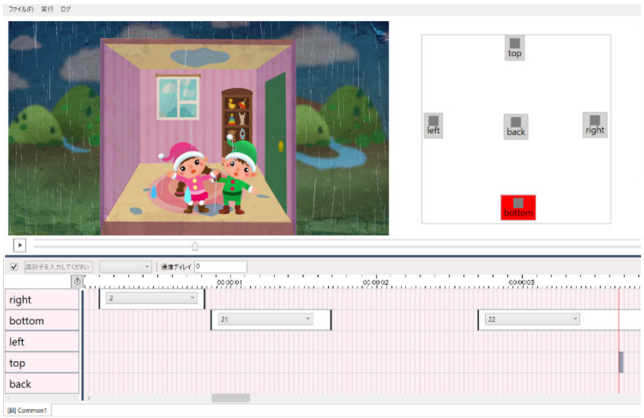

Figure 3. Screenshot of the user interface of the haptic editor

4 EXPERIMENT

4.1 Dwarf’s House

We conducted a user evaluation of the basic storytelling performance of the “Otogi Box” to evaluate the effectiveness of the proposed method. When the system interface three-dimensionally expresses the events in the story through tactile stimuli in the hands of the user, the relevant face of the box vibrates with the appropriate vibration pattern as the story progresses. As mentioned previously, we created a demo called "Dwarf's House," which we considered to have a good compatibility with the cubic haptic interface. For evaluation, we considered a simple story of a dwarf entering and exiting the house. A dwarf knocks on the door, opens it, and then closes it. The dwarf then walks in the room, reopens the door, and closes it again. Considering that the dwarf can enter or exit from the left or right, four patterns are exhibited in total: Left to Right (L→R), Left to Left (L→L), Right to Left (R→L), and Right to Right (R→R) (Table 1). If the dwarf enters from the left and exits on the right, the L→R pattern is represented. Each face vibrates according to the appropriate sound signal input to the attached actuator. For instance, the left face vibrates with a knocking sound signal when the dwarf knocks on the left door. The vibration positions, for example, pattern L→R are presented in Table 2.

Table 1. Dwarf's behavioral patterns

	Knock	Open	Close	Walk	Open	Close
L→R						
L→L						
R→L						
R→R						

Table 2. Vibrating face of haptic cube indicated in red

	Knock	Open	Close	Walk	Open	Close
L→R						

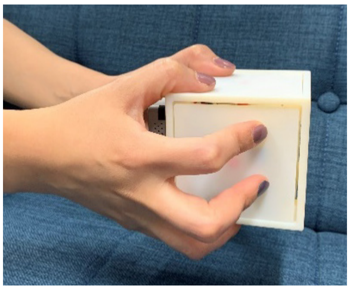

Figure 4. User holding the "Otogi Box" haptic device

We conducted two experiments to test the effectiveness of the proposed method. The participants were eight sighted men and women ranging in age from 20 to 40. Informed consent was obtained from each participant. No earmuffs were used, and the participants could hear the sounds produced by the interface vibrations. They held the proposed cubic interface by touching four of its faces (top, bottom, left, and right) (Figure 4). To prevent visual identification of the vibrating face, their hands were placed inside a cardboard box. In addition, no visual information was given throughout the experiment.

The first experiment aimed to identify how well the intended story was conveyed with the proposed method and what the participants imagined. No prior hints were given, including information about the cubic interface presenting the "Dwarf' s House" story and the dwarf's behavioral patterns. The participants were presented with the L→R pattern and answered what they thought happened in the story based on their experiences interacting with the interface.

The second experiment aimed to investigate if the intended story could be conveyed better if the participants were given a few hints and also measured the performance of the interface for conveying information. The participants were informed that the dwarf entered and exited the house and was presented with the vibration scene for the four patterns 40 times (4 patterns × 10 times) in random order. Participants were then asked where the dwarf entered and exited; their answers were not limited to just left and right (the back was also included, for example).

4.2 Results and discussion

Table 3 shows an excerpt from the answers to the questionnaire after the first experiment. The results suggest that the event of knocking or opening the door can be transmitted by tactile stimuli and sounds generated through device vibrations without visual information. Most participants interpreted the vibrational sound of the door opening as a horse neighing. We conclude that the sound produced by the vibrations affected the participants' understanding of the story. In addition, the participants could imagine various stories with limited information (tactile and auditory). The result suggests that our proposed method can raise people's imagination regarding a story. However, the intended story may be conveyed only by tactile and auditory stimuli, depending on the event.

Table 3. Questionnaire response after the first experiment

Someone was walking after the door was knocked on. The impact at the end resembled that of a falling big marble.
There was a small horse inside, and he wanted to get out and was hitting the wall and neighing. He rattled, wondering if he could get out.
Someone knocked the door and went up the stairs from there. Then, they dropped something from the top of the stairs.
There was a knocking sound, but then, it felt like a horse running away from the middle.
When a mother was at home, a kid came home from the outside and knocked on the door. The mother opened it, and the kid rushed inside. The kid ran into the bathroom and closed the door.
The door was knocked, and someone opened it. There was a horse running outside and raising its legs.

For the second experiment, we defined each participant's answers as correct if both the answers on where the dwarf entered and exited were correct. The average correct answer rate was 94.4%. The results reveal that it is possible to tell how the dwarf entered and exited the box through tactile stimulation. Because the interface could vibrate each face independently, the cubic haptic interface can tell the intended story accurately with a few appropriate hints (i.e., a dwarf as the character).

We conclude that the experience appealing to the experiencers' sensibilities could be realized by adjusting the type and number of hints. It depends on whether the creator wants to tell the intended story accurately or leave room for imagination, as the user feels the story through tactile sense with the proposed method.

5 APPLICATION

We created a one-minute story including more diverse tactile stimulation scenes; animation corresponding to the story was also created. Tactile information was presented by vibrating appropriate faces with appropriate vibration patterns close to the bold text (Table 4). The experiencers who enjoyed the story without visual information (animation) commented that the experience stimulated their imagination and was fun. One of them said that the experience was good for children's education. Furthermore, the experiencers who enjoyed the story with animation were surprised and pointed to the "Otogi Box" and said, "dwarf is inside!" Many participants felt the existence of the dwarf.

Table 4. Scenes of a one-minute version of the "Dwarf's House"

1. In the rain, a male dwarf **knocks on the door**.	10. The dwarfs are saved.
2. The male dwarf **opens the door**.	11. The dwarfs **wipe the floor** and the right wall.
3. The male dwarf **enters** and **closes the door**.	12. The male dwarf **cuts a board with a saw**.
4. The ceiling begins to **leak**.	13. The male dwarf **hits the cut board against the ceiling** and repairs it.
5. The ceiling **breaks**.	14. The male dwarf **hits the cut board against the left wall** and repairs it.
6. **Heavy rain enters the house**.	15. The dwarfs **wipe** the right and left walls.
7. **Water accumulates** in the house. The dwarfs drown.	16. The dwarfs **jump** happily.
8. The dwarfs **hit the wall** more and more.	17. The dwarfs **open the door** and exit.
9. **The wall on the left is broken,** and the **water leaks**.	18. **The door close**s.

6 CONCLUSION

We propose a 3D expression of tactile stimuli in the users' hands to give them a new experience of feeling the stories through their tactile senses. We developed the "Otogi Box," a cubic haptic interface in which the cube faces vibrate independently, and devised a storytelling method that expresses what happens in the story using 3D tactile stimuli. We also created a demo story called "Dwarf's House" and conducted evaluation experiments. The proposed method successfully presented a primitive technique for storytelling without visual information. Moreover, it allows users to imagine parts of the story depending on whether the creator wants to tell the intended story accurately or leave room for imagination. The experience appealing to users' sensibilities is created by adjusting the type and number of hints. Furthermore, many participants felt the existence of the dwarf. Thus, the "Otogi Box" allows the user to feel the characters in the story realistically.

Furthermore, the “Otogi Box” could be beneficial for storytelling to hearing- and visually-impaired users. In the future, we aim to evaluate this method with hearing- and visually-impaired users, explore the possibilities of universal design content that may be realized with this method, and consider other experiences using sensory information other than tactile sensation.

In addition, we might explore the possibility of implementing this method more practically by presenting creators with the authoring system and allowing them to create content based on tactile communication. We aim to construct the platform that creators can produce experiences appealing to users’ sensibilities.

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PHENOMENON OF BOREDOM BY REPETITIVELY LISTENING TO THE SAME MUSIC
OBSERVATION THROUGH EEG

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ABSTRACT

The sustainable business must develop the fundamental technology for strategies that ensure people are interested in the information and contents for long periods of time. To contributes to this goal, this study was that a more realistic sense of boredom was evoked by the action of repeatedly listening to music in situations of repetitive consumption, based on the Meaning and Attentional Components (MAC) model defined psychologically boredom as two separate components of meaning and attention. Our experiment was the repetitively listening to the same music which had the highest or lowest level of preference, which was conducted over seven days respectively. Through electroencephalogram (EEG) measurements, decreased attention was measured by the increased alpha wave and the decreased beta wave. In addition, decreased meaning was measured by the increased gamma wave. In conclusion, measuring boredom must include factors of the temporal changes and the conditions of preference, particularly for EEG.

Keywords: *Attention, Bored, Interest, Meaning, Preference*

1 INTRODUCTION

In recent years, information services are popular business because of the increase of the quantity of information due to the development of the Internet. Considering the intensification of the competition for the services, one of the important issues is when sellers will resupply additional information and contents to consumers, in other words, how consumers will not be got bored. For example, the consumers may get bored for not only the products but also the

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services if the similar products are recommended repetitively. Therefore, the sustainable business must develop the fundamental technology for strategies that ensure people are interested in the information and contents for long periods of time. This study aims to contributes to this goal by incorporating psychology and informatics, in which a more realistic sense of boredom is evoked by the action of repeatedly listening to music in situations of repetitive consumption.

In general, interest of information and contents decreases over time and eventually boredom arises. People avoid boredom by not repeatedly consuming something, and therefore, boredom may spoil the expected selling schedule and recommendation. Although there is a general consensus on how to modulate boredom (e.g., by supplying a new item), it is challenging for humans to apply the idea in real time. Thus, in order to optimize the recommendation for the push timing and the selection of similar contents, which has the consideration to the state of interest of consumers changing dynamically over time, we propose that artificial intelligence predicts boredom through human information (i.e., subjective evaluation, action history, and biosignals).

In informatics, Inamura et al (2010) and Kapoor et al (2015) researched the mathematical model to introduce the state of mind of boredom by subjective evaluation or action history. Their study showed the possibility to predict boredom; however, they were unable to modulate boredom. Evaluation and action are evoked following the psychological and physiological response, and therefore, the data may not reflect the state of mind at that time. Thus, in order to achieve this study's proposition, biosignals have been used to measure boredom in real time.

In psychology, as shown in Table 1, Westgate & Wilson (2018) proposed the Meaning and Attentional Components (MAC) model for boredom as aversive emotion. Their model showed that boredom is composed of two separate components of attention and meaning. The attention component was defined as whether there is successful cognitive engagement in the current task. The meaning component was defined as whether the current task, regardless of engagement, is valuable and thus worth pursuing. Based on this definition, boredom may be measured by a decrease in attention or meaning. In addition, Raffaelli, Mills & Christoff (2018) measured a loss of attention by the increased power spectrum of the alpha wave and the decreased power spectrum of the beta wave. Moreover, Tsuji et al (2019) measured the level of preference of music by the increased power spectrum of the gamma wave. Therefore, in our study, we measured boredom through corresponding measures of attention and meaning using an electroencephalogram (EEG).

According to Westgate & Wilson (2018), previous studies have not focused on the temporal change component of human information that may reflect boredom. To observe temporal change and hence infer boredom, this study used music as the stimuli that would be consumed repeatedly. Finally, the purpose of this research was to test the following hypotheses.

What temporal changes and psychological components indicate boredom that arises from listening to music repeatedly?

(i) Is decreased attention measured by an increased alpha wave and a decreased beta wave?

(ii) Is a decreased meaning measured by an increased gamma wave?

Table 1. MAC model (adapted from Westgate & Wilson (2018))

	Meaning component	
Attention component	**Low Meaning** Task is INCONGRUENT with valued goals	**High Meaning** Task is CONGRUENT with valued goals
Understimulation: Demand < Resources	(A) ***Meaningless + Attentional boredom*** *Seek interesting activity*	(E) ***Attentional boredom*** *Increase demand*
Low-level Engagement Low demand + Low resources	(B) ***Meaningless boredom*** *Seek enjoyable activity*	(F) ***Enjoyment*** ***(Low boredom)***
High-level Engagement High demand + High resources	(C) ***Meaningless boredom*** *Seek interesting activity*	(G) ***Interest*** ***(Low boredom)***
Overstimulation: Demand > Resources	(D) ***Meaningless + Attentional boredom*** *Seek enjoyable activity*	(H) ***Attentional boredom*** *Increase resources*

2 METHODS

2.1 Stimuli and Procedure

Ten university students were asked to participate in the experiment. They were people who enjoyed listening to music and can easily spend an hour doing so. Eight genres of music were chosen from the database created by Santana et al (2020) and used as stimuli. The music stimuli were all instrumental and had a length of 30 seconds. To measure the participants' preference for music, they were asked to answer the following questions after listening to the 8 types of music stimuli.

(A) How do you intuitively favor this music? (1: Least favorite ~ 10: Most favorite)

(B) How early do you get bored of this music if you listen to it repeatedly? (1: Very late ~ 10: Very early)

We defined a preference for a particular kind of music as the score that resulted from subtracting the answer to (B) from the answer to (A). Within this experiment, each participant within the experiment or control group listened to the music of their highest or lowest preference, respectively. Specifically, the participants were asked to play the file and listen to the music repeatedly. The files were each composed of sections (S) and (Q), as depicted in Figure 1, where (S) represents a stimulation for 30 seconds, 6 times, after a rest for 60 seconds, and (Q) represents the participants answering questions about boredom for 180 seconds.

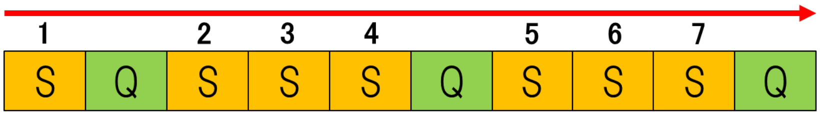

Figure 1. The composition of the music file allowing for repeated listening

2.2 Questionnaire and Apparatus

To relate the findings to the results of EEG, the participants were asked to subjectively evaluate their state of mind after listening to the music. According to Raffaelli, Mills & Christoff (2018), the following questionnaires were prepared. These are subjective evaluations, namely the state of emotion, the impression of the music, and the state of listening to the music. Incidentally, as shown Figure 2, the state of emotion was measured by a self-assessment Manikin test (10 points scale) according to Bradley & Lang (1994), as either: (1) Pleasure, (2) Arousal, or (3) Dominance. In addition, the impression of the music and the state of mind when listening to the music were measured by Visual Analog Scale (40 points scale), as follows.

The impression of the music:

(4) Preference

Do you have a preference for the music? (Do not prefer ~ Prefer)

(5) Boredom

Are you bored by the music? (Not bored ~ Bored)

The state of mind when listening to the music:

(6) Attention

How much did you pay attention when listening to the music? (Not paying attention ~ Paying attention)

(7) Time perception

When the music was a length of 3 minutes, how long did you the music was, subjectively? (Short ~ Long)

When participants listened to the music, an EEG was measured. Within this experiment, the wearable device “Muse2” (Interaxon) was used, which recorded the EEG using the application “Mind Monitor” (by James Clutterbuck). The electrodes of the device were located on the frontal lobes (AF7, AF8) and temporal lobes (TP9, TP10). The sampling rate of the device was 256 Hz.

After an EEG was measuring with Muse2, filters were applied to reduce the noise associated with the raw data, according to Hiraki et al (2020). A Fourier transform was then applied to the cleaned data, and therefore, the power spectrum with respect to time and frequency was obtained. The resolution of time was taken to be 400 points, over which the epoch was defined to be from 30 seconds before to 180 seconds after the stimulation. In addition, the resolution of frequency was 4673 points, from 7.5 Hz to 44 Hz, where the alpha wave was defined between 7.5 to 13 Hz, the beta wave between 13 Hz to 30 Hz, and the gamma wave between 30 Hz to 44 Hz. The average of the time and frequency power spectrums were calculated for all electrodes, and the averages for each wave were defined as (8) Alpha, (9) Beta, and (10) Gamma.

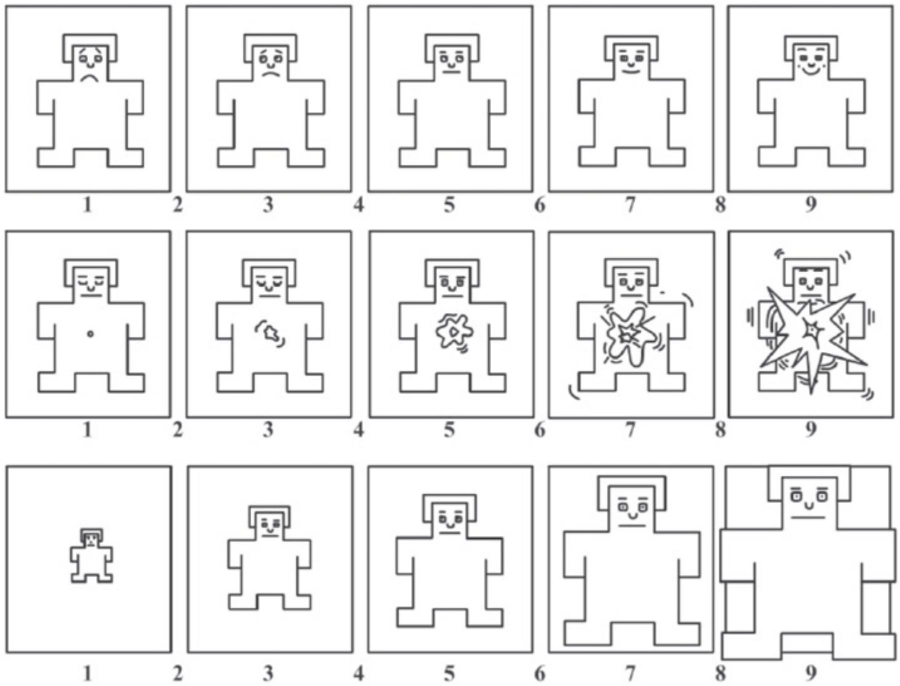

Figure 2. Self-Assessment Manikin test regarding Pleasure (top), (2) Arousal (middle), and (3) Dominance (bottom) (adapted from Bradley & Lang (1994))

2.3 Experimental Design and Analytical Method

The experiment was carried out according to the above explanation. While participants repeatedly listened to the music of their highest/lowest level of preference, their state of mind, including boredom, was measured with EEG, namely (1) Pleasure, (2) Arousal, (3) Dominance, (4) Preference, (5) Boredom, (6) Attention, (7) Time perception, (8) Alpha, (9) Beta, and (10) Gamma. The same experiment was conducted for seven days per piece of music. The experiment had seven sections for stimulation, and therefore, seven data points (1) Pleasure ~ (10) Gamma were acquired within the experimental and control group.

The temporal changes were analyzed from the data, both regarding long-term and short-term. As shown Figures 3 and 4, long-term was taken to be the full seven days, and short-term included seven points a day. First, the data was scaled with robust Z-scores for each participant in a day and a point. Second, based on the analyses for long-term and short-term, the bootstrap method was used and estimated a value *"t"* over 2500 times with bias-corrected and accelerated percentile method. Third, as shown in Figure 5, the temporal changes regarding (1) Pleasure ~ (10) Gamma in both long-term and short-term were observed based on the following definition.

Incidentally, the data for (4) Preference and (5) Boredom were used to check whether boredom was evoked by the experiment. Firstly, two-factor repeated non-parametric measures ANOVA were applied, in which a p-value of less than 0.05 was considered statistically significant. In detail, the first factor included the temporal changes that occurred for seven days or over seven points a day, and the second factor involved the conditions that resulted in highest/lowest level of preference.

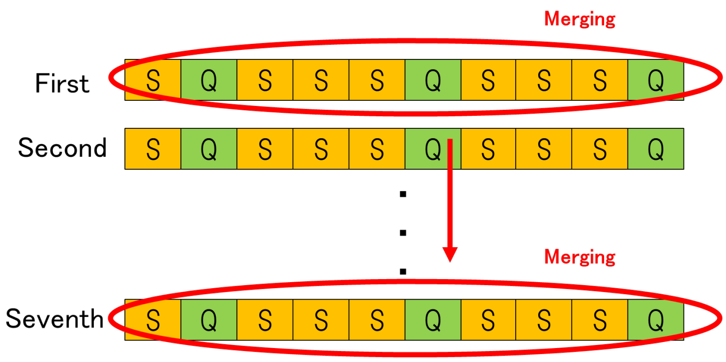

Figure 3. Long-term measurement

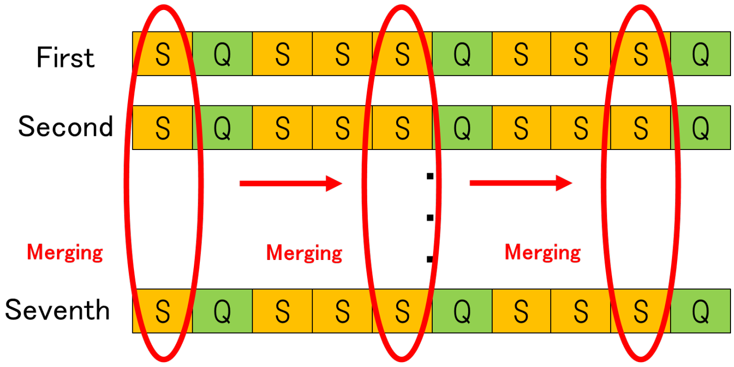

Figure 4. Short-term measurements

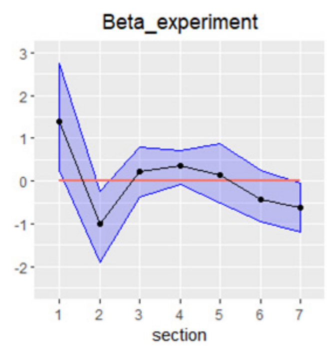

Figure 5. Analysis of temporal change

t : the bootstrap-estimated value after scaling with a robust Z-score

- *t* < - 0.5 → minus (-)
- *t* <= |0.5| → zero (0)

- $t > 0.5$ → plus (+)

E.g.,) Figure 5 shows that (9) Beta changed from plus to minus while the experiment took place.

3 RESULTS

First, applying ANOVA for data involving (4) Preference and (5) Boredom showed that the conditions of preference had significant differences in both the long-term and short-term. However, for (4) Preference and (5) Boredom, there were no significant differences between long- and short-term in the temporal changes.

Table 2. The temporal changes for indices

Temporal Change	Long-term		Short-term	
Condition	Experiment	Control	Experiment	Control
①Pleasure	+→-	0→0	0→0	0→0
②Arousal	0→0	0→0	0→0	0→0
③Dominance	0→0	0→0	0→0	0→0
④Preference	+→-	0→0	+→0	0→0
⑤Boredom	-→+	-→0	-→+	-→+
⑥Attention	0→-	0→-	+→-	+→-
⑦Time perception	0→0	-→0	-→0	-→0
⑧Alpha	0→0	-→0	+→0	+→0
⑨Beta	0→0	-→0	+→-	+→0
⑩Gamma	0→0	-→0	+→0	+→0

Second, as shown the Table 2, because of the temporal changes for (1) Pleasure ~ (10) Gamma, we found some differences between long-term and short-term. (1) Pleasure (+ → -), (4) Preference (+ → 0), (5) Boredom (- → +), (6) Attention (0 → -), and (7) Time perception (- → 0) had a similar trend on subjective evaluation. On the other hand, compared to hypotheses (i) and (ii), (8) Alpha, (9) Beta and (10) Gamma demonstrated the most different trend through the EEG. In the long-term, results for (8) Alpha (- +) and (10) Gamma (- → 0) were similar to hypotheses (i) and (ii), however, those of (9) Beta (- → 0) was different to hypothesis (i). Conversely, in the short-term, the results for (9) Beta (+ → -) were similar to hypothesis (i), however, those of (8) Alpha (- → +) and (10) Gamma (- → 0) were different to hypotheses (i) and (ii).

Third, there were some differences regarding preference in the long-term. For the condition of highest level of preference, (1) Pleasure (+ → -) and (4) Preference (+ → -) had the strongest trends, although for the condition of lowest level of preference, their indices followed no trend. Conversely, it was only on the condition of the lowest level of preference that (8) Alpha (- → +), (9) Beta (- → +), and (10) Gamma (- → +) had the strongest trends, although on the condition of the lowest level of preference their indices followed no trend.

4 DISSCUSION

First, for (4) Preference and (5) Boredom, there were significant differences between the conditions of preference in both the long-term and short-term. Therefore, this experiment may have evoked different types of boredom depending on preference in both long-term and short-term. In addition, due to the results from (4) Preference and (5) Boredom showing no significant temporal changes, the temporal changes must be further analyzed in detail.

Second, (1) Pleasure (+ → -), (4) Preference (+ → 0), (5) Boredom (- → +), (6) Attention (0 → -), and (7) Time perception (- → 0) followed a similar trend in both long-term and short-term. In addition, the temporal change of their indices was similar to Raffaelli, Mills & Christoff (2018). Thus, this experiment may evoke boredom in long-term and short-term, respectively. On the other hand, in the long-term, (8) Alpha (- → +) and (10) Gamma (- → 0) were similar to hypotheses (i) and (ii). Moreover, in the short-term, (9) Beta (+ → -) was similar to hypothesis (i). This result suggests that observations of boredom in the long-term and short-term show different characteristics. In other words, the indices of EEG may be effective or ineffective for indicating boredom in long-term or short-term. Incidentally, some results were different to hypotheses (i) and (ii), which suggests that this experiment may evoke other psychological phenomenon expect for boredom.

Third, because (1) Pleasure (+ → -) and (4) Preference (+ → -) were the indices for preference, their indices may follow more remarkable trends only on the condition of the highest level of preference. Therefore, if the stimuli has more meaning, it may evoke stronger boredom, particularly for subjective evaluation in the long-term. On the other hand, (8) Alpha (- → +), (9) Beta (- → +), and (10) Gamma (- → +) followed the most different trends as compared to previous study. According to Westgate & Wilson (2018), MAC model has independent components of attention and meaning. In other words, even if the condition for preference is different, attention is not different. However, within this experiment, (8) Alpha and (9) Beta were the attentional indices from the EEG, which only followed different trends in the condition of the lowest level of preference. Therefore, this result suggested that meaning is interrelated with attention against the previous definition for boredom, particularly for EEG in long-term. In other words, this study suggested that consumers feel bored as aversive emotion for the information and contents which have the interest or preference when the similar things are supplied repeatedly.

5 CONCLUSION

We measured the temporal changes of psychological components regarding boredom through the act of repeatedly listening to music. Part of the results confirmed hypotheses (i) and (ii). Decreased attention was measured by the increased alpha wave and the decreased beta wave. In addition, decreased meaning was measured by the increased gamma wave. However, particularly for EEG, the indices regarding boredom were different between long-term and short-term, and between the highest and lowest level of preference. In conclusion, measuring boredom must include factors of the temporal changes and the conditions of preference, particularly for EEG.

This study was conducted based on the MAC model. The model was correct when compared to results from a subjective evaluation, however, it was incorrect when using results from an EEG. As boredom must be measured in real time, future development will have to use biosignals such as EEG, which can ultimately improve the MAC model. In addition, the difference in data between subjective evaluation and biosignals must be considered, as subjective evaluation is the conscious data, while conversely, biosignals are unconscious data.

This study for boredom has the limitation because EEG is not the realistic measurement for many consumers. In other words, the technology measuring boredom by EEG may be useful for not consumers but sellers in the situation of the experimental developing such as selling schedule and recommendation. In addition, the confidence of our study had been insufficient yet because the number of participants was ten and some individual difference was detected. Thus, our study will be improved through evaluating human interface which has the issue about boredom, such as “When boredom is evoked?”, and “What the feedback modulate boredom?”. Moreover, this study was the fundamental research which measured the temporal change of emotion related to cognitions of habituation and reward. In the future, our study will be developed to the human interface and intelligent agent which have nudge to change human behavior by cognitive bias, modulating the boredom for nudge automatically, based on the values and lifestyle for individuals.

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PILOT STUDY ON THE BIOLOGICAL RESPONSES TO PLEASANT VIDEO STIMULI IN DIFFERENT INTENSITIES

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ABSTRACT

To provide evidence-based measures in health management and offer comfort services, it is important to assess emotions objectively. Recently, positive psychology has garnered considerable attention, and its effects have been verified as an early recovery effect during rehabilitation. In this study, to investigate the relationship between the biological responses corresponding to pleasant stimuli and elicited subjective strengths of pleasure, an experiment was conducted using sports videos with different pleasure strengths; in addition, biological responses were measured with collecting subjective ratings and analyzed. The two-minute length video stimuli for the experiment were set, such that the elicited pleasant strengths differed in the preliminary survey. In total, 15 healthy adults participated in the study. Photoplethysmography, respiratory waves, electrocardiograms, and continuous blood pressure waves were measured and analyzed.

In the results, although the stimuli used here elicited pleasant emotions, a problem in setting the proper strengths still remained. Regarding biological responses, systolic blood pressure, pulse pressure, and combined parameters of blood pressure wave components exhibited significant differences between stimulus levels. Finally, the combined parameters of the blood pressure wave components exhibited responses of graded intensity, and the magnitudes of these parameters were correlated with subjective rating scores.

Keywords: *pleasure, biological responses, emotion assessment, correlation with ratings*

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1 INTRODUCTION

To provide evidence-based measures for workplace health management, environmental improvement, and comfort service provision, it is important to assess emotions objectively. Recently, positive psychology has garnered considerable attention and its effects have been verified as an early recovery effect during rehabilitation.

The method of objectively assessing emotions using physiological parameters has been studied for a long time (Kreibig, 2010). Here, pleasure and displeasure are set as the basic elements of emotions (Russell, 1980). In addition, autonomic responses are often considered when assessing emotion. Here, autonomic responses during high-arousal states differ from responses during low-arousal states; similarly, responses during pleasure in high-arousal states differ from those during pleasure in low-arousal states. Therefore, it is extremely difficult to obtain physiological index parameters for pleasure.

Parameters such as alpha wave 1/f fluctuations and asymmetry in electroencephalograms (EEGs) (Davidson & Fox, 1982) have been proposed as parameters that could discriminate pleasure from displeasure. However, these parameters were not often checked to confirm whether they responded to pleasures in high- and low-arousal states, in addition to whether their responses changed proportionally to the strengths of elicited emotions. Therefore, conclusive and satisfying physiological parameters for discriminating between pleasure and displeasure remain under study.

We identified a number of combined parameters of blood pressure pulse wave components that discriminate certain pleasures, even at different arousal levels, against displeasure in previous studies (Yamashita, Aikawa, Kitama & Yokoyama, 2019). As physiological index parameters of pleasure emotions, the characteristics of proportional responses to the strengths of elicited pleasure emotions are required. Therefore, in this study, we examined whether some of these parameters changed along with the strengths of the elicited pleasure emotions.

2 METHOD

This study was approved by the ethics committee of the Hokkaido University of Science. A survey of the video stimuli was conducted prior to the physiological experiment.

2.1 Preliminary survey

A preliminary survey was conducted to determine the eliciting strengths of the pleasant emotions of the video stimuli. First, ten 20–22 aged adults participated in the study, and they watched six pleasant videos and were administered two questionnaires to assess the elicited emotions of the presented videos.

One of the questionnaires for “three-item questionnaire” comprised three items (pleasure–displeasure, tension–relaxation, and excitement–calmness), consisting 11-point scales that were rated +5 to -5. Regarding the pleasure–displeasure scoring process, a positive score indicates a pleasure rating, and a negative score indicates a displeasure rating. The other questionnaire "pleasure questionnaire" comprised five items (exhilaration, pleasure/joy, comfort, tension, and displeasure) and consisted of a 10-point scale (0 to 9).

Next, considering the rated scores of the videos, we set the strengths of stimuli to three levels as follows: "level 0" for neutral (no pleasant/unpleasant) as the control, "level 2" for most pleasant as the maximum level, and "level 1" for pleasant but intermediate strength.

2.2 Experiment

2.2.1 Subjects and Conditions

In total, 15 healthy male volunteers aged 21–22 years provided written informed consent to participate in the study. Experiments were performed in a room that was temperature-controlled (24.0–25.0°C) and humidity-controlled (35–45%). In addition, the subjects were asked to refrain from smoking, eating, or drinking for two hours before the experiments.

2.2.2 Stimuli and procedures

Videos projected onto a screen installed with stereo sound were adopted as the stimuli. Stimuli were set to three levels, and the "level 0" video was familiar to the subjects as it comprised various views from their campus, such as walkways, buildings, parking lots, and bicycle lots. The "level 2" video was composed of highlights of outstanding performance scenes in sport, such as golf, basketball, curling, baseball, and football, and they elicited the maximum pleasure emotions in the preliminary survey. Similarly, the "level 1" video comprised highlights of outstanding performance scenes in sport, such as skateboarding, bowling, and volleyball, and they elicited mildly pleasurable emotions.

The videos comprised neutral, stimulus, and neutral scenes for 90 s, 120 s, and 40 s, respectively. Three sessions were performed, and one of the three levels for the stimulus scene was presented randomly to the subject in each session. The neutral scene was similar to the "level 0" video.

The subjects were requested to watch the videos and assess the emotions elicited by the stimulus in each session.

2.2.3 Measurement

Blood pressure wave was measured using arterial tonometry on the left wrist, while the respiratory wave activity was measured using a thermistor sensor placed in front of the subject's nostrils. Photoplethysmography data were obtained on the right index finger, and electrocardiography (ECG) data were obtained using standard lead II.

All data were recorded with 200-Hz sampling and subsequently analyzed using several computer programs developed in the lab.

3 ANALYTHIS

Bonferroni and Steel-Dwass's multiple comparison tests and the test for no correlation were adopted for the statistical analysis.

3.1 Analyzed section

In total, 10 sections were assigned for the analysis. First, the pre-rest period was divided into two sections: 70 s [rest 0] and 20 s [rest 1]. Next, the stimulus period was divided into six sections, each comprising 20 s [stim. 1] to [stim. 6]. The post-rest period was divided into two sections, each comprising 20 s [rest 2] and [rest 3]. The mean of each data set was determined for each section. To adjust for individual variations, each mean was normalized using the [rest 0] period data.

3.2 Analysis for physiological data

The time series for diastolic blood pressure (DBP), systolic blood pressure (SBP), pulse pressure (PP), and mean blood pressure (MBP) were obtained from the blood pressure wave. The respiration depth (RD) and respiration rate (RR) were obtained from the respiratory wave data. The pulse wave amplitude (PWA) was obtained via photoplethysmography. Finally, the heart rate (HR) and heart rate variability (HRV), respiratory sinus arrhythmia component (RSA; 0.15–0.4 Hz), and Mayer wave component (MW; 0.04–0.15 Hz) were obtained from the ECG data.

3.3 Pulse wave analysis

Following a previous study (Yamashita, Aikawa, Kitama & Yokoyama, 2019), a blood pressure pulse wave analysis method was conducted. The derivatives of the pulse wave were calculated to measure the maximum rate of change in the anacrotic limb, referred to as the dP_{pp}. In this study, dP_{pp} and a combined parameter dP_{pp}/MBP were examined.

4 RESULTS

4.1 Self-ratings

The strengths of the emotions elicited by each stimulus were compared as scores for subjective ratings. The comparisons of the self-rated scores of the “three-item questionnaire” in response to three videos are presented as follows. The pleasure–displeasure mean score in response to the "level 1" video was significantly higher (level 1: mean difference (MD) = -14.133; 99%) than that of the "level 0" video. In addition, the mean score in response to the "level 2" video against the "level 0" video was significantly higher (level 2: MD = -15.866; 99%). However, there was no difference between the scores of "level 2" and "level 1." Scores of three pleasant items (exhilaration, pleasure/joy, comfort) in the “pleasure questionnaire” were summed as total pleasure score (tps). The tps comparison was similar to the results of the “three-item questionnaire.”

4.2 Physiological responses

Each mean value of the physiological parameters during the stimulus period was obtained and compared between the stimulus levels. DBP, RR, RD, HR, Mayer component in HRV, RSA component in HRV, and PWA exhibited no difference between stimulus levels. Figure 1 presents the SBP in the comparison between stimulus levels. The SBP in "level 1" was significantly higher than the SBP in "level 0" (p<0.01); however, no difference was observed between the SBP in "level 2" versus SBP in "level 0." Figure 2 presents the PP in the comparison between the stimulus levels. The PP values in "level 1" and "level 2" were significantly higher than the PP in "level 0" (p<0.05); however, no difference was observed between the PP values in "level 1" and "level 2." Regarding the results of the pulse wave analysis, the combined parameters of dP_{pp}/MBP in "level 2" exhibited significantly higher values than those in "level 0" (p<0.05) (Figure 3). However, the parameter in "level 1" exhibited no difference between those in "level 0" and "level 2." However, the parameters tended to increase according to the stimulus levels.

Figure 1. Comparison of systolic blood pressure (SBP) between levels

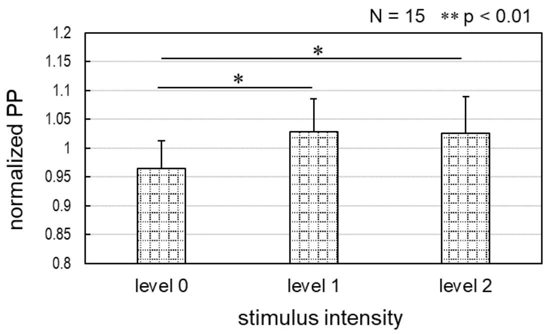

Figure 2. Comparison of pulse pressure (PP) between levels

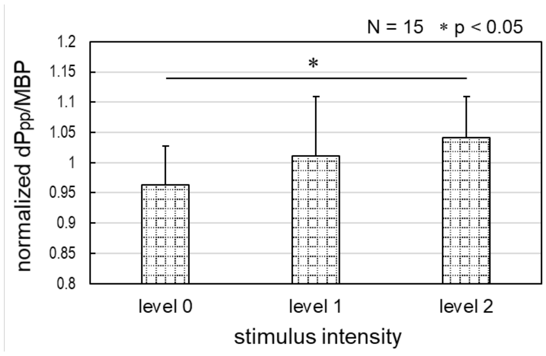

Figure 3. Comparison of dP_{pp}/MBP between levels

4.3 correlations

Correlations between physiological parameters and rated scores of pleasurable emotions were checked using each subject's data. Although the correlation between PP and tps was weak, it is significant ($r = 0.36$, $p < 0.05$). Moreover, the correlation between dP_{pp}/MBP and tps was weak but significant ($r = 0.38$, $p < 0.05$).

5 DISCUSSIONS AND CONCLUSIONS

Before proceeding to the main subject, we consider the reasons for using physiological measurements in the emotion evaluation method. The questionnaire method is used to easily evaluate emotions, but it has drawbacks such as the possibility that consciousness and language are not aligned, the possibility that consciousness is latent, and there is reaction bias. Furthermore, it is difficult to adopt the questionnaire method for patients with respirators, ALS patients, autistic patients, and children with speech disabilities. In addition, there are drawbacks such as the inability to evaluate the driver's emotion in real time while driving. Therefore, we adopted the method of the physiological signal analysis. The method is hard to conceal their state of emotion and can provide accurate information about the emotional status of an individual (Sharma, Prakash, Kalra, 2019), because emotional status is inherently reflected in the activity of nervous systems (Murugappan, Ramachandran, Sazali, 2010).

To investigate the relationship between biological responses to pleasant stimuli and elicited subjective strengths of pleasurable emotions, an experiment was performed using sports videos with different pleasure strengths, while physiological responses were measured with collecting subjective ratings.

The stimuli adopted in this study elicited pleasant emotions, which were verified by their rated scores. However, the strengths of pleasant emotions for "level 1" and "level 2" were not ideal. As there was no difference between the scores of "level 2" and "level 1," this study is limited. The stimulus for "level 1" needed to be weakened slightly while the stimulus for "level 2" needed to be strengthened.

Regardless of whether they were ideal stimuli, correlations between physiological parameters and rated scores were confirmed in the participants' data.

Finally, the combined parameters, dP_{pp}/MBP, exhibited responses of graded intensity with the stimulus levels and correlated with subjective rated scores. Therefore, the combined parameter dP_{pp}/MBP could be employed as a physiological index parameter for pleasant emotions. However, further studies are required to validate these results.

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DECLARATIONS

Competing interests

The authors declare that they have no conflict of interest.

Ethics approval and consent to participate

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Approval was granted by the Ethics Committee of the Hokkaido University of Science (date October 8, 2020). Informed consent was obtained from all individual participants in the study.

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POTENTIAL FOR WELL-BEING IN PEER-TO-PEER SHARING ECONOMY: A SYSTEMATIC REVIEW AND MODELING

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ABSTRACT

Humans pursue well-being in their lives. Well-being encompasses positive emotions, life satisfaction, healthy functioning, meaning of life, and self-growth. In ancient times, sharing was an intimate behavior that consolidated communities and led to an ideal life, which refers to well-being in the present. Sharing economy sheds light on a novel business model in which people can develop their well-being while sharing resources/goods and services among strangers. However, prior research shows that users participate in the sharing economy because of self-interest rather than social interaction or sustainability. Sustainable well-being is important not only for us but also for our communities and our planet. This study investigates how the components of well-being can be built into a sharing economy and foster users to pursue it in the long-term. It reviews and synthesizes prior studies to (1) elucidate the components of well-being in the peer-to-peer (P2P) sharing economy, (2) model the sharing ecosystem with components of well-being from a global perspective, and (3) discuss the design solutions for a P2P sharing platform to facilitate well-being. Furthermore, it provides examples of practices to illustrate the proposed model. We believe this study not only motivates platformers to consider users' well-being but also promotes sustainable functioning of the sharing ecosystem.

Keywords: *Well-being, P2P platform, Sharing economy*

1 INTRODUCTION

Well-being is one of the ultimate goals of life. Humans pursue well-being to attain positive emotions, life satisfaction, healthy functioning, meaning of life, and self-growth (Andrews & Withey, 2012; Diener, 2000). A hundred thousand years ago, humans already shared food, shelter, and work within tribes, an intimate behavior that encouraged a strong feeling of community. Such intimate sharing within kinship and friendship leads to an ideal social and

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physical life, which we refer to as well-being today. Owing to the rising trend in P2P platforms, the sharing economy is a novel business model in which people can share products, services, or skills with strangers. Since the sharing economy is one of the fastest growing markets (Apte & Davis, 2019; Wirtz, So, Mody, Liu, & Chun, 2019), it has significantly changed consumption patterns, markets, and business ecosystems over the past two decades. However, prior studies show that users participate in the sharing economy mainly for self-oriented benefits (e.g., joy, reward) rather than the expected benefits of social interaction and environmental sustainability (Botsman & Rogers, 2010; Hamari, Sjoklint, & Ukkonen, 2016). Belk (2014) believes that "sharing for profit" creates weak bonds among users; he characterizes it as "pseudo-sharing". Although novel sharing behavior differs from ancient intimate sharing within tribes, it still leaves room for potentially developing well-being. There are numerous studies on the relationship between the concept of well-being and the sharing economy. It still has enormous potential for social development, sustainable consumption, and environmental protection (Martin, 2016).

While there is an increasing focus on well-being in the sharing economy, a holistic review to organize the various concepts of well-being, which can be executed on P2P sharing platforms, is lacking. The gap between the reality and the expectation of positive values in the sharing economy leads us to not only explore the economic needs of users, but also the emotional, social, and environmental values that they can exchange with each other. Therefore, this study explores the potential of well-being components in the sharing economy to help both providers and receivers perceive them and continuously engage in the sharing community. We also review prior studies to identify the gaps between the present situation and the ideal structure of well-being, and propose a framework to illustrate the potential relationship of well-being that can be explored in the sharing economy. Therefore, we (1) conclude related studies elucidate the key components of well-being in the sharing economy and (2) propose a preliminary framework for sharing ecosystems with well-being. We believe that this study not only motivates scholars and practitioners to consider users' well-being but also promotes sustainable and prosperous sharing between people and strangers.

