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WonJoon Chung
Cliff Sungsoo Shin *Editors*

Advances in Affective and Pleasurable Design

Proceedings of the AHFE 2016 International Conference on Affective and Pleasurable Design, July 27–31, 2016, Walt Disney World®, Florida, USA

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7th International Conference on Applied Human Factors and Ergonomics

Proceedings of the AHFE 2016 International Conference on Affective and Pleasurable Design, July 27–31, 2016, Walt Disney World®, Florida, USA

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Preface

This book focuses on a positive emotional approach in product, service, and system design and emphasizes aesthetics and enjoyment in user experience. This book provides dissemination and exchange of scientific information on the theoretical and practical areas of affective and pleasurable design for research experts and industry practitioners from multidisciplinary backgrounds, including industrial designers, emotion designer, ethnographers, human–computer interaction researchers, human factors engineers, interaction designers, mobile product designers, and vehicle system designers.

This book is organized in seven sections which focus on the following subjects:

I. Design of Human Interface and Affective Communication
II. Kawaii/Affective Value Creation
III. Affective/Emotion in Design Education (ADE)
IV. Design for Smart Environments and Well Living
V. Emotional Engineering
VI. Empathetic Design
VII. Designing Affective and Pleasurable Interactions

Sections I through III of this book cover new approaches in affective and pleasurable design with emphasis on diversity, value creation, cultural and traditional contexts, and ergonomics and human factors. Sections IV through VII focus on environment and design issues in product, service, and system development, human interface, emotional aspect in UX, and methodological issues in design and development. Overall structure of this book is organized to move from special interests in design, design and development issues, to novel approaches for emotional design.

All papers in this book were either reviewed or contributed by the members of editorial board. For this, I would like to appreciate the board members listed below:

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This book is the first approach in covering diverse approaches of special areas and including design and development methodological researches and practices in affective and pleasurable design. I hope this book is informative and helpful for the researchers and practitioners in developing more emotional products, services, and systems.

Ottawa, Canada — WonJoon Chung
Champaign, USA — Cliff Sungsoo Shin
July 2016

Contents

Part I
Design of Human Interface and Affective Communication

Questionnaire Survey Result of the Use of Communication Robots for Recreational Activities at Nursing Homes

Teruko Doi, Noriaki Kuwahara and Kazunari Morimoto

Abstract We are using information communication technology (ICT) and communication robots (hereafter referred to as "robots") to examine a system to assist recreational activities at nursing homes. The system relies on visual content to deliver a variety of recreational activities, from exercises to reminiscence therapy. Robots support those activities by interacting with nursing home residents. These systems are currently being evaluated at various elderly care facilities, where the prototype has been installed. In this research, we will examine the influence of this service brought to the care staff and nursing home residents based on the result of questionnaire taken from the care staff after the assessment.

Keywords Dementia · Care recreation activity · Communication robot

1 Introduction

Recreational activities at elderly care facilities play an essential role in the maintenance of a quality life. Recreation serves more than the purpose of bringing enjoyment to the residents; it also helps with rehabilitation [1, 2]. On occasion, caregivers get stuck in a rut, and the less experienced staff in particular tends to resist taking the lead in livening things up. With regards to managing recreational activities, one of the issues that need addressing is the training of the young staff [3]. Because of this, nursing facilities frequently end up using DVDs or visual aid in leading exercises, singing and other activities. Although healthy elderly possibly

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enjoy such visual contents, it is difficult to sustain the focus of elderly dementia patients on visual contents. For these people, we developed a prototype of care home recreational service with a moving robot with active body interconnected with the recreational visual contents, and assessed its effectiveness.

Reports indicate that replacing message boards and other static forms of communication with robots that communicate improve the message's reliability. Other reports have shown that when robots facilitated face-to-face communication between two elderly dementia patients through the TV phone, the subjects were more likely to direct their gaze toward the TV monitor and liven up conversations [4, 5]. The presence of robots with active bodies was therefore expected to increase one's gaze and focus on the visual contents. It is anticipated that the addition of robots opens up the usual staff-to-residents communication to a three-way channel that creates more opportunities for communication between the care staff and the residents. As a result, expectations were that the services currently under examination would reduce stress on caregivers who manage recreational activities, and that will in turn bring about positive changes to the entire program.