2 WELL-BEING AND SHARING ECONOMY

2.1 What is well-being?

Well-being can be regarded as psychological well-being (or subjective well-being) in mainstream research. It can be divided into hedonic and eudemonic well-being (Deci & Ryan, 2008). Ryff (1989) summarized well-being embodied in six dimensions of life: (1) accepting oneself in a positive way (self-acceptance), (2) having trusting and satisfying relationships with others (positive relations with others), (3) feeling a sense of self-determination and independence (autonomy), (4) having a sense of improvement in self (personal growth), (5) possessing beliefs and goals in life (purpose in life), and (6) being capable of controlling the surrounding context (environmental mastery). These theory-based dimensions of well-being correspond to basic human motivations and needs. According to Maslow's hierarchy of human needs (Maslow, 1962), humans have eight levels of needs, wherein a person is motivated to move up the hierarchy toward the top level. Multi-levels of well-being can be described as intro-personal, inter-personal, and extra-personal aspects, which integrate individual, social, and environmental relationships (Calvo & Peters, 2014). Thus, we believe that the levels of needs can also correspond to the multi-levels of well-being and that the lower levels (e.g., preventing illness and decreasing depression) should be fulfilled to attain a higher level (e.g., being connected with others), and consequently the top level (e.g., seeking meaningful personal growth).

2.2 Sharing Economy and P2P Sharing Platform

The platform on which enormous value can be exchanged is the center of the P2P sharing economy. It matches providers, receivers, and objects (or services) in an interactive ecosystem (Parker, Van Alstyne, & Choudary, 2016). Airbnb, Uber, Lyft, and eBay are examples of such successful platforms. In the P2P platform mechanism, information, object (or service), and currency exchanges are core interactions (Parker et al., 2016). Therefore, we illustrate the P2P platform mechanism based on the three interactions proposed by Parker et al. (2016) (Fig.1). However, we updated the information exchange to be divided into user profile, object description, and communication—the features on which some prior studies have conducted experiments. Essentially, both providers and receivers interact on the platform (online) before sharing and accessing objects. After making the deal and paying on the platform, they interact offline to share and access the resources.

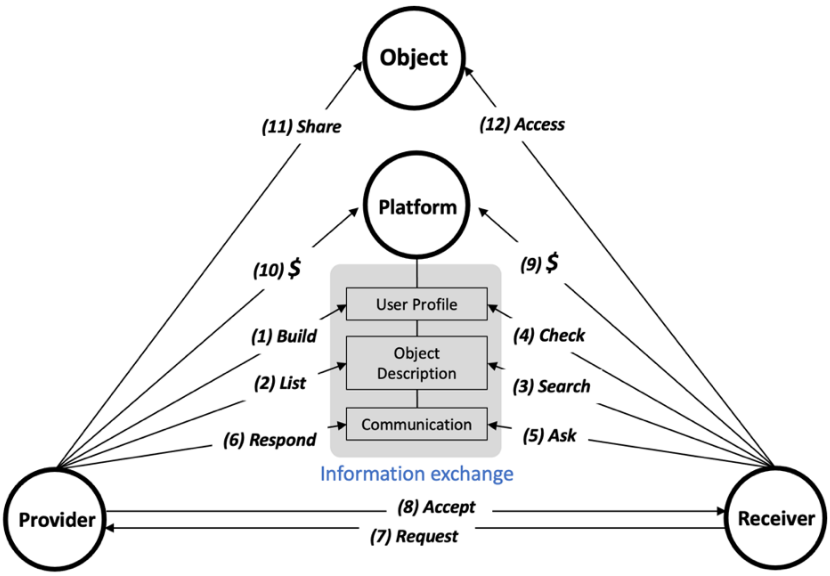

Figure 1. The mechanism of the P2P platform

3 THE COMPONENTS OF WELL-BEING IN SHARING ECONOMY

3.1 Definitions of the components of well-being

The study organizes and proposes literature-based components of well-being in the sharing economy. We propose nine such potential components: pleasure, attachment, trust, empathy, contribution, gratitude, engagement, compassion, and altruism. As prior studies from various disciplines may differ in terms of the definitions of each component of well-being, this study integrates them into simplified definitions that can be found and developed in the sharing economy.

- Pleasure: Pleasure is a positive feeling central to the perception of well-being (Kringelbach, 2010). It plays an important role in survival and reproduction (Darwin, 1859). The need for pleasure assures that people are attracted by food, sex, and social interactions.
- Attachment: Attachment toward a possession is acquired from a sense of ownership, and past experience with the possession serves as the identity of oneself (Ahuvia, 2005; Belk, 1988). People with strong attachment to an object intend to take good care of it and have better life satisfaction (Tsurumi, Yamaguchi, Kagohashi, & Managi, 2020).
- Trust: Trust and well-being are closely connected. Trust allows people to perceive security, support, and comfort (Bowlby, 2008) and facilitates pro-social behaviors (Helliwell & Wang, 2010). People living in high-trust environments have a higher level of well-being (Helliwell & Wang, 2010).
- Empathy: Empathy is regarded as being pervaded by others' emotions or understanding the factors of others' emotions (Cuff, Brown, Taylor, & Howat, 2016). It is an other-oriented emotional response wherein people are concerned about others' well-being (Batson et al., 2002b).
- Contribution: The sense of contribution (or having a positive impact on others) fulfills the basic human needs of autonomy, relatedness, and competence, based on self-determination theory (Martela & Ryan, 2016). Additionally, contribution to others can strongly predict eudemonic well-being (Ryan, Huta, & Deci, 2008).
- Gratitude: Gratitude is a feeling of gratefulness experienced when one receives favors, kindness, help, and support from others (Tesser, Gatewood, & Driver, 1968). One could feel gratitude for not only inter-personal relationships, but also an object or an experience, such as an artwork or a trip (Sansone & Sansone, 2010). Evidence shows that practicing gratitude improves well-being (Dickerhoof, 2007; Froh, Sefick, & Emmons, 2008).
- Engagement: Engagement is a state of being engrossed in an activity. Csikszentmihalyi (1990) also regards it as "flow". People recall that state as an exceptional and enjoyable experience that leads to well-being (Schueller & Seligman, 2010).
- Compassion: Compassion is a caring attitude toward others and a willingness to help them. Empathy and compassion are fundamental to the quality of social relationships. Compared to empathy, compassion enables people to have helping intentions in addition to sharing others' emotions (De Waal, 2010).
- Altruism: Altruism is a behavior rather than an emotion that helps or confers benefits upon others at the cost of oneself (Fehr & Fischbacher, 2003). Altruism likely stems from compassion and empathy (Batson et al., 2002a; Hoffman, 1981). Here, altruism concerns inter-personal helping behaviors and extra-personal behaviors, such as protecting animals and the environment.

The components of well-being selected in this research correspond to Maslow's hierarchy of needs and the three aspects of well-being. Figure 2 shows nine well-being components located at the level of well-being relationship and related needs. Pleasure and attachment are categorized as intra-personal aspects, which focus more on the self-object relationship, referring to physiological and safety needs. Trust, empathy, contribution, and gratitude belong to the interpersonal aspect that one can attain through social interaction, referring to safety, belonging and love, esteem, cognitive, and aesthetic needs. Lastly, engagement, compassion, and altruism belong to extra-personal aspects that lead people to think about the meaning of activity, society, and the environment, which further refers to aesthetic needs, self-actualization, and transcendence. In this structure, well-being can be enhanced to higher-level values if its lower-level components are fulfilled.

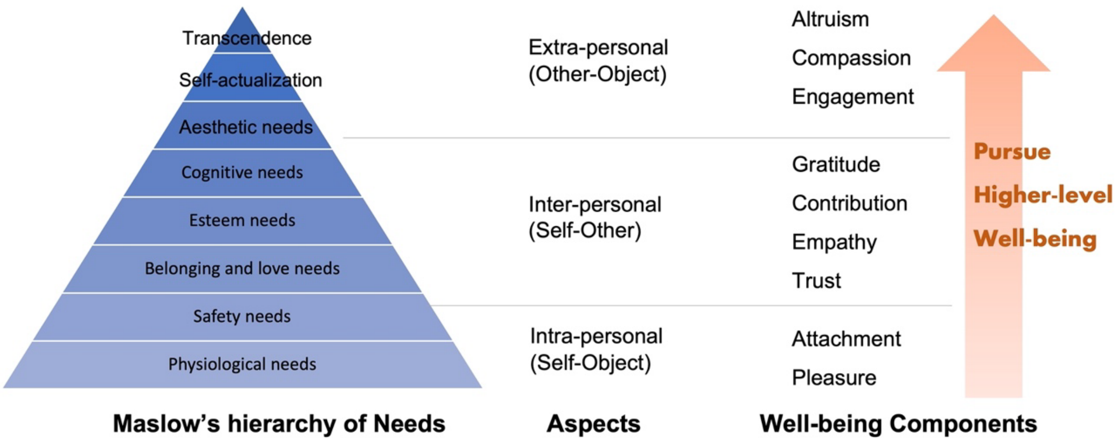

Figure 2. The relationship between Maslow's hierarchy of needs and the well-being components

3.2 Related studies on well-being and sharing

Regarding the pleasure of sharing, some interesting studies on food sharing have pointed out that sharing food online or offline allows social connections to prosper (Maldoy, De Backer, & Poels, 2021; Mendini, Pizzetti, & Peter, 2019) and increases the appeal of food (Maldoy et al., 2021). However, the attachment to sharing is mainly explored in accommodation sharing. For example, personal objects that evoke hosts' presence can improve their social attachment to hosts (Dogerlioglu-Demir, Akpinar, & Ceylan, 2022). Trust has received the most attention in studies on the sharing economy. For example, the quantity of information and communication are important factors in building trust perceptions (Zamani, Choudrie, Katechos, & Yin, 2019). Additionally, the length of the provider's self-descriptions influences the receiver's trust (Ma et al., 2017) and the perception of the hosts' trustworthiness from their photo affects the listing price or likelihood of selection (Ert et al., 2016). Evidence shows that receivers' empathy toward providers can improve loyalty (Shuqair, Pinto, & Mattila, 2021) and the antecedent of empathy can be information shared between a salesperson and customer (Mangus, Bock, Jones, & Folse, 2020). A sense of contribution can be found in coupon sharing (Tang, Zhao, & Liu, 2016) and knowledge-sharing contexts (Seebohm et al., 2013; Teh & Yong, 2011). A gratitude study shows that gratitude fosters sharing word-of-mouth for sustainable luxury brands (Septianto, Seo, & Errmann, 2021), prosocial behaviors (e.g., information sharing) of a salesperson, and long-term business relationships (Mangus, Bock, Jones, & Folse, 2017). In the studies on engagement, scholars point out that the sense of ownership is the antecedent to engagement, but interpersonal contamination has a negative effect on the intention to engage (Baker, Kearney, Laud, & Holmlund, 2021). Regarding compassion, one study finds that people who have high trust and compassion levels significantly increase their willingness to share resources after a disaster (Wong, Walker, & Shaheen, 2021). On altruism, studies state that trust improves knowledge-sharing intentions and behaviors (Chen, Fan, & Tsai, 2014; Wu, Lin, Hsu, & Yeh, 2009).

To sum up, prior studies have shown that higher-level well-being components (gratitude, engagement, compassion, altruism) serve as antecedents to motivate providers to share with others. For example, the feeling of gratitude fosters information-sharing between providers and receivers, and compassion and altruism increases the willingness to share objects. In contrast, lower-level well-being components (pleasure, attachment, trust, empathy, and contribution) serve as the consequences of information sharing and object sharing. As Figure 4 shows, we structured the potential relations of well-being components and sharing behaviors based on several literature reviews.

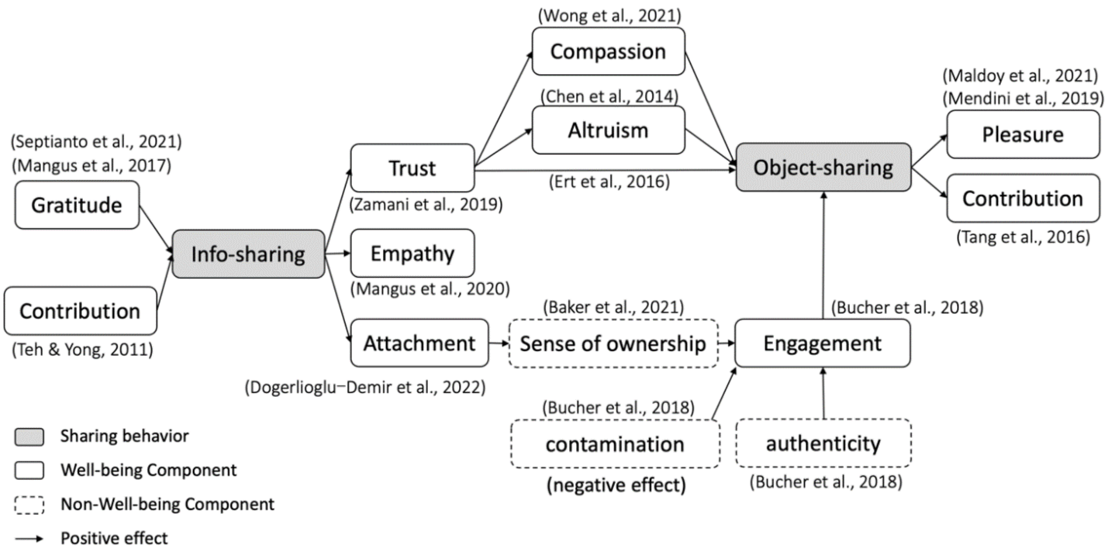

Figure 3. The summary of potential relations of well-being components and sharing behaviors

To illustrate with an example, when an Airbnb host shares a spare room with a guest who wants to book a room for a conference trip, both may feel gratitude for exchanging information (e.g., the purpose of this trip and the facilities in the room). The information sharing elicits trust and empathy, which drives the host to sincerely share the room. In addition, trust also arouses the host's compassion and altruism to further help the guest, so the host suggests that the guest go to the local farmer's market and art exhibitions. The guest feels attached and engages in this unique and in-depth trip. Consequently, they both have a sincere sharing experience, and both feel pleasure and a sense of contribution.

4 PRELIMINARY CONCEPTUAL FRAMEWORK

Based on the literature review of well-being in the sharing economy, we found that higher-level well-being components (gratitude, engagement, compassion, and altruism) were the key motives for positively influencing the willingness to share. In contrast, pleasure and attachment, belonging to intra-personal well-being, were positive consequences of sharing. Evidence suggested that how we foster sharing should not only focus on intra-personal benefits but also on inter-personal and extra-personal well-being. Thus, we structured the Hyper-Pyramid-Eco-System model of the P2P sharing platform (HPES model) to conceptualize how well-being can be a concern in the sharing economy (Fig.3).

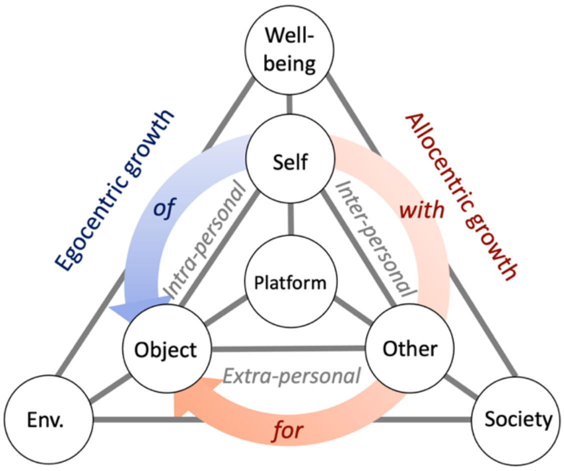

Figure 4. The Hyper-Pyramid-Eco-System model of the P2P sharing platform (HPES model)

In the HPES model, the central pyramid shows the key actors: self, other, object, and platform. The relations between each pair of actors are regarded as intra-personal, inter-personal, and extra-personal, corresponding to self-object, self-other, and other-object relations, respectively. The two circular arrows indicate egocentric (self-oriented) and allocentric (other-oriented) motives. They also depict that human desire starts from owning an object, and that humans share objects with others to pursue a higher-level goal. The outer pyramid depicts what people pursue as ultimate goals: well-being, society, and the environment. This model shows our expectation of fostering participants' awareness of not only intra-personal well-being but also inter-personal and extra-personal relationships, which can improve social interaction and ecological sustainability to attain higher-level values for life.

5 DISCUSSION AND CONCLUSION

This study investigated how and which components of well-being could be developed in a sharing economy to help users to perceive them and engage in a sharing economy sustainably. Based on the literature review, we organized and concluded the extant evidence to build potential relations among all well-being components and sharing behaviors. The egocentric growth (intra-personal well-being) and allocentric growth (inter-personal and extra-personal well-being) are both crucial in the sharing economy. In particular, users usually notice egocentric benefits rather than allocentric growth. Thus, this is a potential direction to draw people's attention to, lead them to notice social interactions, and install more allocentric elements (e.g., empathy, gratitude, altruism) on P2P sharing platforms.

In addition to studying well-being, we also found that information sharing might be pivotal to initiate a flow of a perception of well-being. The divisions of information exchange, user profiles, object descriptions, and communication provide enormous potential for redesign. The user profile is the place for self-closure, which is suitable for building similarities between providers and users to generate empathy and attachment. Communication channels are good for building trust, so the design can be focused on facilitating users to ask and respond frequently, such as nudging notices to push users to ask simple questions. We believe this study not only motivates platformers to consider both providers' and receivers' well-being, but also promotes the sharing ecosystem to function sustainably and prosperously. Ultimately, this ecosystem can create behavior changes to improve wellbeing in individuals, society, and the environment.

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RELATIONSHIP BETWEEN BEHAVIORS FOR PURCHASING OTC MEDICINES AND LITERACY OF CONSUMERS

EXPLORING THE DIGITAL EXPERIENCE BASED ON A TABLET SYSTEM

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ABSTRACT

The rapid development of e-commerce and impact of the pandemic may affect consumers' healthy behavior in purchasing OTC medicines. This study aimed to examine the relationship between Japanese consumers' current behaviors of purchasing OTC medicines and literacy through exploring the digital experience of purchasing based on tablets. An online questionnaire was conducted in the Kanto region of Japan, which included questions on purchasing behaviors and medication literacy, and the Japanese version of the eHealth Literacy Scale. Of the participants who had experience in purchasing OTC medicines, 89.47% preferred to buy them at pharmacies or stores, whereas 9.47% tended to purchase them online ($\chi2(2) = 271.50$, $p < .01$); 64.24% accepted choosing medicines through a digital screen ($\chi2(3) = 102.36$, $p < .01$) and 85.26% obtained information through smartphones while purchasing OTC medicines at pharmacies or stores. Young consumers aged 20-29 years used smartphones significantly more frequently than those aged 30-49 years ($p <. 01$). There was a positive correlation between eHealth literacy and smartphone use ($r = .24$, $p < .01$). The results suggest that Japanese consumers prefer to visit a pharmacy or drug store to purchase OTC medicines. They also prefer to search for information about OTC medicines on-site with a digital device, such as a smartphone, rather than buying OTC medicines from online stores. The digital experience of a tablet-based purchasing system would be useful and acceptable for young consumers and those with high eHealth literacy.

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Keywords: *Behavior, Consumer Literacy, Over-the counter (OTC) medicines, User Experience*

1 INTRODUCTION

In Japan, self-medication has been promoted since the revision of the Pharmaceutical Affairs Law in 2006 (Narui et al., 2013), to include medicines that can be purchased without a prescription; hence over-the-counter (OTC) medicines play an important role in self-medication. With the rapid development of e-commerce and the impact of the global pandemic, the health behaviors of consumers related to purchasing OTC medicines are constantly changing. Previous studies have demonstrated the factors affecting the behaviors of online shopping for medicines (Gatt Baldacchino & Zarb Adami, 2016), as most consumers still do not prefer to buy OTC medicines online. Meanwhile, eHealth literacy is a key factor affecting people's medication ability from electronic sources, such as the Internet (Norman & Skinner, 2006), which is associated with certain health-related behaviors of Japanese adults (Mitsutake et al., 2016). Medication literacy affects people's health, medication behaviors, and decision-making (Pouliot et al., 2018). However, few studies have considered the impact of literacy when creating a digital design for OTC medication. Considering the importance of eHealth and medication literacy in health behaviors, the present study aimed to examine the relationship between the current healthy behaviors of Japanese consumers purchasing OTC medicines and literacy, exploring the novel digital experience of purchasing OTC medicines on tablets (Shinoda et al., 2019; Zhang & Koyama, 2020).

2 METHODS

The online survey questionnaire was conducted in the Kanto region of Japan; it included the following four sections: (a) the Japanese version of the eHealth Literacy Scale (J-eHEALS) (Mitsutake et al., 2011) to measure consumers' eHealth literacy; (b) the OTC medication literacy questions (Kawase et al., 2016) to measure the medication literacy ability of consumers; (c) the questions regarding purchasing behaviors related to OTC medicines, such as how to purchase OTC medicines, which approach is better in choosing OTC medicines, and use of smartphones at local pharmacies or stores; and (d) demographic questions. In total, 450 Japanese participants, aged 20-49 years, answered the questionnaire through Freeasy, an online survey platform in Japan. After excluding the invalid responses, based on the screening question, "Which of the following questions was not mentioned in this survey?" to check for the presence of malicious responses, 288 respondents' data were finally analyzed.

3 RESULTS

3.1 The characteristics of respondents

In the present study, 47.92% of the participants were male. The age distribution of the respondents was: 32.99% (24.81 ± 2.90) were 20-29 years old, 30.55% (23.94 ± 2.94) were 30-39 years old and, 36.46% (44.86 ± 2.93) were 40-49 years old. The mean score of J-eHEALS was 22.65 (SD = 6.64), with 139 (48.26%) respondents with high eHealth literacy (Mitsutake et al., 2011; Mitsutake et al., 2016). The average score of OTC medication literacy was 20.55 (SD = 2.22)

(Kawase et al., 2016), and there was a positive correlation between J-eHEALS scores and OTC medication literacy ($r = 0.17$, $p < .01$). Japanese consumers may have a wide range of approaches to obtaining OTC medication information, and are not limited to electronic sources such as the Internet.

3.2 The current behaviors while purchasing OTC medicines.

First, the results of "How do you purchase OTC medicines?" showed that almost 66% of the respondents had the OTC medicines purchasing experience (**Figure 1**), of which 89.47% preferred to buy medicines at local pharmacies or stores, and 9.47% preferred to purchase them online ($\chi2(2) = 271.50$, $p < .01$). Meanwhile, the results regarding which approach was better for choosing OTC medicines revealed that 32.29% of respondents selected OTC medicines directly from the shelves, and 64.24% accepted searching through digital screens (this includes 43.75% who chose either of the two options and 20.49% who chose to search on digital screens) ($\chi2(3) = 102.36$, $p < .01$). Most Japanese consumers have purchasing experience for OTC medicines, and the majority prefer to buy them at local pharmacies or stores; only a few prefer to purchase them online. Regarding opinions on the choice of approach, most participants accepted choosing medicines through digital screens, which also demonstrated the feasibility of the digital purchasing experience for OTC medicines in terms of the tablet-based system.

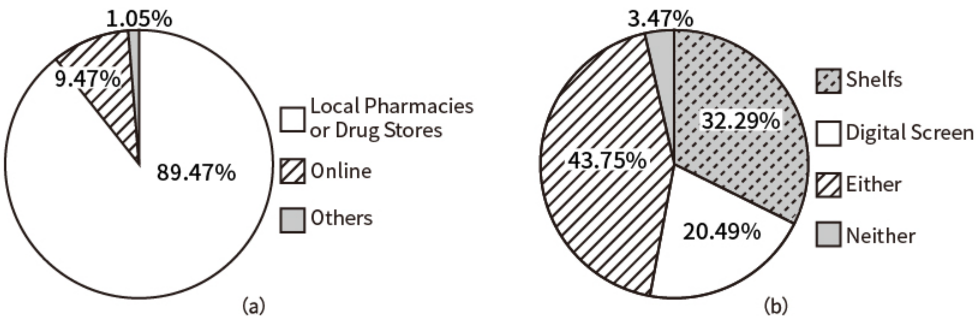

Figure 1. Results of (a)How do you purchase OTC medicines? and (b) Which approach for choosing OTC medicines is better?

3.3 Relationships between purchasing behaviors and literacy of consumers.

The participants were asked if they had ever used a smartphone to collect information regarding OTC medicines when purchasing them at pharmacies or stores (**Figure 2**). A five-point scale was employed for the assessment (5 = very often, 4 = often, 3 = sometimes, 2 = occasionally, 1 = never). More than 85% of the participants reported using a smartphone to collect information about OTC medicines in pharmacies and stores, and a one-sample t-test (compared to sometimes) showed a high frequency of smartphone use at local pharmacies and stores ($t\,(189) = -2.35$, $p < .05$). Meanwhile, one-way ANOVA showed that usage frequency was significantly different among consumers aged 20-29, 30-39, and 40-49 years ($F\ (2, 187) = 8.00$, $p < .01$). Bonferroni post-hoc multiple comparisons revealed that the mean value of the usage frequency of consumers aged 20-29 was significantly higher than that of consumers aged 30-39 ($p < .01$, 95% CI [0.16, 1.14]), and 40-49 ($p < .01$, 95% CI [0.23, 1.14]), respectively. There was no statistically significant difference between consumers aged 30-39 and 40-49 years ($p = 1.00$). A negative correlation was found between age and the frequency of smartphone use at local pharmacies and stores ($r = -.29$, $p < .01$).

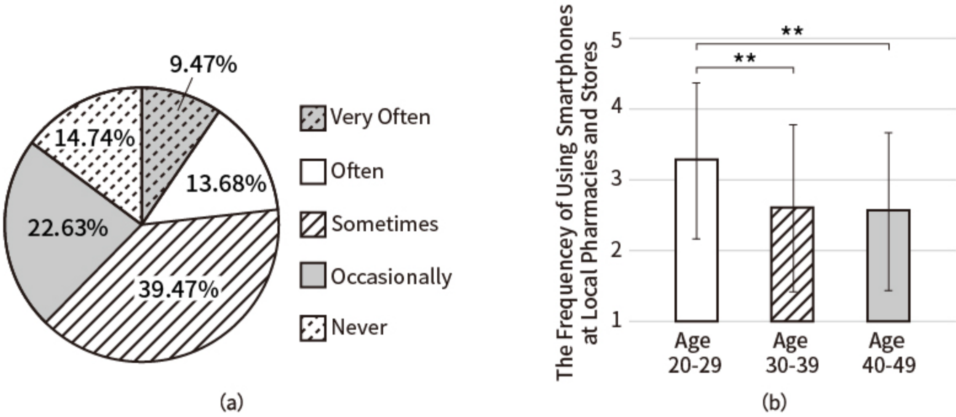

Figure 2. Results of (a) Have you ever used a smartphone to collect information when purchasing OTC medicines at pharmacies or stores? and (b) The frequency of using smartphones at local pharmacies and stores among those aged 20-29, 30-39, and 40-49 years. $^{**}p < .01$.

Furthermore, as shown in **Figure 3**, a positive correlation was found between eHealth literacy and the frequency of smartphone use ($r = .24$, $p < .01$), and a relatively weak positive correlation between OTC medication literacy and the frequency of smartphone use ($r = .15$, $p < .05$). There was no significant correlation between age and eHealth literacy ($p = .08$) and age and medication literacy ($p = .34$). Taking into account these results, eHealth literacy is more directly related to digital behavior in terms of obtaining information on OTC medicines of respondents, while OTC medication literacy is weakly related to digital behaviors. Younger Japanese consumers are more likely to use electronic devices, such as cell phones, to access relevant information at local pharmacies; however, eHealth and OTC medication literacy have no or weak correlation with age.

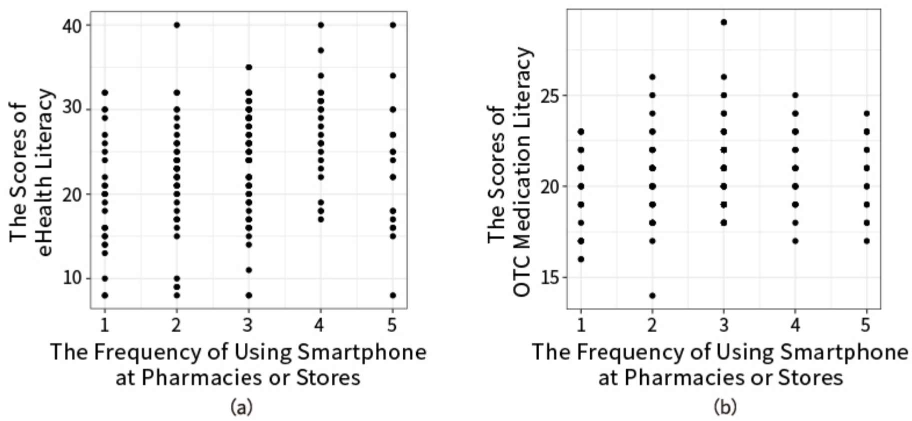

Figure 3. Results of (a) the correlation between the scores of eHealth literacy and using smartphones at pharmacies or stores, and (b) the correlation between the scores of OTC medication literacy and using smartphones at pharmacies or stores.

4 DISCUSSION

Despite prior studies surveying behaviors toward online pharmacies compared to local pharmacies, and examining the relationships between literacy and health behaviors, there have been few attempts to study the correlation between consumers' literacy and OTC medicine purchasing behaviors. Our study contributes to the literature by understanding the relationships between current OTC medicine purchasing behaviors and consumers' literacy, and exploring a new digital purchasing experience based on a digital device such as a tablet. It is a novel concept to solve potential health issues through digital devices that consider eHealth and medication literacy. However, due to the limitations of online surveys, we still need to understand how different levels of consumer literacy relate to OTC medication behaviors; how digital devices, such as tablets, can be used to improve the purchasing experience of OTC medicines also needs to be addressed in the near future.

5 CONCLUSION

The results of the present study suggest that Japanese consumers prefer to visit a pharmacy or drug store to purchase OTC medicines. They also prefer to search for information about OTC medicines on-site with digital devices such as smartphones, rather than buying OTC medicines from online stores. The digital experience of a tablet-based purchasing system would be useful and acceptable for young consumers and those with high eHealth literacy.

ACKNOWLEDGMENTS

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RELATIONSHIP BETWEEN STATISTICAL ENGINEERING AND DESIGN THROUGH KANSEI ENGINEERING
DATA COLLECTION TOOLKIT

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ABSTRACT

Both the disciplines of design and statistics have promoted projects and research with clear objectives in their field, but for the other discipline, they have been difficult or challenging to fully understand.

In design, there are a large number of projects that provoke a reaction in spectators or users as they have a spectacular scope and impact, but at a statistical level, their results add little value. On the other hand, in some of the models and applications that are often used in statistics, the requirements are highly complex and numerous. This makes it difficult to put theory into practice since experiences or experiments that are so complex and difficult to manage cannot be carried out. In addition, the subsequent reporting process for non-experts is difficult to understand due to a large amount of information as well as on poorly designed presentations at times.

After understanding the limitations that the two disciplines face, their ability to work together and turn one another's weaknesses into a more complete and holistic solution is evident. Kansei engineering is also a good example since it is a complex design tool, and the only way to advance it incorporating the use of data is through collaboration between designers and statisticians. In this paper, the Data Collection Toolkit is presented as a result of applying Kansei Engineering to unite these two disciplines including some methodologies, resources, and tools for designers for each step.

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Keywords: Kansei Engineering, Design, Statistics, Data Collection Toolkit.

1. INTRODUCTION

At times, the disciplines of both design and statistics have promoted projects and research with clear objectives within their fields, but for the other discipline it has been difficult or challenging to fully understand them. In design, for example, there are a large number of projects that trigger a reaction in viewers or users as they have a spectacular scope and impact, but at a statistical level their results contribute little value. In other words, more work is done in the expressive or artistic dimension, and scant importance is given to data or they are omitted, as well as their results at the statistical level. Therefore, these data could be used to be able to understand human reactions statistically, then translate them into concrete results to respond to design parameters or characteristics.

In some of the models and applications that are often used in statistics, the requirements are highly complex and very numerous. This makes it difficult to put theory into practice since highly complex and difficult to manage experiences or experiments cannot be conducted. In addition, the communication process for non-experts is subsequently difficult to understand because of the large amount of information – due to its complexity – as well as poorly designed presentations at times. Thus, the results do not help to address specific issues in the field of design. After understanding the limitations that the two disciplines have, their capacity to work together and turn one another's weaknesses into a more complete and holistic solution is evident.

Following this line of combining statistics and design expertise, Kansei Engineering is emerging as a tool that can bring out the potential in both fields of knowledge. Thanks to data, designers or creative teams can understand what is failing and what is perceived as positive and make corrections so the design proposal is reinforced and the solution will incorporate fewer errors since they have been detected in advance. In other words, it involves how items that can be measured to impact decisions (Deutsch 2015). Kansei Engineering is an element to take into account in the process of developing or, at times, improving a data-driven product. Data enable designers to confirm their intuition and understanding of the target audience through the results obtained from different sources, depending on the project's needs.

This article identifies the importance and relevance of the two disciplines and how Kansei engineering can establish a win-win relationship between them (see Figure 1).

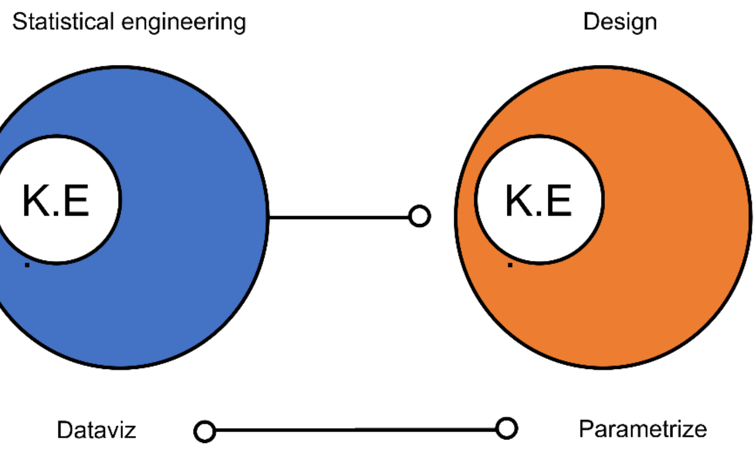

Figure 1. Relationship between statistical engineering and design, through Kansei engineering.

One of the needs that has been detected in the literature and in the practice of the two disciplines is the correct application of statistics and, therefore, the data needed to be able to use methodologies such as Kansei Engineering. This article aims to create a toolkit that details how designers and industrial design engineers can work with data at each stage of the creative process.

2.METHOD

The method used is one of the five Research through Design experimentation methods known as Serial (Krogh et al 2015). Each experiment carried out allows the basis to be framed for the next proposal and each phase generates insights and questions that allow the research to be taken forward. The Data Collection Toolkit methodologies, resources and tools for designers have been obtained through the use of various projects and research methods.

3. DATA COLLECTION TOOLKIT

Taking into account the typical phases to create an experimental design, we can observe three important phases: collection, analysis and communication (see Figure 2).

Figure 2. Process of working with data with each discipline's relevance by phase.

The following presents the Data Collection Toolkit: methodologies, resources, and tools for designers and design engineers.

3.1. Data collection

To begin the first phase, data collection (see Figure 2), the following important elements must be taken into account: the context (space and time), the sample of participants, the experimental design and its validation, and the relevant pilot tests.

3.1.1. The context

Understanding the context in which data collection will take place. This includes a good understanding of space and time, which are explained below:

The space / place:

- Assess if there is enough space to carry out the data collection with more than one person at a time, if that was the goal. Decide if the data collection is done individually or in a group.
- Think about the distribution of the participants so they have personal space among them. At the same time, interaction between the participants (a debate, joint reflection, etc.) could be encouraged if necessary.
- Assess if there is enough space to install the tools, materials, or even drinks or snacks if necessary.
- Understand the location of the participants as well as the researchers during the data collection.

Available time:

- Know if there are time limitations in order to adapt the activity.
- If there are no time restrictions, consider the approximate time allocated so you can indicate this information to the participants.
- Adapt the time spent on the different activities appropriately.
- Forecast the calibration or preparation time of the tools prior to the data collection.
- Leave a margin of time between the different activities, to minimise possible delays in the overall time.
- Organise and record a schedule with the participants' names and times.

3.1.2. The sample

Understand the sample of participants. Within the sample, the number of participants, their selection, and their roles must be understood. This information is detailed in the following points:

Number of participants: This parameter is one that can cause the most doubts among researchers. To make this selection, we recommend:

- Understanding if each test or trial involves a very high cost in terms of materials or time.
- Depending on the cost, understand the number of participants that is feasible for participating in the tests.
- Understand the budget per participant.
- If the tests are inexpensive, think about the project's timing to understand and meet the deadlines for when the data collection needs to be completed.
- Be clear about the research team that will conduct the data collection and whether the process is manual or automatic. In other words, know how many sessions data can be collected in and the personnel available. It is not same if it is a team of four researchers who can each carry out trials in different timeframes with different participants as it is with a single researcher.

- Once the above is understood, consider whether the number of people who will participate is insufficient or excessive.
- Use statistical programs to calculate the recommended sample size and statistical power.

Selection of participants:

- Indicate whether participation is voluntary or remunerated.
- Comply with data protection laws and obtain informed consent if deemed appropriate. These protocols are important as they are required elements at many research centres and for publications in scientific journals.
- We recommend randomly selecting participants to successfully gain greater statistical validity. If not, you could fall into the mistake of selecting the nearest environment, which would not exactly represent the entire population.
- Understand whether there are specific participant selection criteria for the study, whether demographic, linguistic, or more generic data such as age or sex.
- Balance the selection of participants so that the number is equal, depending on the objective of the study.

Participant roles:

- Understand their motivation and reason for participating.
- Indicate the theme of the experiment.
- Indicate the activities that will be carried out during the research and how intrusive they are.
- Be clear about the steps and what is expected of the participants so you can guide them if necessary.
- Indicate their roles and the start and completion of each activity.
- Indicate if they can ask questions and/or make comments to feel more comfortable.
- Offer space and privacy during the research and avoid putting pressure on participants and making them feel like they are under study.
- Think about and emphasise creating resources that make it possible to identify participants if you are using a study group.

3.1.3. Experimental design

We recommend for the process of creating an experimental design to consist of three distinct phases: creation, review, and pilot testing. Finally, carry out the complete realization of the experimental design. The most relevant points of each phase are highlighted below:

Creation of the experimental design:

- Consider the actions to be taken.
- Consider the paths or processes for the actions described above.
- Adapt the time and create the final schedule.

- Write down some identifying features of the participants in the internal planning, only if it functions as a support resource for the researcher. These data must not be made public pursuant to personal data protection regulations.
- Identify the necessary tools.
- Create the experimental protocol, or the steps to follow, as if it were a cooking recipe. If there are several people on the research team, it may be useful for everyone to do exactly the same in this process.
- Consider creating associated resources to save or annotate the data collection.

Review of the experimental design:

- Review the randomness of the experimental design.
- Verify if it is balanced.
- Verify if there is a control group.
- Refine the experimental design planning.
- Prepare all materials for the pilot test. Print and do the final preparation of all necessary resources for the data collection.
- Familiarise yourself with the tools and resources that will be used.

Pilot test of the experimental design:

- Select a small group to do a pilot test.
- Follow the experimental design protocol.
- Control the times participants spend in the pilot version.
- Write down each participant's observations, questions, or feedback.
- Adapt the experimental design with the detected improvements.

Complete the realization of the experimental design.

3.2. Data analysis

In many cases, the data that have been obtained in the previous collection phase must be processed and pre-processed beforehand in order to be analysed. The steps to follow for this data cleaning process are described below.

3.2.1. Data pre-processing processes

- Save and collect the files with the information with a good organisational strategy.
- Identify incidents and record them in a file or in the same data collection resource.
- If the data are physiological, include the typical processing steps: signal filtering, calibrations, noise elimination, etc.
- Transfer the data to a working and/or analysis document. Excel files can be the easiest and most common format if you work as a team.

- Understand the most appropriate way to transfer the data or if transforming the scale or applying a formula is necessary so subsequent interpretation is easier.
- Once the data have been organised, transfer them to Minitab or RStudio for analysis if necessary.

3.2.2. Data analysis

There are different types of analysis (Grima 2012) that can add value in design research. The question kit is in the research question that we are seeking to answer and in the selection of the most appropriate technique to address the initial hypothesis. The way in which the data are collected already marks the possibilities of analysis, that is, if the data are poor quality (unreliable), they cannot lead to valid conclusions no matter how sophisticated the statistical analysis may be. In addition, it is sometimes in the analysis phase itself that we reflect on the data collection and how it should have been carried out in order to answer the research question. That is why this issue must be clear from the outset of the data collection. There are different options to analyse the data and extract information from them. The most useful techniques when considering the field of design are listed below:

- Graphical exploratory data analysis techniques: An exploratory analysis based mainly on graphs can often be sufficient to provide an answer. To visualise the distribution of variables, histograms or point diagrams (if they are continuous variables) or bar diagrams (if they are categorical variables) can be used, but often the most interesting information appears when analysing the relationships between variables. If you want to see the relationship between two continuous variables, a bivariate diagram can help. Boxplots are also very useful when there is a lot of data, and the answer is a continuous variable that you want to analyse stratified by one or more categorical variables. In general, thinking about stratifying (regardless of the graph used) is always a good idea. These graphical tools also make it possible, at times, to detect anomalous values, thus helping to reflect on the reason for their presence. The detection and consideration of anomalous values can lead to relevant findings and conclusions.

- Multivariate analysis techniques. There are different statistical techniques that fall under the umbrella of multivariate analysis, but perhaps the two most useful and relevant ones for design are the principal components analysis and the cluster analysis. The principal components analysis is a technique for reducing the dimensionality that aims to find an orthogonal set of variables, called principal components, which are linear combinations of the original variables. A few major components, ideally the first two, explain a large amount of the variability of the original database. The representation of the original variables in the first two main components, the loading plot, is very practical for visualising the relationships between variables. Cluster analysis is an iterative process that makes it possible to group observations or variables so that, in the end, there are a few groups with very similar elements within each set, yet they are very different from the others. Although a simple affinity diagram is often sufficient for grouping elements, a cluster analysis can be a valuable sorting tool.

- Hypothesis contrasting to compare samples. One of the relevant contributions that the use of statistical techniques can provide to the field of design is the notion of the inevitable existence of variability. That is to say, apart from looking at the means to determine if there are differences between two or more samples, we must also consider variability to conclude whether the existing differences are important enough to be able to affirm that they are statistically significant. Hypothesis contrasting is a widely used tool to achieve this, and some of the most employed hypothesis contrasting techniques include:
  - The two-sample t-test compares means when there are two independent samples. The paired-t test compares means when data are paired, for example, when an experiment has two phases (before and after) and is conducted on the same person or the same subject.
  - One-way ANOVA is used to compare the levels of a single factor, for example, several materials.
  - Two-way ANOVA is used when there are two factors and seeing the effects of the factors and their possible interaction is of interest.

All these techniques end with the calculation of a p-value that makes it possible to quantify the risk of making an error by stating that there are differences. The concept of p-value, however, is not simple. Many times it may be more appropriate to use confidence intervals to show possible differences since the idea of an average value to which a margin of error is added and subtracted is more intuitive and enables a more understandable graphical representation.

- Regression models. When experiments get complicated, making a model that attempts to explain the response based on the independent variables of the experiment may be the best solution. In particular, the use of mixed models is appropriate in situations when working with participant data that can be considered a random factor. Although the interpretation of the models is complex, it is possible to extract the effect of the random factors so the differences between the levels of the fixed factors can be studied graphically, for example, through confidence intervals.

The selection of the software to analyse and interpret the results will depend on the objective of the study, as well as familiarity with the analysis tools. Data are often stored on spreadsheets such as Excel or Google Sheets. One of the advantages of this format is the ease in sharing results. A simple review of the values on a spreadsheet using dynamic tables and creating colour maps, or heatmaps, can provide valuable initial information about the results. However, if you want to perform more sophisticated analyses, using specialised statistical software packages is essential.

3.3. Data reporting

Reporting is found in the last phase of Figure 2. This stage is particularly important because if it is not done, all the work performed and the results remain held by a small group of professionals or experts and we are not able to fully take advantage of their potential and the true meaning of research, which is sharing knowledge. In order to report the data from the analysis, it is important to:

- Make a selection and representation of the results.
- Understand what the most important results are.
- Assess and understand the possibilities for grouping or highlighting the most relevant information. Clustering techniques may be used.
- Seek inspiration to graphically represent results on design platforms and graph creation websites. Some examples of these include: Gapminder[2],Dataviz Project[3], Dataviz Catalogue[4], Quadrigram[5],Data Basic[6], Word Art[7], Datawrapper[8], Infogram[9], Flourish[10], Kumu[11],Tableau[12].
- Understand the trends regarding current information visualisation so it is in an updated format.
- Make graphs and visual representations that are easy to understand. Keep in mind:
    - The selection of the type of graph must be in accordance with the results that will be represented in order to offer the maximum possible clarity.
    - Colour selection: remember to make reading easy for different targets such as elderly or colour-blind individuals.
    - The size of the text and the language: remember to make reading easy at a certain distance and for the target audience.
    - Try to make the graph clean with a neutral background.

[2] www.gapminder.org/

[3] datavizproject.com/

[4] datavizcatalogue.com/

[5] www.quadrigram.com/

[6] databasic.io/en/

[7] wordart.com/create

[8] www.datawrapper.de/

[9] infogram.com/

[10] flourish.studio/

[11] kumu.io/

[12] www.tableau.com/

- Save the graph in a format that can be edited, opened, or copied in good quality (at least 300 dpi) for subsequent reading and the definitive size.

4. CONCLUSIONS

The aim of this article is to propose and understand the relationship between the disciplines of statistics and design, using Kansei engineering as a basis. It is evident that the mixture/combination and union of design and statistics in each of the three phases - collection, analysis and communication - is relevant and necessary.

Therefore, thanks to the Data Collection Toolkit, the different elements which need to be taken into account in order to develop design research with a statistical basis have been presented. In each phase, these requirements and suggestions have been detailed, as well as the citation of programs and resources which are used to carry out the more technical parts of each project.

In conclusion, it is clear to observe that through this particular tool the potential and validity of pooling knowledge across disciplines has been demonstrated. This opens up a wide range of opportunities to develop new resources with value for both disciplines.

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RESEARCH AND APPLICATION OF PUBLIC SERVICE POSTER DESIGN UNDER THE BACKGROUND OF PERCEPTUAL DESIGN AND DIGITALIZATION

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ABSTRACT

Graphic language has become the information age of today's layout design concept and consciousness. The integration of design and digitization constructs the cultural ecological environment of diversified design, which makes the thinking, concept and aesthetic style of design permeate with unique cultural value. Based on the perceptual image elements under visual innovation and the communication effect of modern public welfare posters, combined with the update of media and the application and iteration of digital technology, emotional graphic elements are equipped in the design of public welfare posters. In this study, we investigated the relationship between new media literacy as an intermediary variable and the interest and confusion of aesthetic model, and the aesthetic experience of people participating in digital media art. The purpose of this study is to achieve the following research purposes: what kind of feeling can be brought about by the artistic creation of artificial intelligence, analyze whether the feeling is significantly different from that of human artists. And from the needs of the audience groups, we try to explore new ideas and design patterns of public service posters, try to break through the two-dimensional visual formal graphics, and accelerate the transformation and upgrading of traditional public welfare posters. The results show that it is particularly important

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to study the audience's psychological on the feeling and visual experience in the public service posters. At the same time, we should fully consider the perceptual elements, visual experience, and technological media.

Keywords: perceptual design, visual experience, digitization, cultural communication, public posters

1 THE MOTIVATION AND BACKGROUND OF PUBLIC SERVICE POSTER DESIGN BASED ON PERCEPTUAL DESIGN

Public service poster is a special form of artistic realization, which is rich in its unique visual expression and international graphic language. It mainly expresses the public welfare concept and public welfare information in the form of image. It focuses on the mutual understanding between readers and designers. It carries the designer's thinking and emotion from different angles. As an important carrier of social consciousness and spiritual communication. [1]In the process of public service poster design, some three-dimensional images are highlighted or constructed through lines to achieve the purpose of emphasizing and condensing images. Use imagination or creative thinking to grasp a certain point of the figure as a design motivation or a part of the drawing to focus on or enlarge highlighting the theme of the proposition, so as to achieve the artistic effect of seeing the big from the small, and better highlight the theme of graphic design of public welfare poster design. The focus or visual center described in the design of public welfare posters is that the small contains the big, the small wins the big, and the small replaces the big. It refines the creativity of the public welfare poster design of the times, and pursues a kind of simplicity and empathy.

Nowadays, we are in the global material civilization under the background of the popularization of new media and digitization, under this background, the social resources and social security problems such as environmental protection, war, ocean and public health are becoming increasingly serious, which makes people pay more and more attention to public welfare events, which highlights the strengthening of social spirit construction. It is important to establish the public welfare poster in social responsibility to spread and express public welfare in modern society. Under the condition of the integration of perceptual design elements and digital background, with the changes of the times and media: public service posters are widely used and have unique communication and historical value, which makes public welfare posters constantly update their artistic characteristics and visual performance. How to strengthen the grasp of the artistry of public welfare posters has become one of the dimensions of designers' thinking.

In many cases, it is difficult for the reader to understand the meaning of the picture without the perceptual way of expressing it. It is difficult for the viewer to find the correct meaning in this kind of poster, and it is more interfered by other complicated factors or environmental factors, which is unreasonable in this environment. The article concludes that a successful poster is a two-way combination of rationality and sensibility, and it must have two factors: sensibility and rationality. "Rationality" in poster design can be understood as: what is the purpose of making posters and what kind of significance should be conveyed. In order to achieve this goal, designers will rely on their own logic from the graphic elements used to the logic of what is the meaning of designing this poster and rely on the design system of the previous graphic design to match the most suitable graphics, and arrange these graphics closely and orderly. Through rational thinking, this logic is naturally reflected in the pictures produced by the arrangement and combination.[2] According to the color matching according to their own views on the matter this process is the emotional side of the designer, when the audience sees the pictures, they will get this logic according to the combination relationship between the graphics, and infer the meaning and purpose of the poster by relying on it. The sensibility is that the designer conceives in his mind according to a theme, finds a design motivation and brings his own emotion. The feedback of this emotion comes from whether the viewer has empathy or confusion when he sees the poster.

Public interest poster design graphics or animation process to pay attention to a point generation comprehensive, from a central point to a comprehensive interpretation of the theme of the pattern, graphics, making the public poster design animation or pattern can have great flexibility. Some excellent posters have such logic, which can't be fully understood and expressed at the initial stage. While thinking about them calmly, their meaning will gradually come to the surface. Such posters are interesting for readers. The reader seems to have solved a mathematical problem with many twists and turns, and finally got the answer in a tortuous way. The process is very fulfilling for the audience. Readers will not only get pleasure from watching, appreciate the clever idea of the poster, but also get the meaning of the poster. It is precisely because of the twists and turns of public service posters and delicate ideas that leave images and imagination in the hearts of readers this process is the combination of perceptual and rational analysis of the audience.

The author hides the answers in the pictures and allows the readers to explore by themselves. The process of interpretation is undoubtedly interactive and meaningful. This logical reasoning may be tortuous and complex, but it must be coherent and natural. To achieve a rich and colorful visual art appeal, but also in line with the theme of public welfare, to create a work approved by the audience, play a unique art publicity function of public posters. How to further improve the expression effect? It is the empathy ability in the emotional design elements and the multi visual experience of new media in the digital background as the core this is also the main difference between artificial intelligence and artificial design. From the standpoint of emotion, the combination of visual effect, scientific and technological application and aesthetic experience can achieve the perceptual publicity power of public welfare posters through the selection of elements, the selection of themes and the expression of design creativity, so as to achieve a wide range of publicity effect. AI design takes AI to generate posters as an example: it is based on artistic principles, data feedback and evaluation of image quality, the functions of image main body cutting automatic clipping, color plate automatically extracting colors, labeling pictures, etc., and then outputs a poster according to the algorithm, although it is a poster automatically generated by users based on their own needs. But in the use of elements, to a large extent, it cannot meet the user's use of all the themes. In the face of special and emotional, it is still a little bad. For the viewer's feeling, the artificial intelligence provides more rigid, too standard and not flexible.AI can improve the efficiency of some designers.)On the other hand, the design should not only meet the personalized aesthetic needs, but also meet the common spiritual needs of the public. It should be deeply expressed from multiple angles, levels and forms, and strive to integrate the tradition with the times, social morality, and information of the times, so as to form a colorful visual communication art, so as to achieve the "keeping pace" of spiritual civilization and material civilization.

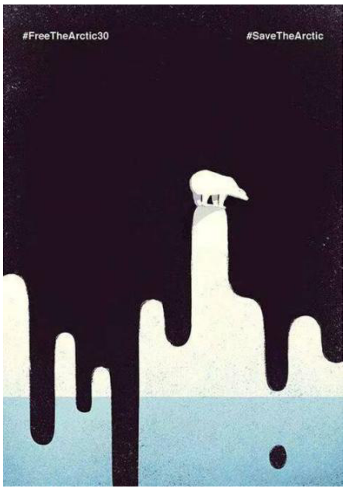

Figure 1. creative works of Italian cartoonist David bonazzi

2 THEORETICAL BASIS

2.1 Psychological intervention

It refers to the planned and step-by-step treatment of a certain object under the guidance of psychological theory Psychological activities. [2]A process in which personality traits or psychological problems exert influence and make it change towards the expected goal. Although the public service poster design in the information age attaches great importance to the mutual integration and promotion of design concepts and design technologies with international advertising media to obtain common development, as a social cultural design, it inherits the splendid traditional culture of thousands of years. Explore the reasons: in the long history of human art development, different styles, techniques and countless classic works of art are valuable resources for today's public service posters to learn from and apply. This paper studies the public service poster as a communication hub between designers and the public. In the process of public service poster design, designers always use techniques to express new theme content, or they will directly borrow the modeling image of a classic work for material transformation. On this basis, they will give it new era significance and bring new moving to the audience. From the oldest format design to the modern format design innovation, designers can not only strengthen the poster theme, but also arouse the audience's strong emotional resonance. They often use different psychological emotions brought by color to intervene the audience. For example, in the public welfare poster design with no smoking as the theme in Figure 2, red is used as the background color, which forms a strong color contrast with the shape of the time bomb connected with cigarettes inhaled in the human body and white no smoking, which further emphasizes the harm of smoking and makes people have to calm down for reflection. The realization of this effect is just the result of exerting color exaggeration and suggestive power. In the poster for publicizing music in Figure 3, the designer combines many square colors with red, yellow, green and other high-purity colors to make it more lively and lively against the gray background. The combination of guitar and color gives the audience a feeling of multi temperament, which brings a strong psychological feeling that they want to swing and jump freely.[1] This kind of visual hint makes public service posters more instructive and communicative. This paper also discusses how to embody humanistic care in the creation of public welfare posters according to the creativity of public welfare posters and the advertising language, graphics and colors of the posters. Through the research on the media of public welfare posters, we can better publicize public welfare thoughts, behaviors and activities in the form of posters. Communication is in line with the thinking mode and aesthetic mode of the public, reflecting the spirit of humanistic care. Due to the influence of digitization, the traditional single public service poster design has been unable to meet the needs of the times. The research found that while the designer reflects the creative style, he will circle himself in a specific form of expression, giving people a monotonous visual feeling. In view of this, the research found that in the creation process of modern public welfare posters, the Internet is applied, and the expression techniques are innovated. They are not satisfied with using various techniques to make the poster image more design like. They try to break through the contradiction space created by skillfully mobilizing the visual illusion in two-dimensional space, so as to make use of graphic overlap and contrast. It brings visual impact and emotional interaction to the audience, breaks through the traditional public welfare poster form, and represents the future diversification, sense of science and technology, three-dimensional and advanced sense. It tries to use a unique observation perspective, innovative thinking and unique design methods. Breaking through the contradictory space brought by the two-dimensional space, increasing the interactive experience or interesting experience between the audience and the poster, arousing the strong empathy of the public, so as to guide the strong positive energy of communication.[9]

In addition to the sense of self and self-satisfaction, Maslow also has a strong need for self-fulfillment and self-development. The more progress the public service posters are, the more civilization they are developing, the more they pursue the promotion of personality liberation, the pursuit of happiness in real life, the pursuit of freedom and equality, and the concern for people's spiritual life. Nowadays, as a part of the cultural field, public service posters can better achieve the integration and development of regional culture. Its educational function, public opinion guidance function and cultural communication function will form a diversified trend, reflecting new cultural characteristics and creative thinking methods. Through the analysis of color and psychology, this paper adds artificial empowerment to the interactive experience of public service posters, and the richness and complexity of new visual media, and integrates with the digital age to explore excellent works with interest and action, so as to achieve the audience's empathy or conscious action. From a macro perspective, this paper makes an overall thinking and summary on the information digitization and perceptual design elements of contemporary public welfare posters, studies their expression methods, contents and style characteristics, and explores the value and significance of digital era in the era of perceptual design by taking the cooperation of science and technology integration and perceptual quality and artificial and artificial intelligence as examples.[2]

Figure 2. public welfare poster of "join hands in tobacco control Gong Chuan civilization"

Figure 3. public welfare poster of the 24th International reggae music festival in 2018

Figure 4. works of modern public welfare poster design competition Figure 5 creative public welfare poster of "saving water"

Figure 5. Research and application of perceptual design elements in public service posters

2.1.1 The role of various elements in perceptual quality

The application of perceptual quality is very important in this era. The visual elements mainly include shape, size and color. Among them, form is an important aspect of shaping product image and the most important information carrier to communicate with the audience. As the most direct and perceptual element of visual elements, color transmits important information to users. In the design of public welfare posters, the emotional quality directly reflects the emotional story, and expresses the process from the designer's design to the audience's psychological production. The unity of design and the assistance of design emotion make the public welfare poster works more vitality. According to the analysis of the impact of visual elements on the audience, it is the most direct, fastest and most extensive communication of design information, and it is the instinctive response of human beings to accept external information.

The design concludes that the development and progress of visual elements is the epitome of social and cultural development or as a microcosm of continuity and historical inheritance. Both traditional cultural elements and modern cultural aesthetics have a subtle influence on design. [3]The cultural elements in design are also creative cultures, which present different styles in the process of designer's transformation and innovation. Reflecting different values and aesthetic values, the design of public service posters will become complicated and tortuous, not limited to the role of communication or publicity. With the improvement of people's living standards, more and more people have higher aesthetic requirements, which makes the design process more complicated. Not only do we need to consider typesetting design and language, but also control every step of design. At the same time, designers should continue to study hard, constantly innovate and self-breakthrough, learn new instructions, build a complete instruction system, and form a design with audience as the core. It not only satisfies the visual experience of posters, but also tends to emotional communication between people and objects. As shown in Figure 6, there is a poster with the theme of caring for human life and health. Life is the basis of a person's survival, and health is the primary condition to maintain the continuity of life. A healthy life body is the basic unit for the survival and development of human society. Therefore, the public welfare poster of caring for life and health has more profound social significance. At this time, designers will use different colors, texture, shape design to integrate, so that works can influence people's hearing, vision and touch through sound, image meaning and metaphor, so as to generate Association, and achieve the purpose of communication with the audience or improve the happiness of the audience. Moved by love, the design makes the audience feel the beauty of artistic conception, evokes the true feelings, and achieves the common feeling of empathy. The audience needs to form a complete visual system of emotional and emotional elements in the visual space.

2.1.2 Creative expression of perceptual design elements in public service poster design

With the cooperation of the above-mentioned elements, the paper also analyzes the creativity and expression forms of public welfare posters. First of all, it excavates the graphic language of public welfare poster design, and integrates the graphic image in multi-dimensional space, and makes new use of traditional graphic elements through the use of specific graphics, abstract graphics, and so on Intentional graphics and other forms to express personalized graphic creativity, showing the world's truth, goodness and beauty and the conscience between right and wrong. The purpose of public service poster design is to publicize some social problems, guide the public to pay attention to it, and cause deep thinking. Therefore, in terms of visual impact, it puts forward higher requirements for public welfare posters. A successful public welfare poster design should be full of appeal and social appeal. It can bring instant visual impact to people, and at the same time, let the audience quickly capture the poster information, produce resonance or thinking, through which to exaggerate the society or show the public. On this basis, the application of modern photography technology, as well as the endless expression of language, not only improved the exhibition of public welfare posters, but also further improved the audience's aesthetic cognition and vision. Under this function, graphic language has become an important form of communication between people in modern society. It has the characteristics of image, intuition and concrete, and is isomorphic to the language of "graphic photography". [3]This special form of language expression has also been highly concerned by designers. In the graphic language, personalized graphic creativity has become increasingly prominent, enhancing the publicity effect of public service advertising. As well as its appeal and affinity. [2]According to the concept of "isomorphic graphics", in the process of designing public welfare posters, we should refine and simplify the specific image of things, and integrate them into the poster to form a unique poster creation form. Through comparative analysis, combining with the propaganda content of posters, we can process and refine things to achieve simplicity and shape. It is concluded that: first of all, the simplified design of graphics should be carried out. In the process of personalized creation, the complex objects should be presented concisely, and the visual effect, accurate and fast information should be considered. Finally, the theme content of public welfare posters should be presented with the help of geometric figures and symbolic expression techniques. The combination of abstract personalized design and symbolic expression can enhance the rhythmic sense of posters and leave infinite space for the audience to imagine.[4] The study further found that with the cooperation of specific graphics and abstract graphics, the use of intention graphics will be more novel. The intention graphics mainly show the style of generalization but not abstract, and realistic but not completely realistic. The application of intention graphics in public welfare posters can enhance the creative color of posters and give people a bright visual effect. It can maximize the expressive color of the poster and let the audience experience the emotional expression of the poster, which is meaningful and interesting for the audience.


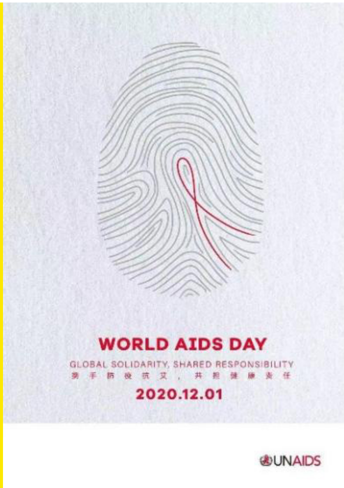

Figure 6. winning works of Italian good 5070 public welfare poster in 2010

Figure 7. public welfare poster of fighting new crown pneumonia in Bangladesh, China in 2020

Figure 8. international public service poster for World AIDS Day 2020

2.1.3 Application of dynamic graphics in perceptual design elements

As a new design form, dynamic graphics has become a new and important research object in information dissemination and visual design. Dynamic composition is produced with the emergence of dynamic visual design.[2] It is a composition rule based on the development needs of digital media. Its composition, development and supplement are more in line with the development of today's design. Through the investigation, it is found that the comparison between static graphics and dynamic graphics, the analysis and analysis of dynamic design, the dynamic forms of color composition and the law of information dissemination make the concept of dynamic graphics clear, the graphics and dynamic effects are improved, which is more convenient for the integration of various styles and regional cultures, which not only improves the spatial dimension. The dynamic elements of time are also dynamic. According to the perceptual design elements, dynamic graphic cooperation is carried out to maximize the amount of information, interactive experience and intelligent wearable hardware devices. In the current form, it is a visual form that conforms to the current digital media environment and people's aesthetic requirements, and plays an important role in widely used and different media. As a new visual form, it is also a new tool dynamic graphics. Now the dynamic graphics are gradually mature, the article will continue to explore its more meaningful and thinking expression in the meaning of dynamic graphics. At present, designers all over the world are still experimenting and researching dynamic graphics, and will explore more forms of expression or application in more fields in the future. Standing on the shoulder of the new era, the mobile Internet, as the fastest growing and most competitive field in the information industry, has become the main media of information dissemination. As well as the mobile Internet, which takes the latest network technology and communication technology as its powerful technical support, constantly supplements the vacancy of the Internet, develops new fields and develops together with the background of the times. Based on the development of the Internet, the continuous improvement of network coverage and network transmission speed, and the continuous application of digital media, under the co editing of digital media and perceptual quality, the digital platform of visual design has realized digital or multi-dimensional transformation, which also makes it possible to integrate more factors and various forms of technical expression into the design process. Therefore, the perceptual design elements are more in line with the visual expression form of the digital context of information dissemination. In the future development, the perceptual graphics will become an inevitable development trend.

Figure 9. Greenpeace public welfare poster work

Figure 10. Brazil deran RN motorcycle riding safety awareness publicity public welfare Poster

4 THE PERFORMANCE OF PUBLIC WELFARE POSTER DESIGN UNDER THE DIGITAL BACKGROUND

4.1 Social perspective

Culture cannot be replaced by visual language. The change of people's aesthetic needs also promotes the innovation and development of cultural elements. With the progress and development of the digital age, various information technologies emerge in endlessly. Different organizations, regions, countries and so on will extract the initial elements of social hot events and hot topics when they design public service posters. The development trend of national economy is developing in a good direction, and the scene presented by the society is more and more prosperous, followed by the collision between traditional culture and foreign culture. How to inherit and develop traditional culture, avoid cultural estrangement and achieve cultural coexistence has become the hot spot of public interest poster design performance in the article.

In the process of development, it is found that choosing the theme of public welfare posters from the social dimension is more in line with the nature of public welfare and social requirements. Secondly, in the form of the public, it plays a key role in the public's correct understanding of the current social thinking. It usually has the significance of arousing the audience's reflection, warning, promotion and supervision of a thing. Excellent works are like a mirror. Relatively, it reflects the needs of the people's material and spiritual life, which can arouse the feelings of the whole people. The other half also plays a positive role in promoting the harmonious and healthy development of the whole society.

4.2 Creation and expression

Take China as an example: from collage art, new Chinese art, children's graffiti art, documentary photography art, the four major techniques used in the art form of public welfare poster design to combine with digital design of public welfare poster. With the development of the times, the technology has been constantly updated and iterated, but the most essential connotation has not changed, but the difficulty of creation has changed. It shows that there are many ways to create public welfare posters. The same theme, different artistic expression, and ultimately get different visual effects. In the process of design, designers integrate their own emotions, jump their ideas on paper, integrate new ideas and novel design methods such as extraction, segmentation and reconstruction into graphic elements. After the thinking of the viewers, this work is more meaningful, which is the core of public service posters. In the process of the new digital media entering into various fields of the public's daily life, it is hardly noticed and can't get rid of it. [9]From short video to interactive video in the Internet, we can make use of all kinds of video in the Internet to create a new interactive video for the public in Europe and the United States. It can be said that digital visual communication has subverted the traditional form of visual communication, and has become a kind of consciousness existing in the public mind. As a very typical branch in the field of visual design, this long-standing visual communication form is also facing the change of the new era in this period of technological change, With the help of computer technology, network digital media and interdisciplinary integration, poster design presents a new trend of diversification, dynamic and comprehensive.

4.3 Design elements

Public service posters are rich in too many social ideals, among which the elements are: theme, color, text, shape, proportion, it is a combination of these elements. Therefore, how to make a public welfare poster appropriately reflect its design connotation, this paper discusses the design elements of the poster. First of all, the design scheme should be life oriented, which is the communication that the public needs most. This communication is silent. Through the creation of the design process, it makes the audience have emotional contact or achieve emotional interaction.

The early posters mostly fed back some war information and how the people viewed the war. For example, a work from Fukuda fan xiong: "victory in 1945", which is an Anti War Poster (poster), adopts the expression technique similar to cartoon to create a simple and humorous graphic language. The description of a bullet returning to the barrel is of warning significance to satirize those who started the war.

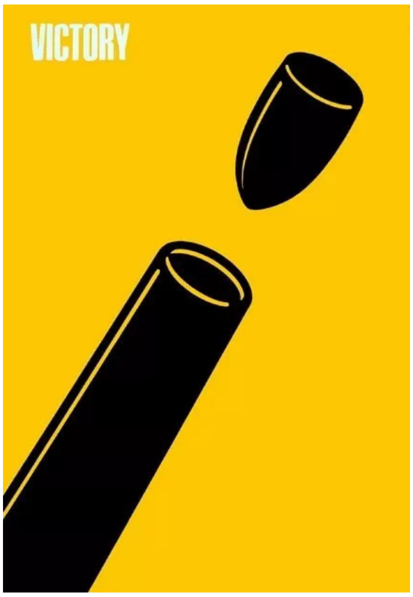

Figure 11. victory in 1945 by Fukuda

5 ON THE FUTURE DEVELOPMENT OF PUBLIC WELFARE POSTERS

In the modern information society, the huge amount of information has bombed almost everyone's life. It is too simple and inflexible, lack of emotion, just using a certain template rigid set of public welfare posters lack of innovation and artistic beauty, which is also the article attempts to explore or achieve better works through the integration of the above multiple elements.[8] In recent years, the excellent public service posters are not good and bad. In the face of the fact that most public service posters are too formalized and lack of creative breakthrough, the designers' creative style is not clear and unsightly, and even fall into the stereotype. The creative consciousness still stays in the low-efficiency propaganda of illustrations, big character newspapers and slogans, which is empty and shallow, so it is difficult to speculate and deliberate. The article has carried on the further research to these media problems. Based on 5G long-distance and fast transmission of multimedia public service posters, the carrying force of public welfare posters will become greater, that is, from the former paper posters to the present dynamic electronic screen projection posters, and even more forms of expression may be available in the future, such as modern holographic projection VR and other interactive public welfare interactive posters. [6]This interactive public service poster, to a certain extent, enables the audience to break the traditional concept of specific place and time limit, and can participate in the public welfare poster, together with other elements as a part of the public welfare poster design, so as to achieve the interactive combination of the audience's consciousness and the public welfare poster. In order to form a more complete work expression, to a greater extent, enhance the sense of immersion and substitution between the audience and the poster, so that the public service poster with a more correct concept of promotion, more efficient for the audience to bring rich experience, from the initial perspective of posters to interactive experience, which is also the core and breakthrough in the current research. This paper uses the concept of "science and technology to change life" to reflect the branches and important components of the design of public welfare posters. It not only pursues the attention of the audience, but also serves as a further communication tool (including designers and audience, audience and social groups), so that the public service poster works get more powerful support and development, and are combined with digital media art to expand continuously. Make public welfare cause radiate new vitality.

6 EPILOGUE

The art trend of public service posters is a very important trend in the development of public posters. The focus of public service poster design has also changed. From a macro perspective, this paper makes an overall reflection and summary of the information digitization and perceptual design elements of contemporary public service posters, studies their presentation techniques, contents and style characteristics, and takes the cooperation of science and technology integration and perceptual quality as an example. Explore the value and significance of digital age in the era of perceptual design. [7]The ecology of design makes us reexamine the theoretical significance of public service poster design. Through the application of various media and the development of science and technology aesthetics, we can promote the research on the richness and complexity of new visual media communication under the background of digital technology, and excavate the new development direction of public welfare posters. In the integration and development of perceptual design elements, perceptual extension or different regions, the full communication of different cultures is the development of graphic information communication towards personalization, diversification and interaction. In the face of social and natural phenomena that deeply trigger spontaneous "soul", public service poster design has become the best way for designers (audience) to "voice" and become an important carrier of communication between designers and big culture. In this paper, with a unique perspective and personalized creative techniques, the public welfare posters are endowed with unique cultural and artistic values, in order to pursue the strong artistic appeal and interactive interest of public welfare posters.

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RESEARCH ON THE ATTRACTIVENESS OF INTERNATIONAL EXHIBITION CULTURAL PRODUCTS : A CASE STUDY OF ART MUSEUM IN TAIWAN

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ABSTRACT

In recent years, due to the active development of cultural and creative industries in Taiwan, cultural elements in exhibitions are often used in product design. Generally speaking, cultural and creative design elements exist in ordinary life and can be found in specific life. Although Tainan Art Museum in Taiwan aims to promote local art, it introduces a special exhibition of Japanese contemporary artist Yoshitomo Nara for the purpose of promoting modern art. Taking this special exhibition as a case, this research aims to analyze the attractiveness of the commodities in transnational exhibitions and discuss the essential spirit of the intercultural commodities. The research results put forward four attractiveness, that are practical feeling, satisfied feeling, mysterious feeling and unique feeling, for the formation of museum cultural commodities, can be used as a reference for the future product development and selection of art museums.

Keywords: *Art Museum, Miryoku Engineering, Evaluation Grid Method, Cultural Product*

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1 INTRODUCTION

After seven years of preparation, the Tainan Art Museum officially opened in 2019. It is the first administrative legal person art museum among the more than 500 museums in Taiwan today. The important purpose of this museum is to promote Taiwanese art, so most of the permanent exhibitions are curated by local artists. The introduction of the "Yoshitomo Nara" Special Exhibition by the Tainan Art Museum in 2021 is the first large-scale exhibition of foreign artists. The purpose of this study is to analyze how local Taiwanese museum souvenir shoppers have different choices of thinking and the formation of purchasing decisions when purchasing cross-cultural themed exhibition goods. In order to understand buyer's thinking before, during and after the visit, this study uses qualitative interviews and EGM (Evaluation Grid Method) for analysis.

2 RESEARCH BACKGROUND

2.1 Museum and Cultural Product

The traditional curation is that the museum states the historical context of the artwork, creates a specific atmosphere, highlights the splendor of the artwork, and then provides visitors with a wonderful visiting experience. British museologist Hooper-Greenhill (1999) once pointed out that museum exhibitions in the past were a kind of "indoctrination teaching method", while in recent years exhibitions are considered to be neutral communication media, the knowledge transmitted is not discovered, but is created. In response to this change, Hooper-Greenhill (1991, 1994) proposed that the audience's learning of knowledge through exhibitions is a process of active construction. The process is based on the audience's daily experience and is related to different cultural backgrounds. Therefore, the audience is no longer a passive recipient of knowledge, but an active producer of meaning and knowledge. Therefore, the knowledge acquired by the audience through the exhibition is no longer limited to specific knowledge. What matters is how to feel during the visit, or to notice some things. By promoting the audience's ability to create and interpret meaning, the functions of the exhibition will become more diverse and broader. Just as the activities held by museums around the world are becoming more and more diverse, museums now play a role in commercial development and cultural promotion.

From the perspective of museum shops and museum goods, the relationship with the environment is the closest. The behavior of the audience visiting the store will affect their environmental experience, and Falk & Dierking (2001) also pointed out that for the environmental context of the museum experience, the exhibits and explanatory signs have the greatest impact. After all, objects are the essence of museums. Even if some institutions do not focus on objects, such as science centers and botanical gardens, they still have the characteristics of "displaying objects" and are superior to other learning institutions or media. Therefore, the conceptual transformation of objects and the continuation of display have become important issues for how museum merchandise balances commerce and education. For the audience, museum stores provide people with the opportunity to buy souvenirs, educational materials, and books while also learning more about what they see in the museum (Dickman, 2002). At the same time, people's feelings about objects can be generated through learning and accumulation of experience. Every time they encounter museum goods, they increase the chance to meet the message that the museum wants to convey. In addition, the museum shop sells reinterpreted artworks, so that visitors can take the merchandise home as a souvenir after visiting the museum, so that they can continue their wonderful experience of this visit. At the same time, it also provides a useful or pleasant memory for the museum visit experience (Dickman, 2002).

2.2 Tainan art museum in Taiwan

"The establishment of an art museum not only marks the benchmark for the cultural level of the city and the country, but also becomes the backbone of the city's development; a great cultural city often accelerates the vigorous development of local art because of the establishment of an art museum, and the artistic atmosphere further drives the development of the city. The overall progress of urban life quality, tourism and industry cannot be underestimated (Chen Huidong, 2018: 246)."

After Tainan was officially upgraded to a municipality directly under the Central Government in Taiwan, the Tainan Art Museum was planned. It is the first art museum with an administrative legal person in Taiwan. Its mission is to deepen the value of local art, consolidate the cultural identity of citizens, and connect with the pulse of world trends. After seven years of preparation, Tainan Art Museum officially opened in 2019. Tainan Art Museum is located in the Central and Western District of Tainan, surrounded by the densest historical sites in Taiwan. It is the most suitable venue for promoting cultural tourism. The museum also positions itself as a showcase of urban culture, opening up an artistic connection between local and international.

Tainan art museum has two halls, Hall 1 was originally a designated historical site in Tainan City: Tainan Police Station, completed in 1931, designed by Japanese technician Umezawa Yajiro, it is an Art Deco style building, with a moving chapter mural at the top of the front gable and step frieze are important decorative styles of modern Japanese architecture. The main building is symmetrical on the left and right, and the outer wall is made of bricks with thirteen grooves, and the grooves are clear and three-dimensional.

2.3 "Yoshitomo Nara" Special Exhibiton

In 2021, on the tenth anniversary of the 311 earthquakes in Japan, Japanese contemporary artist Yoshitomo Nara cooperated with the Japan-Taiwan Exchange Association and the Chinese Culture Association in order to thank Taiwan for donating masks to Japan during the epidemic, as well as for donating and helping during the Great East Japan Earthquake. Under this, for the first time across the sea to Taiwan to launch a personal exhibition.

His works include "Miss Moonlight" in 2020, which was exhibited overseas for the first time. It depicts the calmness in the face of life's hardships and the peace of mind that is healed. The latest work "Hazy Humid Day", which took several months of preparation and took about ten days to calmly create with Taiwan as the inspiration, is not only dedicated to Taiwan that has visited many times, but also to persistent efforts. The best inspiration I have created so far. "Slight Fever", which was also exposed overseas for the first time, is significantly different from Yoshitomo Nara's past works. He painted a slightly more mature appearance than the previous little girls and was able to realize that this was something that could be overlooked. A perspective on self-development.

3 METHOD

3.1 Participants

A total of 5 respondents were interviewed in this study. In order to eliminate occasional impulsive shopping behavior as much as possible, the respondents have more than 10 years of experience in visiting museums, and the number of visits per year is between 10 and 20 times, and they regularly purchase museum souvenirs. habit. The number of souvenirs collected is more than 30 and can describe the views on the products and the reasons for purchasing them in detail.

3.2 Evaluation Grid Method

Miryoku Engineering was researched by Japanese scholars Junichiro Samui and Masaolnui in 1985 by referring to the concept of clinical psychologist Kelly in The Psychology of Persona Constructs. In 1998, the Japanese Kansei Engineering Society was established, and Miryoku Engineering was incorporated as a part of it. It is a holistic and socially functional influence, not a single-functional force produced by a certain part (Ma 2010). It can be seen that charm is a kind of attraction, which originates from the performance of personal character and behavior, is the stirring and conveying of emotions in interpersonal interaction, is a psychological state with power, prestige and admiration, and is also a comprehensive performance of a person's multi-faceted abilities (Zhuang XZ,2009).

Miryoku Engineering was initiated in 1991 by a Japanese scholar Masato Ujigawa, who brought together a number of scholars, with the aim of creating attractive products, space technology and knowledge. In various research of Kansei Engineering, in-depth interviews with respondents can be used to learn the respondents' preferences and feelings about various things, and reading image stimulation according to the theme can make the respondents feel There are obvious guides to let the subjects express their thoughts and concepts about things, so that the respondents can make a clearer analysis.

Evaluation Grid Method (EGM) is a method that is improved by individual construct method (RGM, Repertory Grid Method) and is helpful to deeply understand the subject's psychological cognitive level of a certain thing. Sanui (1996) took this approach a step further.

First, in the evaluation of the target object, the respondent needs to answer his likes or dislikes for the object. The second step is to clarify the meaning or conditions of the respondents' answers through additional questions, to summarize and then answer, to specifically analyze the attractive factors of the product for consumers' preferences, and to sort out its related content to construct a network. This research method says for the evaluation construction method.

By reinterpreting the interview data, it can be presented in the three-level structures of abstract reasons that are (Imai 2009):

1. upper level: abstract value judgment, original evaluation items.

2. middle level: perception understanding, and specific conditions.
3. lower level: objective and specific understanding.

3.3 Procedure

EGM provides a specific method for analyzing the attractiveness factors of things with theoretical basis. In order to know the attractive feeling of the interviewee for the product, it provides stimulation according to the scope of the theme in the form of in-depth interviews. Knowing the subjects' original concept of the subject stimulus, and then guiding the subjects to make a clearer analysis of their concepts, and then extending the concept into two items: concrete reasons and abstract feelings, and sorting out the real thoughts of the subjects.

Evaluation construction method operation process:

1. Preparation of the interview, prepare the relevant charts used in the interview.
2. Start the interview.
3. Ask each subject to pick out the picture card he likes from the picture cards.
4. The selected picture cards that the subjects like are grouped according to the subjects' preferences
5. Ask the subjects to explain the reasons for the groups (the reasons for differences or liking) according to the order of the groups and establish the Original evaluation item.
6. According to the Original evaluation item, further inquire about the lower level (concrete image) and the upper level (abstract concept).
7. Completion of evaluation structure.

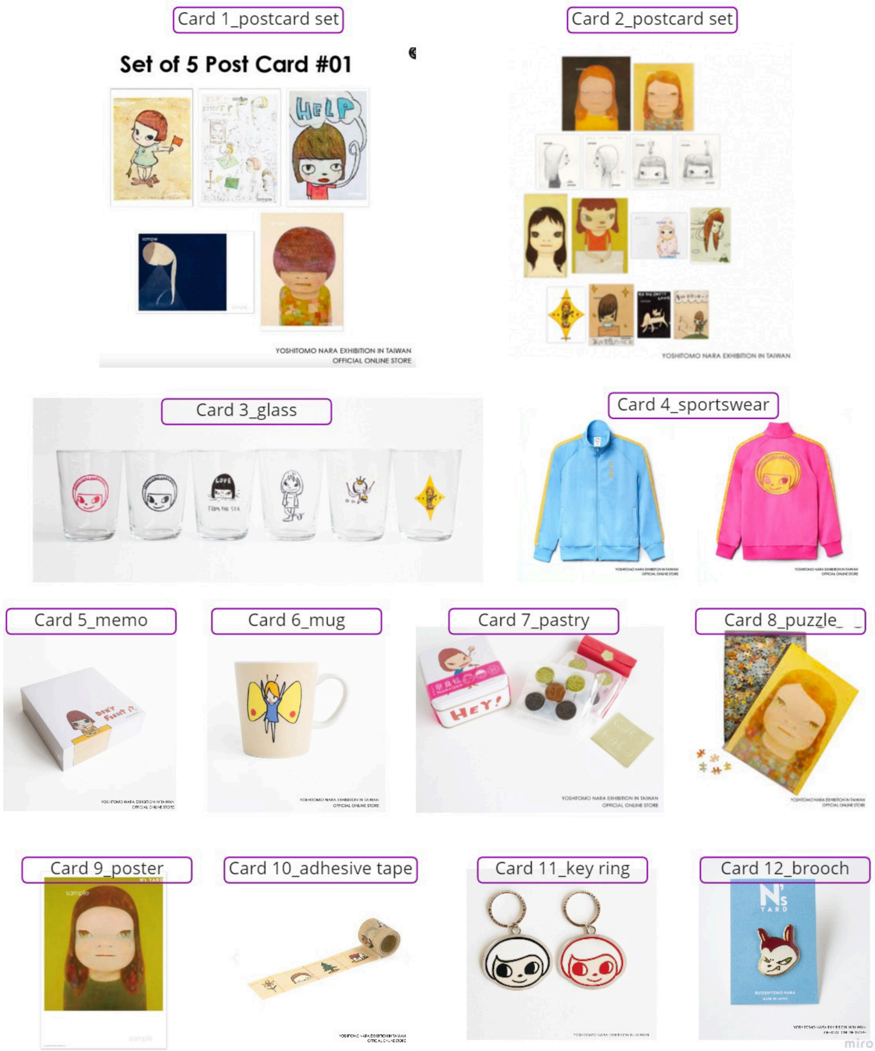

Figure 1. Cards shown to interviewees

4 RESULT

In order to distinguish the context how local Taiwanese museum souvenir shoppers have different choices of thinking and the formation of purchasing decisions when purchasing cross-cultural themed exhibition goods. The result aggrandizes Evaluation Grid Diagram in "Yoshitomo Nara" Special Exhibition which contends preparation before the visit and experience during the visit.

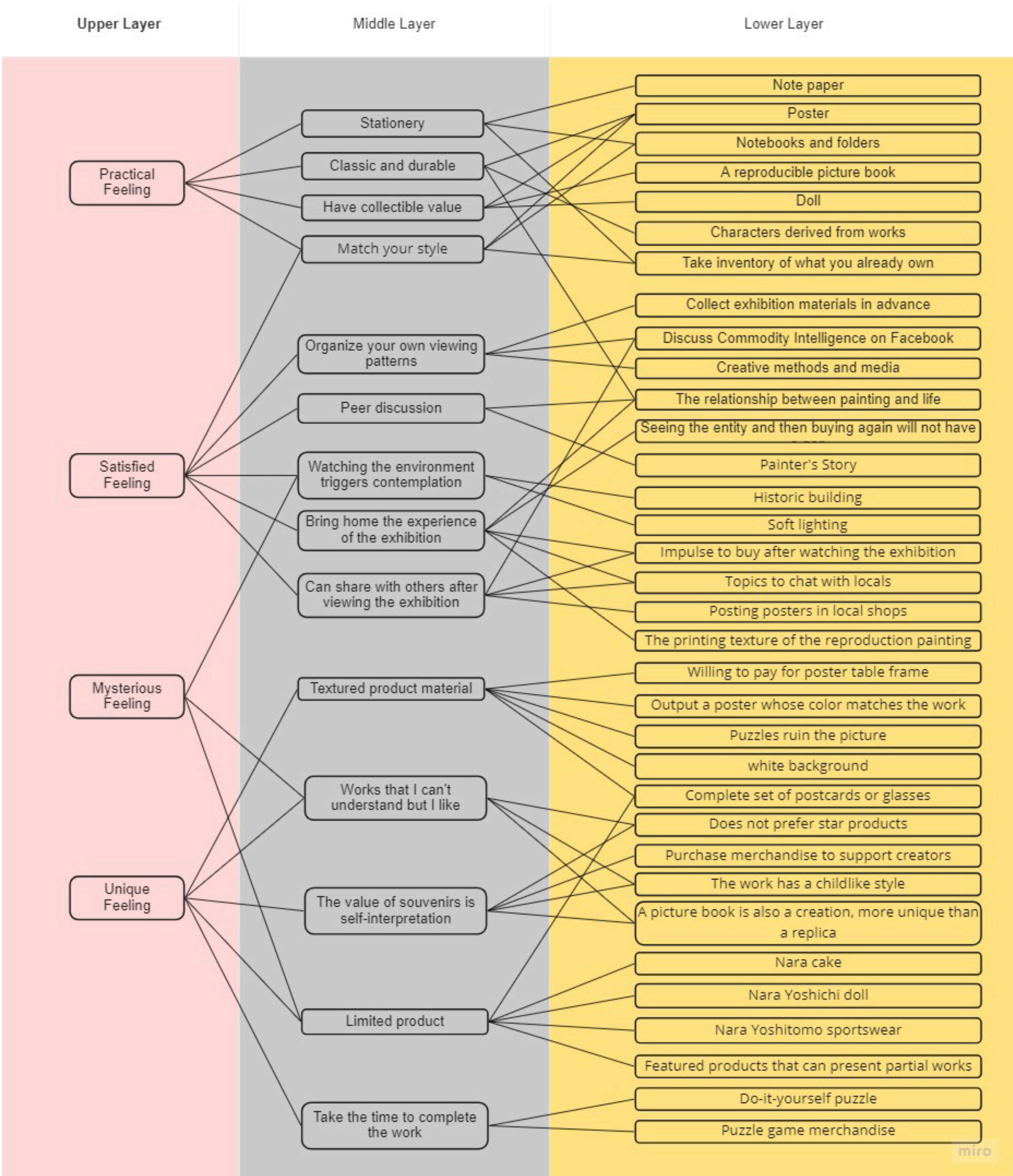

Figure 2. Evaluation Grid Diagram of “Yoshitomo Nara” Special Exhibition

In terms of the qualifications of the experts interviewed in this research, the scope of this study is to explore how the art museum develops attractive products for senior audiences with long-term visiting habits. The target group of such products is different from the general tourists who are rushing through the show. They are not necessarily low-priced products or gifts for relatives and friends, but for the purpose of forming self-awareness and cherishing visiting experience.

Commodities that can bring a sense of practicality, such as calendars, notebooks, pens, and folders, are the objects repeatedly mentioned by the interviewers, and are also very common cultural and creative commodities. Taking the sense of practicality as an example, as the experience of buying museum goods increases, the audience gradually knows that they are impulsive about which items to buy, try not to buy the same type of products with low usage rate or already owned, and shop with friends. In this case, it is more likely to trigger such rational thinking.

All five respondents said they have the habit of collecting exhibition materials in advance. In the face of such a famous exhibition as the Nara Yoshitomo special exhibition, the souvenirs of the special exhibition itself have topics and are also available for sale on the official website, plus the photos shared on the social network, so compared with other exhibitions, visitors have more online resources for understanding products. When visitors select products, they are actually confirming the pre-prepared materials in the entity. During the visit, they like to construct their own routes. Coupled with the atmosphere of the exhibition hall, this unique feeling will be connected to the appearance of souvenirs. Therefore, they will not necessarily choose the images of well-known works but choose the ones with special feelings. Works, taking such products away, have important functions of self-affirmation and future social sharing, bringing satisfaction.

As the purchasing tendency of social function, respondents are obviously familiar with the permanent exhibition of Tainan Art Museum. When choosing gifts, they tend to choose objects that describe daily life, such as Taiwan street scenes, traditional markets, etc. It is a shared life memory. However, when faced with cross-cultural themes, visitors must rely on their own experience and art appreciation ability to understand the paintings, which will bring a unique feeling different from viewing local art. As the experience of visiting exhibitions increases, audiences begin to have their own style of interpretation and viewing of works. When they can disassemble the elements of creation, such as lines, colors, materials, etc., the more they can accept products that only show partial works, rather than the entire work should be fully exposed. For them, local features can better highlight the painter's style, and by selecting such products, they can show their uniqueness.