Nippon Telegraph and Telephone West Corporation (hereafter referred to as "NTT West") and Nippon Telegraph and Telephone East Corporation (hereafter referred to as "NTT East") are currently examining the recreation system in the aforementioned system using ICT and communication robots. In collaboration with two nursing facilities in the Kansai region and two in the Kanto region, assessment of the expected effect mentioned above was conducted.

In this report, we examined and discussed the influence of this service brought to the care staff and nursing home residents based on the result of questionnaire taken after the assessment.

2 Assessment Method

2.1 System Outline

Figure 1 shows the outline of the system. The hardware used was Hikari BOX$^+$ [6], a set-top box provided by NTT West Japan, and a robot connected to that. We used FLET'S Hikari [7], an Internet service provided by NTT West Japan and NTT East Japan. Nursing home recreational activities (visual contents) will be available as application of Hikari BOX$^+$. Hikari BOX$^+$ and robots are connected via wireless LAN, and the robot will synchronize its actions with the visual content. The robot Sota [8], as seen in the drawing, will appear only as a torso, 30 cm in height and used on a tabletop.

Hikari BOX$^+$ is shaped like a box measuring 115 mm × 105 mm × 31.5 mm and operated with remote control buttons. The TV is connected through an HDMI cable. The content will vary from children's stories and exercises, to quizzes (calculations, kanji characters), reminiscing (topics from the past), and an introduction to famous local spots.

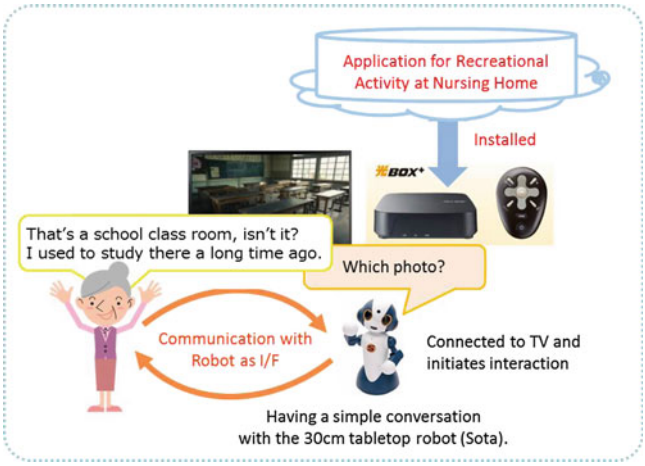

Fig. 1 System outline

The nursing home recreation system can be activated with the mere press of a remote control button on Hikari BOX$^+$. On the other hand, after the remote is used at the time of starting recreation activities or moving on to the next question on a quiz, the robot begins to operate. The robot will then gesticulate and speak words of starting recreations or encouragement.

2.2 Outline of Assessment Schedule

Care staff were given a 2-week pretrial period to become accustomed to the Hikari BOX$^+$ and learn how to operate the nursing recreation system. At the same time, contents were narrowed down to those that will undergo the assessment. Afterwards, 3 months trial was conducted. During the trial period, a portion of the usual recreational programs carried out at the facilities incorporated Hikari BOX$^+$ and robot system. Pretrial by NTT West Japan began in mid-June for the Kansai region's assessment, and the 3-month trial began in July. Pretrial by NTT East Japan began in August for the Kanto region's assessment, and the trial was held between August and October.

2.3 Facilities Collaborated with the Assessment

4 facilities in total collaborated with our assessment. In the Kansai Region, Supercourt Co., Ltd., Kyoto Shijo Omiya (privately run nursing home, hereafter referred to as SC) and Telwel Nishi Nihon—Carr Port Osaka Nishi Suita Center

(day care, hereafter referred to as CP). In the Kanto region, Social Welfare Corporation Zenkokai—Butterfly Hill Hosoda (special elderly nursing home, hereafter referred to as BH) and Telwel Higashi Nihon—Setagaya Day Service Center (day care, hereafter referred to as SD).