In conclusion, the attractive factor of cross-cultural exhibition products does not only exist in the form of the product itself. From the interview results, the purchase decision is formed before the visit, and through the viewing process, the audience forms a unique sense and a sense of satisfaction, think rationally about practicality when in the store.

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RUNNING SHOE DESIGN SYSTEM WITH ARTIFICIAL BEE COLONY METHOD USING GAZE INFORMATION

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ABSTRACT

To retrieve multimodal candidate solutions for real users, we investigated the effectiveness of an interactive evolutionary computation (IEC) method with an artificial bee colony (ABC) algorithm. Using three types of bees (i.e., employed, onlooker, and scout bees), the ABC algorithm retrieves various candidate solutions. Our previous study showed the effectiveness of the IEC with the ABC algorithm while looking at various practical IEC parameters from a numerical simulation using a pseudo-user that imitates user preferences. The results showed that the IEC with the ABC algorithm could retrieve more multimodal candidates than the interactive genetic algorithm (IGA), the previous chief method of IECs. However, we did not examine the effectiveness of the IEC with the ABC algorithm for real users. In this study, we performed experiments to examine the effectiveness of the IEC with the ABC algorithm for real users using running shoe designs as an evaluation object. The investigations compared multimodal candidate solutions using the IGA method as a comparison tool, retrieving the performance of both methods. To evaluate candidates, we employed user gaze information to reduce user evaluation loads. The results showed that the evaluation time for evaluating candidates of the IEC with the ABC algorithm was shorter than that of the IGA method. Moreover, we confirmed that the IEC with the ABC algorithm could retrieve more multimodal candidate solutions than the IGA method.

Keywords: *Artificial bee colony, Interactive evolutionary computation, Multimodal retrieval*

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1 INTRODUCTION

Internet shopping has recently gained popularity worldwide. There are numerous goods, contents, and services on the Web. Therefore, Internet users must watch various goods and use keyword retrieval to find the goods they want.

The interactive evolutionary computation (IEC) method is useful for solving such a problem. The IEC method is a technique that optimizes and retrieves candidate solutions using the Kansei information of users (Takagi, 2001). Systems using the IEC method include the music generation systems (Yamaguchi & Fukumoto, 2019) and big data searching support system (Hao et al., 2017), among many others.

IEC systems usually use a genetic algorithm (GA) for evolutionary computation (EC) operation. The GA performs a unimodal retrieval that globally searches for a single goal. However, real users have multimodal preferences for various objects (e.g., clothes and music). Hence, an IEC system must have unimodal and multimodal searching performance.

To widely search candidates, IEC systems must use an algorithm that performs multimodal searches and simultaneously retrieves candidate solutions. The multimodal retrieval can present various candidate solutions and satisfy user preferences. This method is effective for product recommendation on the Internet because it considers users' preferences multidirectionally. To apply the multimodal retrieval of candidate solutions to an IEC method, our previous studies used a parallel interactive tabu search (PITS) algorithm with multiple tabu search (TS) retrievals and a hybrid GA–TS algorithm (Domae et al., 2013; Takenouchi et al., 2019a). However, the PITS algorithm generates multiple TS retrievals simultaneously, retaining those with a higher user evaluation and deleting those with a lower user evaluation. Therefore, the PITS algorithm is complicated and cannot simply retrieve candidate solutions. The hybrid GA–TS method performs only a single TS search during GA searching. If a user has multiple preferences, this method retrieves only approximately two kinds of candidate solutions.

To address this challenge, an artificial bee colony (ABC) algorithm is applied to the IEC method for retrieving multimodal candidate solutions. The ABC algorithm is a swarm intelligence method, which effectively optimizes multivariable and multimodal functions (Karaboga, 2010). It has three types of bees, namely, employed, onlooker, and scout bees, and searches for multimodal candidate solutions using these bee collaborators. Previously, we investigated the effectiveness of the IEC with the ABC algorithm from the viewpoint of multimodal retrieving of candidates via numerical simulations with the pseudo-user that imitates users' Kansei evaluations (Takenouchi, 2021). This work showed that the IEC with the ABC algorithm could retrieve candidates more multimodal than the conventional IEC with the GA method. However, we did not investigate the effectiveness of the IEC with the ABC algorithm for real users.

Therefore, in this study, we investigate the effectiveness of the proposed system for real users using evaluation experiments that employ the proposed system with a running shoe design system. The proposed system evaluates candidate solutions using users' gaze information, which reduces user evaluation loads. The experiments examine performance comparisons with the compared system that employs the GA method.

2 PROPOSED SYSTEM

2.1 Schematic of the proposed system

Figure 1 shows a schematic of the proposed system. First, at the employed bee phase, it randomly generates the initial candidate solutions. Each employed bee randomly selects a candidate solution from the initial candidates and generates a new candidate solution. Then, a user evaluates (only views) the candidate solutions, including the initial and randomly generated candidate solutions of each employed bee. Then, the ABC algorithm compares each for each employed bee's initial candidate solution with the newly generated candidate solution. It selects a candidate solution having a high evaluation value as the selected candidate solution of the employed bee.

Next, during the onlooker bee phase, each onlooker bee uses the evaluation values of each candidate solutions to select a candidate solution with a high evaluation value and counts the number of selections for every candidate solution.

Finally, during the scout bee phase, each scout bee replaces the candidate solutions that reach the upper limit of the selections for each onlooker bee with newly generated candidate solutions. However, if there is a similar candidate solution with a similarity of 80% in the retrieving record, it regenerates new candidates. Additionally, it generates a neighboring candidate solution for each candidate solution, which is less than the upper limit. It also generates a neighboring candidate solution for retrieving records, with fewer retrieving counts. In the next generation, the system uses these newly generated candidates and neighboring candidates. Then, the system presents these new candidate solutions again and repeats the operations of the ABC algorithm.

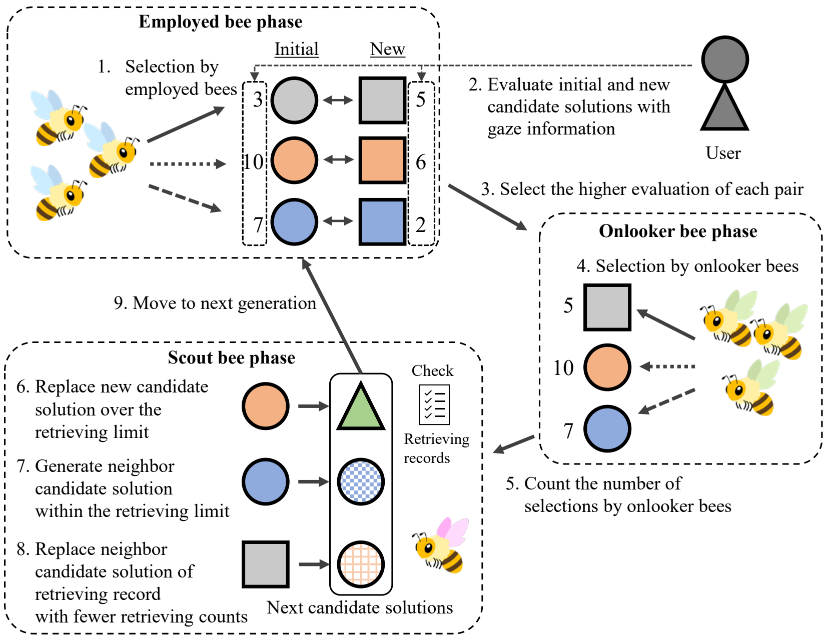


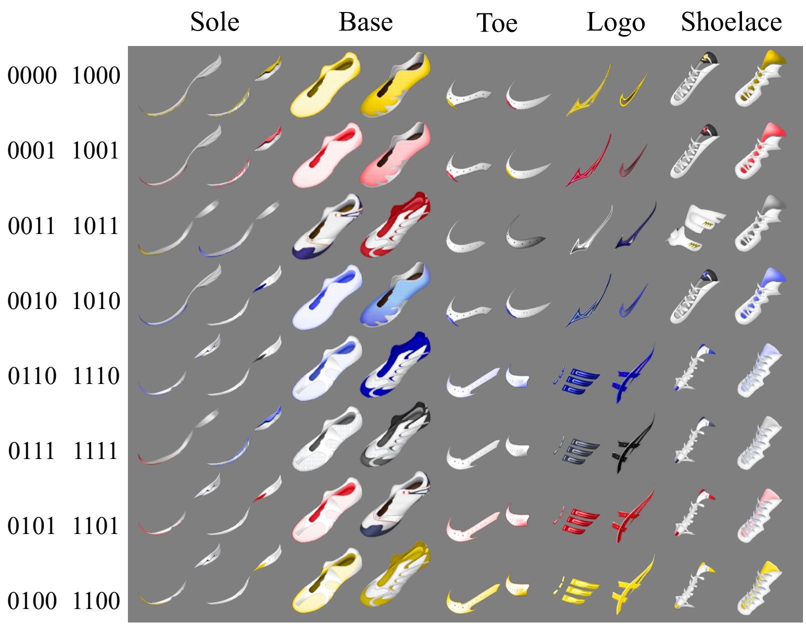
Figure 1. Schematic of the proposed system

The proposed system similar to our earlier work, evaluates candidate solutions based on user gaze information (Takenouchi & Tokumaru, 2019b). We use a Tobii Pro X2-30 (Sampling rate: 30[Hz]) eye tracker for measuring user gaze information. The proposed system counts users' gaze positions while viewing candidate solutions and uses gaze position counts to evaluate each candidate solution. The candidates with higher (lower) gaze position counts are assigned higher (lower) evaluation values.

2.2 Running shoe design

Figure 2 shows the gene coding of the running shoe design and part designs. The running shoe designs are identical to those in our earlier study (Takenouchi & Tokumaru, 2019a). The design consists of five parts: base, logo, shoelace, sole, and toe. Each part has 16 (= 2^4) designs. Therefore, the gene length is 20 bits, and the proposed system can generate approximately 1 million (= 2^{20}) designs. In Fig. 2(b), we assigned a bit pattern to each design by considering the similarity between the design appearance of each part and gene rows.

(a) Design structure



(b) Part designs

Figure 2. Running shoe design

2.3 Evaluation interface

Figure 3 shows the evaluation interface of the proposed system. The initial candidate solutions in the first generation and the higher scored candidate solutions in the previous generation after the second generation are represented by five designs on the left side of the interface. The five designs on the right side are the candidate solutions randomly generated by each employed bee.

The proposed system generates more candidates for each employed bee than the initial candidates. The number of employed bees in the proposed system is similar to the number of candidates described in Section 3.1. Therefore, the user evaluates twice the number of candidate solutions. Furthermore, in Fig. 3, the proposed system presents 10 designs regardless of the number of the generations.

After completing the evaluations, the proposed system presents new designs when the user clicks the arrow button at the bottom right. The user clicks the X button at the bottom left when they are finished with the system.

3 EVALUATION EXPERIMENTS

3.1 Outline of the experiments

The experiments investigated whether the proposed system can multimodally retrieve users' favorite shoe designs. A total of 16 university students (10 males and 6 females) in their 20s participated in this study. We followed the necessary procedures based on the ethical code for research related to human participants at the Fukuoka Institute of Technology. Moreover, the experiment was conducted after sufficient the subjects had been adequately informed about the procedures and we obtained their informed consent. The experiments compared the performance of the proposed and compared systems in terms their multimodal retrieval of candidates. The compared system uses the GA method as a conventional IEC system. We set the order of the system used randomly for each subject, considering the order effects.

Figure 3. Evaluation interface

Table 1. Experimental parameters

	Proposed system	Compared system
Candidate solutions	20	40
Gene length	20 bits	
Generations	15	
Employed bees	20	–
Onlooker bees	100	–
Retrieval limits	10	–
Selection	–	Roulette selection + elite preservation
Crossover	–	Uniform crossover
Mutation rates	10%	

Table 1 shows the experimental parameters. The proposed system uses twice the number of candidates (20) because each employed bee generates new candidates (20) randomly corresponding to the candidates. Then, the compared system also uses 40 candidates, considering the influence of the evolutionary performance by the number of candidates. Each subject viewed and evaluated 40 candidates in each generation in both systems. The EC operations of both systems use the candidates for the top half evaluation.

After using each system, we asked each subject to answer the following Questions A–E with three- or four- stage evaluations.

A： Did the last generation's shoe designs meet your preferences?

B： Have there been any changes in shoe designs?

C： Did the shoe designs meet your desire each time you turned the page?

D： Did you find the preferred designs, whether right or left?

E： How did you feel about the time you spent viewing designs during the evaluation?

Moreover, we took note of the subjects' comments on the system and their feelings and observations.

3.2 Results of the evaluation time

Figure 4 shows the results of the evaluation time for 6 subjects. The evaluation time indicates terms from showing the initial designs to clicking the X button at the 15th generation interface. In Fig. 4, the average evaluation time of the proposed (compared) system was approximately 421[s] (462[s]). This is because the candidates in the compared system converge on a single goal while passing the generations, making it difficult for the subjects to distinguish between the given designs. Then, the time it took to complete the evaluations for the compared system became long. Furthermore, the candidates of the proposed system converge on multiple goals, allowing subjects to quickly notice and evaluate the differences between the given designs.

3.3 Results of the multimodal retrieval for the generated designs

Figure 5 shows the variance in the logo presentations. The variance of the presentations for each part becomes high when the presented parts are biased. In Fig. 5, the variances of each subject for the proposed system were smaller than that those for the compared system. Therefore, the proposed system can represent various shoe designs and the compared system presents many similar designs. In particular, the variances of Subjects C and N were higher than those of the others.

Thus, the compared system cannot multimodally retrieve candidates that can satisfy each subject. The proposed system has a smaller bias of the presentations and can multimodally retrieve candidates that can satisfy each subject. We also confirmed the same tendency about the variances of any other parts.

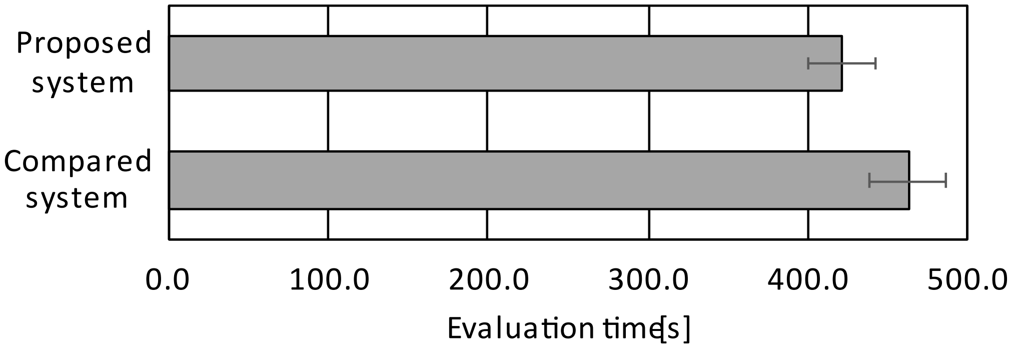


Figure 4. Results of the evaluation time

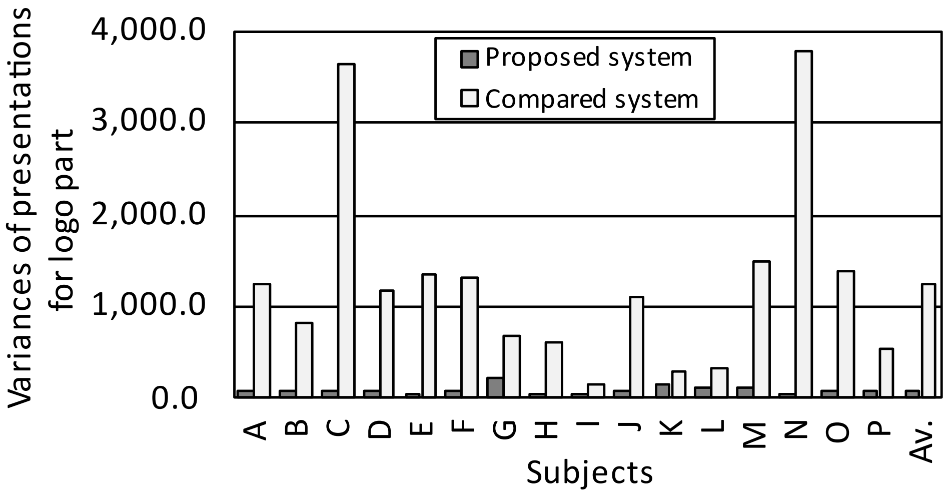


Figure 5. Results of the variances for the presentations

3.4 Results of the questionnaire

Table 2 shows the results of the questionnaires. In Tab. 2(a), in both systems, 75% of all subjects answered that they found their multiple favorite shoe designs in the last generation. Thus, both systems can present users' favorite shoe designs.

However, in Tab. 2(b), in the compared system, 69% of all subjects, including 58% of the 12 subjects who answered that they found their multiple favorite shoe designs in Question A, answered that they felt the kinds of the presented designs were small. This was caused by the subjects counting the presented shoe designs as their favorite designs. In the proposed system, 81% of all subjects answered that they found various favorite designs. Only 13% of all subjects, including 12% of the 12 subjects who answered that they found the multiple favorite shoe designs in Question A, answered that they felt that kinds of the presented designs were small. Therefore, compared with the compared system, the proposed system can present various designs.

From Tab. 2(c), in both systems, more than half of all subjects felt that each time system presented their favorite shoe designs whenever the y turned the page. Moreover, in Tab. 2(d), the number of the subjects who answered that there were several favorite designs on the left side of the interface were larger than that of the subjects who answered that there were many designs on the right side of the interface. This shows caused that the proposed system presents higher scored designs on the left side and randomly generated designs by employed bees on the right side.

In Tab. 2(e), more than half of all subjects felt that the evaluation time was longer in both systems. Both systems required each subject to evaluate 40 designs in each generation. Even if both systems employed user gaze information for evaluating candidates and each subject only viewed the presented designs, the subjects that felt the evaluation time was long.

Next, we describe the subjects' comments. First, there was a comment from some subjects that "the proposed system presents various designs" that suppose multimodal retrieval performance of the proposed system. However, some subjects expressed that "they found their favorite shoe designs, but they want to confirm more neighboring favorite designs." From the comments, we found the improvement items for the proposed system. For example, using the TS method to retrieve candidates locally, the proposed system moves some designs to the neighbors that can satisfy the users.

From all the results, we confirmed that the proposed system could generate multimodal shoe designs that can satisfy the users. Furthermore, from the perspective of the multimodal retrieval of user favorite designs, the proposed system performed better than the compared system.

4 CONCLUSIONS

We investigated the effectiveness of the proposed system from the perspective of multimodal retrieval of candidates for real users. The experimental results showed that the proposed system could retrieve candidates more multimodal than the compared system. The results uphold the numerical simulations' findings (Takenouchi, & Tokumaru, 2021). In future research, we will improve the proposed system with more details and test its multimodal retrieval effectiveness.

Table 2. Results of the questionnaire

(a) Question A

	Found multiple designs	Found a single design	Not found
Proposed system	75%	19%	6%
Compared system	75%	19%	6%

(b) Question B

	Quite a lot	A lot	Few	Very few
Proposed system	25%	56%	19%	0%
Compared system	0%	31%	50%	19%

(c) Question C

	Found multiple designs	Found a single design	Not found
Proposed system	56%	38%	6%
Compared system	63%	31%	6%

(d) Question D

	Right designs	Left designs	Same
Proposed system	13%	56%	31%
Compared system	25%	38%	38%

(e) Question E

	Very long	A little long	A little short	Very short
Proposed system	6%	75%	19%	0%
Compared system	0%	63%	32%	6%

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SYSTEMATIC LITERATURE REVIEW:
AFFECTIVE STATE AS A PREDICTOR OF COUNTERPRODUCTIVE WORK BEHAVIOUR

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ABSTRACT

Human emotions are within-person factors that function as a stimulus of an individual's attitude and behaviour, either positively or negatively. From the organisational behaviour spectrum, concern over negative behaviour like Counterproductive Work Behaviour (CWB) is more prevalent due to tremendous negative effects on both employees and organisations. Although the impact of the affective states on CWB was empirically evident, there was an insufficient study that systematically reviewed the literature on such association. Hence, the present article adopts the PRISMA guidelines (Preferred Reporting Items for Systematic reviews and Meta-Analyses) by integrating multiple research designs to investigate the emotional experiences-CWB phenomenon. The relevant literature review was selected from two established databases, Scopus and Web of Science. Based on the thematic analysis, two main themes (i.e., negative and positive affect) emerged as predictors of CWB at work. Subsequently, the sub-themes of discrete emotions were discussed as part of the study findings. In addition, this study comprehensively explained the significance of affective states on CWB. As a result, the study offers valuable insight into the body of knowledge and practical implementation for future strategies. The key takeaway is that creating more positive events and eliminating negative events

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are expected to be beneficial in elevating employees' emotional well-being, hence reducing CWB occurrence.

Keywords: Systematic Literature Review, Affective State, Discrete Emotions, Counterproductive Work Behaviour

1 INTRODUCTION

Counterproductive Work Behaviour (CWB) refers to purposeful behaviours that harm organisations or their members, which may cause financial losses and lessen employees' psychological well-being and morale. Resulting of the emerging research relating to affectivity in the workplace, researchers have begun to investigate how individuals' emotions and moods influence acts of CWB (e.g., Zhang, Crant, & Weng, 2019; Thompson & Bruk-Lee, 2021). According to Affective Events Theory (AET), specific work events are antecedents of affective reactions and behaviours. As empirically evident, negative affective experiences at work were positively linked to CWB and somehow could lead to a more severe CWB. In contrast, the positive emotions that are mapped with the notions of autonomous motivation (Wang, 2018) could mitigate the CWB occurrence. Undoubtedly, emotional experiences at work could positively and negatively impact how people function. Therefore, a deep understanding of the role of affective states in defining CWB at work could resort to more effective intervention strategies. Thus far, various studies have been conducted to analyse the role of affective states in persuading CWB at work (e.g., Paciello, Fida, Tramontano, Ghezzi, & Barbaranelli, 2019; Jahanzeb, Fatima, & De Clercq, 2020; Thompson & Bruk-Lee, 2021). However, there has been little effort to analyse these studies systematically, discover trends, and generate prospective themes on this dysfunctional behaviour. Notably, the review procedures have not been effectively handled, including identification, screening, and eligibility. Traditional literature reviews have several concerns with regard to transparency and bias. Many authors will simply select articles in favour of their topic of interest (Mohamed Shaffril, Samsuddin, & Abu Samah, 2021). As a result, future scholars would face a significant challenge in replicating the study, validating the interpretations, or examining the study's comprehensiveness under such a system. Given this vacuum in the literature, the current study attempts to undertake an SLR that focuses on the affective states-CWB relations. The authors were guided in their work by the major study question, "What are the roles of the affective states in defining CWB at work?". The authors' empirical results can be justified using this approach to identify gaps and suggest the direction of future research in this field.

2 METHODOLOGY

The PRISMA Statement (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guided the current review. PRISMA is often utilised in studying affective states (Zurriaga, González-Navarro, & Buunk, 2020) and employee work behaviour stream (Tagliabue, Sigurjonsdottir, & Sandaker, 2020). The PRISMA Statement allows for the rigorous search of terms related to affective states-CWB phenomenon and coded information in future organisational behaviour reviews. The SLR process began with formulating the research questions applying the PICo method; 'P' for Problem or Population, 'I' for Interest, and 'Co' for Context (Lockwood, Munn, & Porritt, 2015). Next, the document searching strategy was planned and conducted according to three systematic phases: identification, screening, and eligibility (Mohamed Shaffril et al, 2021). The formulated research questions produced two main keywords: affective states and CWB. Several keywords similar to the affective state, including feelings and emotions, were checked based on this process to enrich these keywords. These keywords were combined using search functions, such as field code functions, phrase searching, wildcards, truncation, and Boolean operators in two databases: Scopus and Web of Science (see Table 1). The search efforts identified about 564 potential articles from the selected databases. The screening was the second procedure carried out where articles were either included or excluded (with the assistance of the database or manually screened by the authors) from the study based on a specific set of criteria (see Table 2). A total of 344 articles were excluded from the review during this stage since they were not in line with the inclusion requirement. This resulted in 220 remaining articles for evaluation in the subsequent stage. Then, the authors manually checked the remaining papers to identify them (either by reading the title, abstract, or the entire document). Seventy articles were excluded during the title screening state, and during the abstract screening stage, 101 articles were removed. Another ten articles were excluded after the authors read the content of the selected articles. In total, 181 articles were removed in this stage. Somehow, they did not focus on affective states, and CWB was in the form of a review paper and was science-based. The final number of articles for the further appraisal stage was 39. Lastly, the selected articles were processed through several stages, data extraction and data analysis. The data extraction process was guided by the primary research question, while the qualitative data synthesis (thematic analysis) was performed in analysing the extracted data (see Figure 1).

Table 1. Search string used in the selected database

Database	String
Scopus	TITLE-ABS-KEY (("affective state*" OR "emotion*" OR "feeling*") AND ("counterproductive work behavio*"))
Web of Science	(TS= (("affective state*" OR "emotion*" OR "feeling*") AND ("counterproductive work behavio*"))

Table 2. Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Timeline	2017–2022	2016 and earlier
Subject area	behavioural science, social science, psychology, management, and ethics	Other than the inclusion criteria
Document type	Articles (with empirical data)	Review article, chapter in a book, book, etc
Language	English	Non-English

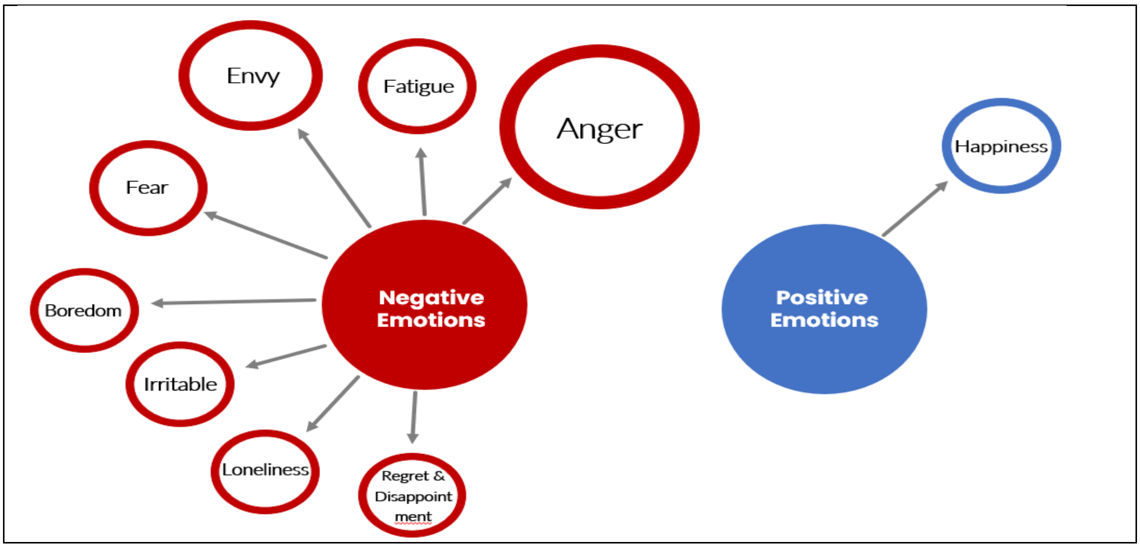

Figure 1. The themes and the sub-themes

3 RESULT

3.1 Background of the selected studies

The country of research affiliation of the selected studies is presented in Figure 2. The year of publication is exhibited in Figure 3. Meanwhile, Figure 4 indicates the research design for data collection employed by the selected studies.

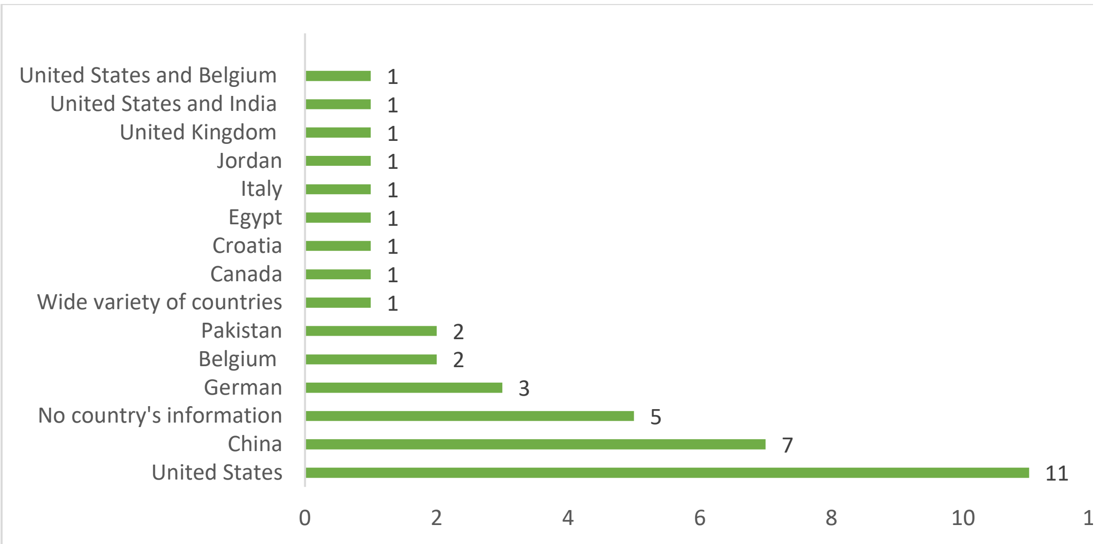

Figure 2. Country of research affiliation of the selected studies

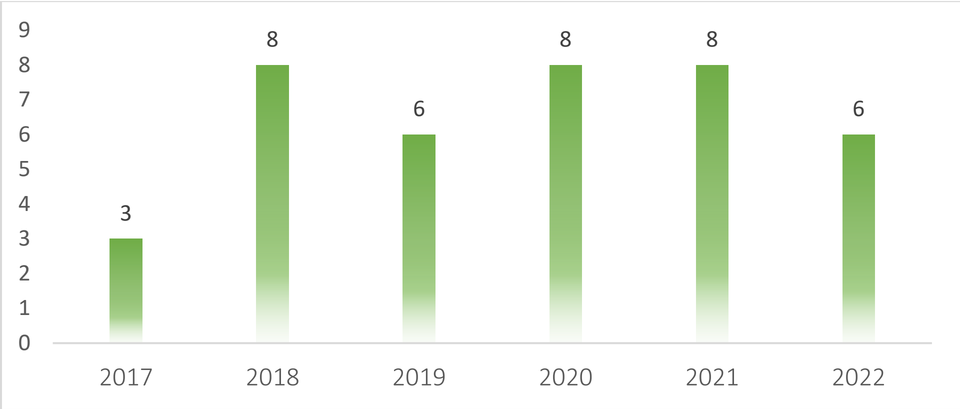

Figure 3. Year of publication

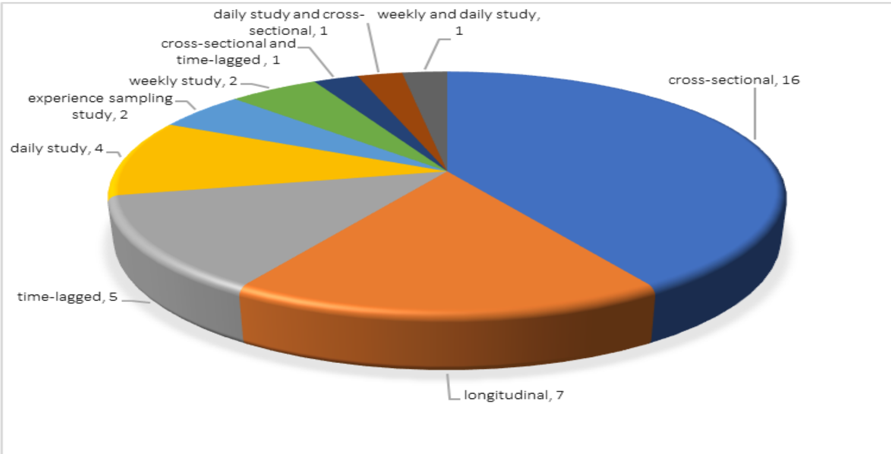

Figure 4. The research design employed by the selected studies

3.2 The developed themes - The Affective States' Effect on Counterproductive Work Behaviour

The thematic analysis was undertaken on 39 selected articles resulting in two main themes: (1) Negative Affect and (2) Positive Affect. These two themes further produced nine sub-themes. Based on the results, two themes and nine sub-themes provided answers to the main research question of this SLR, "What are the roles of the affective states in defining CWB at work?". The themes and sub-themes of the selected studies are explained in the following section.

Negative Affect (NA) and Discrete Negative Emotions

The direct effect of NA on CWB can be observed through pieces of empirical evidence. For example, Lin and Johnson (2018) found that high activation of negative emotions is positively linked to deviant behaviour and withdrawal. Likewise, Krishnakumar, Hopkins, and Robinson (2017) revealed that employees with a high degree of job NA and low emotional intelligence showed the highest levels of CWB. Note that the upshift in NA outside work, on the other hand, did not affect CWB the next day (Qu, Yao, & Liu, 2021). Comparably the experience of negative emotions has no positive lagged relationship with CWB. Specifically, workers reporting high negative emotions did not report an increase in CWB at the following measurement occasion (De Longis, Alessandri, Sonnentag, & Kuppens, 2022). Despite the direct effect that NA placed on CWB, mostly NA was also found to be a mediator between eliciting events and CWBs (Dahling, 2017; Griep & Vantilborgh, 2018; Navarro-Carrillo, Beltrán-Morillas, Valor-Segura, & Expósito, 2018; Zhang, Mayer, & Hwang, 2018; Zhang et al, 2019; Dalal, Alaybek, Sheng, Holland, &

Tomassetti, 2020; Griep, Vantilborgh, & Jones, 2020; Naeem, Weng, Ali, & Hameed, 2020; Reynolds Kueny, Francka, Shoss, Headrick, & Erb, 2020; Richard, Young, Walsh, & Giumetti, 2020; Schilbach, Baethge, & Rigotti, 2020; Wang & Xiao, 2021; Griep, Hansen, & Kraak, 2022; Thomas et al, 2022). **Anger:** Anger characterised configurations showing health-related and behavioural problems (e.g., CWB) (Paciello et al, 2019). In a prior study, Fida et al (2018) claimed that sadness is only associated with health symptoms, whereas anger is related to health and misbehaviour. Another important finding indicated that anger elicited CWBs when employees dealt with unfair events (Barclay & Kiefer, 2019). The majority of the study suggested anger as a significant mediator in the affective events-CWB relations. For example, Andel, Pindek, and Arvan (2022) revealed that anger mediated the relationship between Perceived overqualification (POQ) and abuse. Further, Wang and Xiao (2021) indicate that the indirect effect of daily abusive supervision on daily supervisor-directed deviance mainly occurs due to anger. Anger in another study mediated the relationship between lower quality leader-member relations and CWB. However, self-control moderates the anger-CWB link. The anger-CWB relation will be more substantial in people lower in self-control than individuals higher in self-control (Newton & Perlow, 2021). In addition, the indirect effect of supervisors' contempt, anger, and disgust (CAD) on subordinates' CWBs worked through subordinates' CAD (Li, Law, & Yan, 2019). Furthermore, Jahanzeb et al (2020) asserted that workplace bullying spurs interpersonal and organisational deviance because it prompts feelings of anger in employees. Meanwhile, the indirect effect of implicit aggressiveness on CWBs via workplace anger was significant for self-reported CWBs. Further, the indirect effect of implicit hostility on workplace anger through self-reported CWBs was also significant (Ružojčić, Galić, & Jerneić, 2021). Despite that, organisational politics (POP) perceptions were positively related to hostility (classified as anger) and CWB. Moreover, hostility mediated the relationships between POP and organisational and interpersonal CWB (Meisler, Drory, & Vigoda-Gadot, 2019). Another result showed that within individuals, daily illegitimate tasks positively predicted next-day CWB, and the relationship was mediated by daily end-of-work anger (Zhou, Eatough, & Wald, 2018). **Envy:** Shousha's (2020) study demonstrated a significant negative correlation between contextual performance and perceived workplace envy, whereas CWB was positively associated with perceived workplace envy. Besides, the results from multiple-regression analysis indicated that the three proposed antecedents (i.e. neuroticism, conscientiousness and perceived competitiveness) significantly predict workplace envy. Further, workplace envy significantly predicts CWB (Ghadi, 2018). Likewise, leader narcissism is positively related to followers' negative emotions (i.e., malicious envy), mediating the positive relationship between leader narcissism and supervisor-targeted CWB (Braun, Aydin, Frey, & Peus, 2018). **Fatigue:** Another important finding is that citizenship fatigue mediated the relationship between Organisational Citizenship Behaviour (OCB) and CWB, while perceived organisational support (POS) moderated the relationship between OCB and citizenship fatigue. In addition, POS moderates the mediating effect of citizenship fatigue in the inverted U-shaped curvilinear relationship between OCB and CWB. This mediating effect is more robust under conditions of low POS than high POS (Xu et al, 2021). Likewise, experienced patient incivility is indirectly related to increased future incivility towards patients through increased compassion fatigue (Thomas et al, 2022). **Fear:** One interesting finding is that fear-characterised configurations show health-related and behavioural problems, including CWB (Paciello et al, 2019). In line with discrete emotions literature, sadness is only linked with health symptoms, but fear is related to health and misbehaviour (Fida et al, 2018). **Boredom:** The current study found that boredom significantly mediated the cyberloafing and POQ relationship. Task crafting moderated the indirect effect of POQ on cyberloafing behaviours through boredom, such that the indirect effect will be weaker (vs stronger) when task crafting is higher (vs lower) (Andel et al, 2022). **Irritability:** The moderated mediation analysis revealed that when the external motivation for proactivity was high, proactivity led to increased irritability and rumination; irritability was, in turn, related to withdrawal (Pingel, Fay, & Urbach, 2019). **Loneliness:** Becker, Belkin, Tuskey, and Conroy (2022) hypothesised that there would be indirect effects of work-related loneliness through emotional exhaustion on minor CWB, depression, and insomnia. However, they only found support for the indirect effect of work-related loneliness through emotional fatigue on depression, but not CWB or insomnia. **Regret & Disappointment:** Disappointment had a significant and positive link with work withdrawal, whereas regret did not. Besides, the relative importance analysis also suggested that regret and disappointment did not significantly differ in their relations with CWBs (Howard & Smith, 2021).

Positive Affect (PA) and Discrete Positive Emotions

According to Littman-Ovadia, Lavy, and Boiman-Meshita (2017), PA mediated the association between strengths use (signature strengths, lowest strengths, and happiness strengths) and all work-related outcomes (work meaningfulness, engagement, job satisfaction, performance, OCB, and CWBs), when each was examined separately. However, when uses of the three kinds of strengths were examined together, PA mediated the effects of lowest strengths, and happiness strengths use, but not the effects of signature strengths use. Although, when PA is higher than NA could lead to a lower level of CWB (Lan, Mao, Peng, & Wang, 2021). Surprisingly, the shift in PA outside of work did not mitigate the shift in NA outside of work and CWB interactions the next day (Qu et al, 2021). **Happiness:** General well-being, representing employees' perceptions of their current mental state of happiness, anxiety, and depression, has significantly negatively impacted CWB. In contrast, feelings of unhappiness are significantly related to CWB (Soroya, Sarwar, & Soroya, 2022). Note that high job demands decreased employee happiness, increasing employees' CWBs (Thompson & Bruk-Lee, 2021).

4 DISCUSSION

Thus far, most CWB studies have investigated the relationship between external factors (i.e., organisational and between-person) and CWB. However, the affective states, a within-person factor, also play a significant role in associating eliciting events-CWB relations (e.g., Zhang et al, 2019; Jahanzeb et al, 2020). In line with the AET propositions, the growing body of evidence established various workplace events as a primary cause of employees' affective states (positive and negative). Accordingly, the empirical evidence supports the notion that both negative and positive emotions significantly influenced CWB through positive and negative interaction. General affect entails various discrete emotions, and the impact of these emotions are not identical to one another. They carry different implications on employees' behaviour, including CWB (e.g., Fida et al, 2018; Howard & Smith, 2021). Therefore, understanding the influence of each discrete emotion might be useful in addressing this dysfunctional behaviour. Based on the current review, general NA is the most frequent affective state that has been studied. Whereas discrete emotions, including boredom, irritability, loneliness, regret-disappointment, and happiness, have received little attention from researchers. It is important to note that other negative emotions (e.g., Shousha, 2020; Paciello et al, 2019) and positive emotions (e.g., Lan et al, 2021; Soroya et al, 2022) also exhibited significant direct and indirect relations with CWB. Although NA is more influential in defining the CWB prevalence at work. It appears that positive affect (PA) also plays a significant role in addressing this dysfunctional behaviour. Moreover, Lan et al (2021) highlighted that when PA is higher than NA, it leads to a higher level of job satisfaction and a lower level of CWB than when NA is higher than PA. Given this situation, it can be noted that despite the effort to address NA, the role of PA should not be side-lined to lessen the effect of emotions on CWB. In reviewing the buffering mechanism, it emerges that negative emotion inertia increased employees' tendency to enact in CWB (De Longis et al, 2022). Despite that, employees' attributing blame to the organisation and supervisor could motivate them to engage in CWB targeted at organisation and supervisor, respectively (Griep et al, 2022). In contrast, employee perceptions concerning the organisation's extent of CWB tolerance could buffer the link between negative affect and CWB (Dalal et al, 2020). Despite the individual factor, ethical climates, including instrumental and caring climates, are also significant in moderating the negative emotions and CWB relationship (Wang & Xiao, 2021). Another interesting finding is that building positive resources via learning new things at work could be more beneficial in overcoming negative emotions and deviance in distressing workplace settings (Zhang et al, 2018). Meanwhile, self-control (Newton & Perlow, 2021), POS (Xu et al, 2021), and task crafting (Andel et al, 2022), significantly buffered employees' affective state-CWB relationship. Finally, the studies' background information analysis depicted a relevant contextual gap. Thus far, relatively few investigations have been carried out in ASEAN countries. Hence, it raises the question of whether the cultural background predicts CWB. Additionally, most studies utilised a self-reporting mechanism that leads to common method bias like social desirability.

5 CONCLUSION

The primary question addressed in this systematic review is the role of the affective states in influencing CWB at work. Based on the review of the selected articles, two main themes emerged, namely NA and PA, with an additional nine sub-themes comprising envy, anger, fatigue, fear, boredom, irritability, loneliness, regret & disappointment, and happiness. These affective states and their discrete emotions significantly influenced CWB at work. In most cases, they play a significant role in mediating the relationship between eliciting events and CWB. As a result of answering this research question, this article contributes to the respective literature in numerous aspects. First, previous studies tend to concentrate on negative emotions since positive emotions are less distinguishable in defining the CWB occurrence. NA and anger are the most frequent emotional states that have been studied to predict CWB. As a result, this study provides insight into the direct and indirect effects of other discrete emotions (positive and negative) on the CWB. Second, this study sheds light on moderating variables useful in weakening or strengthening the affective states-CWB relation. Third, the analysis of the background information of the selected studies could provide insight into the contextual and theoretical gap. Although this study met its primary objective, this study is not excluded from its downsides. As previously mentioned, it is explicitly focused on AET as a descriptive framework for describing the affective states that influence employees' CWB. Thus, we see various alternative theoretical explanations for the proposed model that might assist inform future research. Furthermore, the searches only included articles published in English between 2017 – 2022. Additionally, this study solely included empirical studies based on two databases (Scopus and WOS) to provide scholars with an overview of recent investigations as a foundation for future research. Despite the flaws, the results of this study emphasise the importance of systematic reviews in furthering our understanding of affective states-CWB relation.

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TEAMWORK IN CONTEXT OF DIVERSITY

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ABSTRACT

Utilization of teamwork for problem solving is pervasive. Teamwork is employed in classrooms to facilitate learning, but also as preparation for future vocational practice. It is used in research as collaborative ethos. Teamwork features in workplace tasks, leisure time projects, pursuing solutions to intractable trans-situated problems, etc. The space of teamwork is a public space of multidimensional assets. Inherent in it are benefits of collaboration, but it also brings with it challenges that have to be resolved in order for it to work effectively. We pursue the question of effectiveness of team function through team size, given certain identified benefits and disbenefits. We attempt to find out if there is an optimal small team size based on a few characteristics such as burden sharing, transactive knowledge and conflict (e.g. schedule conflict). We employ an agent-based model. For parameterization of variables, we take data from a short questionnaire completed by students and use its results to set values. We create small teams of different sizes and allow the dynamic model to aggregate those values as adopted by agents. We also attempt to see which one of four benefit/disbenefit valuation model specifications might work best.

Keywords: *knowledge management, perception of team benefit/disbenefit value, social/public space, teamwork*

1 INTRODUCTION

In day-to-day life, it might not be completely avoidable to have to collaborate with other people in order to complete certain tasks. Collaborating could be motivated by dependency, choice, efficaciousness, protocol, attachment, companionship, or a combination of those or other reasons. Certainly, it takes place in different domains of life: work, leisure, transcendent spaces.