2.4 Assessment Method

2.4.1 Assessment Outline

The assessment included a survey after the 2-week pretrial period that asked the subjects their impressions and opinions of each recreational activity, and the service improvement in response to that. Then, every two weeks during the 3-month trial period of the improved service, that followed, the GBS scale [9] for rating the severity of dementia and its qualitative differences are being used to measure the subjects' emotional function and mental state. Furthermore, on the third month when the nursing staff and the residents have become fully accustomed to the robot and the recreational activities, two evaluations by DCM [10] took place to assess changes in the quality of the facilities' nursing care caused by the incorporation of the new service. When the assessment was concluded, a questionnaire asked the care staff about their impression of using this service or changes among the nursing home residents that they noticed. In this study, we will examine the influence of this service has on the care staff and nursing home residents based on the result of this questionnaire.

2.4.2 About Post-assessment Questionnaire

The questionnaire taken after the assessment was largely consisted of 5 categories listed below. In this study, in order to proceed the discussion based on the results of (1) Changes in the nursing home residents, (2) Influence on the care staff, and (4) The general impression of this assessment, we will list the details of these 3 categories shown in Tables 1 and 2.

1. Changes in the nursing home residents (10 questions)
2. Influence on the care staff (10 questions)
3. Evaluation of the care recreation visual contents (13 questions)
4. The general impression of this assessment (4 questions)
5. Possibility of adopting this service to private homes (4 questions).

Answering methods for the Tables 1 and 2 are listed.

*1 Select from [Agree, Partially agree, Partially disagree, Disagree].
*2 Please write freely.
*3 Select from [Agree, Partially agree, Partially disagree, Disagree].

Table 1 Detail of questions category 1

1. Changes in the nursing home residents		Answering method
Q1	Compare to the usual recreation, the residents participated more actively	*1
Q2	Compare to the usual recreation, the residents started to look forward to having the recreation time more	*1
Q3	Compare to the usual recreation, the residents spoke more frequently during the recreation	*1
Q4	Compare to the usual recreation, the residents had more energetic conversation during the recreation	*1
Q5	The residents showed actions that suggest emotional attachment toward Sota, such as actively talking to Sota	*1
Q6	The residents showed actions that suggest dislike toward Sota, such as their mood turning bad when Sota started to talk	*1
Q7	Compare to before using Sota, the emotional/mental condition of the residents became more stable	*1
Q8	Compare to before using Sota, the health condition of the residents became more stable	*1
Q9	Please write down if there were any other changes than those listed above among the residents	*2
Q10	Do you think the residents were satisfied with the recreation using Sota?	*3

Table 2 Detail of questions category 2

2. Influence on the care staff		Answering method
Q1	Compare to the usual recreation, the time needed for planning/preparing recreation was shorter	*1
Q2	How much time per day did this service help you to shorten?	*4
Q3	Please write down the main reasons why the time did not get shorter	*2
Q4	Compare to the usual recreation, it was easier to implement	*1
Q5	Please specify how exactly did it become easier? * Check all the corresponding points	*5
Q6	Please write down the main reasons why you did not feel it was easier to implement	*2
Q7	Was there anything that felt like reducing the mental burden or supporting you (e.g. healing, sense of security, positive feeling)?	*1
Q8	Please specify exactly in which way did you feel you were receiving mental support? * Check all the corresponding points	*6
Q9	Please write down if there were any other elements than those listed above that helped you in your work	*2
Q10	Aside from Sota, please write down if you have any suggestion for "If there was this kind of product or if you have any problem in your work, it would help my work"	*2

*4 Select from More than 30 min, About 15 min, About 5 min, Less than 5 min.

*5 Please check the corresponding answers from the list below, or write freely.

- Recreation required less staff.
- Introduction and running of recreation became smoother because of the visual contents and/or direction from Sota.
- It enabled me to work on other duties during the recreation.

  What other duties? (Answering telephone. Responding to calls. Writing daily report. Others ()

- It enabled me to support the residents more.
- Others ()

Please write the reasons for "Partially disagree" or "Disagree".

Table 3 Participants to the questionnaire

Care facility	Participant	Type of work	Years of experience	Gender	Age
SC	A	Care staff	8 years	Male	In 40s
	B	Care staff	3 years	Female	In 20s
	C	Care staff	1 year and 6 months	Male	In 20s
	D	Care staff	3 years	Female	In 20s
	E	Care staff	6 months	Female	In 20s
	F	Care staff	3 years and 6 months	Female	In 50s
CP	G	Consultant for everyday affairs	8 years	Female	In 30s
	H	Care staff	3 years	Female	In 60s
	I	Care staff	2 years and 10 months	Female	In 40s
	J	Care staff	1 years and 6 months	Female	In 50s
	K	Care staff	3 months	Male	In 30s
	L	Care staff	3 months	Male	In 50s

*6 Please check the corresponding answers from the list below, or write freely.

- Appearance/Movement/Speech of Sota was soothing.
- It enabled me to conduct recreation easily and helped me to focus on other duties.
- See the residents enjoy made me more positive about my work.
- Others ()

2.4.3 Participants Answering to the Questionnaire

In this study, we present the result of questionnaire given to the 12 staff members from 2 facilities in Kansai region. Table 3 shows the profiles of the participants.

3 Results of Evaluation from Questionnaire

3.1 Changes Among the Nursing Home Residents

Figure 2 shows the evaluation result of the changes among the nursing home residents. Figure 2 was generated by taking average of 3–0 points given in the 4 choices evaluation of answering methods *1 and *3 shown in Sect. 2.4.2.

Questions that received more than 2 points were; Q1: Improvement of motivation in participating in recreation, Q2: Improvement of the attraction of recreation, Q3: Enlivenment of conversation among the residents, Q4: Enlivenment of conversation among residents, Q5: Emotional attachment of residents toward the robot, Q10: Satisfaction of residents for recreation. About these sections, it can be

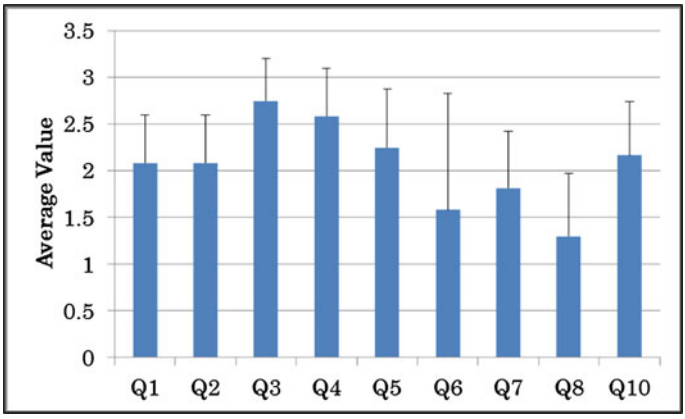

Fig. 2 Evaluation result of the changes among the nursing home residents

considered that the care staff is generally thinking that this care recreation service had positive influence on the nursing home residents.

Questions that received less than 2 points were; Q7: Stabilization of the emotional/mental condition of the residents, Q8: Stabilization of the health condition of the residents. The effective of this care recreation service was not observed for these sections. Moreover, as Q6 asked if the residents displayed any dislike toward the robot, the answer shows they did not show such dislike.

On the other hand, Q9: Other changes observed among the resident, generated these positive comments listed below.

1. The residents grew attached to the robot and started to touch it more each day.
2. They started to notice the changes in the movement or eye color of the robot, leading to more diverse conversation.
3. The focus of the residents mildly improved.
4. They agreed to join the recreation when we mentioned the robot.
5. Their bad mood decreased
6. They started to smile as though they were looking at a child.

However, there also comments that questioned the effectiveness of the robot, as the residents were focusing on the TV and it was unclear if they understood about the robot.

3.2 *Influence on the Care Staff*

Figure 3 shows the result of evaluation of the influence on the care staff. Figure 3 was generated by taking average of 3–0 points given in the 4 choices evaluation of answering methods *1 shown in Sect. 2.4.2. Q1: Compare to the usual recreation, the time needed for planning/preparing recreation was shorter, Q4: Compare to the