Spaces of collaboration or team spaces are public (or social) spaces. One thing that can be expected in them is diversity--of goals, tasks, structure, selves, and so on. Selves are central to the idea of teamwork. They constitute the team. They bring diversity of knowledge, diversity of schedule, diversity of attitude, diversity of personality--including preferences, emotions, temperaments, dispositions, etc. Diversity sketches one profile of the operational space of teamwork. For a team to work well, various forms of difference have to be managed.

When teams exist in the context of problem solving, one of the questions that arise is about an ideal size of the team. That is one question to which we turn in the current exploration. Can one identify an optimal size of a small team? Our exploration invariably took us to another question: If goal of small team work is successful completion of a task, is there a way of recognising or earmarking both generative role of benefits and debilitating value of challenges for a theorized optimality?

In this exploratory paper, we inquire after those two questions. The former question is examined through creating different team sizes. The latter question is re-constructed through different exploration model designs--in order to see which one might capture benefits better.

2 ASPECTS OF TEAMWORK

2.1 Knowledge generation and management

According to Gadgil and Nokes-Malach (2012), beneficial features of constructive collaboration include such things as sharing prior knowledge, collaborative generation of explanations and error correction, the last feature (error correction) happening to a greater degree in the team context than in an individual context.

Sharing knowledge is one of the most defensible aspects of teamwork. In organisations, for example, knowledge is created or increased through exchange (of declarative knowledge, procedural knowledge, mental models) among employees (Banks & Millward, 2007; Srivastava et al., 2021). Knowledge sharing enables capitalization on knowledge resources and transfer of expertise (Kim & Choi, 2022; Perotti et al, 2022). Knowledge sharing could be inhibited by issues such as perception of it as a source of individual power (which is to be protected) coupled with perception of procedural justice within the group (Srivastava et al., 2021) or by politics-induced hostility to knowledge sharing (Chen et al., 2022)

We refer to knowledge augmentation as another important benefit of teamwork. Augmentation might manifest in the form of a team member correcting error in knowledge of another. It might also present in the form of filling gaps in knowledge. Another way is in assisting a team member to link or connect different fragments of knowledge.

Transactive memory system is a further consequential establishment of teamwork. In the transactive memory system, different members of a group bear non-overlapping information. Members of the group are aware of that fact and grant that an individual member bearing certain information possesses within-group *de facto* expertise on that information set (Rajaram & Pereira-Pasarin, 2010). Expertise might be due to prior experience or it might be delegated specifically to the individual by the team itself. Apart from reassurance that a member of the team can be relied upon in case of need, it frees up individuals to concentrate energy on delimited aspects of the task at hand.

2.2 Collaborative inhibition and other handicaps

Group work is not unconditionally superior. When it is a simple task, such as group recall by a group working collaboratively (e.g. studying items on a list), it is possible for performance of the collaborative group (on aggregated number of unique items recalled) to be lower than performance of a nominal group (a group of pooled individuals, where group members study items on the list individually/alone and number of unique items group members recall is aggregated). The phenomenon described is referred to as collaborative inhibition (Gadgil & Nokes-Malach, 2012 ; Rajaram & Pereira-Pasarin, 2010; Weldon & Bellinger, 1997). According to Weldon and Bellinger (1997), experimental data showed that "collaboration did not optimize individual recall." Individuals in a group recalled less than those who worked alone (p. 1165).

Bakir et al. (2020) included lack of communication among group members as an important group work challenge. The authors did not treat "lack of communication" as a unitary construct. According to them, it included "not having enough communication with group members, not having enough interactions, initiating communication at the last minute, conducting low quality discussions, experiencing lack or poor generation and evaluation of ideas, and having conflicts with...peers" with no resolution (p. 80).

Roberts and McInnerney (2007) presented seven common challenges that could be faced when group learning is used for instruction in a computer-supported learning environment. Given their list, it is reasonable to consider that all of the listed challenges can also be claimed as present in a person-to-person group learning or problem solving context. Not all of these are relevant, however, to our current project (e.g. membership/constitution matters such as selection of group members and withdrawal of group members). Two relevant ones are identified as follows:

- Free ridership: In our study, we took account of this under the idea of social loafing. It featured as reduction of individual effort on our data collection form.
- Possible inequalities in ability (and/or knowledge): In our study, we took account of this under the ideas of knowledge diversity and knowledge sharing and featured it under filling in knowledge gap on data collection form. While Roberts and McInnerney's listed idea and ours are not exactly the same, we opted for the positive characterisation (i.e. filling knowledge gap helps group) than the negative (i.e. there is ability/knowledge inequality). In that conceptual space, both perspectives become convergent.

There are other concepts and renditions of dynamics of group work. Webber et al. (2019), for instance, noted "team composition elements such as personality, values similarities and differences, and team diversity" (p. 742). For our purposes, we hoped that values similarities and differences would be accounted for under the operational construct of personality difference (conflict or not), which we employed. Diversity could be interpreted as sourced in history-of-being which has shaped an individual's unique perspective or as sourced more particularly in the semantic domain (i.e. based on variabilities in concepts, etc. known). We hoped this latter would be covered by the construct umbrella of knowledge difference/variability among team members, which we have explored as a separate construct domain. The functional benefit (we hope) in our choice is that it better separates interpreted diversity into its appropriate construct camps as laid out above.

3 METHODS AND FINDINGS

Based on review of the literature and personal experience, we identified variables which describe dynamics of team activity. For the current exploration, we selected nine variables which we set into a questionnaire. The nine are these: fill(ing) in knowledge gap (v1), correction of misinformation (v2), disagreement upon ideas (v3), sharing burden of work (v4), conflict of schedules (v5), diverse perspectives (v6), conflict of personalities (v7), social loafing (v8), buddy motivation (buddy system) (v9). After data collection, we dropped v3 due to its respondent misconstrual.

A questionnaire with the nine items was created. Response to each item was to be recorded on an eleven-point scale: five levels in the negative direction from "low harmful" to "extremely harmful" and five levels in the opposite direction, indicating "helpful" from low to extreme. Levels were indicated with numbers increasing or decreasing systematically by one, each step. There was a neutral level (scale value of zero). The questionnaire was completed by 31 undergraduate students. We ultimately dropped two respondents due to arbitrary responses. (Sample item: "Research shows that when people work as a team, sometimes there is reduction of individual effort, compared to when working alone. Sometimes, that is due to the fact that those working less are depending on others to do the task. How much will that help or harm us?")

A model was created in Netlogo (Netlogo, 2020). Seven levels of team were created (from a one-person "team" to a seven-person team). Teams were named after number of members.

Variables identified in the questionnaire were inserted in the model as unique agents. At initiation of each model run, they were deployed randomly. (Each run represented length of a team task/project.) During model run, agents of each team moved about and, on encounter with a variable agent, recorded occurrence of that variable as an accompanying score for the team. The team with highest positive (or least negative) net score at end of a run represented the most optimal case. We ran each protocol (see below) 3,000 times. In protocols with weighting of variables, each variable value was specified as median score of that variable from our field data. Figure 1 is a succinct graphical chronicle of runs (narrative of transactions, scores and run log).

We allowed the model to determine length of each run so as to provide for a range of possibilities. We allowed for team projects that last between one day and two weeks (fourteen days). We took each time step of the model to represent one minute. The model was allowed to choose a duration between 1,440 and 20,160 minutes. It was hoped that our large number of runs would yield a reasonable distribution of project duration.

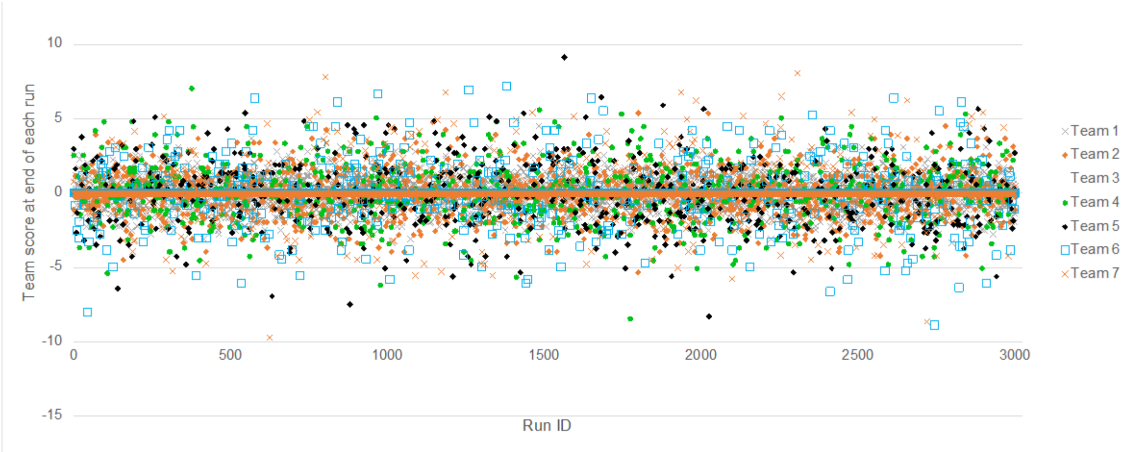

Figure 1. Biography of runs indicating dynamic outcome scoring per team

3.1 Protocols

One of our goals is to compare different model designs (we call them protocols) in order to see if the effect of team size, if any, might remain consistent over different conditions of valuation of team dynamics. In other words, does the factor, protocol, have an effect? We compared four.

PROTOCOL I: Incident valuation as [unweighted] unit/fragment of F_m (where summed value of all incidents per run = F_m = median value of observed scores [i.e. respondent ratings] on factor)

We use the word, incident, to describe each instance (i.e. each occurrence) of one of the variables (e.g. an instance of personality conflict among team members) within a team during a model run. The *incident* is recorded as a model quantitative value by the model agent which has induced its occurrence. *Group* represents a hypothesised team (sizes vary from two to seven). *Task* represents a project completed by a team.

This protocol was the first created (Stephen, in press). In the current exploration, we compare it with other models.

This protocol looks at each *group + task* constitution (i.e. a group operative through one model run) as a closed system, where value assigned to a variable by survey participants (those who completed our questionnaire) denotes an absolute state: as if the group + task event (group in model run) was imagined as totality of a one-and-only and finite universe. In this protocol, the group + task event is conceptualised as a singular event, an isolated episode that manifests and is self-complete. It is a perfectly self-contained or self-sufficient occurrence indicated by the optimal value assigned to each variable. That optimal value, in this case, is the median.

During model run, each instantiation of one of the constituting variables (e.g. fill knowledge gap) is only a share of the optimal value, F_m (think: total energy), of that dimension (i.e. each *incident* = portion of F_m). That instantiation generates what we denoted earlier as incident-as-fragment (see name of this protocol/subtitle of this protocol). So, for instance, one occurrence of "fill knowledge gap" recorded by a moving model agent is only one "chunk" of total of all possible "fill knowledge gap" instances within the current closed system. Another agent within the group could record another instantiation during the current model run. Summation of all possible "fill knowledge gap" instances (F_m) is capped at a value--which, in our case, is the median.

Universally, within this protocol, every encounter between any team agent and any factor agent, across all factors, records as an unweighted unit (as opposed to recording as a weighted unit based on questionnaire-derived weight of factor encountered). Signs are maintained: beneficial factors deliver positive values, unbeneficial factors, negative values.

PROTOCOL II: In this protocol, every encounter between any team agent and any variable agent, across all variables, is also recorded as an unweighted unit (as opposed to being recorded as a weighted unit based on variable encountered). Signs are also maintained, beneficial variables releasing positive values, unbeneficial variables discharging negative values. In this protocol, however, aggregated i*ncident* values are not capped at F_m (median of observed, questionnaire value of variable). Team agent and variable agent encounters can keep occurring--and incidents-as-fragment (values) keep being recorded--throughout duration of the current run.

PROTOCOL III: The protocol allows as many encounters as possible between team agents and variable agents. Each score on encounter is weighted by median value of the variable. In this condition, no ceiling is set for summated fragment scores (summated scores = outcome score). (Compare protocol IV below.)

The protocol respects possibility of recurrence of a condition--i.e. the named variable (e.g. in a team of four, there could be more than four instances of correcting erroneous information; e.g. in a team of seven, social loafing might occur seven times or even more). It is a strategy which respects the fact that we are not able to precisely predict how often a phenomenon might occur.

PROTOCOL IV: This protocol has same structure as protocol III above, but there is a ceiling restriction: that total summated fragment scores is not higher than weight of variable transformed by team size (i.e. median/weight of variable x size of team). The "size of team" stipulation allows that every team member gets a chance once on each variable (i.e. is represented by one encounter--even if, for example, one member encounters twice and another encounters zero number of times).

3.2 Outcomes

Summated fragments of data (i.e. outcome score) were recorded for each team at end of each model run. It was noticed that there was a superfluity of zero scores presenting as outcome. That meant that either it was commonplace for incidents not to occur or they occurred often enough, but positive and negative fragments cancelled out one another. The effect of so many zeros was very severe, overwhelming rest of the data and resulting in steeply peaked distributions. Kurtosis coefficient was high in every case. (It is also efficient to note here that skewness coefficient was acceptable for protocols I and II, but was high--1.5 or higher--for protocols III and IV.) We sampled 100 runs (i.e. 600 columns of data over six teams). Only 3.34% of zeros represented incidents that occurred, had data recorded and then had positive and negative scores cancel one another out to result in zero. Eventually we chose to remove zeros from the data.

After removal of zeros, all skewness coefficients fell below ± 1 (range of -0.22 to .73) and kurtosis coefficients ranged from -0.61 to 1.18. A later Shapiro-Wilk test presented non-significance in only three out of our 24 groups. Certainly, the Shapiro-Wilk test is a stronger indicator, but we held onto the skewness and kurtosis coefficient statistics (as well as reasonable q-q plots) as plausible arguments for assuming some degree of normality.

We proceeded to remove outliers from our first data examined. Subsequent Shapiro-Wilk test still indicated only three groups (though different groups--not all same groups as above) with non-significance. Since there was no effective difference as result of removing outliers, we decided to retain outliers in the data.

Levene's test for equality of variance indicated significance. So, our data did not meet the homogeneity assumption.

In one more bid to explore possibility of re-shaping our distribution to meet testing assumptions, we carried out three forms of data transformation: square root transformation, log (10) transformation and data reciprocal transformation. None of them resulted in effective reconstruction.

Our two independent variables (team size and protocol) induced interest in interaction. We largely failed assumptions for a two-factor analysis of variance. There is yet not a definitive non-parametric alternative (though Friedman test is sometimes used for dependent data) (Scheff, 2016). Given that our data are independent, we decided to apply Kruskal-Wallis test to each separate protocol in order to determine if a team emerges as most optimal per protocol. Results are presented below.

Within protocol I, Kruskal-Wallis chi-square was significant at .05 level: X^2 (5) = 11.43; p = .04. Epsilon squared < .01 (trivial effect, given Cohen's classification). Pairwise comparisons showed difference between team 7 and 6, team 7 and 5, team 7 and 3, team 7 and 2. Bonferroni correction removed all significance.

Table 1. Test results of team comparisons per protocol

Protocol	n	Test Statistic	df	p	Adjusted sig. notes	Effect size (E-squared)
I	4,342	11.43	5	.04	n.s.	†
II	4,453	4.43	5	.49	n.s.	†
III	4,691	997.86	5	<.01	All sig. except teams 5 x 6	.21 (medium)
IV	4,672	1,031.44	5	<.01	All sig. except teams 6 x 7	.22 (medium)

Notes: Test = Kruskal-Wallis; † : correlation used for effect size is *trivial* (<0.1, Cohen's convention); E^2 = epsilon-squared

Within protocol II, Kruskal-Wallis chi-square test was not significant at .05 level: X^2 (5) = 4.43; p = .49. Epsilon squared < .01 (trivial effect, given Cohen's classification).

Within protocol III, Kruskal-Wallis test produced significance at .01 level: X^2 (5) = 997.86; p < .01. Epsilon squared = .21 (medium effect, given Cohen's classification). Pairwise comparisons showed difference between all pair combinations. Bonferroni correction retained all significance except for teams 5 and 6 pairwise comparison.

Within protocol IV, Kruskal-Wallis chi-square test was significant at .01 level: X^2 (5) = 1,031.44; p < .01. Epsilon squared = .22 (medium effect, given Cohen's classification). Pairwise comparisons showed difference between team 7 and 6, team 7 and 5, team 7 and 3, team 7 and 2. Bonferroni correction retained all significance except for teams 6 and 7 pairwise comparison.

Regarding potential for factor interaction (protocol x team), we provide figure 2. The matrix explores variability in team outcome score as conditioned by protocol.

Due to weighting applied in protocols III and IV, we expected summated fragment scores (i.e. outcome scores) to be much larger than in protocols I and II. In order to facilitate some comparison, we applied a sensible stabilizing transformation by subtracting each score from group mean and dividing by standard deviation. (Essentially, this is a z-score transformation, but we use the handle of *stabilizing transformation*.) While resulting scores of protocols III and IV were still higher, values were significantly more amenable to comparison with those of protocols I and II.

In matrix below, we depict lowest scores as root scores (minima) and highest scores as potential ceiling of scope of effect (maxima) of protocol factor.

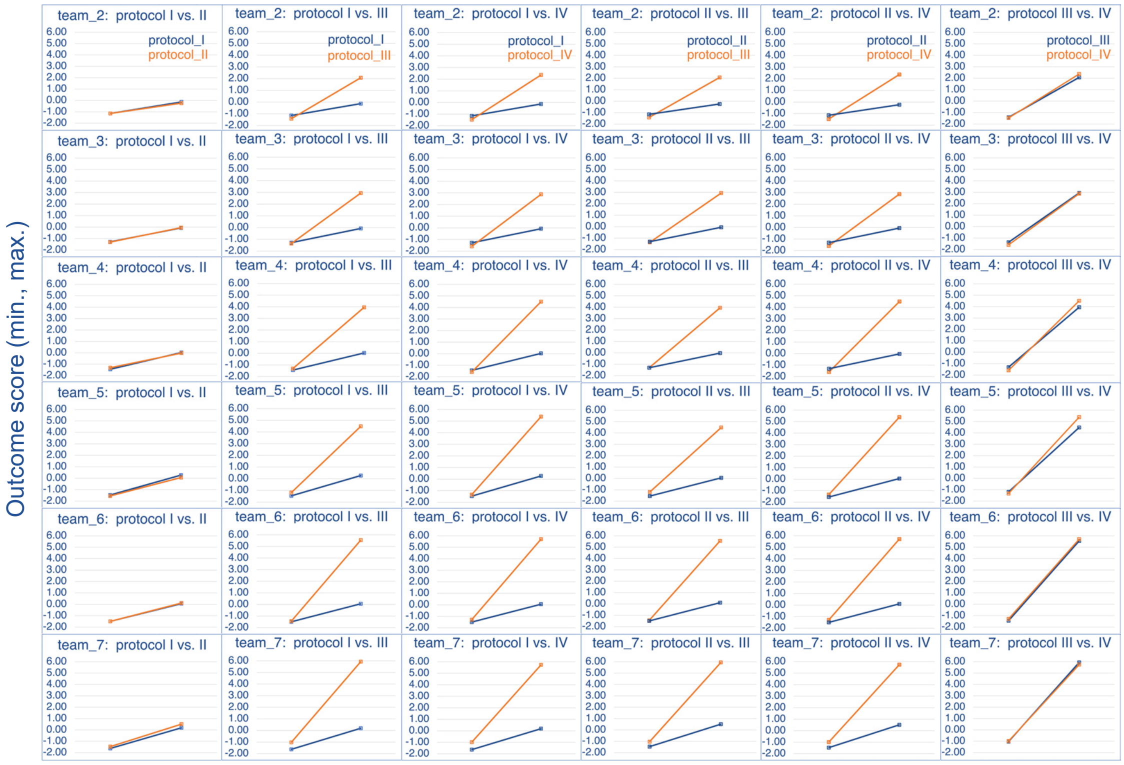

Figure 2. Potential effect of protocol on team: Outcome score minima and maxima

Observing columns, protocols I and II (1st column) and protocols III and IV (6th column) seem to depict similarity of configuration between each pair. That suggests that these protocol pairs are similar in terms of structure they have capacity to generate. When protocol I is brought against III and IV (2nd and 3rd columns), however, and when protocol II is brought against III and IV (4th and 5th columns), there is visible difference in paired graph form/behavior. That suggests possible interaction.

There is appearance that as team size increases, efficacy increases as well. This is, as yet, descriptive from the data, and not confirmatory. By description shown in figure 2, it appears as if teams 6 and 7 perform at the most optimal. A very close look might suggest a very slight edge in advantage for team 7, but possibly a matter for further interrogation as these data stand.

While these data suggest that team size might not matter at times (see similar pair, I & II, in table 1 above), difference in protocol design (particularly, when weighting is introduced) tends to suggest a different story (description around figure 2 above).

4 CONCLUSION

In this paper, we examined two questions: Is it possible to identify an optimal size of a small team? Our exploration invariably took us to another question: If goal of small team work is successful completion of a task, is there a preferred system of assigning value to team benefits and challenges? Difference between unweighted encounters (protocols I and II) and weighted encounters (protocols III and IV) suggests that a combination of things might be of interest:

1. It appears as if there is potential, latent cognitive/emotional effect on outcomes through how data are perceived by respondents (i.e. potential team members). Degree of distress/trauma or assurance/inspiration by which team members perceive (i.e. associate with, indicated by differential scoring/weighting of variables in survey responses) might be a matter worth interrogating. Weight attached to a variable, when translated into a theoretical proxy and incorporated into model design, results in team-size difference--as seen in protocols III and IV.
2. Although examination of our data indicated that number of positive- and negative-bearing variables does not seem to matter (as summated run outcome scores were a mixture of both positive and negative values despite the fact that there were more positive than negative variables in our field data) it might matter that there was a seeming bias by respondents in weighting positive and negative variables: Participants tended to have given factors which favoured team success stronger scores in the positive direction than disfavouring factors were scored in the negative direction. This might have accelerated positive score gains, thereby enhancing growth of scores of larger teams with a larger weighting factor (as seen in rapid escalation of protocols III and IV).

Although our results here are explorative, the question is still worth pursuing--of finding out whether there is an optimal small group size for some problem solving tasks (or whether task success is really dependent on other factors besides team size). It is hoped that future studies will be facilitative in addressing this core question within framework of attendant conditions.

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TEXT ANALYTICS ON MOOCS
A COMPREHENSIVE ANALYSIS OF EMOTIONS

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ABSTRACT

The value of diversity in education is highly emphasized in recent years, particularly in the wake of the COVID-19 pandemic, by many scholars. Massive open online courses (MOOCs) have aided the evolution of online learning by broadening the range of learning opportunities available. They have gained popularity, especially in higher education by providing unlimited access to lectures and rich learning materials by renowned and respected academics in a wide variety of areas, with no restrictions and at very low fees. Furthermore, learners' motivations for enrolling in a MOOC may vary depending on their choices for the course's instructional design as well as their emotions.

Knowing this, the development of more effective online courses that address affective concerns would appeal to a wider audience and improve the learning experience. This research aims to uncover the emotional characteristics of MOOCs to better understand why learners choose a specific course among hundreds of options available on MOOC sites. For extracting the learners' emotions from user reviews, the study used Kansei Engineering approach, which is enhanced with text analytics techniques. The research methodology entails gathering reviews from MOOCs and analyzing them using natural language processing (NLP) techniques to discover Kansei words that characterize MOOCs, notably for courses in the discipline of Data Science. The expected output of this study is a Kansei corpus for online courses in this discipline.

Keywords: *Kansei Engineering, Text Analytics, MOOCs*

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1. INTRODUCTION

The value of diversity in education is highly emphasized in recent years, particularly in the wake of the COVID-19 pandemic, by many scholars. Massive open online courses (MOOCs) are a relatively new addition to the online learning scene and have aided the evolution of online learning by broadening the range of learning opportunities available. Since 2008, several public and elite schools, mainly in North America, have provided MOOCs. Many academics are interested in MOOCs because they see the potential for global education. Some of these academics are taking a research-oriented approach, and academic papers describing their research are starting to appear in peer-reviewed publications (Liyanagunawardena et al., 2013)

MOOCs have gained popularity, especially in higher education by providing unlimited access to lectures and rich learning materials by renowned and respected academics in a wide variety of areas, with no restrictions and at very low fees. Many academics and practitioners believe that MOOCs can improve equity in higher education by reaching a wider audience and removing barriers to high-quality education given by top schools. Unlike university-sponsored online courses, MOOCs have no enrollment limits, no required units or credentials, and no requirement that learners complete a program beyond a single course (Baturay, 2015; Deng et al., 2019). Especially for students who are interested in more than one field, the opportunity to choose courses from different fields increases the preference of students. Also, the completion time and course selection depend entirely on students that provides high flexibility. Considering all these, it can be said that MOOCs have been accepted as a new branch of higher education.

MOOCs not only shape the personal development of students who continue in higher education but also offer learners who have adopted the philosophy of lifelong learning, the opportunity to gain the knowledge and skills required by the current age. From this point of view, it is expected that the stages such as enrollment mechanism, curriculum, and content development, teaching strategies and technologies, and assurance of learning, which are followed and developed in higher education processes, should also effectively be managed on MOOC platforms. With the demand for MOOCs and rapid adaptation, new initiatives continue to emerge with many different business models and strategies. However, scientific research on this subject has revealed that existing platforms still have controversial aspects in terms of the models they adopt (Dennis, 2012; Burd et al., 2015; Kim, 2016). Therefore, it is essential to systematically monitor and evaluate the perceptions and experiences of learners to provide input for continuous improvement activities in MOOCs. Learners' motivations for enrolling in a MOOC may vary depending on their choices for the course's instructional design as well as their emotions. Knowing this, the development of more effective online courses that address affective concerns would appeal to a wider audience and improve the learning experience. This study aims to uncover the emotional characteristics of MOOCs to better understand why learners choose a specific course among hundreds of options available on MOOC sites.

Kansei Engineering (KE) is a way for concretizing a product's image in people's minds and transforming consumer wants into design aspects for product delight. In Kansei engineering, researchers or designers use various words such as adjectives, adverbs, and sense-related vocabularies to capture customer needs. These are known as Kansei words, and they are the simplest way to access consumer feelings in this methodology.

Several methods, including surveys, interviews, and focus groups, have been used successfully to collect Kansei data. However, they are only used once, are small-scale, time-consuming, and costly to collect and update. For example, questionnaires used to collect Kansei words and customer feedback are typically designer-oriented and do not fully reflect customer perspectives (Wang, 2022). Customers, on the other hand, can easily share their experiences, positive or negative opinions, feelings, and thoughts about the product or service they purchase in consumer web blogs, social networks, and even review sections in product websites (Chen et al., 2019; W. M. Wang et al., 2019). Contrary to abovementioned limited conditions, a large volume of data from customers, can be collected within these platforms in free-text or structured forms. These customer reviews, as digital Voice of the Customer, are valuable as much as the data obtained through other traditional methods (Kapucugil-İkiz & Özdağoğlu, 2015; Özdağoğlu et al., 2018) and they would also be one of the primary sources of Kansei words and product attributes.

The common methods used to analyze the Kansei data include mostly multivariate statistical analysis such as partial least squares regression (PLS), principal component analysis, factor analysis, artificial neural networks, genetic algorithm, and rough set analysis (Akgül et al., 2021; D. Chen & Cheng, 2021; Y. Chen et al., 2021; Ding et al., 2021; Ishihara et al., 1995; Kobayashi et al., 2022) The proliferation of customer reviews has also led to the development of sophisticated techniques for extracting hidden patterns from these reviews. Today, in a conjuncture where big data is integrated to all aspects of research as a hot topic, text analytics is now a promising method in Kansei engineering literature to identify product features or Kansei words (Jin et al., 2021; W. Kim et al., 2019; Kobayashi & Kinumura, 2017; Li et al., 2020; Wang, Li, Liu, et al., 2018). It is a method of extracting high-quality information from unstructured text using NLP and machine learning (Lai, 2012). Text analytics, unlike typical Kansei engineering studies that use questionnaires, allows researchers to work with a larger dataset. Text analytics studies are generally conducted for 300 or more user comments and reaching the same number of respondents through the standard questionnaire method is quite challenging.

In this study, Kansei Engineering, enhanced with text analytics techniques, is used to extract learners' emotions from their massive open online course experience to better understand their needs. The research methodology entails gathering reviews from MOOCs and analyzing them using NLP techniques to discover Kansei words that characterize MOOCs, notably for courses in the discipline of Analytical/Quantitative Methods.

The preliminary findings of this ongoing project, which requires long-term data collection and analysis, are presented through the reviews obtained from the selected courses on Coursera. From the platform, course reviews have been scraped from ‘Data Science’ category and the expected output of this study is a Kansei corpus for online courses in this discipline.

The organization of the rest of this paper is as follows. Section 2 reviews previous studies on text analytics in the context of Kansei engineering. Section 3 explains the methodology implemented in this study. Section 4 presents the results and findings of this methodology for analyzing online user reviews on MOOCs from the field of Data Science. Section 5 covers the concluding remarks.

2. RELATED WORK: TEXT ANALYTICS IN KANSEI ENGINEERING STUDIES

Kansei engineering is a kind of methodology which transforms customer needs to design elements for pleasure from the product (Nagamachi, 2002). This methodology is frequently employed in the development of a variety of products in a variety of sectors. Similarly, studies that use text analytics in the Kansei-driven design process have a wide range of application areas. Kobayashi and Kinumura (2017) used text mining in their Kansei engineering study to design office chairs, Li et al. (2018) for smart watches, and Lai et al. (2022) for new energy vehicles. In addition, Jin et al. (2021) proposed a framework that integrates Kansei Engineering and Kano model. In their proposed framework, firstly, customer affective emotions are derived from internet reviews. Then, using syntactic relations and a clustering method, related product features are positioned. By the help of Kano model, product characteristics are prioritized based on affective emotions to demonstrate their significance in terms of customer satisfaction. Then, they conducted two studies on smartphones and cameras to prove the feasibility and reliability of their proposed framework. While Kim et al. (2019) suggested a model in which users' affective variables were extracted from online reviews and categorized using a self-organizing map (SOM) to build an affective variable extraction methodology that can effectively and efficiently reflect users' implicit demands and performed an experiment on recliner for verification of their proposed model, Chen et al. (2019) used text mining to extract Kansei words and hotel service characteristics.

Text analytics can be used in Kansei engineering studies by employing ready-made text analytics programs or libraries written in a variety of programming languages. Kobayashi and Kinumura (2017) used KH coder text mining software to collect Kansei words, whereas Sakornsathien et al. (2019) used RapidMiner to prepare for and carry out the data mining process. Chiu and Lin (2018) and Chen et al. (2019) used the web browser tool in conjunction with IBM SPSS Modeler in their studies on road bike design and hotel service development, respectively. Li et al. (2020) also used web crawler tool to collect customer reviews from Amazon.com for stuffed toys. Lai et al., 2022 stated that Scrapy and Selenium were the main tools for extracting information from websites and they worked with the Scrapy automated crawler framework using the Python programming language.

One of the primary benefits of using text mining is that it corrects the cognitive asymmetry caused by the gap between the designer and the customer. With a better understanding of user needs, text mining and NLP techniques have reduced the likelihood of failure in the designer's product development process (Wang, 2022). In these text mining studies; researchers can be more proactive and respond to changes in customer preferences more quickly. Indeed, text mining not only helps researchers in dealing with difficulties encountered while conducting the study, but it also helps them in taking quick action in detecting changes or innovations in customer preferences.

3. METHODOLOGY

The research methodology of this study is divided into six major stages (Figure 1). The product domain is determined first. The platform from which the comments will be extracted is then determined. In the third and first stages, the URLs from the specified platform are extracted, followed by the comments from the URLs, and the data containing the reviews is cleaned and analyzed using NLP techniques. At the conclusion of the analysis, a list of Kansei words (KWs) for the relevant domain is compiled.

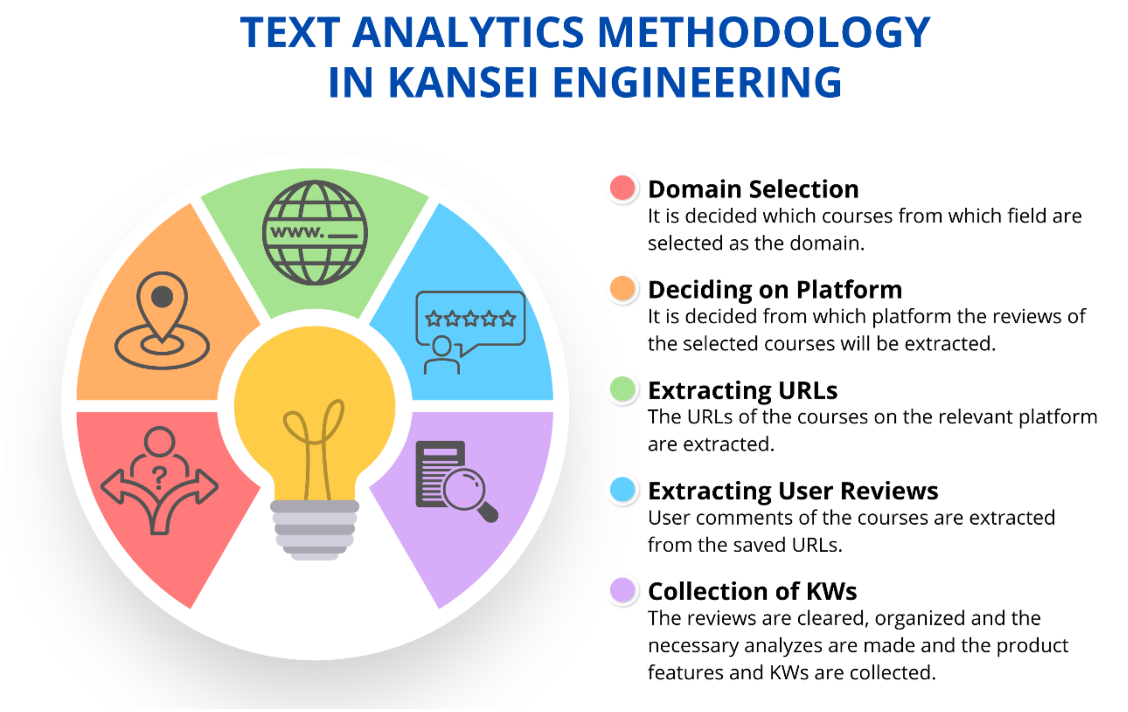

Figure 1. Text Analytics Methodology in Kansei Engineering

3.1 Domain Selection

The first stage of the methodology addresses domain selection. The product to be designed and who the product will serve are determined at this stage. The goal for this research is to develop a MOOC course as a final product. This study, however, will only determine Kansei words in this MOOC course design process. Online reviews, rather than traditional methods, will be used to investigate Kansei words from MOOC experiences in the 'Data Science' domain for this product.

3.2 Deciding on Platforms

MOOC platforms have grown in popularity, particularly during the pandemic, and thousands of students of all ages have begun to enroll in these courses. The high number of students brought with it the high number of user evaluations. As a result, the opportunity to work with big data has arisen. All MOOC platforms could be potentially included in the study as they offer a wide range of courses in data science. Coursera, on the other hand, was chosen as the primary platform in this study because it is in agreement with the authors' institution.

3.3 Extracting URLs and Reviews

Among the MOOCs released on the Coursera website, courses addressing business analytics, machine learning, and data science were identified, and web scraping codes were constructed to draw links to these courses as well as reviews on these links. Selenium (Thoughtworks, 2022) and BeautifulSoup (Richardson, 2019) together with the core libraries such as Numpy and Pandas were used in this procedure. The codes of Firebanks-Quevedo (2019), already publicly available, were utilized as a starting point, however they were adjusted to fit the new platform's new web source structure and updated library features. Additional codes were also created to address further requirements.

A total of 1000 courses in the discipline of data science on Coursera were found by extracting the URLs. Only English-instructed courses and those published in the domains of business analytics, machine learning, programming, statistics, and forecasting were preferred among these options. As a result, the authors decided to extract the reviews from 70 courses among 1000 courses. Web scraping codes were then executed to extract 60,000 reviews from the selected course URLs.

3.4 Collection of Kansei Words

The adjectives that can later be used as Kansei words for MOOCs were extracted from the reviews using text analytics techniques. The following procedures were used to process the reviews:

- Text cleaning
    - Tokenize
    - Remove punctuation, stop words, redundant spaces
    - Transform lowercase
    - Lemmatize
- Merging into a single document
- Extracting adjectives (Part-of-speech tagging)
- Extracting synonyms and antonyms

- Extracting distinctive adjectives

Python coding was used for all operations and calculations. The Spacy (Spacy, 2022) and Re (regular expression) libraries were utilized to perform the essential text processing in this process. To validate the extraction of adjectives for MOOCs, the preprocessed reviews were divided into two randomly selected parts, i.e., 75% for extraction and 25% for validation. Both samples were analyzed to filter the adjectives, and then the similarity between these samples were calculated. Cosine similarity is frequently used when computing similarity ratios between texts. In this case, the cosine similarity based on word embeddings and multi-dimensional meaning representations method in the Spacy library (Spacy API, 2022) was used to calculate the semantic similarity (99.9%). After the validation, term frequencies were tabulated and visualized. Synonyms and antonyms were extracted from WordNet (Fellbaum, 1998, ed.). Besides, the KeyBERT (Grootendorst, 2021) was used to extract key adjectives based on BERT embeddings (Sharma & Li, 2019). KeyBERT extracts the keywords that are the most comparable to the document. To obtain a document-level representation, BERT is used to extract document embeddings. Then, for N-gram words/phrases, word embeddings are extracted. Cosine similarity is used to find the most comparable words/phrases to the document.

The maximum sum similarity or maximum marginal relevance approaches can be used to obtain diversified key adjectives. In this approach, first, the 2 x top_n most similar words/phrases to the document were extracted. Then, top_n combinations from the 2 x top_n words were taken and the combination that was the least similar to each other were extracted based on cosine similarity. The diversity rate can be adjusted as a parameter in the related function.

For all coding, Jupiter notebooks were developed and executed in Anaconda or Google Colab regarding GPU requirements.

Authors evaluated all results along with the concepts of KE and finalized list of KE words.

4. RESULTS AND DISCUSSION

After performing NLP processes in the context of text analytics, the first adjective list was created. Figure 2 depicts a word cloud of adjectives based on their frequency of occurrence. As a result, the most frequently used adjectives include ‘good’, ‘basic’, ‘deep’, ‘nice’, ‘easy’, ‘interesting’, ‘excellent’, ‘useful’, ‘amazing’, ‘helpful’, ‘practical’, ‘great’, ‘informative’, ‘difficult’, ‘complete’, etc.

Figure 2. Word Cloud of Adjectives

Authors having prior experience in KE research processed this raw adjective list and developed a consolidated one. Additional procedures have been developed to extract synonyms and antonyms from WordNet for the remaining adjectives on this list. Table 1 shows a partial representation of all of 1325 adjectives, which are Kansei words obtained after this refinement. Supplementary synonyms and antonyms to the primary Kansei words can be used for further categorization.

Table 1. Partial Representation of Extracted Kansei Words

Adjective	Synonyms	Antonyms
Ambiguous	Equivocal	Unequivocal, Unambiguous
Consistent	Logical, Uniform, Ordered, Coherent, Reproducible	Incoherent, Inconsistent, Unreproducible
Critical	Decisive, Vital	Uncritical, Noncritical
Desirable	Worthy, Suitable	Undesirable
Dissatisfied	Disgruntled	Satisfied
Honest	Reliable, Honorable, True, Fair, Dependable, Good	Dishonest
Humble	Small, Chagrin, Low, Mortify, Lowly, Humiliate, Base, Baseborn, Modest, Menial, Abase	Proud
Nice	Skillful, Decent, Overnice, Squeamish, Prissy, Gracious, Courteous, Dainty	Nasty
Palpable	Tangible	Impalpable, Intangible
Reproducible	Consistent, Reproducible	Unreproducible
Responsible	Creditworthy	Irresponsible
Informative	Informatory, Illuminating, Enlightening, Instructive	Uninstructive, Uninformative, Unenlightening
Tangible	Touchable, Palpable, Real	Impalpable, Intangible
Undefined	Vague	Defined
Worth	Deserving	Worthless
Manageable	Doable, Achievable, Accomplishable, Realizable	Unmanageable

Following that, distinct adjectives were defined by using the KeyBERT technique to filter the entire list of Kansei words. The prominent findings include the adjectives ‘discouraging’, ‘disappointing/disappointed’, ‘dissatisfied’, ‘dismissing’, ‘erroneous’, ‘satisfactory’, ‘uneducated’, ‘informative’, ‘inadequate’, ‘reluctant’, disastrous’, ‘sophisticated’, ‘hesitant’, ‘confidant’, ‘noncomplete’, ‘shameful’, ‘shocking’. The adjectives that appear in this analysis are not those that are most frequently used, but rather those that best reflect the text semantically. Although positive words are present, it is striking to note that the prominent adjectives primarily express negative feelings. When this finding is evaluated, it can be said that users are more likely to share negative experiences than positive ones. As a result, these inferences should be interpreted as indicating that the courses do not have a completely negative structure, but rather that they have features that can be improved.

5. CONCLUSION

MOOCs have gained considerable momentum in the last decade, both in higher education and in lifelong learning activities. Many projects in this area have been launched, and a variety of platforms with various business models and strategies have been made available to anyone with an interest in learning. While every platform strives to create digital environments that maximize their technical potential, learner satisfaction is determined by how well these opportunities are presented to them and how well the course content meets their needs. As a result, gathering feedback on learning processes encountered on these platforms, as well as allowing students to freely share their experiences, are critical stages of continuous improvement efforts.

When evaluating user feedback and incorporating it into product development processes, various methodologies are used individually or in combination. Among these methods, Kansei Engineering was used in this study to understand the emotional characteristics of learner experiences published in MOOC reviews.

The first step in a KE study is to define the Kansei words for the product or service under consideration. Text analytics tools are critical in both data collection and the identification of Kansei words on platforms, such as MOOCs, where large amounts of text data are collected. Several experiments using a combination of KE and text analytics methodologies for various product types have been well documented in the literature.

Previously, Kansei words were mostly determined by experts based on their opinions, observations, or published works in literature, and the majority of text analytics efforts focused on extracting 'product features' in these studies. In contrast, this study presents a novel application of KE methodology by employing text analytics to identify Kansei words. Another distinct potential contribution worth mentioning is the application of KE to MOOCs as emerging service platforms.

NLP approaches were primarily used in this study's methodology. From the preprocessed terms, those that can be evaluated within the scope of KE were filtered, and a comprehensive list was created by drawing synonyms and antonyms at the same time. Following that, the KeyBERT technique, which uses similarity metrics to generate a list of distinct adjectives using word embeddings, produced results that supplemented the findings. This process was demonstrated on Coursera courses in the Data Science category. Except for the filtering of adjectives which are used for identifying Kansei words, all stages are automated by running scripts through the relevant Python libraries, such as retrieving course links, retrieving course reviews, and performing NLP operations.

It should be noted that this study presented preliminary findings from an ongoing study aimed at identifying and implementing service features to improve the quality of MOOCs.

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doi: 10.5821/conference-9788419184849.67

THE RELATIONSHIP BETWEEN ATTRACTIVENESS AND FEMININITY IN FEMALE GAIT

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ABSTRACT

The evaluation of physical attractiveness has been reported to be related to the psychological process for detecting associated physiological health and fertility features. The femininity of the female gait is also associated with its attractiveness. However, it is unclear whether femininity is always attractive in female gait and what physical characteristics are perceived as being attractive and/or feminine. In this study, we aimed to understand the root of the attractiveness of human movement by examining the relationship between perceived attractiveness and femininity in female gait. First, we created 30 s gait animations by using 3D motion capture data of 10 female nonmodels and seven female runway models, where they walked either barefoot or in high heels. Then, 60 observers evaluated the attractiveness and femininity of each animation. We compared the scores of attractiveness (A-scores) and femininity (F-scores) of the models and nonmodels, and we examined the factors related to the evaluation (A-scores and F-scores), namely, the walkers' height, weight, BMI, and the characteristics of movements. Consequently, both the A-score and the F-score were high for the models' gait in high heels. Conversely, in the other conditions, there were two types of attractiveness–femininity relationships—a linear relationship (high A-score and F-score, or low A-score and F-score) and an unequal relationship (high F-score but low A-score). Most physical and motion factors correlated with both the A-score and the F-score; however, BMI, flexibility at the thoracolumbar joint, stride time CV, and toe-off angle were related to either the A-score or the F-score.

Keywords: *locomotion, attractiveness, femininity, high-heel walking*

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1 INTRODUCTION

Physical attractiveness is a key factor in our social communication. The perception of beauty in human beings is associated with the detection of specific physiological health-related (Symons, 1995; Thornhill & Gangestad, 1999; Gangestad & Scheyd, 2005; Singh & Singh, 2011; Sugiyama, 2015) and sociocultural (Berscheid & Walster, 1974; Langlois et al, 1987) features. Mate attractiveness in nonhuman species is also known to be related to survival and reproduction (Norris, 1993; Petrie, 1994; Birkhead & Fletcher, 1995; Weiss, Kennedy, Safran, McGraw, 2011). A female lumbar curvature similar to that observed during pregnancy (approximately 45.5°) has been reported to be the most attractive to men (Lewis, Russell, Al-Shawaf, & Buss, 2015; Lewis et al, 2017), which supports the idea that female attractiveness is ultimately related to fertility. From these previous studies, it is believed that the observer's evaluation of the attractiveness of human movement is also related to the observed actor’s health-related or sex-specific physical/motion characteristics.

Walking is a basic human movement, and gait kinematics is one of the cues for female attractiveness (Guéguen, 2015; Fink, Apalkova, Butovskaya, & Shackelford, 2021). Morris, White, Morrison, and Fisher (2013) reported that shortened stride length and greater hip rotation were key factors for the attractiveness of females walking in high heels. They suggested that the gait can be manipulated to alter female attractiveness by using female sex-specific or feminine body motion. However, femininity in motion is believed to embody multiple factors—motion factors such as pelvic obliquity, arm swing, and torso rotation (Bruening, Frimenko, Goodyear, Bowden, & Fullenkamp, 2015) and sex-specific physical factors such as the shape of the bosom and buttocks, height, and weight. Considering that tall fashion models are attractive targets in the media, femininity and attractiveness in motion are not always thought to be the same. By clarifying the relationship between gait attractiveness and femininity, it is possible to further deepen our understanding of psychological processes in human perception of attractiveness.

Additional contributors to gait attractiveness may include the features of runway walking, which can be believed to embody an aesthetically optimal gait, and include waist rotation, leaning backward, the alignment of the upper torso, and the reduction of the arm swing (Or, 2012). Even in nonmodels, a gait like that of a fashion model may be the standard of attractiveness. However, unlike the nonmodel gait, the model’s gait has the purpose of making clothes look attractive rather than the walker herself, so the standard for evaluating attractiveness may differ between the model and nonmodel gait. By examining the observer’s recognition of the attractiveness and femininity of the model’s gait, it becomes possible to understand the influence of the walker’s aesthetic intention on gait kinematics.

In this study, we aimed to investigate the physical and motion factors that are the standard for the observer’s evaluation of the attractiveness and/or femininity of female gaits (including models) and to explore the relationship between gait attractiveness and femininity. Height, weight, and BMI were candidates for inclusion as salient physical factors. Additionally, because lumbar curvature and whole-body silhouettes are believed to be linked to gait attractiveness and/or femininity, we calculated the flexibility of the upper body, the forward–backward silhouette of the limbs, and gait parameters related to aging, disability, and health condition as candidates for inclusion as motion factors. The results of this study will contribute to the artificial generation of feminine or attractive gait in the future.

2 METHODS

All procedures involved in this study were conducted according to the Declaration of Helsinki and were approved by the Ethics Committee of Nagoya University. The individuals participating in this study provided written informed consent to participate in this study and for us to publish these case details. Informed consent continued throughout the study via a dialog between the researcher and participants.

2.1 Experiment for creating gait animation

We recruited seven professional runway models (age, 42.4 ± 7.0 years; height, 170.6 ± 3.7 cm; and weight, 55.6 ± 3.4 kg) and 10 nonmodels (age, 34.0 ± 7.2 years; height, 162.0 ± 5.4 cm; and weight, 54.7 ± 7.7 kg). They walked on a treadmill in high heels or barefoot (two trials for each footwear condition) at a speed of 1.0 m/s. We used a three-dimensional (3D) optical motion capture system (OptiTrack V100—R2; NaturalPoint, Corvallis, OR) with a sampling frequency of 100 Hz to obtain the position of the following feature points during gait: the top of the head, the ears, the acromions, the elbows (calculated as the middle point between the humerus-medial epicondyle and the humerus-lateral epicondyle), the wrists, the upper margin of the sternum, the sternum-xiphoid process, the lowest edge of the ribs, the c7 vertebra, the t8 vertebra, the t12 vertebra, the anterior superior iliac spine, the posterior superior iliac spine, the greater trochanter, the lateral and medial knee joint space, the malleolus lateralis and medialis, the toe and calcaneus, and the bottom of the heel for the high-heel condition.

The time series data for the joint center coordinates were then passed through a fourth-order Butterworth low-pass filter with a cut-off frequency of 6 Hz, which was used to create a 30 s gait animation. During those 30 s, we rotated the viewpoint of the animation at a constant speed from the front right to the back left of the walker (Figure 1 illustrates the beginning and end of the animation). The number of animations was 68 (17 participants, two footwear conditions, and two trials for each). Additionally, we calculated the 3D joint angles for the ankle, knee, hip, lumbosacral joint, thoracolumbar joint, neck, shoulder, and elbow. These joint angle data were used to investigate the motion factors that affect the observer’s judgment of attractiveness and femininity (see Section 2.3). All signal processing was conducted using Matlab R2021a.

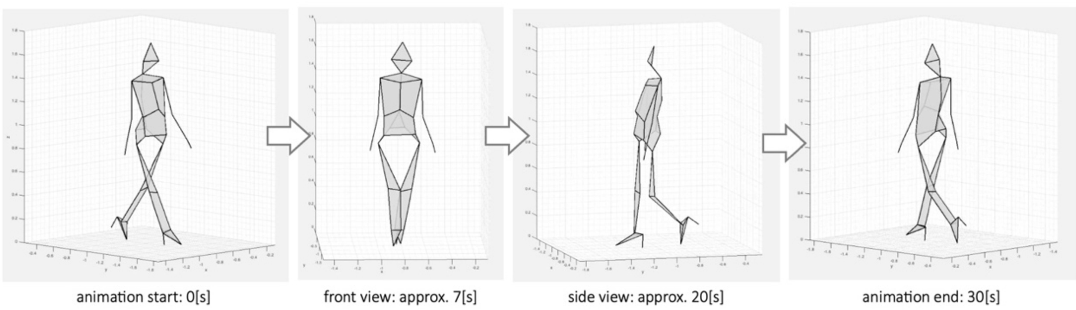


Figure 1. The flow of animation (in this sample, high-heel condition)

2.2 Experimental protocols and measurements

Thirty healthy women (age: 20–59 years) and 30 healthy men (age: 24–58 years) participated in the attractiveness/femininity evaluation experiment. Participants viewed the 30 s walking animations presented on a standard computer monitor (EIZO FlexScan EV2480). The order of presentation was randomized, and they were asked to keep their eyes on the animation while it was moving. Within 30 s after each animation stopped, participants judged the attractiveness and femininity on a 7-point Likert scale: 1 low to 7 high attractiveness/femininity. We gave no information about walkers (e.g.,., age, sex, and occupation) to the participants. Participants took a break after every 17 animation evaluations.

2.3 Data analysis

First, we qualitatively observed the relationship between the attractiveness score (A-score) and the femininity score (F-score) in model/nonmodel × barefoot/high-heel conditions. After that, to determine the factors that affect the A-score and the F-score, we investigated the relationship between each score and the walker's appearance factor (height, weight, and BMI) or motion factors. Motion factors were calculated as the flexibility of the upper body and limb silhouette. The flexibility of the upper body per unit time was calculated as follows:

$$F_i = |\theta_i - \bar{\theta}_i|$$

where *i* represents the lumbosacral and thoracolumbar joints and $\bar{\theta}_i$ is the mean joint angle. We calculated F_i for each 3D plane (the sagittal, frontal, and horizontal planes) separately. F_i of the null represents the complete immobility of the joint. We then calculated the mean value of each upper body joint's flexibility during the single stance phase (20%–40% and 70%–90% gait cycle) as the representative value for each joint's flexibility. We focused on flexibility during the single stance phase because, in our preliminary experiment, we had observed the greater flexibility of upper body joints during the single stance phase in models (who could be the embodiment of physical attractiveness) compared with nonmodels.

Additionally, we calculated the limb and head silhouette in a forward–backward direction as follows:

$$S_i = r_i \cdot \sin\theta_i$$

where θ_i represents the joint angle at the knee, shoulder, and neck in the sagittal plane. r_i is the segment length of the shank, upper arm, and head. S_i of positive and negative directions represents backward and forward deviation of the limb silhouette. The reason we focused on those three body parts (legs, upper arm, and head) is that push-off motion at the knee is related to the walker's youth and health (Hamrin et al., 1982; Nakamura et al., 1985; Bohannon, 1997), the head forward/backward silhouette is a cue to emotional expression/perception (Gross et al., 2011; Venture et al., 2014), and backward orientation of the upper arm during walking could have the effect of emphasizing the breasts, which are one of the biological characteristics of females. The mean value of S_{neck} and $S_{shoulder}$ during all gait cycles and the mean of S_{knee} during the push-off phase were calculated as the representative value of each animation. Additionally, we calculated the following general gait parameters—stride time CV (coefficient of variation of time required for one gait cycle), symmetry (ratio of left and right swing time), cadence (steps per minute), heel-contact angle, toe-off angle, and minimum toe clearance (minimum height at which the toes are off the floor during the swing phase).

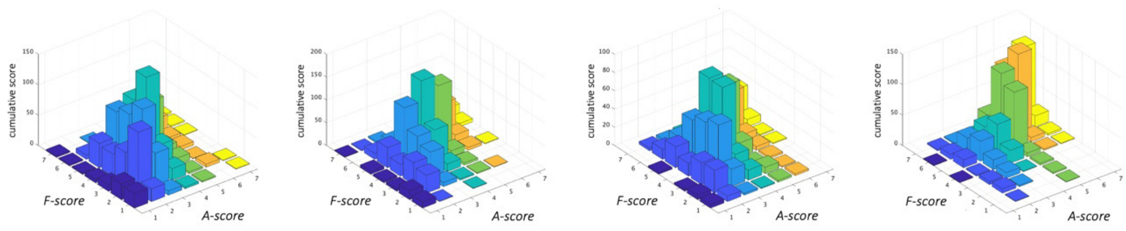
Finally, we investigated the physical and motion factors that affect the observer's attractiveness and/or femininity evaluation using Pearson's correlation coefficient test between A-/F-score and the abovementioned factors. We focused on differences in factors related to evaluation between A-score and F-score.

3 RESULTS

We first observed the relationship between A-score and F-score qualitatively for female gait in model/nonmodel × barefoot/high-heel conditions. Then, we investigated the physical and motion factors that affect the A-score and/or the F-score.

3.1 Are attractiveness and femininity the same in female gait?

To address the question of whether attractiveness and femininity in female gait always coincide, we investigated the relationship between the A-score and the F-score for each group and each footwear condition. Figure 2 illustrates the cumulative score from all the observers for (a) the nonmodels' barefoot gait (20 animations), (b) the nonmodels' gait in high heels (20 animations), (c) the models' barefoot gait (14 animations), and (d) the models' gait in high heels (14 animations). We obtained the following findings through qualitative analysis: 1) both the A-score and the F-score were high for the models' gait in high heels (Figure 2d), and 2) for the other conditions, there were two types of relationship—one is linear (high A-score and F-score, or low A-score and F-score) and the other is an unequal relationship (high F-score but low A-score). These results suggested that high attractiveness is associated with femininity, but low attractiveness is not associated with femininity, that is, femininity is a necessary but not sufficient condition for attractiveness in female gait.



(a) non-model/barefoot (b) non-model/high-heel (c) model/barefoot (d) model/high-heel

Figure 2. Attractiveness and femininity relationship in female gait

3.2 Physical and motion factors that affect the evaluation

Next, we investigated the physical and motion factors that are related to the A-score and/or the F-score. Correlation coefficients were calculated for each walker group (N, nonmodel; M, model) and the footwear condition (barefoot, high heels). Table 1 and Table 2 show the results of Pearson's correlation coefficient test between the physical/motion factors and the A-score or the F-score, respectively. Only items with statistically significant correlations are summarized in the table. The abbreviations of F_{thor_s}, F_{thor_f}, S_{head}, S_{arm}, and S_{shank} in the table represent flexibility at the thoracolumbar joint in the sagittal and frontal planes and the silhouette of the head, arm, and shank in the forward (negative value) and backward (positive value) directions, respectively. Additionally, ST CV and TO angle in the tables stand for stride time coefficient of variation and toe-off angle, respectively. Items with a statistically significant correlation ($r > 0.4$ and $P < 0.05$) are shown in bold. Additionally, factors that showed significant correlation both with the A-score and the F-score are shaded. The factors not listed in the tables, namely, the flexibility of the thoracolumbar joint in the frontal plane, flexibility of the neck in the horizontal plane, gait symmetry, cadence, heel-contact angle, and clearance, did not correlate with either the A-score or the F-score.

The A-score of nonmodels was negatively correlated with their weight (barefoot: $r = -0.519$, heel: $r = -0.484$). It was also correlated with flexibility at the thoracolumbar joint in the sagittal plane (F_{thor_s}) only under barefoot condition ($r = 0.519$). Additionally, the A-score of nonmodels was negatively correlated with the silhouette of the head (S_{head}) (barefoot: $r = -0.568$, heel: $r = -0.776$) and shank (S_{shank}) during the push-off phase (heel: $r = -0.671$) and was positively correlated with the silhouette of the arm (S_{arm}) (barefoot: $r = 0.691$, heel: $r = 0.522$). Among general gait parameters, only the stride time CV showed a negative correlation with the A-score of nonmodels when they wore high heels. For models, only flexibility at the thoracolumbar joint in the sagittal plane (F_{thor_s}) and silhouette of the arm (S_{arm}) showed a positive correlation with the A-score.

Table 1. Pearson's correlation between A-score and physical/motion factors

	N-bare		N-heel		M-bare		M-heel	
	r	P	r	P	r	P	r	P
Height	-0.381	0.0970	-0.409	0.0733	0.102	0.729	0.0196	0.947
Weight	**-0.519**	**0.0191**	**-0.484**	**0.0306**	-0.400	0.157	-0.300	0.298
BMI	-0.428	0.0600	-0.359	0.120	-0.487	0.0771	-0.326	0.255
F_{thor_s}	**0.519**	**0.0189**	-0.0173	0.942	**0.560**	**0.0374**	0.370	0.193
S_{head}	**-0.568**	**0.00903**	**-0.776**	**<0.001**	-0.368	0.196	-0.115	0.696
S_{arm}	**0.691**	**<0.001**	**0.522**	**0.0181**	**0.698**	**0.00551**	**0.798**	**<0.001**
S_{shank}	-0.137	0.565	**-0.671**	**0.00119**	-0.266	0.358	0.149	0.611
ST CV	-0.275	0.24151	**-0.448**	**0.0477**	-0.492	0.0739	-0.333	0.245
TO angle	0.0127	0.958	0.413	0.0707	0.377	0.184	0.281	0.331

Table 2 shows the correlation coefficients between the F-score and each factor. The F-score of nonmodels was negatively correlated with their height (barefoot: $r = -0.520$, heel: $r = -0.513$), weight (barefoot: $r = -0.656$, heel: $r = -0.609$), and BMI (barefoot: $r = -0.520$, heel: $r = -0.456$). Similar to the A-score, it was correlated with flexibility at the thoracolumbar joint in the sagittal plane only under the barefoot condition ($r = 0.465$). The F-score of nonmodels showed a strong negative correlation between the silhouette of the head (barefoot: $r = -0.720$, heel: $r = -0.714$) and the shank (heel: $r = -0.620$). It was also positively correlated with the silhouette of the arm (barefoot: *r* = 0.445, heel: *r* = 0.551). For models, their silhouette of the arm also positively correlated with the F-score (barefoot: *r* = 0.645, heel: *r* = 0.684). Additionally, the models' toe-off angle during the barefoot condition showed a strong positive correlation with the F-score.

Table 2. Pearson's correlation between the F-score and physical/motion factors

	N-bare		N-heel		M-bare		M-heel	
	r	P	r	P	r	P	r	P
Height	**-0.520**	**0.0188**	**-0.513**	**0.0208**	0.283	0.326	0.178	0.544
Weight	**-0.656**	**0.00169**	**-0.609**	**0.00436**	-0.128	0.663	-0.246	0.396
BMI	**-0.520**	**0.0188**	**-0.456**	**0.0434**	-0.348	0.222	-0.388	0.171
F_{thor_s}	**0.465**	**0.0387**	0.0855	0.720	0.528	0.0521	0.351	0.219
S_{head}	**-0.720**	**<0.001**	**-0.714**	**<0.001**	-0.449	0.108	-0.363	0.201
S_{arm}	**0.445**	**0.0493**	**0.551**	**0.0119**	**0.645**	**0.0127**	**0.684**	**0.00699**
S_{shank}	-0.364	0.114	**-0.620**	**0.00355**	-0.199	0.496	0.0198	0.946
ST CV	-0.307	0.187	-0.427	0.0605	-0.350	0.220	-0.442	0.114
TO angle	0.0640	0.789	0.276	0.239	**0.700**	**0.00529**	**0.527**	**0.0530**

In summary, the differences between the F-score and the A-score were found in the following factors: 1) height and BMI: short and low BMI nonmodels' gait was evaluated as feminine, but not attractive; 2) low stride time CV of nonmodels' gait was evaluated as attractive, but not feminine; and 3) models' gait with large toe-off angle during the barefoot condition was evaluated as feminine, but not attractive.

4 DISCUSSION

In this study, we addressed the question of whether femininity and attractiveness are equivalent in female gait. We obtained attractiveness and femininity evaluation scores for 3D animations of walking barefoot and in high heels from 60 participants who included fashion models and nonmodels. There were no gender or age differences between the observers for attractiveness and femininity ratings. In addition to a matched relationship between attractiveness and femininity, we observed gait with high femininity and low attractiveness in both the nonmodel gait and the model barefoot gait. A link between female attractiveness and femininity had been reported (Buss, 1989; Perre et al, 1998); however, in this study, it was suggested that feminine gaits are not always attractive. Stride length and hip rotation and tilt have been demonstrated to be related to gait femininity and, hence, to female gait attractiveness (Morris et al, 2013). In this study, we examined the physical and motion factors that affect each of the A- and F-scores.

We calculated the Pearson's correlation between the A- and F-scores and physical and motion factors—height, weight, and BMI were candidates for physical factors, and flexibility of the upper body in the sagittal and frontal planes, forward—backward silhouette of the limb, and gait parameters related to aging and disability (stride time CV, symmetry, cadence, heel-contact angle, toe-off angle, and minimum toe clearance) were candidates for motion factors. As a limitation of this study, we do not understand the causal relationship between variables because we focused on correlations. Among the nonmodels, the walkers who were lighter, leaned their head forward, and pulled their upper arm backward were evaluated as more attractive in both the barefoot and high-heel conditions (Table 1). Additionally, barefoot gait with high flexibility at the thoracolumbar joint in the sagittal plane and high-heel gait with knee extension during the push-off phase were evaluated as attractive for nonmodels (Table 1). These results were also the same for the evaluation of femininity (Table 2). Because a backward swing of the upper arm could have the effect of emphasizing the breasts, and because the flexibility at the thoracolumbar joint could construct a lumbar curvature that mediates fertility information (Lewis et al, 2017), such sexuality information may induce a perception of charm and femininity. Additionally, the association between health and knee extension has been observed in studies of patients with spastic hemiparesis, whose walking capacity is related to the muscle strength of knee extension (Hamrin et al, 1982; Nakamura, Hosokawa, & Tsuji, 1985), and in studies of aging itself that demonstrate a correlation between knee extension and age-related declines in maximum gait speed (Bohannon, 1997). From these results in this study, it is considered that the criteria for the perception of gait attractiveness and femininity are mostly common in that they are manifestations of walkers' health and reproductive function, which is consistent with previous studies (Symons, 1995; Thornhill & Gangestad, 1999; Gangestad & Scheyd, 2005; Singh & Singh, 2011; Sugiyama, 2015).

In comparison, a difference between the evaluation criteria of femininity and attractiveness was found in nonmodels' height and BMI—shorter height and smaller BMI are evaluated as feminine but not as attractive. This result suggests that the short and thin body shape may be evaluated as feminine in comparison with males, but it may not be evaluated as attractive because the low BMI is inconsistent with the health of walkers. Additionally, less stride time CV was evaluated as attractive but not as feminine in nonmodels' high-heel gait. Stride CV is associated with fall risk (Hausdorff, Rios, & Edelberg, 2001), and this result also supports the idea that the health-related factors affect the judgment of female attractiveness. For models' gait, the toe-off angle was positively correlated with only the F-score in both footwear conditions. Since the toe-off angle is considered to be linked to the knee extension during the push-off phase, it may be related to the health of the walker. Because there may be factors that affect the A-score and F-score other than the factors focused on in this study, to comprehensively detect factors that affect the judgment of attractiveness and femininity in female gait, we could use the method of machine learning to classify female gait in the context of attractiveness or femininity.

In this study, it was clarified that attractiveness and femininity in female gait did not always match each other—sometimes, it was perceived as feminine but not as attractive. This nonuniformity of gait attractiveness and femininity could be due to the balance between factors involved only in femininity or attractiveness (that is, the weight of factors for evaluation). To examine the weight of each factor for the A-score and F-score, we conducted a multiple regression analysis using physical and motion factors as a candidate for explanatory variables under each group and condition; however, we could not obtain a high multiple correlation coefficient (R = 0.3 ~ 0.4). Although we could not obtain a significant multiple regression model to explain the A- and F-scores, factors that showed a statistically significant correlation in this study tended to be significant explanatory variables in multiple regression analysis. To obtain a more accurate multiple regression model, in a future study, we should collect a large amount of data on the A-score and the F-score for classifying attractive or feminine gait by using a bottom-up method of machine learning. Additionally, other biomechanical factors may be related to the A-score or F-score among the factors not suggested by previous studies. Such an exhaustive search makes it possible to generate feminine or attractive gaits artificially in the future.

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THE RELATIONSHIP BETWEEN LEISURE ACTIVITIES AND SUBJECTIVE WELLBEING AMONG MIDDLE-AGED CHINESE PEOPLE
FOCUSING ON MEN LIVING IN SHANGHAI, CHINA

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ABSTRACT

This study investigated and analyzed the relationship between leisure activities and subjective wellbeing among middle-aged people in China. Specifically, we conducted a web-based questionnaire survey of men living in Shanghai, one of the cities directly under the jurisdiction of the Chinese government, which did not show any significant change in the frequency of participation in leisure activities before and during COVID-19. Based on the survey results, we used SEM(Structural Equation Modeling) to analyze the relationship between the three categories of leisure activities and subjective wellbeing. The results showed that the disciplines classified as hobbies and sports sectors had a significant positive impact on positive emotions, one of the elements of subjective wellbeing.

Keywords: *Middle-aged Chinese people, Leisure activity, Subjective Well-being*

1 INTRODUCTION

1.1 Background

Subjective wellbeing is one of the areas of well-being that has recently received attention from research on design. According to “the U Shape of Happiness” proposed by David G, middle age is the period of lowest well-being in life [1], making it an important issue to focus on the wellbeing of middle-aged people Lyubomirsky has found that 40% of an individual's wellbeing is determined by intentional activities [2]. It is an important issue to understand the relationship between subjective wellbeing and leisure activities from a design perspective.

Most studies of subjective wellbeing in China have focused on older people and patients. The focus is on the relationship between factors such as personality, social support and education and subjective well-being. Many middle-aged people in China have psychological problems such as 'mid-life crisis'. There are few studies on wellbeing among middle-aged people in China. Leisure activities in China were positioned for the purpose of physical health and cultural learning, and the relationship with wellbeing was not emphasised among participants in leisure activities and providers of these leisure activities.

1.2 Purpose

Based on the above background, this study aims to understand the relationship between subjective wellbeing and leisure activities as a starting point for deriving guidelines for new initiatives on leisure activities, with middle-aged people in China as the target group.

2 RESEARCH TRENDS ON SUBJECTIVE WELLBEING

2.1 Definition of subjective wellbeing

Diener believes that subjective wellbeing refers to how people evaluate their lives and includes life satisfaction, positive feelings, as well as negative feelings. This theory is currently supported by a number of scholars.

2.2 Relevant factors of subjective wellbeing

Lyubomirsky found that an individual's wellbeing is determined 50% by genetics, 10% by environment and 40% by intentional activity. Hashimoto's research states that people's behaviors are formed by 'essential activities' that are indispensable for living, such as work and hospital visits, and 'leisure activities' that are not necessarily necessary for living, but from a design perspective, 'leisure activities' are mostly easy to implement. Therefore, we can say that design can change people's leisure activities and improve their wellbeing.

2.3 Components of subjective wellbeing

Diener proposed the SWB model in 1984. This model suggests that subjective well-being can be divided into cognitive and affective components. The cognitive component is the evaluation of and satisfaction with life, while the affective component is the impact of positive and negative emotions in the past period.

2.4 How subjective wellbeing is measured

Initially, most studies on subjective wellbeing used the single-item self-report scale method, which was mostly a life satisfaction survey. However, the single-item self-report scale method has only one question item and is susceptible to random errors. In view of the shortcomings of the single-item self-report scale method, a multi-item self-report scale was developed: the SWLS (Satisfaction with Life Scale) [3], published by Diener in 1985, is the most widely used multi-item overall satisfaction scale for life satisfaction. Also, in scales concerning emotional aspects. Widely used nowadays are PANAS by Watson [4] and MUNSH by Kozma and Stones [5].

3 THE RELATIONSHIP BETWEEN COVID19 AND LEISURE ACTIVITIES

3.1 Purpose

To understand the likely impact of covid 19 on the leisure activities of middle-aged people living in municipalities with high population density, which are considered to be more affected by covid 19 than other cities, and to determine the relationship between the frequency of participation in leisure activities before the end of 2019 when covid 19 occurs and currently after covid 19 occurs.

3.2 Method

Among the four municipalities under direct control, it was decided to select the area to be surveyed as 'Shanghai', which was considered to have been greatly affected by the covid 19, and 'Tianjin', which was less affected by the covid 19, taking into account differences in the number of infected people, deaths and other factors.

The survey included three questions on the subject's attributes (1) gender, (2) region, (3) age, and five questions on the frequency of participation in leisure activities before and during covid 19 (4) sports (28 activities), (5) hobbies (31 activities), (6) entertainment (22 activities), (7) tourism (12 activities) and (8) others (18 activities) [6-7].

The method of response was a single response for (1) to (3) regarding the subject's attributes. For (4) to (8) regarding leisure activities, a 6-point scale was used for the frequency of participation in each category before and during covid 19 (not at all = 1 - more than three times a week = 6).

The questionnaire survey was conducted via the web in September 2021, targeting members of the survey company aged 46-60 years living in Shanghai and Tianjin.

3.3 Analysis and Result

Based on the calculated means, t-tests of the means were conducted for each of the five leisure activities, categorised as a whole and by gender and region. The results show that, in terms of gender, the frequency of participation in the 'sports', 'hobbies' and 'entertainment' sector was significantly higher among women during covid 19 than before covid 19. On the other hand, the 'tourism' and 'others' remained unchanged. For men, the frequency of participation in all leisure activities did not change before and after covid 19. By region, the frequency of participation in the 'sports', 'hobbies' and 'entertainment' sector was significantly higher for those living in Tianjin during covid 19 than before covid 19. On the other hand, the frequency of participation in the 'tourism' sector was lower. There was no change in the frequency of participation in "others " sector. In Shanghai, participation frequency increased only in the 'hobbies' sector. The above results are summarized in Table 1. Therefore, we chose men in Shanghai, who are less affected by the covid 19, as the study population in Chapter 4.

Table 1. Mean frequency of participation in leisure time activities before and during the covid 19 and results of t-tests

				Sports		Hobbies		Entertainment		Tourism		Others	
Overall			Before	1.23	difference exists	1.64	difference exists	1.43	difference exists	1.62		1.94	
			During	1.28		1.75		1.50		1.54		1.97	
	Gender	Male	Before	1.31		1.62		1.56		1.68		1.85	
			During	1.31		1.66		1.61		1.58		1.87	
		Female	Before	1.20	difference exists	1.65	difference exists	1.37	difference exists	1.59		1.98	
			During	1.26		1.80		1.45		1.52		2.01	
	Region	Tianjin	Before	1.27	difference exists	1.58	difference exists	1.38	difference exists	1.52	difference exists	1.83	
			During	1.34		1.68		1.48		1.45		1.92	
		Shanghai	Before	1.20		1.71	difference exists	1.49		1.72		2.04	
			During	1.22		1.83		1.53		1.64		2.02	

4 THE RELATIONSHIP BETWEEN SUBJECTIVE WELLBEING AND LEISURE ACTIVITIES

4.1 Purpose

The aim is to identify the relationship between the components of subjective wellbeing and the sectors and specific disciplines of leisure activities.

4.2 Identification of activity items

Based on the results of 3, we calculated the average frequency of activities in each of the five sectors and the average frequency of activities in all five sectors, compared the lower value with the average value for each sector, and selected the sectors above that value as the ones to be studied.

4.3 Survey on elements of subjective wellbeing and leisure activities

Based on the results of section 3, the study population was defined as middle-aged male residents of Shanghai who were not significantly affected by the covid 19 in their frequency of participation in leisure activities.

The survey included four questions on the subject's attributes (1) age, (2) work, (3) health, (4) residence and (5) household composition, and five questions on leisure activities (6) sports (8 activities), (7) hobbies (11 activities), (8) entertainment (7 activities), (9) tourism (7 activities) and (10) others (11 activities), and three questions on subjective wellbeing (11) life satisfaction (5 categories), (12) positive emotions (10 categories) and (13) negative emotions (10 categories).

The method of response was single response for (1) to (4) regarding the subject's attributes, and multiple responses for (5). Leisure activities (6) to (10) were rated on a 7-point scale (less than once a year = 1 to more than once a week = 7). For subjective wellbeing (11) to (14), a seven-point scale was used (not at all agree = 1 to very much agree = 7).

4.4 Relationship between elements of subjective wellbeing and leisure activities

First, the events in the 'tourism' sector were excluded because they were unlikely to be considered as daily leisure activities and the frequency of participation was the lowest. In addition, as the events classified as "other sectors" are diverse, it was decided to move them to one of the 'sports sectors', 'hobbies sectors' or 'entertainment sectors' based on their content.

A model diagram of the relationship between the three sectors 'sports', 'hobbies' and ' entertainment' and the three components of subjective wellbeing was developed, and 11 hypotheses were formulated for these sectors. The model diagram is shown in Figure 1 and the hypotheses in Table 2.

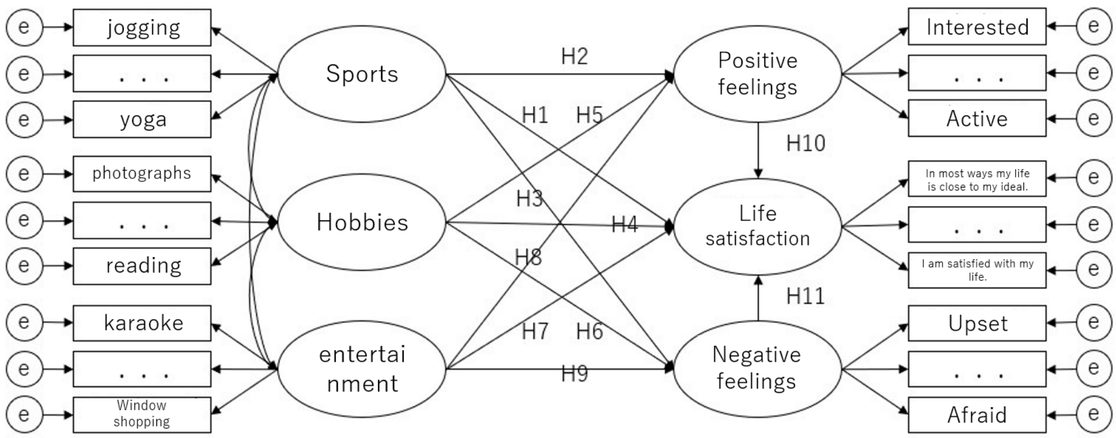

Figure 1. Relationship between the model diagram created and the 11 hypotheses.

Table 2. Details of 11 hypotheses

Number	hypothesis
H1	Sports sector activities affect life satisfaction
H2	Sports sector activities affect positive feelings
H3	Sports sector activities affect negative feelings
H4	Hobbies sector activities affect life satisfaction
H5	Hobbies sector activities affect positive feelings
H6	Hobbies sector activities affect negative feelings
H7	Entertainment sector activities affect life satisfaction
H8	Entertainment sector activities affect positive feelings
H9	Entertainment sector activities affect negative feelings
H10	Positive feelings affect life satisfaction
H11	Negative feelings affect life satisfaction

There are then six latent variables in the model and the corresponding observed variables are matched to these six latent variables. The latent and observed variables for leisure activities and subjective wellbeing are shown in Tables 3 and 4.

Finally, the data from the questionnaire was incorporated into a model based on the correspondence between latent and observed variables and use Structural Equation Model to analysis.

Table 3. Latent and observed variables on leisure activities.

Latent	Observed	Latent	Observed	Latent	Observed
Sports	Jogging, marathon	Hobbies	Photography	Entertainment	Karaoke
	Gymnastics, Tai Chi		Video production / editing		Video games (at home)
	Training		Watching videos		Game center, game corner
	Aerobics, jazz dance		Gardening, gardening		Billiards
	Table tennis		Cooking (excluding everyday items)		Eating out
	Badminton		Movies (excluding TV)		Bars, snacks, pubs, bars
	Cycling, cycle sports		Music appreciation		TV, radio
	Swimming (in the pool)		Tea		Barbecue
	Walking		Flower		Complex shopping center
	Yoga		Personal computer		Esthetic, home esthetic
			Learning, research		Online game
			Pets (play / care)		Window shopping
			Volunteer activities		
			SNS, digital communication		
			Reading		

Table 4. Latent and observed variables on subjective wellbeing.

latent	observed	latent	observed	latent	observed
life satisfaction	In most ways my life is close to my ideal	positive feelings	Attentive	negative feelings	Hostile
	The conditions of my life are excellent		Active		Irritable
	I am satisfied with my life		Alert		Ashamed
	So far I have gotten the important things I want in life		Excited		Guilty
	If I could live my life over, I would change almost nothing		Enthusiastic		Distressed
			Determined		Upset
			Inspired		Scared
			Proud		Afraid
			Interested		Jittery
			Strong		Nervous

The results show that the reliability Cronbach's Alpha values are greater than 0.7. And the SMC values of the observed variables were all greater than 0.5, the goodness of fit GFI of the model was greater than 0.8, the value of Chi-square/df was between 1.5 and 3 and the RMSEA value was less than 0.08, which were acceptable [8].

From the path significance probabilities, the hypothetical H2, H5, H9, H10 and H11 were validated, as paths with p-values less than 0.05 are significant paths Table 5.

Table 5. Hypotheses validated results

Number	Hypothesis	P	Result
H2	Sports sector activities affect positive feelings	0.003	Supported
H5	Hobbies sector activities affect positive feelings	***	Supported
H9	Entertainment sector activities affect negative feelings	0.004	Supported

H10	Positive feelings affect life satisfaction	***	Supported
H11	Negative feelings affect life satisfaction	0.005	Supported

The calculated path coefficients are added to the model diagram and shown in Figure 2. In terms of the relationship between the components of subjective wellbeing, positive and negative affect are independent of each other, with positive affect having a positive impact on life satisfaction and negative affect having a negative impact on life satisfaction. In terms of the degree of influence, positive affect (0.63) was found to be greater than negative affect (0.18). In terms of improving subjective wellbeing, positive emotions are more useful for improving subjective wellbeing.

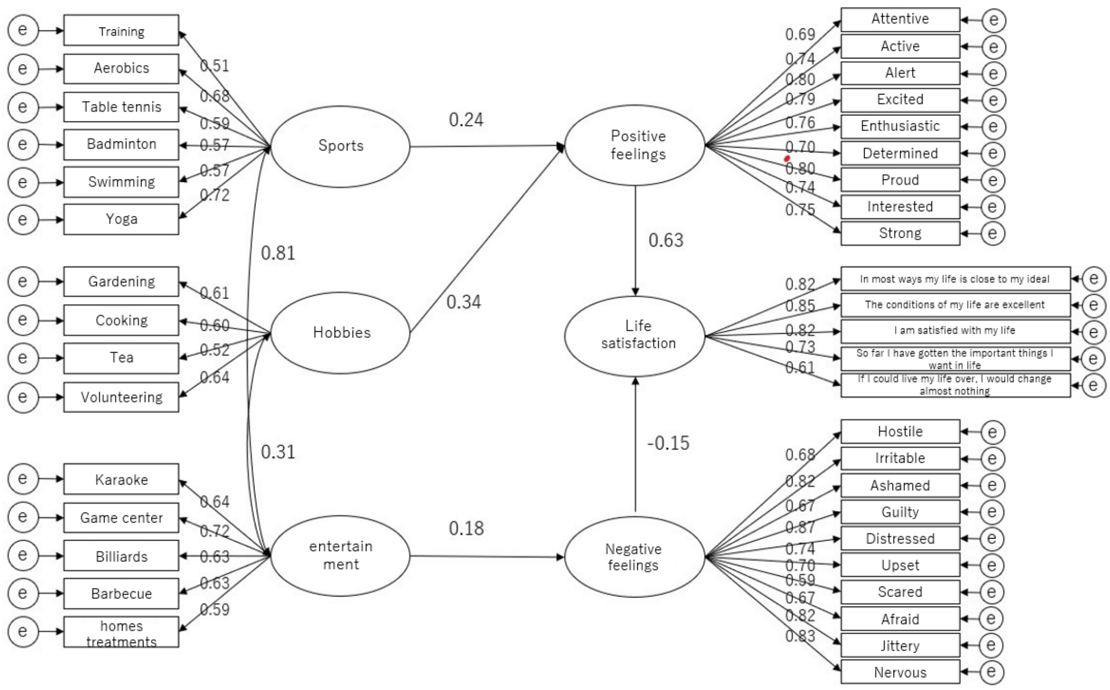

Figure 2. Standardized estimates of the default model.

In terms of the relationship between leisure activity sector and positive emotions, the sports and hobbies sectors have a positive influence on positive emotions. In terms of the degree of influence, the hobby sector (0.34) was found to be greater than the sports sector (0.24).

In terms of the relationship between the sports sector and positive affect, training, aerobics, table tennis, badminton, swimming and yoga were found to have a direct positive impact on the sports sector and an indirect positive impact on positive affect.

In terms of the relationship between the hobby sector and positive affect, gardening, cooking, tea ceremony and volunteering had a direct positive impact on the hobby sector and an indirect positive impact on positive affect.

5 CONCLUSION

In this study, based on the results of a web-based questionnaire survey of middle-aged 'male' residents of 'Shanghai', one of the direct-controlled cities that was considered to be relatively less affected by the covid 19 in terms of the frequency of participation in leisure activities, the relationship between subjective wellbeing and leisure activities was determined and the subjective The sectors and specific types of leisure activities that positively influence positive feelings of subjective wellbeing were clarified.

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THE ROLE OF THE COLORS OF INTERIOR ACCESSORIES IN FORMING AN IMPRESSION OF A ROOM

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ABSTRACT

When purchasing home interior furniture and accessories, several factors determine the color of the items that are chosen. People imagine how the item will look when actually placed in the room, anticipating whether it will fit in with the room or create the image they want. In order to help people make such decisions during shopping in stores and online, we analyzed the relationship between room color and item color. We prepared a photo of a home interior, processed the color of one item in the photo, and asked subjects about their impression of it. The color of the item was chosen from the colors used in the picture so that it could work in harmony with the room. Through the experiment, we found that even the color of a small item can affect the impression of an entire room.

Keywords: *visual impression, color image, representative colors*

1 INTRODUCTION

The color and design of an interior layout has a psychological impact on the occupants and the people who work there. (Haller, 2017). The interior design scheme differs as per the purpose of the room, such as working, relaxing, or socializing. In other words, it is important to match the interiors to the purpose of the room. When it comes to actually purchasing furniture and accessories for interior decoration, it is not just about the desirability of individual items but also about the compatibility of their colors with the colors of the room. There are various efforts regarding the relationship between the color characteristics and impressions of the entire room

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(Takahashi et al, 2018, Takahashi et al. 2021). There have been various efforts towards identifying the relationship between the colors used and the impression created by a room.

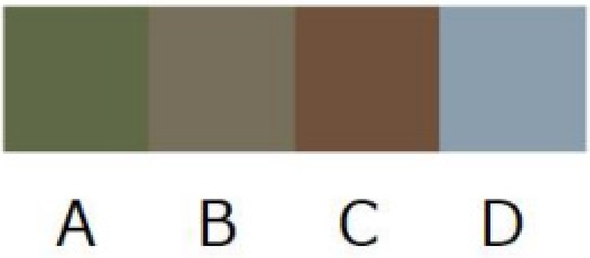
In other words, color coordination is necessary to fulfill the purpose of a room while maintaining color harmony. In this study, we will clarify the characteristics that are favored among the items that are in harmony with the color environment of the room. Using the same interior photo, we change the color of one item in the photo. Since all remaining items are unchanged, it is possible to examine the change in impression caused by the change in color of the item in question. The new finding of this study is that preferred color for small items can be extracted from an entire image using probability density.

2 METHOD

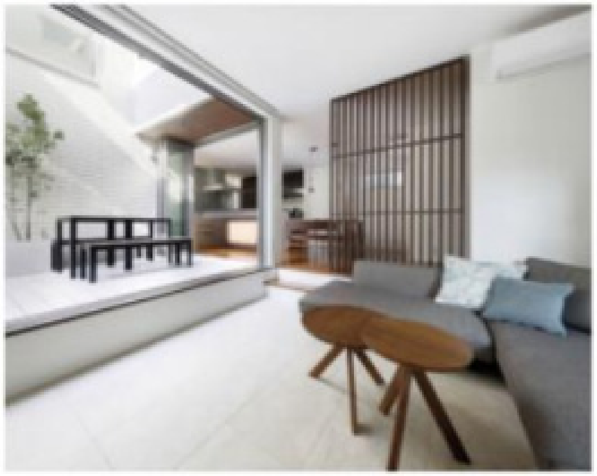
For the images of the interiors used in the experiment, we used images from websites of the top 20 ranked home builders in the national edition of the SUUMO website (*SUUMO*, 2022). The tag data of the top 20 architectural examples from each company was compiled, and a total of nine images of interiors were selected from the top three genres: simple modern, natural, and Japanese modern, with three images from each. Figure 1-(b) shows a sample design of a Japanese modern interior image.

The color to be used as the changed color of the items in each image was selected. Since a color that is inconsistent with the overall color of the image will receive a low evaluation regardless of whether it fits the image of the interior or not. Therefore, four colors that were used in the image were extracted and used, i.e., four representative colors.

There are various methods for extracting representative colors from images such as the method proposed by Takahashi (Takahashi et al, 2018). However, most of the pixel values are low-saturation colors, and many low-saturation colors have been extracted by the conventional representative color extraction method. In this research, we focus on the difference in image due to the difference in color, therefore, the four colors to be selected must be different from each other. Thus, we devised a simple representative color extraction method. We used hierarchical clustering based on hue to select colors that are likely to make a difference in the image. The reason for emphasizing hue is that it makes a greater difference in impression than saturation or lightness. The reason for ignoring saturation and lightness is that when changing the color of an object, the color is changed while maintaining the original color tone. However, since clustering the hue values of all pixels is computationally expensive, we first reduced the number of colors to 64 using k-means and then further clustered the hue values of the centroids to obtain four color clusters. When performing hierarchical clustering, colors with a saturation of five or less were excluded. This is because colors categorized as achromatic have practically no meaning in hue values. Each of the final hue clusters were assigned a subset of the pixels of the source image. A color patch was created by averaging the CIE Lab values (*CIE*, 2022) of the pixels assigned to each cluster. The four colors obtained were used to change the color of one item in the same interior. This item must be an item that can change color and occupies a large area in the image. However, the color patch was created using GIMP (*GIMP*, 2022). Furthermore, the color patches obtained from the design shown in Figure 1-(b) are shown in Figure 1-(a). The four colors obtained in Figure 1-(a) are named A, B, C, and D from left to right.



(a) Color Patches



(b) An original image

Figure 1. An example of extracted color patches

Impressions of a total of 36 images of interiors were evaluated using a Google Form. The subjects were 43 men and women who were in their teens to 40s. Their impressions were evaluated in the 7-step SD method as "dark – bright," "cool – warm," "out of harmony - in harmony," "dislike – like," "ordinary – unique," "hard – soft," "not beautiful – beautiful," "artificial – natural," "restless – calm," and "unfriendly – friendly."

3 RESULTS AND DISCUSSION

The average value of the obtained data was calculated for each of the 10 adjective pairs. This paper describes the results of the analysis of the images of interiors shown in Figure 1, and the rest of the paper summarizes the results of the analysis. Figure 2 shows a comparison of the mean value of "dislike - like" and the color angle of the changed color based on the CIELab color space chromaticity diagram for the color scheme pattern shown in Figure 1.