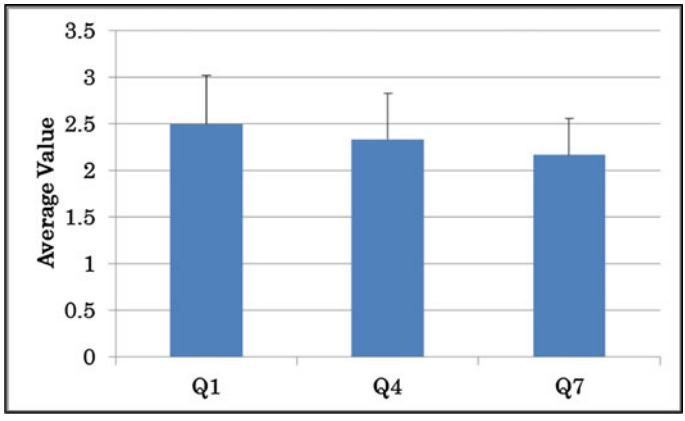

Fig. 3 Evaluation result of influence on the care staff

usual recreation, it was easier to implement, and Q7: If it reduced the mental burden or supported you in your work (e.g. healing, sense of security, positive feeling), all received more than average 2 points. This is considered to mean the introduction of this care recreation service has brought the positive influence on the care staff.

For the Question #2: How much time per day did this service help to save your time?, which is a supplementary question of Q1, 8 out of 12 respondents said it helped to save their time more than 30 min.

Moreover, on Q5: Please specify how exactly did it become easier?, which supplements Q4, 12 out of 12 respondents pointed out the necessity of less staff for the recreations. Additionally, both the fact that introduction/conducting recreation became easier and it became possible to engage with other duties were pointed out by 6 respondents. Furthermore, 4 care staff commented that the service enabled them to support the residents during the recreation. Finally, 1 person raised other points.

On Q8: Please specify exactly in which way did you feel you were receiving mental support?, which supplements Q7, 7 out of 12 respondents pointed out that they found the appearance/movement/speech of the robot soothing. Moreover, 6 care staff pointed out that it helped them to focus on other duties as it enabled them to conduct the recreation more easily, and 4 pointed out that it prompted them to engage with the work with more positive feeling as they saw the residents enjoying. Finally, 1 person raised other points.

Regarding Q9: Aspects other than listed above that the usage of the robot helped in work, there were tendency that many care staff said they were able to enjoy the recreation together with the nursing home residents.

Regarding Q10: Please write down suggestion for "it would help my work if there was this kind of product", or if you have any problem in your work, there were various positive requests regarding the care recreation service.

4 Conclusion

In this study, we examined the influence introduction of care recreation service using communication robot to care facilities has on care staff and nursing home residents. This was done according to the result of questionnaire given to the 12 participants (care staff) at 2 care facilities in Kansai region, taken after the assessment. From the result of the questions about the changes among the nursing home residents, it became clear that introduction of this care recreation service encouraged them to join the recreation more actively, increase conversation and engage in more active communication between the residents. On the other hand, it did not show any particular influence on the stability of emotion/mental or health of the residents. However, some of the care staff commented that it decreased bad mood among the residents. Moreover, the DCM evaluation conducted at the last month of assessment showed that statistically, the condition of the residents were significantly better when this service is in use than when it is not [11].

While the care staff observed their familiar nursing home residents daily while they were engaging with care work, DCM evaluation were conducted by external mappers with special qualification. Due to this, there is a possibility that the care staff thought that the subtle changes among the residents during the care recreation was within the margin of error.

Regarding the influence on the care staff, it showed that many staff noticed the shortening of preparation time of recreation and ease in conducting the recreation, and received mental support through the presence of the robot. It must be noted that 2/3 of the respondents answered that they saved more than 30 min. Moreover, as the robot conduct the care recreation, it allowed the care staff to enjoy the recreation with the residents. This can be considered as a factor in the positive influence on the care staff. Additionally, as it was mentioned in the report on DCM evaluation [11], it can be considered that realization of high quality care was enabled through the use of this care recreation, as it allowed the care staff to conduct the recreation with less staff, engage with other duties and support the residents, thus giving them more time and mental space.

We aim to realize further improvement in the service through responding honestly to the many requests given by the care staff toward this service.

Acknowledgments In realizing this research, we would like to thank NTT West Japan and NTT East Japan for coordinating the assessment and providing us some of the equipment. We thank Vstone Co., Ltd. for providing the robot, and thank Smile Plus Co., Ltd. for providing us some of the visual contents. We thank Super Court Co., Ltd., Care Port Osaka Nishi Suita Center, Social Welfare Corporation Zenkokai—Butterfly Hill Hosoda and Setagaya Day Service Center for participating in the study. We also would like to thank all DCM mapper for helping us with DCM evaluation. And a part of this study received the assistance of JSPS KANENHI Grant Number 15H01698.