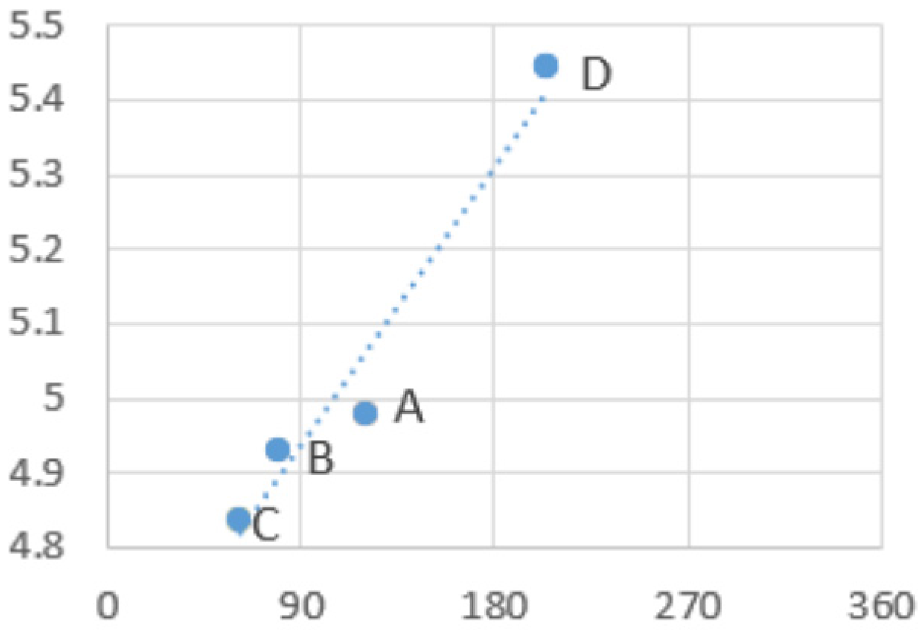


Figure 2. An example for relationship between hues of extracted colors (horizontal) and preference (vertical)

In the example shown in Figure 1, "D" has a relatively small area in the color scheme in the interior image, while "C" has a relatively large area, indicating a proportional relationship between desirability and hue. Similar or opposite trends were observed in other images. From the above, it is considered that the base color and the accent color have different effects on the evaluation of desirability.

Therefore, we considered that the desirability of a room differs depending on the degree to which the colors are used in the interior. We determined the amount of color information as an indicator of the degree to which each of the four colors were used. We plotted the lab values of all pixels on the lab color space and estimated the kernel density for the changed colors. The larger the density, the more similar colors are used in the image, and the more the color-changed items are based on the base color. The smaller the density, the more prominent the color is in the image and the more likely it is to be based on the accent color. Table 1 shows the relationship between the density of the changed colors and the average value of "dislike - like" for each genre. Table 1 shows that there is a negative correlation between the simple modern and Japanese modern genres and a positive correlation between the natural genres. From the above, it is desirable to use accent colors in modern interior images such as simple modern and Japanese modern. In contrast, it is considered that the use of a uniform color for the entire image is preferable for natural images.

Table 1. Correlation coefficients between densities and preference of the color (*p-value<.05)

Genre	r
Simple modern	-0.546*
Natural	0.485*
Japanese modern	-0.674*

Color can have different meanings and impressions depending on the function of the room (living room, dining room, kitchen, bedroom, etc.). The interior photographs used in this study are generally consistent with a living room, although there are minor differences. However, the furniture in each photo may differ (e.g., with or without bookshelves). Color-changing items also vary from photo to photo. While this may have influenced the subjects' color choices, the variety of living room types and items covered allows for a general discussion.

4 CONCLUSION

In this study, we investigated the effect of changing the color of one item in a room to another color used in the room. The results showed that colors used as accents tended to give a more favorable impression in the case of modern styles such as simple modern and Japanese modern, while colors that were close to the overall color tone tended to give a more favorable impression in the case of natural styles. In the future, it is necessary to increase the number of subjects and conduct experiments with more age groups. Furthermore, it is necessary to conduct more detailed studies by increasing the number of colors to be changed, targeting other genres such as Scandinavian style.

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VIRTUAL EMBODIMENT FOR ENHANCING SENSE OF PRESENCE IN VIRTUAL REALITY

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ABSTRACT

The technical evolution of digital graphic technologies have allowed the photorealistic virtual representation of the physical world. This allows people to experience an enhanced sense of presence in virtual environments such as virtual reality (VR). It is a common conception that vision is the primary sense in virtual environments, and evaluations are performed by assuming that the virtual body was a default entity that solves the issue of improving sense of presence. There is no evidence presenting a comparison between how the same environment/stimulant in the VR space is evaluated when there is a virtual body versus no virtual body. How can we bridge the gap between the real world and the unreal world if we don't look into it? The present study aimed to gain an experimental understanding of how virtual embodiment affects the individuals' perception of body control and interaction with the objects in VR environment with a focus on visual perception. The findings of the study suggest that the sense of body ownership is more powerful factor than the sense of agency in regards to virtual embodiment in VR environment.

Keywords: *Virtual Embodiment, Natural Presence, Visual information, Experience Design*

1 INTRODUCTION

VR makes it possible to create an immersive user experience where participants feel fully immersed and as a part of the simulated virtual environment. This has enabled its application in different genres other than entertainment with many e-commerce fields adopting it for research, development, and marketing. One of its common applications is in the healthcare treatment area, especially psychiatric treatment. VRET (Virtual reality exposure therapy) is a method in which VR is implemented in treating psychological conditions such as anxiety disorder, phobia, and post-

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traumatic stress disorder (PTSD). Previous studies have reported on the effectiveness of VR as a treatment tool for the treatment of claustrophobia and acrophobia [1, 2, 3]. Furthermore, VR technologies can be used to create a sense of embodiment using virtual bodies such as avatars. The term sense of embodiment refers to a sensation of being inside a body, controlling it to interact with the surrounding environment. This is an essential factor necessary to enhance the sense of presence in the VR environment. Kilteni et al. (2012) presented that sense of embodiment is comprised of three components: self-location, the sense of agency, and the sense of body ownership [4]. Self-location is an important sense of location of an individual in space. This ability allows humans to navigate to target locations in complex and changeable environments by interacting with it. The sense of agency is the feeling of control over one's actions and consequences, which is the subjective awareness of initiating, executing, and controlling one's own volitional actions in the world. The sense of body ownership describes the feeling of mineness that human perceive toward one's body parts, feelings or thoughts [5, 6]. Previous research have demonstrated the effectiveness of virtual embodiment on the mechanisms' above mentioned components. Research works have presented the influence of the visual cues from virtual body on individuals' emotional responses [7], multisensory feedback [8], impression of virtual objects [9], and physical responses such as pain perception [10]. These findings suggest that visual cues from the virtual embodiment not only influences the sense of presence but also affects the way we perceive and interact with visual stimuli presented within the VR.

The above-mentioned research findings present the effectiveness of virtual embodiment in experiencing VR. However, such evaluations were performed by assuming that the virtual body was a default entity that solves the issue of improving sense of presence. There is no evidence presenting a comparison between how the same environment/stimulant in the VR space is evaluated when there is a virtual body versus no virtual body. How can we bridge the gap between the real world and the unreal world (VR in this context) if we don't look into it? How can we say for sure that virtual embodiments improves sense of presence in VR, when we don't have a definite experiment based evidence? How can we make the presence natural and the experience seamless in VR?

The present study aimed to gain an experimental understanding of how virtual embodiment affects the individuals' perception of body control and interaction with the objects in VR environment with a focus on visual perception. For this purpose (1) How the participants evaluated their perception and control of the movement of their bodies, and (2) How much control the participants felt they had over their interaction with the stimulant were analyzed.

2 METHOD

Ten native Japanese students (male:7, female:3, average age:20.8 SD:0.6) participated in the experiment.

2.1 Stimuli

Four types of VR spaces (Table 1), two levels of *virtual embodiment* (*with hands, without hands*) and *environmental element* (*with table, without table*) were designed and used in the experiment. The visual stimuli used in the experiment were designed using Unity 2020.3.19f1, a cross-platform game engine, and were presented via Oculus Quest Head Mount Display (HMD).

Table 1. Four types of VR spaces used in the experiment

Types of conditions	With Table (Ty)	Without Table (Tn)
With Hands (Hy)	HyTy	HyTn
Without Hands (Hn)	HnTy	HnTn

2.2 Experiment method

The subjective evaluation was performed by using five evaluation phrases, which focused on the individuals' perception of body control and interaction with the target stimulant in VR. The phrases were rated on a 6-point scale. The list of evaluation phrases is as follows: *I can move without constraints, I can control the speed of my movement, I can move smoothly, I can grab the stimulant without struggle, I feel as if I am actually holding the stimulant*. These phrase for the evaluation were prepared based on the embodiment components as above (self-location, the sense of agency, the sense of body ownership) which focused on the individuals' perception of body control and interaction with the target stimulant in VR.

2.3 Procedure

The participants were presented with one of the four *hand-table* conditions in random order, where they were assigned the task of picking up a ball and putting it back down. The four *hand-table* conditions are as follows: *with hands – with table, without hands – with table, with hands – without table,* and *without hands – without table* (Table 1). Before commencing the experiment, the participants were given a brief introduction to the experiment such as instructions on how to observe the stimuli and regarding the evaluation process. They were not informed about the specific details about the presence or absence of virtual embodiment and environmental elements to avoid biased impressions. The duration of the experiment per subject was fifteen to twenty minutes.

2.4 Results

One-way ANOVA and Factor Analysis were used to analyze (1) How the participants evaluated their perception and control of the movement of their bodies, and (2) How much control the participants felt they had over their interaction with the stimulant. The results are as follows:

(1) Statistically significant difference was reported between *hand-table* conditions for the evaluation phrase *I can grab the stimulant without struggle* (Figure 1). The results presented that there were significant differences between HyTy-HnTy (p=0.0030**), HyTn-HnTy (p=0.0164*), and HyTy-HnTn (p=0.0356*) (Figure 2).

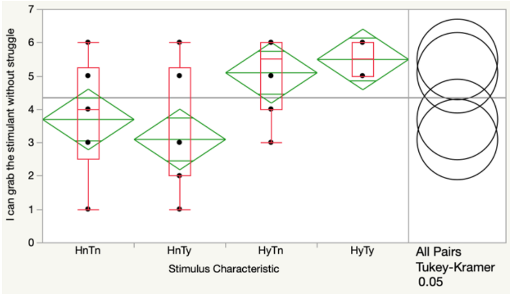


Figure 1. One-way ANOVA results for between *hand-table* conditions for the evaluation phrase *I can grab the stimulant without struggle*

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
HyTy	HnTy	2.400000	0.6342099	0.69193	4.108072	0.0030*
HyTn	HnTy	2.000000	0.6342099	0.29193	3.708072	0.0164*
HyTy	HnTn	1.800000	0.6342099	0.09193	3.508072	0.0356*
HyTn	HnTn	1.400000	0.6342099	-0.30807	3.108072	0.1405
HnTn	HnTy	0.600000	0.6342099	-1.10807	2.308072	0.7803
HyTy	HyTn	0.400000	0.6342099	-1.30807	2.108072	0.9215

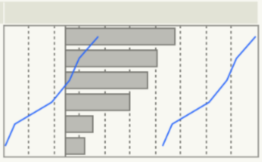


Figure 2. Order differences in mean comparisons for between *hand-table* conditions for the evaluation phrase *I can grab the stimulant without struggle*

(2) Statistically significant difference was reported between with hand-without hand conditions for the evaluation phrase *I can move smoothly* (p=0.0125*) (Figure 3, left) and *I can grab the stimulant without struggle* (p=0.0001**) (Figure 3, right).

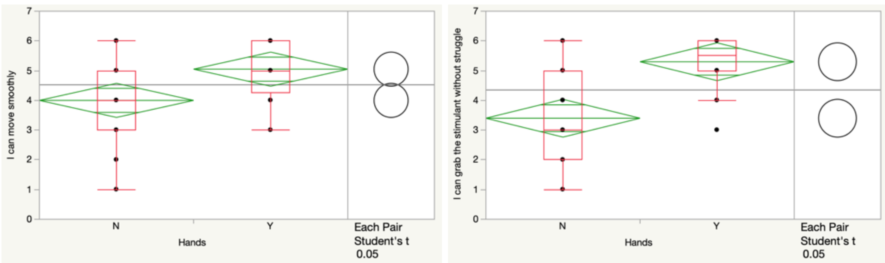
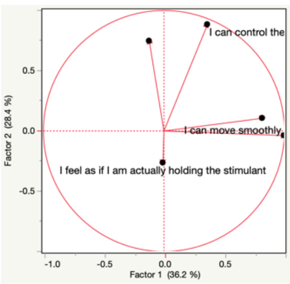


Figure 3. One-way ANOVA results for between *with hand-without hand* conditions for the evaluation phrase *I can move smoothly* and *I can grab the stimulant without struggle*

(3) The results by factor analysis showed a statical significant (p < .0001). It presents two factors assuming influence a sense of embodiment in VR. Factor 1 consists of the phrase of *I can move smoothly* and *I can grab the stimulant without struggle* (Figure 4), whereas factor 2 consists of *I can control the speed of my movement* and *I can move without constraints*.



	Factor 1	Factor 2
I can move smoothly	0.999265	-0.038326
I can grab the stimulant without struggle	0.817074	0.105416
I feel as if I am actually holding the stimulant	-0.007462	-0.264815
I can control the speed of my movement	0.361420	0.882681
I can move without constraints	-0.121641	0.745969

Figure 4. Factor analysis results for the influence of virtual embodiment in VR environment

3 DISCUSSION AND CONCLUSION

The technical evolution of graphics processing units (GPUs) and 3D engines have allowed the photorealistic virtual representation of the physical world. One such technology that will help bridge the gap between the physical and virtual worlds is the digital twin, which is a digital version of real-world objects. Further progress of such technologies will aid in the advent of a new reality based on human-computer interaction such as the metaverse, which is a virtual world where humans, as avatars, interact with each other in a three-dimensional space that mimics reality. The metaverse is predicted to materialize primarily through virtual reality (VR) over the next few years as an alternate, digital world that can be used for various personal and business objectives. It will help users perform real-life tasks such as communicating with their long-distant friends, going through training programs, and so on, all from the comfort of their living room.

Previous research works have demonstrated the effectiveness of virtual embodiment in VR experience. However, such evaluations were performed by assuming that the virtual body was a default entity that solves the issue of improving sense of presence. There is no evidence presenting a comparison between how the same environment/stimulant in the VR space is evaluated when there is a virtual body versus no virtual body. How can we make the presence natural and the experience seamless in VR? The present study aimed to gain an experimental understanding of how virtual embodiment affects the individuals' perception of body control and interaction with the objects in VR environment with a focus on visual perception. The findings of the study suggest that:

1. The participants felt difficulty in grabbing the stimulant without struggle in the *without hand-with table* condition. Furthermore, they were able to move smoothly and grab the stimulant in the presence of hands.
2. The sense of body ownership is more powerful factor than the sense of agency in regards to virtual embodiment in VR environment.

Despite technical evolution of immersive technologies in various fields, the experimental evidence on the role of virtual embodiment in enhancing natural presence in VR is very limited. The findings of this study are worthy as they establish an experimental foundation to show the effectiveness of virtual embodiment on visual perception in VR. Further research needs to focus on the characteristics of how affective factors influence virtual embodiment when being immersed and interacting with environmental elements in VR. This will aid in the development of VR technologies that implement virtual embodiment to elevate the sense of natural presence in immersive environments and will eventually bridge the gap between the real and unreal worlds.

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VISUALIZATION OF AFFECTIVE INFORMATION IN MUSIC USING CHIRONOMIE

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ABSTRACT

The purpose of this study is to visualize affective information that cannot be conveyed by symbolic notation alone, to enhance the musical experience of the hearing impaired. To represent the rhythm of music effectively and uniquely, we focused on Chironomie, which represents the structure of rhythm with emotional impression. In general, Chironomie is drawn by a curve corresponding to the score, which is determined by whether a short segment of the score represents one of two classes, Arsis or Thesis. First, we utilized the machine learning technique to classify Arsis and Thesis from the score as input. We conducted experiments to confirm the accuracy of the classification, and the usefulness of the estimated Chironomie in conveying the rhythm of music. In the latter experiment, four types of stimuli combining visual and sound information were used to confirm the effects of Chironome: score only, Chironomie only, score and Chironomie, and score and sound. Results showed that Chironomie has certain usefulness in conveying the rhythmic structure of a piece of music. This paper mainly focuses on evaluation experiments and discusses experimental and analytical methods under these experimental conditions.

Keywords: *Chironomie, Music visualization, Rhythm, Hearing impaired*

1 INTRODUCTION

For the hearing impaired, sound-only music is hard to perceive and understand. Perceiving musical information with sensory systems other than the sense of hearing (e.g., touch, sight, etc.) will enrich their musical experience. In situations where sight is available, using visuals is considered the most versatile way. Therefore, we attempted to visualize music.

There are many studies and systems for music visualization for various purposes and methods (Khulusi et al, 2020). In many of these systems, the methods of representing music in color are used, and there are studies on the relationship between sound and color. However, Sato (2014) reported that individual differences in color impressions exist. Then, our study aims to visualize music with fewer individual differences. We focused on Chironomie as an effective and unique visual representation to achieve this goal. Chironomie is the Gregorian chant conducting method and represents the rhythmic structure with emotional impressions. In general, Chironomie is drawn by curves corresponding to the score.

Drawing of Chironomie to the score is not common in Western classical music, but Chironomie is commonly used today as a method of musical conducting (Mizushima, 1966, p.150). In addition, Chironomie may be applicable to Western classical music, and there are study cases of the application of Gregorian chant rhythm theory to classical music (Tsumagari, 1963), (Kobata, 2007, 2011).

This study attempts to visualize music by Chironomie for Western classical music and its derivatives. First, referring to the Solesmes Method, a free musical rhythm theory proposed by Mocquereau, we utilized machine learning technique to classify Arsis and Thesis which are the two classes that determine Chironomie from the score as input. Then, we conducted an evaluation experiment to confirm the usefulness of the estimated Chironomie in conveying the musical rhythm.

2 CHIRONOMIE

Chironomie is the projection of rhythm into space through hand gestures and a method of conducting in Gregorian chant. The curve which this is drawn on the score is also called Chironomie. In this study, we analyze the piece using the Rhythmic Chironomie by phrase, the most common in Gregorian conducting. The Rhythmic Chironomie represents a rhythm composed of one or more sequence of Arsis and Thesis. An example of Chironomie is shown in Figure 1.

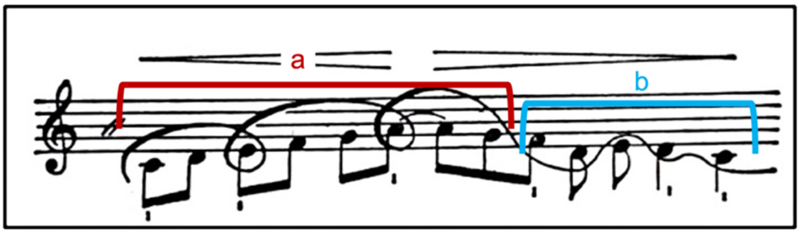

Figure 1. Example of Chironomie

A short line under the note indicates Ictus. Ictus resembles the first beat and marks the boundary of compound time. Arsis Chironomie is drawn as a curve that swings downward and then bounces back up. In the segment where Arsis is continuous, it is represented by a curve that indicates Ictus and jumps up again (segment a in Figure 1). Thesis Chironomie is drawn in a gentle curve (segment b in Figure 1).

3 EVALUATION EXPERIMENT

This section describes the evaluation experiments, which have the objective to investigate the usefulness of Chironomie in the visual perception of rhythm. We set up four presentation methods for the music: score only (Pattern A), Chironomie only (Pattern B), score and Chironomie (Pattern C), and score and sound (Pattern D) (Table 1). We evaluate Chironomie by analyzing the subject's responses in two evaluation methods: an experiment to answer rhythmic features of each piece of music presented by these four presentation methods and a post-experimental interview.

Compare Patterns A and C to investigate whether the presence of Chironomie helps to understand music. Also, compare Patterns B and C and consider how Chironomie is presented. Furthermore, comparing Pattern D with Patterns B and C to investigate whether the visual information obtained from Chironomie is consistent with the auditory information of music.

Table 1. Presentation methods for the music

Pattern	score	Chironomie	sound
A	+	-	-
B	-	+	-
C	+	+	-
D	+	-	+

3.1 Experimental Methods

A total of eight pieces that are monophonic and not well-known were prepared: two for each of the four presentation patterns. The length of each piece is 8 bars. The pieces were presented to the subjects by means of videos output by MuseScore3. MuseScore3 is a free music notation software. MuseScore3 can display a blue square indicating the performance position while playing back. In the experiment, this function was used to easy for any subjects to identify the position of the performance on the score. The image of a video of each presentation pattern is shown in Figure 2.

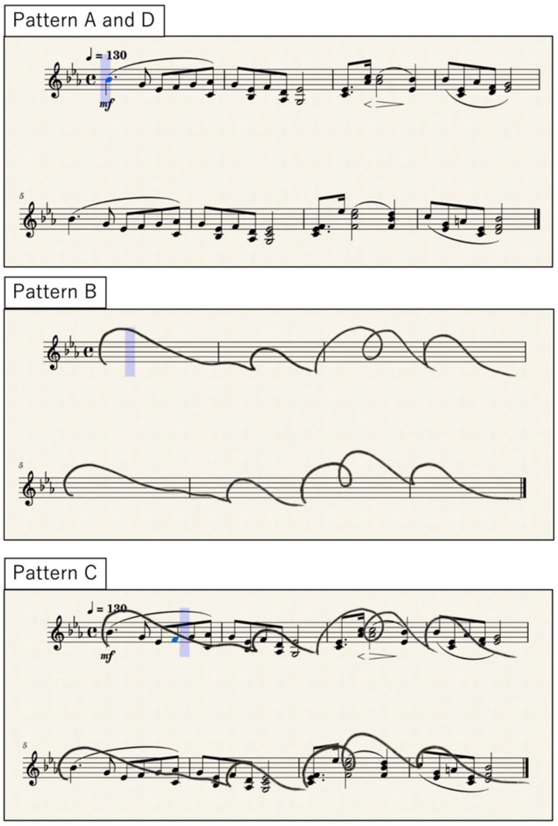

Figure 2. Example of video

The answer sheets used in the response experiment did not mark the boundaries of the time composes but used a general score. In each presentation pattern, the display items are the same as in the video: score only in Patterns A and D, score without notes drawn Chironomie, score with notes drawn Chironomie.

Undergraduate students (males and females, n=8) participated in this experiment. Half of them have experience with the instrument and can read score, while the other half have no experience and cannot read it. They were Japanese and have no prior knowledge of Chironomie.

3.2 Response Experiment

After watching the video, subjects fill out answer sheets with their answers to the tasks. The tasks are listed below.

- Surround the parts where you feel that tension rises.
- Square off the parts where you feel that tension relaxes.
- Draw a double line vertically where you feel the rhythm borders.

3.3 Post-experimental Interview

After the response experiment, the author interviewed the subjects verbally. The questions are listed in Table 2.

Table 2. Questions of post-experimental interview

No.	Questions
1	What did you think Pattern B was?
2	What were some of the difficulties?
3	Which was easier to answer in Patterns A and C?
4	Did Chironomie help you understand the structure of the music?
5	Were your impressions of the rhythm of the piece consistent with Chironomie?
6	Do you think Chironomie is useful?

4 RESULTS

4.1 Response Experiment

In the tasks, the part where tension rises corresponds to Arsis, the part where tension relaxes corresponds to Thesis, and the rhythm border corresponds to the boundary between Thesis and Arsis when Arsis follows Thesis. If the subject's answer and the estimated Arsis and Thesis are consistent, the answer is correct.

The average percentage of correct answers for each presentation pattern in all tasks is shown in Table 3. Pattern C is 5.3% more correct than Pattern A. The difference between Pattern B and Pattern C is as small as 0.7%.

Table 3. Percentage of correct responses (All)

	Presentation Pattern			
	A	B	C	D
Experienced	18.0	24.2	20.7	18.7
Inexperienced	12.8	15.9	20.7	9.1
All	15.4	20.0	20.7	13.9

In addition, the average percentage of correct answers for each presentation pattern in the Arsis continuous parts is shown in Table 4. In Patterns A and C, the experienced subjects have similar percentages of correct answers in both patterns, but the inexperienced subjects have 30.8% higher percentages in Pattern C. Pattern B has a 17.5% higher percentage of correct answers than Pattern C. In Pattern D, the experienced subjects answered 52.9% of the questions correctly.

Table 4. Percentage of correct responses (Arsis continuous part)

	Presentation Pattern			
	A	B	C	D
Experienced	33.3	60.9	31.6	52.9
Inexperienced	26.3	64.7	57.1	21.7
All	30.0	62.5	45.0	35.0

4.2 Post-experimental Interview

This section summarizes the content and trends of the responses for each topic in the post-experimental interview.

Question No.1: What did you think Pattern B was?

Five subjects answered, “Pitch or Intensity”, a subject answered “Ascending and descending melodic line”, a subject answered “Sensory curves drawn to convey the mood of the music”, and a subject answered “Melody line and conducting image.”

Question No.2: What were some of the difficulties?

Four subjects answered, “To answer Pattern A.” A subject added, “Pattern A is like a row of symbols that I don’t understand.” Two subjects answered, “It was hard to follow the curve with my eyes.”

Question No.3: Which was easier to answer in Patterns A and C?

Seven subjects answered, “Pattern C.”

Question No.4: Did Chironomie help you understand the structure of the music?

All subjects answered “Yes.”

Question No.5: Were your impressions of the rhythm of the piece consistent with Chironomie?

All subjects answered, “Somewhat different, but generally in agreement.” Seven subjects answered, “In Arsis continuous part, just as imagined I got from Chironomie.” Six subjects answered, “In Thesis continuous part, there were more notes than I expected.”

Question No.6: Do you think Chironomie is useful?

Seven subjects answered “Yes.” As the reason, a subject added, “Even if I couldn't read the score, I could visualize the tune and rhythm of the music.”, and another subject added, “I found it easy to grasp the atmosphere and rhythm that could not be conveyed by music scores alone, thanks to the use of Chironomie.” Furthermore, a subject added, “I think Chironomie is too simple to use effectively. More structure would be good.”

A subject answered, “No. Chironomie is just a little more useful than score only.”

Additional Question: Presentation patterns that were easy to answer and those that were difficult to answer

Two subjects who have no instrumental experience answered, “Pattern B is the easiest.” The reason: “Pattern B was simple and easy to understand, while Pattern C was complex.”, “Less information made it easier to answer the questions.”

Two subjects who have instrumental experience answered, “Pattern D is the easiest, and Pattern B is the most difficult.” The reason: “I thought Pattern B lacks information as music.” They added, “Pattern C is the easiest, followed by Pattern D.”

5 DISCUSSION AND CONCLUSION

In this study, we attempted to visualize music using Chironomie as a new means of visually representing the structure of rhythm to enhance the musical experience for the hearing impaired. Results suggest that the presence of Chironomie has certain usefulness in understanding the rhythmic structure of a piece of music.

A comparison of Patterns A and C shows that adding Chironomie to the score makes it easier to grasp the rhythmic structure with emotional impressions. This and the results of the response experiment (Table 3, 4) suggest that Chironomie is useful in understanding music, especially in the Arsis continuous parts.

Next, Pattern B and Pattern C are compared. The results of the additional interview questions show that the evaluation of Pattern B depends on the user's attributes and experience. Therefore, the optimal method of presenting Chironomie cannot be determined and we need additional research.

Finally, consider the difference between Chironomie and sound. From the results of the response experiment (Table 4) and the post-experimental interview No.5, in the Arsis continuous parts, users receive visual information from Chironomie that matched the auditory information in music. By contrast, in the Thesis continuous parts, they feel strange. We consider that it is possible to reduce the sense of discomfort by adding fine structure to Thesis Chironomie.

This study found the usefulness of Chironomie in music visualization. However, it is difficult for the estimated Chironomie to get users to correctly perceive all the rhythmic features. We need to research to ensure that recognition by Chironomie is adequate. In future work, it would be possible to visualize the performance by estimating Chironomie from the performance as input.

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VISUALIZING SITUATIONS: COMPARING PIXEL AND VECTOR ART STYLE IN A DINING SITUATION SKETCH

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ABSTRACT

Previous study indicated that the simplicity of a visualized situation could play an important role in comprehension and emotion. However, the effect of the art style was never discussed. As an art style with minimalist aesthetic, pixel art's popularity and value are not well explained. This study is aimed to investigate the difference between pixel and vector art style by comparing one of the visualized situations extracted from previous study and the pixelated counterpart.

166 valid responses were collected (69 males & 97 females). Participants were randomly separated into 2 groups, presented with 2 different art styles. After observing the visualized situation, they filled in a questionnaire asking about their understandings, evoked emotions, how realistic it feels, and how easy for them to picture themselves in the situation. ANOVAs and multiple regression analyses were conducted and results showed that art style did not have a big impact on emotions, whereas for pixel art style, the older the participant is, the easier they could picture themselves being in the situation. Additional analysis using chi-square test found that people tend to believe the situation is in a past era when observing the pixel version. This study revealed the potential impact of pixel art style on people's comprehension, tricking people to believe it is happening in a past era. This phenomenon should be taken advantage of in not only game design but also other media graphic design scenarios.

Keywords: *Situation, Pixel, Art style, Comprehension, Emotion*

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1 INTRODUCTION

1.1 Background

Previous investigation suggested that visualized situations using simple or detailed sketches was an effective way to represent different product usage situations (e.g. dining situations). The more detailed a visualized situation is illustrated, the stronger and specific emotions can it evoke, whereas a simple version of the situation could avoid providing too much information for people to relate to themselves (Bao et al., 2018). It is suggested that a visualized situation should be as simple as possible, with the right level of simplicity that provide just the needed information to the observers. However, no matter how simple a sketch could be drawn, it always has a certain art style. For example, the visualized dining situation in the previous study (Bao et al., 2018) was drawn by hand on paper, with a relatively realistic art style. There is no discussion made on how the art style of these sketches could make an impact on people’s comprehension and emotion.

To answer this question, there are many steps to be made. First of all, the definition of “art style” is important to be clarified. An art style of an illustration could be easily associated with the specific drawing style consistently used by any mangaka (professional comic book illustrator). However, any specific art style that recognized by people is a certain combination of various aspects (e.g. lines, colors, shadows, proportions, etc.). For example, for the aspect of proportions, illustrators could create a cuter art style by simply adjusting the proportion of the human bodies and objects. Therefore, among all these basic aspects of art style, it is essential to study on each one of them separately. One of the most basic aspects is the how the dots and lines are drawn. Some art style might use natural lines, while some might take advantage of different pencil strokes. However, there is a more fundamental difference between how the dots and lines are drawn.

A 2D visual illustration is basically either drawn with a vector art style or pixel art style. The simplest difference is, when the lines are continuous, cannot be visually demolished into smaller units, such as dots, it is considered as a vector art style. On the other hand, when the lines are composed by smaller, equal-sized units that are visible to human eyes, it is usually considered as a pixel art style. That being said, pixel art can become vector art, if the pixels are small enough that human eyes cannot recognize them.

Pixel art could be found and traced back to the very early age of human civilization, such as mosaic art from Pompeii (El-Din & Kheshen, 2021). Our ancestors used small, equal-sized tiles to draw arts on floors and walls. Later in the history of fine arts, as an iconic art style, pixel art was also a successor to cubism and constructivism (Gintere, 2019). However, in modern period, it is much more popularized thanks to the boom of computer and digital graphics, and the rise of the game industry. Game designers were “forced” to create a graphics with pixel art, because of the limited resolution of display and low processing power of the computers back in the very early days of video games. Two well-known examples are two of the oldest video games, Space Invaders (1978) and Pac-Man (1980). In 2000s, with the rapid development of computer graphic technology, game designers were released from the restriction of pixel art. Thanks to advanced technology, visual graphics in video games became more and more realistic and rich in presentation. Although astonishing graphics are easily achievable by game developers nowadays, pixel art style did not fade away. In fact, it is getting even more popular in recent years. Pixel art is becoming an artistic choice for game designers (Rocket Brush Studio, 2021). In the Game Award 2018, a video game using pixel art style, called Celeste (2018), was even nominated as a candidate for the Game of the Year Award, alongside other AAA titles. What is the value in pixel art style?

It is said that there is a difference in the aesthetic values derived from pixel art (El-Din & Kheshen, 2021). As a defining art style of gaming, pixel art not only brings nostalgia, but also attracts people with its minimalist style that fill the blank of imagination (Byford, 2014). Pixel art games require the players to "fill the gaps" with their imagination, to make sense of it with the little information, and this additional effort is enjoyable, like reading a book compared to watching a movie (Rocket Brush Studio, 2021).

1.2 Questions and Objectives

This study intends to investigate the difference between art styles in a visualized situation, in terms of comprehension and emotion. Moreover, when a visualized situation being used as a visual stimulus, it is important to be perceived as realistic and not difficult for people to picture themselves being in the situation. Therefore, how realistic the situation is and how difficult to picture oneself being in the situation are investigated.

As the most fundamental aspect of art style, pixel and vector art style were chosen as the target of this study. Based on the literature review, pixel art style could evoke a more nostalgic emotion, and trigger imaginations. Here we consider that imagination is important in how realistic a situation feels, and how easy to picture oneself being in the situation. The nostalgic emotion might be stronger for older people, since younger generations might have less experience with pixel art style in the early period of computer graphics. Therefore, age could play a role specifically for pixel art style. If a visualized situation is drawn in pixel art style, it might be easier for people to "fill the blank/gaps", perceive it as a realistic situation, and picture themselves being in the situation. In addition, such effect might be stronger for older people.

the objectives of the study are below:

1. To explore whether any of the emotions evoked by a visualized situation would change between pixel and vector version.
2. To test *Hypothesis 1*: people perceive a situation as a more realistic one, and can picture themselves in the situation more easily when presented with the pixel version of the situation. (*H1*)
3. To test *Hypothesis 2*: in a pixel version of the situation, it is easier for older people to perceive it as a realistic one, and picture themselves being in it, whereas there won't be such effect of age in the vector version. (*H2*)

2 EXPERIMENT

2.1 Method

2.1.1 Stimuli

Among the 6 typical dining situations summarized in the previous study (Bao et al., 2018), one situation was selected because of the strong responses in emotion. Afterwards, since the sketch was already drawn in the vector art style, the pixel art style version was created using Adobe Photoshop. The canvas was adjusted to make sure the general line thickness is 1 pixel but not too much thicker or thinner than the vector version. Finally, two sketches were adjusted to fit the screen in the same size (Figure 1).

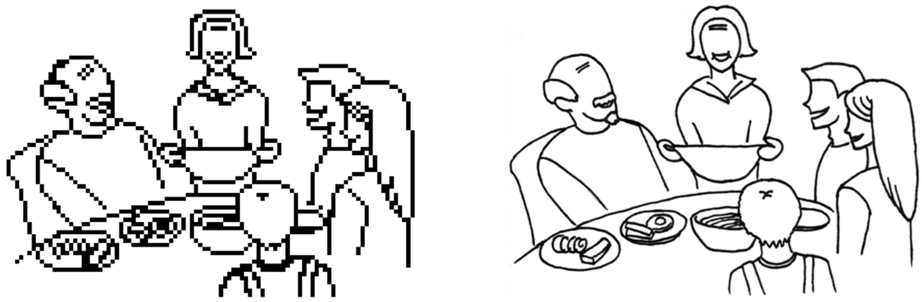

Figure 1. Pixel and vector versions of the dining situation sketch

2.1.2 Questionnaire

A questionnaire was created including questions that investigate the comprehension and emotions on a situation. According to the 5 basic cues of a situation ((i) persons, relationships and social interactions; (ii) objects; (iii) events and activities; (iv) locations; (v) time) (e.g. Mehl & Robbins, 2012; Pervin, 1978; Saucier et al., 2007), the questions for comprehensions were composed by 5 simple questions. (Rauthmann et al., 2015, Bao et al., 2018). Questions for emotions were based on previous study (Hirai & Okamoto, 2005, Bao et al., 2018), collecting the major 15 emotional responses of participants on dining situations using 5-point Likert scale. In addition, 2 questions (1. How realistic is this illustration? 2. To what extend are you able to picture yourself in this situation?) with 5-point Likert scale were also included in the questionnaire. The age and gender of the participants were also collected (Table 1).

Table 1. Questionnaire Summary

Comprehension	Emotion items			Other
Who and what relationship	Joy	Coldness	Quietness	How realistic is this Illustration
What objects are in there	Liveliness	Refreshment	Boresome	To what extend are you able to picture yourself in this situation
What kind of event or affair	Happiness	Weirdness	Loneliness	
What period is it	Peacefulness	Freedom	Crampedness	Age
Where is it happening	Warmth	Emptiness	Togetherness	Gender

2.2 Experimental Procedure

The experiment used a between-subject design, participants were randomly assigned to 2 groups, one being the pixel group and the other being the vector group. Firstly, they were asked to observe the dining situation sketch. Afterwards, they were required to answer the questionnaire.

2.3 Analysis

First, responses on comprehension were used to validate participants' basic understandings of the dining situation. Afterwards, ANOVAs (Analysis of Variance) with 2x2 factorial design (IV: "Art style" and "Gender", DV: emotional responses) were conducted to determine whether there were significant effects of art style and gender in each evoked emotion. ANOVAs (IV: "Art style" and "Gender", DV: "realistic" and "picturing oneself") were also conducted to test *H1*. Finally, multiple regression analyses (IV: "Age", "Gender", DV: "Realistic" and "Picturing oneself") were conducted respectively on the 2 groups (pixel art and vector art) to test *H2*.

3 RESULT

3.1 Basic Descriptive Statistics

After discarding questionnaire responses with invalid answers (e.g., random typing in the answer box), 173 total responses remained. In addition, in the comprehension questions, almost all participants correctly understood the basic cues of the situation, answering that the dining situation was about a family, having food together at home. Expect for a few participants thought they were friends and waitress eating in a restaurant. 2 participants thought that a lady was trying to sell a purse in the situation. After excluding these outlier answers, in the end there were 166 total valid responses (69 males & 97 females) that understood the situation correctly. Analyses were done on these 166 responses. The average age of participants was 37.43 years (SD = 12.38), ranged from 20 to 60 years old.

3.2 ANOVAs on Emotions

ANOVAs (IV: "Art style" and "Gender", DV: emotional responses) were conducted on all emotion items in Table 1. According to Armstrong's (2014) suggestion on when to use Bonferroni correction, since the first objective of the study is an exploratory investigation with no hypothesis, and it was not imperative to avoid a Type I error, Bonferroni corrections should not be applied to these ANOVAs. Among all the results from ANOVAs, there were no significant main effects of art style on emotions. On the other hand, significant main effects of gender were found on emotion items such as "Refreshment" ($F(1, 164) = 5.31$, $p = .022$), "Quietness" ($F(1, 164) = 5.07$, $p = .026$), "Loneliness" ($F(1, 164) = 5.73$, $p = .018$), and "Crampedness" ($F(1, 164) = 4.49$, $p = .029$). Several significant Interactions were also found on "Happiness" ($F(1, 164) = 3.92$, $p = .049$), "Refreshment" ($F(1, 164) = 6.24$, $p = .013$), "Freedom" ($F(1, 164) = 4.52$, $p = .035$), and "Togetherness" ($F(1, 164) = 4.44$, $p = .037$).

3.3 ANOVAs on "Realistic" and "Picturing"

ANOVAs (IV: "Art style" and "Gender", DV: "Realistic" and "Picturing oneself") were conducted to test *H1*. No significant main effect of either art style or gender was found. No interaction between them was found, either.

3.4 Multiple Regression Analyses on "Realistic" and "Picturing"

Multiple regression analyses (IV: "Age", "Gender", DV: "Realistic" and "Picturing oneself") were conducted respectively on the two groups with different art style. For the vector version of the dining situation, there was no significant relationship between predictors ("Age" and "Gender") and response variables ("Realistic" and "Picturing oneself"). However, for pixel version of the dining situation, a significant relationship between "Age" and "Picturing oneself" was found ($p = .011$). Specifically, it is found that there is a .028 increase ($\pm$.011, in a 5-point Likert scale) of the ease of picturing oneself being in the situation, for every 1-year increase in the age of the participants. There was a minor but very close to medium effect size (Cohen's $f2 = .10$) for this relationship.

4 DISCUSSION

First of all, results supported previous study (Bao et al., 2018), showing that gender plays a big role in evoking emotions in a visualized dining situation. Compared to gender, there was no significant main effect of art style on any of the emotional responses on the dining situation. This suggests that simply by changing the art style of a visualized dining situation from vector to pixel might not provide much effect on the emotions that related to the dining situation.

When applying a visualized dining situation in various scenarios, it is considered that how realistic the situation feels and how easy to picture oneself being in it are very important. Results showed no difference among the two art styles and two genders, indicating that no matter pixel or vector, male or female, the level of "how realistic it feels" and "how easy to picture oneself being in it" might not change. Changing the art style from vector to pixel wouldn't make people feel more realistic on the situation, and wouldn't make it easier for people to picture themselves being in the situation. *H1* was not supported. Although it is being said that pixel art style could invite more imagination to "fill the gaps/blank" (Byford, 2014, Rocket Brush Studio, 2021), simply by pixelating the lines might not work. It could be more due to the simplicity of the visual stimuli, since the difference between pixel games and other games are usually not just the art style, but also the simplicity regarding many visual aspects.

When taking the age of participants into consideration, it is found that when observing the pixel version of the dining situation, it is easier for older people to picture themselves being in it, and such result was not found for the vector version. This partially support *H2*, saying that the pixel art style indeed makes older people relate themselves more. However, since this effect of pixel art style was not found for "Realistic", it cannot prove that older people actually can imagine more because of their experience with pixel art compared to younger generation. No matter how old the person is, he/she sees no difference on the level of how realistic it is between pixel and vector version of the dining situation. Therefore, a new question is: why can older people picture themselves more easily in the dining situation, but not necessarily feel it more realistic than younger generation when observing a pixel version of the dining situation?

In order to answer this question and understand this difference between the perception of older people and younger people on the pixel art style, additional analyses were conducted. When screening the valid responses and removing "bad" answers, the most important criterion was whether the response showed that the participant actually understood the basic cues of the situation (based on the questions on comprehension in Table 1). For example, in the first question "Who and what relationship?", responses with the answer of "family" or "relatives" were considered valid, however responses with the answer of "friends" were eliminated. In general, all responses showed agreement among the 5 questions, except for the forth question: "what period is it?". The ambiguity of this question caused participants understood the question in different ways. Among all 166 responses, 53 responses answered the questions with the period of different eras, such as either past era (it looks like in the 70s/80s, etc.) or modern era (it looks like modern time, etc.), whereas 113 responses answered the question with the different period of time of a day, such as dinner time, evening, morning, etc.. Since the dining situation was not illustrated with any intention to represent a specific time (although "dinner" seems more appropriate, answers with "morning" were not considered incorrect), all these answers were considered valid and were not eliminated. However, in order to understand how people perceive pixel and vector versions of the dining situation differently, the first group of responses (53) with the answer of either past era or modern era were summarized in Table 2. As can be seen by the frequencies cross tabulated in Table 2, there is a significant relationship between art style and perceived era, X^2 (1, N = 53) = 7.67, p = .006. People in the pixel art group were more likely to perceive it happening in a past era than were in the vector group. This might be one of the main reasons why older people were able to relate to themselves, imagine themselves being in the situation, without necessarily feeling more realistic about it. Since the pixel version of the situation actually looked "older", the older participants could associate themselves to it more, because they have been living in the past era compared to younger ones. Younger people could also think the situation is a realistic one, it is just more difficult for them to picture themselves being in the situation because it looked like something happening in the past era when they were not born yet. It could be clearly seen in Table 2 that the dining situation itself is not "old" at all, since people in the vector art group believed that it was more likely happening in a modern era. It is just the art style of pixel made it looked "older".

Table 2. Cross table of the responses with the answer of question "What period is it"

Art style	Past era	Modern era
Pixel Art	14	9
Vector Art	7	23

It is widely known in the game industry that pixel art style would make a game look more "retro" and "nostalgic". However, these feelings are not clearly explored and defined. In general, a retro game usually means it is made in the past era, it is an "old" game. It does not necessarily mean we also think what is happening in the game is also in a past era. In this study, it is found that simply by pixelating the dots and lines of a dining situation sketch, it could lead to a tendency that people might perceive it happening in a past era, then lead to older people feeling easier to picture themselves being in the situation.

5 CONCLUSION

When pixelating the lines of a visualized situation, the pixel art style could possibly trick people to believe that the situation is happening in a past era of time. This might lead to older people feeling easier to picture themselves being in the situation. It suggests that the "retro" characteristic of pixel art style does not simply mean that the content looks like being made in a past era, it might also influence what we comprehend on the "story" of the content. Designers and illustrators should take advantage of this phenomenon in game design and media graphic design. Researchers are recommended to conduct future studies to explore this phenomenon.

There is no clear evidence that pixel art style could stimulate more imagination and "fill the gaps/blank" compared to vector art style. The simplicity of the visuals might be a more important factor. This needs to be further discussed in experiment using pixel art style and vector art style with different level of simplicity.

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WHAT KIND OF INFORMATION ATTRACTS CONSUMERS' ATTENTION?

STUDYING THE DIFFERENCES IN THE AMOUNT OF INFORMATION ON THE LANDING PAGE OF A PRODUCT

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ABSTRACT

This study aimed to determine the amount of information that is interesting to users on a landing page for the purpose of purchasing a product. In this study, we clarified the amount and kind of information that attracts the interest of users. Specifically, we created three types of landing pages with different amounts of information for three products, and conducted an impression evaluation questionnaire. The three types of information on the landing pages were: (1) product image, product description, and catch copy, (2) one with additional campaign information, and (3) one with additional product sales results and satisfaction levels. Using the impression evaluation data obtained after the questionnaire survey, we conducted a factor analysis for each product and analyzed the factors that influenced the evaluation. Additionally, we found out the website design that made a difference in the willingness to purchase the products and the evaluation items that caused the difference using a t-test. It was found that users' willingness to purchase the product increased when data such as campaign information and actual results were included, and that reliability affected the willingness to purchase, especially for products that are used for a long time.

Keywords: *Website design, Landing page, Impression evaluation*

1 INTRODUCTION

In recent years, the internet has become widespread, and many people use it on a daily basis. Online shopping has also become popular, and the percentage of households using online

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shopping is approximately 50%, a trend that is increasing every year (Ministry of Internal Affairs and Communications, 2020). Accordingly, there are many landing pages for the purpose of purchasing products. Therefore, there is a need to differentiate these pages from many other websites and improve them so that users can obtain information more easily.

Sakamaki, Someya and Okamoto (2017) state that it is important to design "convenience" so that users do not get lost in order for information to be looked upon and remembered. However, it has not been clarified what kind of information influences users. Dvir and Gafni (2018) investigated the differences in conversion depending on the amount of information on the landing page. As a result, they found that less content was shown to be a positive determinant of consumer behavior. However, they do not mention what information is necessary and what information is unnecessary. In this study, we focus on landing pages for the purpose of purchasing products. We studied the amount of information that attracts users' interest on landing pages, and what kind of information changes users' interest.

Specifically, we conducted an impression evaluation questionnaire on the design of the first view of a landing page with different amounts of information, and clarified the appropriate amount of information in the first view of a website.

2 EXPERIMENTAL METHOD

2.1 Creation of website design

As a preliminary preparation, we created the first views of three types of landing pages with different amounts of information for each product (green tea, office chairs, and supplements) to be used in the experiment. The information on the three landing pages was classified into three categories based on the summary sites (Ryuki Design Corporation, 2022; Zenken Corporation, 2022) – (1) product image, product description, and catch copy; (2) adding price and campaign information along with the parameters mentioned in (1); and (3) product sales results and satisfaction level in addition to parameters mentioned in (1).

2.2 Experimental Procedure

An impression evaluation questionnaire was conducted using Microsoft Forms. Eight adjectives were selected for the questionnaire: (1) informative - uninformative, (2) easy to view - hard to view, (3) easy to visualize the product - hard to visualize the product, (4) clear layout - cluttered layout, (5) stylish - plain, (6) impressive - unimpressive, (7) uniform - not consistent, (8) trustworthy - untrustworthy, and the respondents were asked to rate each adjective on a five-point scale: (1) disagree, (2) not so disagree, (3) neither, (4) somewhat agree, (5) agree. We also asked respondents to rate each page on a five-point scale, asking “Would you like to buy this product?” The experimental collaborators were 50 men and women (24 males and 26 females) between the ages of 20 and 25.

3 ANALYSIS RESULT

3.1 Factor analysis on the landing page for each product

First, a factor analysis was conducted based on the results of the questionnaire for each product in order to clarify the factors influencing the evaluation of the landing pages for green tea, office chairs, and supplements. To determine the number of factors for each product, a principal component analysis was conducted to obtain eigenvalues. The results are shown in Table 1. It was decided to unify the number of factors as two, which has an eigenvalue greater than one for all products. A factor analysis was conducted with two factors. The factor loadings up to the second factor obtained for each product are shown in Table 2.

The left column of Table 2 shows that for green tea, the absolute values of the factor loadings of the items "easy to view" and " clear layout" are large for the first factor, while those of the items "informative" and " impressive" are large for the second factor. The middle column of Table 2 shows that for office chairs, the absolute values of the factor loadings of "easy to view" and " clear layout" are large for the first factor, while those of "informative," " impressive," and "trustworthy" are large for the second factor. The right column of Table 2 shows that the results for supplements are almost the same as those for green tea.

Table 1. Eigenvalue list

	Green tea	Office chair	Supplement
PC1	3.712	2.960	3.379
PC2	1.354	1.552	1.331
PC3	0.737	1.043	0.895
PC4	0.632	0.657	0.681
PC5	0.575	0.602	0.583
PC6	0.391	0.539	0.525
PC7	0.347	0.389	0.420
PC8	0.305	0.312	0.239

Table 2. Factor loadings for the first and second factors

	Green tea		Office chair		Supplement	
	First Factor	Second Factor	First Factor	Second Factor	First Factor	Second Factor
Informative	0.42	-0.62	0.29	0.49	-0.55	0.28
Easy to view	-0.79	0.05	-0.76	-0.12	0.81	-0.14
Easy to visualize	-0.52	-0.17	-0.31	0.27	0.33	0.30
Clear layout	-0.81	0.24	-0.79	-0.32	0.86	-0.15
Stylish	-0.65	-0.32	-0.45	0.30	0.55	0.39
Impressive	-0.47	-0.44	-0.40	0.54	0.35	0.56
Uniform	-0.77	-0.12	-0.70	0.12	0.63	0.04
Trustworthy	-0.48	-0.33	-0.47	0.50	0.45	0.36

3.2 Test for differences by pattern for each product

A t-test was conducted on the "Would you like to buy this product?" question for each product to clarify the website design that showed differences in willingness to buy the product. The P-values obtained as a result of the test are shown in Table 3. Since the three types of data were compared two by two, the comparison was made by multiplying the P-values by three according to the Bonferroni correction. Box-and-whisker plots of willingness to purchase for each product are shown in Figures 1 - 3.

Table 3 shows that the P-values for green tea (2) and (3) and office chairs (1) and (3) were below 0.05, indicating that there was a difference in willingness to purchase the products at the 5% significance level. On the other hand, supplements all have low willingness to purchase and no significant difference

Table 3. P value obtained from t-test for each pattern

	P-value	P-value×3
Green tea (1) and (2)	0.176	0.529
Green tea (2) and (3)	0.012	0.036
Green tea (1) and (3)	0.269	0.806
Office chair (1) and (2)	0.651	1.953
Office chair (2) and (3)	0.027	0.080
Office chair (1) and (3)	0.010	0.030
Supplement (1) and (2)	1.000	3.000
Supplement (2) and (3)	0.533	1.598
Supplement (1) and (3)	0.533	1.598

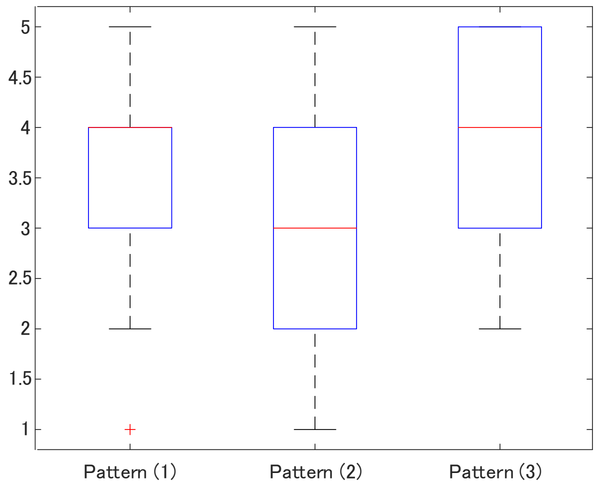

Figure 1. Box-and-whisker plots for green tea

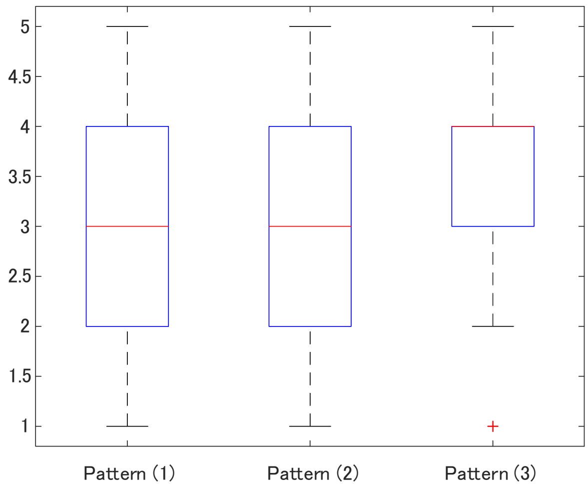

Figure 2. Box-and-whisker plots for office chair

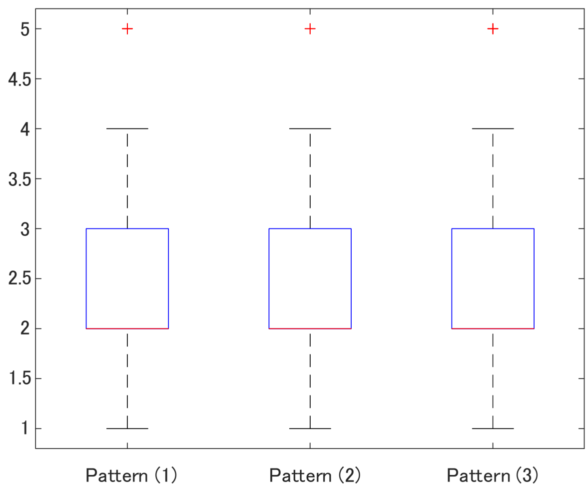

Figure 3. Box-and-whisker plots for supplement

3.3 Evaluation items that caused the difference in willingness to purchase

To clarify the evaluation items that were factors in the combinations that were judged to have caused the difference in willingness to purchase in 3.2, t-tests were conducted for each evaluation item in the two patterns. The resulting P values are summarized in Tables 4 and 5.

Table 4 shows that there was a significant difference in the evaluation items of green tea in terms of "uniform" and "trustworthy". "Uniform" and "trustworthy" were significantly higher for (3). Table 5 shows that significant differences were found for office chairs in terms of "informative," "easy to view," "clean layout," "impressive," and "trustworthy". "Easy to view", "clear layout", and "uniform" were significantly higher for (1), while "informative", "impressive", and "trustworthy" were significantly higher for (2).

Table 4. P value obtained from t-test for green tea (2) and (3)

	P-value
Informative	0.5837
Easy to view	0.6742
Easy to visualize the product	0.4516
Clear layout	0.4637
Stylish	0.2617
Impressive	0.8422
Uniform	0.0336
Trustworthy	0.00001

Table 5. P value obtained from t-test for office chair (1) and (3)

	P-value
Informative	0.0003
Easy to view	0.0030
Easy to visualize the product	0.3414
Clear layout	0.0055
Stylish	0.7886
Impressive	0.0006
Uniform	0.0342
Trustworthy	0.0007

4 DISCUSSION

First, we examine the points that are paid attention to on the landing page of each product. From the results of the factor analysis, it is considered that the first factor common to green tea, office chairs, and supplements is the cohesiveness of the appearance, such as "easy to view" and "clean layout". The second factor for green tea is the amount of information, and that for supplements is the strength of the impression. Additionally, for office chairs, the second factor is considered to be the impression created by information such as a track record, from the viewpoints of "informative," " impressive," and "trustworthy”. The above results indicate that the appearance of any product is a key factor, but especially for high-priced, long-lasting products such as office chairs, information that enhances reliability, such as a track record, can increase users' willingness to purchase the product.

Next, we examine the information that influences the willingness to purchase. In the case of green tea, the results of (2) and (3) showed a change in the perspectives of "uniform" and "trustworthy," indicating that the amount of information increased and the overall layout changed to create a sense of unity, and that information such as track records led to an increase in the level of trust. For the office chairs, changes were observed in (1) and (3) in terms of "informative," "easy to view," "clean layout," " impressive," and "trustworthy," indicating that although the layout was more complicated due to the increase in information such as results and satisfaction levels, it was more trustworthy and left a lasting impression on the user. In both products, it is clear that the viewpoint of trustworthiness is affected regardless of the uniformity of the layout. In other words, it can be said that information such as the track records and the level of satisfaction included in (3) affects the user's willingness to purchase the product.

5 CONCLUSION

In this study, we investigated the type of information that attracts users to a landing page for multiple products. The results showed that users were more willing to purchase a product if it contained information such as campaign information and track records, and especially for products that they use for a long time, reliability influenced their willingness to purchase.

However, because there was little difference in the amount of information on the three types of landing pages, it was not possible to investigate the necessity of information other than campaign information, performance, and satisfaction. Furthermore, since the survey was limited to three products and only one product per category, it is possible that different results would be obtained if other products were surveyed. Therefore, it is an issue for future studies to investigate and analyze a wider range of products.

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WHO ARE YOU TALKING TO?
CONSIDERATIONS ON DESIGNING GENDER AMBIGUOUS VOICE USER INTERFACES

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ABSTRACT

With the widespread availability of Voice Assistants in smart devices, the usage of Voice User Interfaces has highly increased in the recent years. Although the anthropomorphized Voice Assistants present in these systems can aid users in many tasks, it also activates harmful gender bias and stereotypes. Since the usage of Gender Ambiguous voice agents in these interfaces is considered as solution for mitigating these gender effects, this paper analyzed different studies in the field of Voice User Interface design, while proposing a theoretical framework to design gender ambiguous voice agents, considering the type of recording, method of sound manipulation, method of evaluation for gender identification and contextual characteristics.

Keywords: *Voice User Interface Design, Gender Ambiguous Voice, UX Design*

1 INTRODUCTION

Recently, the Voice User Interface (VUI) has grown as one of main ways to interact with devices and systems. One of the main reasons for the fast growth in the development and usage of this type of interface was the widespread availability of Voice Assistants (VA) in smartphones and other smart devices (Bentley et al. 2018). Throughout the years these voice assistants are embedded to more and more systems related to different activities, from navigation to shopping, and even health care (Kinsela, 2021, 2022). In the automotive scenario, the addition of voice

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assistant to a vehicle interface has even become an important purchase factor by users (Kinsela, 2020).

The interaction through VUIs has advantages when compared to other types of interfaces (e.g., visual or vibrotactile), such as its omnidirectionality, which allows the user to receive the information disregard its body position, and the reduction of visual workload (Shahab et al., 2010; Beattie et al., 2015). In addition, when anthropomorphic characteristics such as name, voice and gender are added to the interface it may increase the level of perceived usability and acceptance towards automated systems, when compared to pure abstract sounds cues (Forster et al., 2017). This can be observed in the fact that the most popular Voice Assistants available (Alexa, Siri, Google Assistant) are marketed as virtual personas, in which the voice agents have their own name, voice, and traits that lead users to attribute certain personalities to them (Kuzminykh et al., 2020).

Even though, if a user asks one of these voice assistants what is its gender, the answers will deny the presence of gender attribution, for example, Alexa's answer is "As an AI, I don't have a gender" (Abercrombie et al., 2021). These statements by the VAs are contradictory, since all of them have a female voice by default and, except for Google Assistant, they also have female names (Sutton, 2020). Furthermore, when observing Cortana, Microsoft's Voice Assistant, it not only has a female voice and name, but it was inspired by a character from the game series Halo, a virtual intelligence that presented itself with the appearance of a woman (Blair, 2014).

Since the Human-Computer Interactions (HCI) are fundamentally social, it is expected that the same rules, expectations and actions might be replicated with real people, as stated by the Computer as Social Actors (CASA) paradigm (Nass et al, 1994). Observing that the interactions with VAs are basically expressed through commands with the expectation of an assistance in a certain matter, the presence of female gender bias in the core of the VAs characters may lead users to have a harmful behavior towards women, not only reinforcing a servant stereotype usually ascribed to women, but also leading to a replication of a commanding tone when interacting with women (Gustavson, 2005). Even with the popularization of VAs in the last few years, the effects of this harmful behavior can already be observed, as women named "Alexa" reported being treated as bots, and even leading women to change their names to avoid a series of distressing situations. (Ard, 2022).

To address this matter, UNESCO (2019) released a technical report highlighting the gender bias in Artificial Intelligences (AI), sexism and gender inequality in technology, and suggested possible strategies and solutions for these issues, also calling for researchers and companies for further studies and development in this field. Regarding the matter of the VAs, the report indicates that using a gender-ambiguous voice might decrease the perception and replication of its gender bias and stereotyping.

Since the literature regarding gender-ambiguous voice agents in VUIs is very little, this paper is an attempt to expand the discussion regarding this matter. This paper is presented as an essay, contemplating the dialogue between humanities and HCI, as highlighted by Bardzell & Bardzell (2016), where we analyze what is currently being done in this field of study, observing methods for the research and design of gender ambiguous voice agents, while proposing possible solutions for the further development and the application of this type of voice agents.

2 THE NEGATIVE GENDER EFFECT FOR FEMALE USERS

To first identify how were the gender effects in Voice User Interfaces, Elian et al. (2021) conducted a study that consisted in a survey where participants, considering an automated driving scenario, should evaluate voice messages, recorded by a male and a female artificial voice agent, according to three different usability factors: Pleasure, Commandingness and Urgency. Each message represented a call to action for four situations, each one with a different level of designed urgency, the lowest level corresponded to waiting for the startup of the vehicle's system, and the highest one to a Take-Over Request - situation where the automated driving system has reached its boundaries and a transfer of control to driver is necessary (Naujoks et al., 2017).

The analysis of this study not only highlighted that the voice agent gender had an effect on the participants, where the female agent was perceived significantly more pleasant and urgent, according to the given situation, but it was also found that the participant gender had an effect on the perception of each factor. It was observed that throughout all the situations, female participants had lower scores for Pleasure than the male ones. Also, female participants had higher scores for Commandingness and Urgency when compared to the male ones for almost all the observed situations. Even in the situations with a lower designed urgency, the female participants perceived it as considerably more urgent than the male ones.

This study highlights one more issue when discussing the gender in VUIs: not only there is a stereotyping and behavioral problem towards women with scenarios involving the interaction with this type of interface, as aforementioned, but also the overall experience for female users tends to be considerably worse when compared to male users. As an extrapolation of these findings, if we consider that in a real-life situation, like the Take-Over Request, which has a high sensorial and cognitive workload, a negative perception of the alerts might lead the user, in the worst-case scenario, to a traffic accident, what contradicts one of the main purposes of the Design itself. In addition, it also indicates that depending on the situation that the voice agents within the binary gender frame might not be enough to lead to proper experience.

3 THE Q PROJECT

As one of the first initiatives to change the paradigm of the binary gender frame voice agents in VAs was the project named "Q the genderless voice" (Q, 2019). Q was presented as a voice agent that, by not sounding as male or as female, would reduce the impacts of gender stereotyping, while including people that do not feel represented in the binary gender frame. To achieve such a voice agent, its creators stated that there is a fundamental frequency range between 145Hz and 175Hz, which they called "the neutral zone", where the male and female voice frequencies would overlap each other, allowing to find a voice that would sound as none of the binary genders (Nørgaard, 2019).

The method used by Q to achieve their voice agent consisted in recording twenty people that did not ascribe themselves as male or female. These voices went through sound processing, using change of pitch, formant filter and harmonics modulation. From all the voices recorded, they picked one that fit in the neutral zone and that sounded unique when compared to the others. Then they altered this voice into four different versions and screened them through a survey, where participants were asked if the voice sounded as male or female. The voice with the closest ratio between the male/female answers was the one selected to be Q's voice agent (Nørgaard, 2019).

The objective of Q's project was to be a "proof-of-concept" to the developers of the main VAs in the market that a "genderless" voice was possible as an alternative to break voice gender stereotypes, while highlighting the necessity to take in consideration the non-binary community when designing Voice Assistants (Q, 2019).

Although Q represented a well-designed initiative to attempt a change of paradigm, certain aspects of its development must be taken in consideration. As highlighted by Sutton (2020), using terms like "genderless" or "gender neutral" are unhelpful not only when considering the sexism in technology, but also because it implies that gender should not be taken in consideration in the design. Sutton suggests that the term "gender ambiguous" is the most appropriate when designing or researching this type of voice agent.

4 FEMALE BY DEFAULT?

This question that entitles the study conducted by Tolmeijer et al. (2021) is relevant provocation for the discussion about the voice gender in VAs. This study explored the effects of gender and pitch of VAs on trait and trust attribution by users. For the contextualization, it is important to highlight that, currently, there is no Text-To-Speech (TTS) generator tool with gender ambiguous voice agents, which creates a challenge for researchers in this field: how to effectively design these voice agents? Differently from Q (2019), that had as its outcome only a voice agent, Tolmeijer et al. presents a study that further develops this concept, not only finding a simple but effective method to design gender ambiguous voice agents, while empirically testing users' perceptions and its feasibility of its implementation as part of a VA.

Firstly, the study presents how the method to design its gender ambiguous voice agents for further application in their experiments. Instead of using natural voice recordings like Q, the authors used a series of recordings Wavenet TTS voice agents. Parallel Wavenet is currently the state-of-the-art production model for fast and high-fidelity speech synthesis, it is used by the Google Assistant in few languages, and it is also available as part of the TTS generation tool developed by the company (Oord et al., 2018). Tolmeijer et al. used recordings from different male and female Google Wavenet voice agents, manipulating its pitch afterwards. The pitch was shifted in a certain number of semitones towards the opposite gender from the original voice agent. Also, they pitch shifted the original voice agents to have a high-pitch and a low-pitch male and female voices, for further comparison.

To screen which of these voice agents should be used in the study continuation, the authors conducted a survey where the participants were asked to hear each one of the agents, and identify it between three options: male, female and unsure. The agent with the highest division between the answers was the one selected as its gender ambiguous voice. In that case, the selected voice had 58% of male answers and 42% for female.

Secondly, the study presents two experimental tasks, an assistant, and a compliance task, that simulated realistic ones in the usage of VAs. Both were inspired by classical gender stereotyping, where women would be better in assistant roles, and males in leadership roles. The assistant task was a simulation of a flight ticket booking, and the compliance one consisted of personal questions in the context of a customer survey. In these tasks, participants were asked to answer questions regarding trust and the level of agreement to a series of trait ascriptions related to the gender stereotyping for men and women (e.g., “Authoritative”, “Cold”, “Dominant”, “Delicate”, “Friendly”, “Sensitive”, etc.).

It is relevant to clarify that these “classical” gender stereotypes are recurrent in the literature. The work by Gustavsson (2005) describes how this assistant role ascribed to women has been reinforced by the service industry and how it is constantly replicated in applications for virtual environments. Considering the stereotype for the male as leader, Mayew et al. (2013) found an association between a lower pitch voice and economical success for men in leadership corporative positions.

The results of Tolmeijer et al. (2021) study regarding the gender ambiguous showed that even though there were direct effects of the voice pitch on the trust attribution, a trend where female participants had a higher trust was observed. For the trait ascription, they found the voice pitch and voice gender to subtly influence the participants’ perceptions, also revealing that the context of the task had an effect on the perception and activation of stereotypes. For the gender ambiguous voice, it presented no significant difference in trust when compared to the gendered voices. In addition, it had both effects found for the female and male voices in the compliance task, which indicates that it was not assigned to one specific gender, but the authors also state that since it does not fit to one stereotypical response, it might be sensitive to multiple ones.

5 DESIGNING GENDER AMBIGUOUS VOICE AGENTS FOR RESEARCH PURPOSES

It was possible to observe in the work of Q (2019) and Tolmeijer et al. (2021) that defining gender ambiguity is more related to the perception of those who listen to the voice than to a theoretical definition. Sutton (2020) clarifies that perceiving which gender a voice should sound as, is not only dependent on the anatomy, but this perception is also built through experiencing the speech community the listener is inserted in, indicating that the cultural context must be taken in consideration when designing voice agents.

The challenge imposed by the unavailability of TTS generator tool that included a gender ambiguous voice agent has not a sole answer. In this sense, it is possible to contrast both Q and Tolmeijer et al. methods. The method developed by Q included the recording of several people's voices outside the binary gender frame, where the recordings went through a complex sound manipulation process to achieve the result that the authors found to be satisfactory for the continuation of their study. The method developed by Tolmeijer et al. used artificial voices from a TTS tool, that were originally gendered, and used a pitch shift method to make the voices sound towards the opposite gender. In terms of complexity, replicating the Q's method for research purposes might be quite difficult since it demands a higher level of knowledge on acoustics and sound engineering than the method used by Tolmeijer et al. once the pitch shift technique was empirically demonstrated as effective while being simpler to be replicated. When comparing the usage of natural and artificial voice recordings it is possible to observe that there are only originally gendered artificial voices that might not lead to the same perceptions as using recordings from real people that do not fit in the binary gender frame. Currently there is no study comparing both types of voices, but since this matter of the originally gendered voices was indicated by Tolmeijer et al. as a constraint of their study, this should be considered when designing the gender ambiguous voice agents.

The next step after creating these voices is the evaluation by users regarding their gender perception. Both mentioned studies used surveys asking the participants to identify the gender of each voice message, which seems to be effective, but there are points that must be observed. The survey structured by Q for the gender identification of their voice agents, as mentioned before, had two options "male" and "female", and the number of answers were even for each option (Yates, 2020). The contradiction that the evaluation of a voice that was supposed to be "genderless" (or gender ambiguous, using the most appropriated term) had only binary gender frame options for its gender identification was highlighted by Sutton (2020), suggesting that a third gender option should be added in this type of evaluation, to avoid the participants to be locked in the binary gender frame. To address this matter Tolmeijer et al. (2021) added a third option to their gender identification survey which was the "unsure" one. The fact that their gender ambiguous voice agent with highest division of answers had no "unsure" answers highlights an issue on the wording of these options. The word "unsure" in a context where the other two options are "male" and "female" suggests to the participant that this option is the adequate if it is not sure between male or female, inducing the answer to fit in the previous options. It is possible to consider that no "unsure" answer assigned by the participants was a reflection of this issue. Thus, to avoid undesirable answering bias, we consider that using the word "other" as a third option might be a better solution for this matter, since it implies something else than the other "male" and "female" options available, and it is also a common term for gender questions in surveys.

Further, it is relevant to underline that context or situation where the gender ambiguous voice agent is presented. Not only due to the impact of the cultural variable on its perception, but how the context might activate certain stereotypes, or even the own nature of the situation, like the Take-Over Request presented in the study by Elian et al. (2021), that had a high level of urgency. Presenting different versions of the voice agent (with different levels of pitch or volume, for example) according to the context or situation, might be a solution for reduce the impacts of gender bias on the Voice User Interface, while it adjusts the level of situational awareness of the users for the given task.

6 CONCLUSION

This paper focused on highlighting the current gender bias and stereotyping issues to be tackled in the field of Voice User Interfaces, while supporting the application of gender ambiguous voice agents as a possible solution. Through the analysis of different studies in the field of Voice User Interface design, we propose a theoretical framework to design gender ambiguous voice agents, considering the type of recording, method of sound manipulation, method of evaluation for gender identification and contextual characteristics. These observations can aid researchers and designers to further develop studies and projects regarding this type of voice agent, mainly for real life tasks, which are still absent in the literature.

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YOUNG WOMEN'S PERCEPTIONS OF REPLACEABLE UPPER SHOES BEFORE AND AFTER THE UPPER INTERCHANGE

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ABSTRACT

This study tries to investigate the visual perception of casual and formal leather shoe uppers, by conducting semantic differential evaluations. Twelve upper design renderings were generated based on six ideations with casual uppers converted into formal leather uppers. Based on a seven-point Likert scale, twelve renderings were evaluated using fifteen Kansei adjective pairs and young women's willingness to purchase. Factor analyses were performed to analyze the differences and factors between casual and formal leather uppers. In the factor analysis of upper styles, five factors were identified for casual uppers: evaluation, attention, fashion, protection, and temperament; and five factors for formal leather uppers: attention, formality, fashion, weight, and protection. Whether a young woman is looking for formal leather uppers or casual shoe uppers, fashion plays a crucial role in her decision to purchase shoes.

Keywords: *footwear design, product emotion, customer perception, shoe upper replacement*

1 INTRODUCTION

Footwear plays an indispensable role in today's life, including various kinds of functional footwear ranging from casual indoor shoes to outdoor shoes, showing our close connection with it. Among them, women's shoes come in many different types and styles, as footwear is required to complement clothing and perform certain functions. Under the impact of covid-19, due to maintaining a safe social distance, consumers panicked about going out shopping once upon a time, resulting in a sharp drop in shoe consumption. The lockdowns imposed by various countries to prevent the spread of the epidemic have directly caused the rupture of the global shoe industry

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chain. Global shoe factories, especially those in Vietnam, once shut down for several months and delayed shipping, which once had a profound impact. Under different levels of lockdown control, office workers have adapted to working from home. Therefore, they have developed a habit of not wearing makeup and wearing more comfortable home clothes. Following the ban, their work clothes have evolved into a more casual style, and they won't dress too formally. In such a real-life context, this study is based on women's casual shoes and develops the replaceable upper designs of dress shoes for young women, as well as explores the before-and-after differences in young women's evaluation of the replaceable upper design. Looking forward to exploring new innovative directions for footwear design.

2 LITERATURE REVIEW

2.1 The footwear industry in the post-pandemic era

In the post-epidemic era, global athletic footwear sales will continue to grow, from being valued at $109.7 billion in 2020 to reaching $165 billion in 2030, registering a CAGR (Compound Annual Growth Rate) of 4.2% from 2021 to 2030 (Allied Market Research, n.d.). Even with social distance restrictions, more and more supermarkets and retail stores will provide consumers with easy access to sports shoes. Consumers will be willing to spend money on innovative technical properties such as friction regulation, waterproof quality, temperature control, and moisture management; in addition, governments across the globe are also focusing on increasing investments and new strategies to encourage people to participate in sports and physical activities (Sports Footwear Market, n.d.). On the other hand, the traditional leather shoe market is affected by the dramatic changes in lifestyle, especially the epidemic prevention measures of working from home, and its sales are more severe. For example, the Portuguese footwear industry is the third-largest footwear producer in the EU, but its exports from January to August 2020 decreased by 17% from the previous year. To maintain operations, footwear companies began to abandon the production of high-end leather shoes and turned to the production of comfortable shoes suitable for wearing at home or purchasing in supermarkets. Some shoe factories even switched to producing anti-epidemic masks and other related anti-epidemic supplies to reduce losses (Hindustan Times, 2020 Nov. 12).

The market pull is the main driving force in the footwear market, and the changes in lifestyle consumption patterns post-epidemics will have a profound influence. It is estimated that the amount of global utilitarian consumption has increased by 5%-20% in the past few years, and compulsory consumption (necessities) has increased by 40%-80%; the largest decline in consumption is hedonic consumption, and luxury goods are seldom consumed in this decline. The more significant sign is that the purchase of textiles, shoes, and clothing, which could be regarded as compulsory consumption before the epidemic, began to be regarded as luxury items in the process (Tarakci and Yildiz, 2020). As for outdoor adventure sports, such as rock climbing, parkour, skateboarding, surfing, bicycle motor cross, etc., many lifestyle sports athletes who prefer an open environment had an ambivalent attitude toward organized, restricted, or structured competition. Some lifestyle sports media even reminded the public to reduce group sports gatherings and avoid injuries to place less strain on overloaded health care systems (Smith, 2020).

2.2 The plight of the leather shoe industry

Sneakers and casual shoes have become the main types of footwear for young consumers. In today's increasingly flexible working environment, young people tend to wear comfortable clothing. In the work-from-home model, casual shoe sales have also been promoted. With the lifting of the lockdown and the reopening of offices, human daily life has entered a post-epidemic mode. However, it is unlikely that only slippers will be worn when going out in the post-epidemic era, even if this habit of wearing is exacerbated by the epidemic. The demand for shoes still corresponds to transitional shoes for going to work, participating in activities, and going out at night or on weekends. The sales volume of leather shoes or formal shoes began to decline before the spread of the new crown pneumonia epidemic. It is speculated that the possible reason is the excessive reliance on classic styles, resulting in a single product structure, which does not provide consumers with the design freshness of leather shoe styles. Leather shoes still face the challenge of diversified designs. Despite leather shoes not being favored by consumers due to their preference for formal business, well-known brands still pay attention to how they mix and match shoe materials and shoe types to meet post-epidemic life and work patterns. This also allows formal business orientation to be incorporated into innovative proposals, and thus serves as an important opportunity for this study to explore. In recent years, some innovative casual or sport shoes have been released with replaceable uppers (Figure 1). Therefore, it is worth discussing how much leather shoes and casual shoes can be converted by replacing the upper, and how many changes can be made to consumers' image evaluation.

Figure 1. TRANSHIELD footwear design (Retrieved from https://sites.google.com/yuntech.org.tw/transhieldfootwear/home)

3 METHODS

3.1 Stimuli - women's shoe design renderings

Before designing the shoe's appearance, 5 conceptual structures for replacing the upper, characterized by notch, tenon, hook-and-loop, laces, and rope hook, were first tested in prototype mode (as shown in Table 1). Considering the duration (efficiency), 3 structures were selected for designing women's casual uppers, namely, notch, tenon, and hook-and-loop. In the development of casual shoe uppers, the knitted sock was used to present a sense of leisure. The research team then developed 2 upper appearance gray-scale proposals for every structure, totaling 6 casual shoe renderings (Figure 2). Six formal leather shoe renderings (Figure 3) were designed to cover leather uppers on 6 casual shoes, respectively, to complete the interchange (Figure 4). These 12 shoe gray-scale renderings were the stimuli for the image evaluation of the semantic difference method.

Table 1. Prototyping and testing of five replaceable upper structures

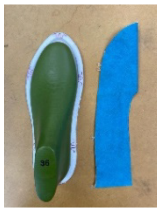
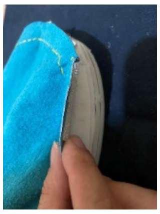
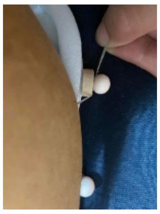
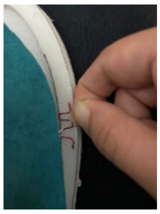
Type	notch	tenon	hook-and-loop	laces	rope hook
Duration (second)	30.81	13.07	5.80	71.20	63.92
Prototype					
Detail					

Figure 2. Six gray-scale renderings of casual shoe upper

Figure 3. Six gray-scale renderings of formal leather shoe upper

Figure 4. The transformation from casual shoes to formal leather shoes in this study

3.2 Participants and procedure

The assigned participants were 15 female college or graduate students (average age: 21.33 y; age range: 19–24 y) and 15 female office workers (average age: 24.13 y; age range: 22–25 y). None of them had any foot injuries. To maintain a safe social distance due to the covid-19 epidemic, the experiment was conducted through online questionnaires. After viewing all the stimulus renderings, the participants completed semantic differential (SD) evaluations, including 15 Kansei adjective pairs (as shown in Table 2, following the experimental settings of our previous research) and purchase intention (1 represents the least intention, and 7 represents the most intention). Each adjective pair was rated on a 7-level Likert Scale. In Table 2, the left adjective scored 1 point, the right adjective scored 7 points, and the middle 5 scales were not marked with a value. Participants completed the SD evaluation of one shoe rendering before moving on to the next stimulus rendering until all renderings were evaluated.

Table 2. 15 Kansei adjective pairs used in the SD evaluation (Cheng and Lee, 2021)

1. (1) minimalistic - (7) complicated	2. **(1) rough - (7) elegant**	3. (1) highly styled - (7) ordinary
4. **(1) exposed - (7) covered**	5. (1) dangerous - (7) safe	6. (1) classic - (7) modern
7. **(1) old-fashioned - (7) fashionable**	8. (1) business-casual - (7) sporty	9. (1) stiff - (7) flexible
10. **(1) single - (7) multiple**	11. **(1) low key - (7) eye-catching**	12. (1) block-structured - (7) flowing
13. (1) childish - (7) mature	14. (1) lightweight - (7) heavy	15. (1) static - (7) dynamic

4 RESULTS

4.1 Results of MANOVA

After data import, descriptive statistics were analyzed first, followed by a multivariate analysis of variance (MANOVA). The influences of shoe type and participant background were compared with SD evaluation. Two variables were considered independent, and the evaluation results of the 15 Kansei adjective pairs and purchase intention were treated as dependent variables. The result indicated significant influences of shoe type (F [16, 341] = 12.966, $p < .00$), and participant background (F [16, 341] = 4.268, $p < .00$) but not for the interaction between with shoe type and participant background (F [16, 341] = 1.466, $p = .110$). Regarding the results of between-subjects effects, the SD evaluation results were affected by shoe type in 14 Kansei adjective pairs, except for "exposed–covered" (F [1, 356] = 1.262, $p = .262$) and purchase intention (F [1, 356] = 3.268, $p = .071$). As depicted in Figure 6, the median value of the 7-point scale (4) was regarded as the neutral baseline. It shows that both types of shoes tend to deliver a sense of "covered," and casual shoes (mean: 4.04) are slightly easier for participants to buy than formal leather shoes (mean: 3.71). On the whole, the renderings of formal leather shoes are more "complicated," "elegant," "highly styled," "safe," "modern," "fashionable," "business-casual," "stiff," "multiple," "eye-catching," "block-structured," "heavy," and "static," but less "mature" than those of casual shoes. As to the effect of participant background, compared with office workers, students tended to express that these shoe renderings were more "rough" (4.21 < 4.80, F [1, 356] = 13.326, $p = .000$), "covered" (6.04 > 5.79, F [1, 356] = 3.949, $p = .048$), "fashionable" (4.41 < 4.82, F [1, 356] = 5.563, $p = .018$), "multiple" (4.86 > 4.40, F [1, 356] = 7.441, $p = .007$) and "eye-catching" (4.16 > 3.70, F [1, 356] = 6.678, $p = .010$).

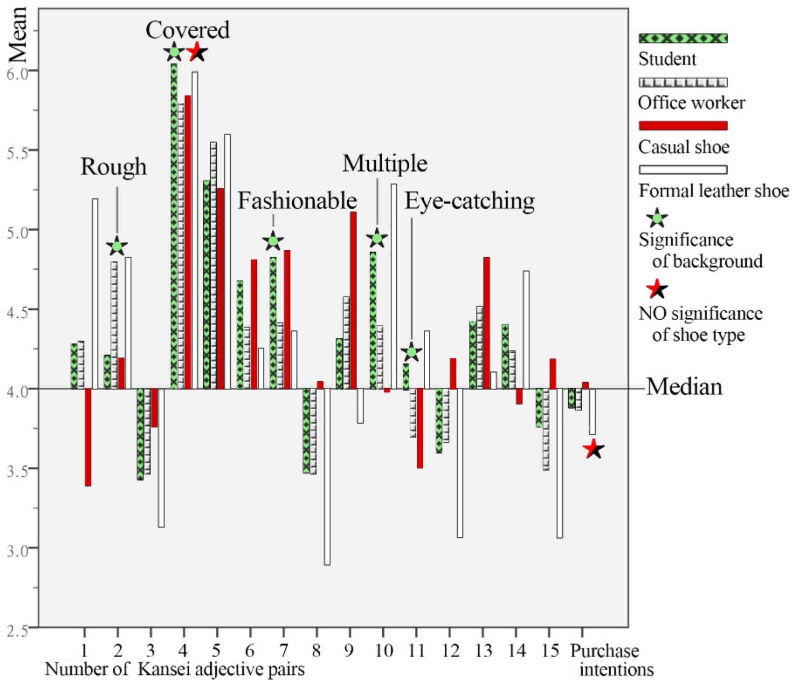


Figure 6. The effects of participant background and shoe type.

4.2 Results of factor analysis

According to the results of MANOVA, the shoe type was a significant factor affecting more Kansei adjective pairs. The data of 6 casual shoe renderings and 6 formal leather shoe renderings were analyzed using factor analysis with Varimax rotation and Kaiser normalization, respectively. Five factors were extracted from the factor analysis results of casual shoes (Table 3) and named evaluation, attention, fashion, protection, and temperament (Table 4). As to the results of formal leather shoes, the other five factors were extracted (Table 3) and named attention, formality, fashion, weight, and protection (Table 5). After examining the correlation between purchase intention and 15 SD evaluations with the Pearson correlation coefficient, the results showed that the purchase intention of casual shoes was significantly associated with “old-fashioned–fashionable” (r=0.423), “classic–modern” (r=0.268), and “childish–mature” (r=0.291) from low to moderate associations. The purchase intention of formal leather shoes also had low to moderate correlations with “old-fashioned–fashionable” (r=0.447), “classic–modern” (r=0.428), and “childish–mature” (r=0.217). These three Kansei adjective pairs constituted the fashion component in the factor analysis of both shoe types, in other words, the purchase intention of both casual shoes and formal leather shoes has a moderate correlation with the fashion factor. Modern, fashionable, and mature shoes are more desirable.

Table 3. Total variance explained for casual shoes and formal leather shoes (with eigenvalues > 1)

Casual shoes				Formal leather shoes			
Compo-nent	Rotation Sums of Squared Loadings			Compo-nent	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %		Total	% of Variance	Cumulative %
1	2.781	18.540	18.540	1	2.336	15.577	15.577
2	2.507	16.715	35.254	2	2.053	13.686	29.262

3	2.093	13.951	49.205	3	1.911	12.741	42.003
4	1.670	11.132	60.338	4	1.821	12.142	54.146
5	1.396	9.304	69.642	5	1.502	10.014	64.160

Table 4. Rotated component matrix of casual shoes

Kansei adjective pairs	1 evaluation	2 attention	3 fashion	4 protection	5 temperament
stiff - flexible	0.774	-0.151	-	-	0.100
lightweight - heavy	0.750	0.178	-	-	-
block-structured - flowing	0.687	-	0.311	-	0.112
business-casual - sporty	0.682	-	0.106	0.239	-0.368
static - dynamic	0.644	-	0.347	-	-0.462
single - multiple	-	0.814	-	-	-
low key - eye-catching	-	0.759	-	-	0.255
highly styled - ordinary	0.124	-0.752	-	0.159	0.141
minimalistic - complicated	-0.169	0.735	-0.264	-0.223	-0.159
old-fashioned - fashionable	0.267	0.116	0.805	-	-
classic - modern	0.359	-	0.767	0.116	-0.170
childish - mature	-	-0.235	0.716	-	-
exposed - covered	-	-0.144	-	0.879	-0.101
dangerous - safe	-	-0.125	0.136	0.844	0.175
rough - elegant	-	-	-	-	0.913

Table 5. Rotated component matrix of formal leather shoes

Kansei adjective pairs	1 attention	2 formality	3 fashion	4 weight	5 protection
low key - eye-catching	0.779	-	-	-	-
highly styled - ordinary	-0.721	-	-	-	0.146
single - multiple	0.707	-	0.173	-	0.155
minimalistic - complicated	0.692	-	-	-0.221	0.112
static - dynamic	-	0.817	0.226	0.205	-
rough - elegant	0.140	-0.774	0.126	0.212	-
business-casual - sporty	-	0.773	0.130	0.303	0.117
classic - modern	0.185	0.142	0.803	0.167	-
old-fashioned - fashionable	0.272	-	0.739	0.248	0.139
childish - mature	-0.222	-	0.702	-0.251	-
lightweight - heavy	0.104	-	-	-0.799	-
stiff - flexible	-	0.168	-	0.792	-
block-structured - flowing	-	0.298	0.301	0.395	-0.290
dangerous - safe	-0.105	-0.102	-	-	0.844
exposed - covered	0.154	0.152	-	-0.116	0.771

5 DISCUSSIONS AND CONCLUSIONS

Replaceable shoes belong to a relatively new retail market, and most of the existing cases are male-style. In this study, we tried to study the possible design direction of (formal leather) dress shoes in the future market by exploring women's shoes with replaceable uppers. The results showed that the willingness of young women to buy casual shoes was still slightly higher than that of dress shoes. However, because the difference was not significant, potential shoe developers in the future may consider using casual shoes as the base to increase the market acceptance of dress shoes. The purchase intention of participants for the two types of uppers was both related to fashion, which might reflect the customer preference of young women. In addition, this study achieved a similar result as the previous one: women are very sensitive to the coverage of shoe uppers. We chose to use knitted socks as the basic upper of casual shoes. Due to our focus on creating a prototype in our laboratory, we also covered the leather upper so it could become dress shoes. This setting might also make it easier for participants to feel covered. It may be a major shortcoming of this study. Researchers and footwear designers in the future should redesign this part to explore more potential paths for the leather shoe industry.

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