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Representation of Fundamental Movements and Pauses for Archiving Traditional Skills

Hiroki Nomiya and Teruhisa Hochin

Abstract Considering the reduction of the number of persons engaging in traditional skills, archiving various types of traditional skills is required to preserve and transmit them to future generations. We focus on representing fundamental movements and pauses in traditional skills because they are key components in describing traditional skills and archiving them. The fundamental movements and pauses can be described based on the movements of a number of body parts obtained using motion capture system. In this paper, we propose an efficient method to represent fundamental movements and pauses using the motion data. The proposed method generates concise and informative feature values from the motion data on the basis of dimensionality reduction and feature selection. The effectiveness of the proposed method is evaluated through an experiment to describe several types of fundamental movements in Japanese traditional tea ceremony.

Keywords Archiving · Traditional skill · Fundamental movement · Pause · Dimensionality reduction · Feature selection

1 Introduction

There are a wide variety of valuable traditional crafts and industries. It becomes, however, more and more difficult to preserve and transmit them because young people are less interested in traditional cultures and not willing to obtain traditional skills. Moreover, aging of the skilled people makes it more difficult to transmit the traditional skills [1–3]. Therefore, preserving traditional skills is urgently needed.

Most of the traditional skills and industries are founded on various traditional skills. It will be thus effective to archive traditional skills for preserving and

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transmitting them. The archives will be helpful for the people interested in traditional cultures.

In order to archive traditional skills, representing them as a certain type of digital data is important since such type of data can be easily and widely utilized by commonly-used personal computers. For example, video data can be used as an archive. It is relatively easy to make an archive by recording traditional skills using a video camera. However, the amount of video data tends to be very large and thus archiving a wide variety of traditional skills requires a large-scale storage system. In addition, it is difficult for novices to obtain traditional skills by simply watch the video.

In this paper, we propose a method to concisely represent traditional skills using motion capture system. The system captures the movements of several body parts of a skilled person using a number of markers attached on the body parts. The movement is represented by time-series data of the position of each marker. We define some feature values on the basis of the motion data. The amount of raw motion data is very large due to the high sampling frequency of the motion capture system. We intend to fully reduce the amount of data by applying dimensionality reduction to the raw motion data. Additionally, we introduce a feature selection method to further reduce the amount of data and find out the important movement. Our feature values can be defined for each marker. Thus, selected features indicate the important movement of a certain body part. This will be helpful to obtain traditional skills.

We attempt to represent a traditional skill by decomposing it into several fundamental movements because a traditional skill generally consists of several fundamental movements. In this paper, we focus on Japanese traditional tea ceremony as one of the representative traditional skills in Japan. It includes a sequence of fundamental movements. Additionally, a pause, which is called “Ma” in Japanese, is considered to be important as well as the fundamental movements [4]. We conduct an experiment to represent seven types of fundamental movements and the pause in Japanese traditional tea ceremony. The proposed method is evaluated from the viewpoints of the conciseness and accuracy of the representation.

The remaining of this paper is organized as follows. Section 2 presents related work. Section 3 explains the representation of fundamental movements and pauses. Section 4 evaluates the representation through an experiment. Section 5 gives a consideration about the experimental result. Finally, Sect. 6 concludes this paper.

2 Related Work

The movements of traditional skills have been studied to transmit them for future generations. For example, the movements of craft works have been analyzed [1–3]. The pauses in traditional skills have been investigated as well [4]. A learning system has been provided by visualizing the movements of the skills [5]. It is, however, still difficult to precisely represent fundamental movements and pauses of various traditional skills due to their complexity.

The motion data could be effectively utilized to analyze and describe fundamental movements in traditional skills [4]. For the analysis of the motion data, dynamic time warping [6] or Fourier transform [4] have been widely used. However, such methods have a problem of high computational cost.

We have proposed a method to concisely represent fundamental movements and pauses by introducing dimensionality reduction into motion data on the basis of a quantization technique [7]. The amount of data can be considerably reduced by this method. However, this method simply reduces the motion data of each marker. Hence, it is impossible to distinguish important markers from unimportant ones.

In this paper, we make it possible to find out important markers as well as reduce the amount of data. This will be useful for obtaining traditional skills as well as developing concise archive systems.

3 Representation of Fundamental Movements and Pauses

3.1 Raw Motion Data

The motion capture system we use provides the coordinates of twenty-nine body parts in the three-dimensional Euclidean space. Raw motion data can be represented as the sequences (i.e., time series) of the x-, y-, and z-coordinates of the body parts. This is the same system used in our previous work [7]. The motion M_i of the ith marker is given as the time series represented by Eq. (1).

$$M_i = (x_{i,1}, y_{i,1}, z_{i,1}), \ldots, (x_{i,N}, y_{i,N}, z_{i,N}). \tag{1}$$

In this equation, N is the length of the time series (we call N number of frames), and $x_{i,n}$ ($y_{i,n}$, and $z_{i,n}$, respectively) is the x-coordinate (y- and z-coordinates) of the ith marker at the nth frame.

The markers used to record the coordinates are shown in Fig. 1. Figure 1a shows a skilled person with the markers and (b) illustrates the marker numbers.

3.2 Dimensionality Reduction

The aforementioned motion capture system records the positions of markers 100 times per second. Hence, 8700 real values are generated for each second since there are 29 markers and the position of each marker represented by 3 real values (i.e., x-, y-, and z-coordinates). Using all the values leads to high computational complexity. For the purpose of efficient computation, we apply dimensionality reduction to raw motion data.

At first, the x-, y-, and z-coordinates in the Cartesian coordinate system are converted to the radius, inclination, and azimuth in the spherical coordinate system

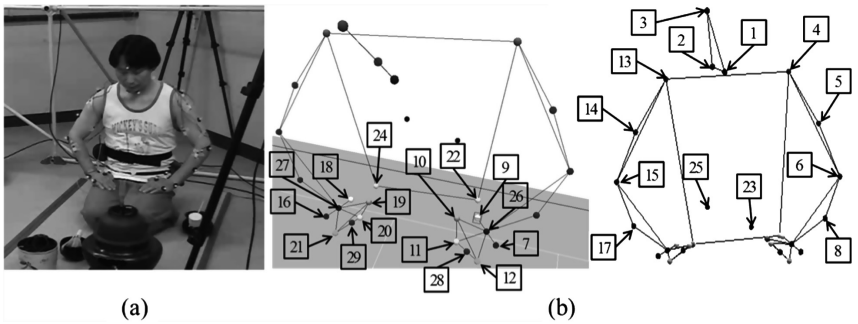

Fig. 1 Positions of markers

because the angles of body parts are considered to be more useful to represent fundamental movements and pauses. The radius $r_{i,n}$, inclination $\theta_{i,n}$, and azimuth $\varphi_{i,n}$ of the ith marker at the nth frame are given by Eqs. (2), (3), and (4), respectively. Note that the marker number i corresponds to the one shown in Fig. 1b.

$$r_{i,n} = \sqrt{x_{i,n}^2 + y_{i,n}^2 + z_{i,n}^2}. \tag{2}$$

$$\theta_{i,n} = \arccos\left(\frac{z_{i,n}}{r_{i,n}}\right). \tag{3}$$

$$\varphi_{i,n} = \arctan\left(\frac{y_{i,n}}{x_{i,n}}\right). \tag{4}$$

Based on this representation, the time series of the ith marker at the nth frame to the $(n-k+1)$th frame can be described as $(r_{i,n}, \theta_{i,n}, \varphi_{i,n}), \ldots, (r_{i,n+k-1}, \theta_{i,n+k-1}, \varphi_{i,n+k-1})$, consisting of $3k$ values. This representation is used in our previous work [7].

The dimensionality reduction is performed by dividing the time series into S parts and quantizing each part. For example, when $k = 20$, $S = 4$, and $n = 1$, the time series is divided into four parts P_1, P_2, P_3, and P_4 such that $P_1 = \{(r_{i,1}, \theta_{i,1}, \varphi_{i,1}), \ldots, (r_{i,5}, \theta_{i,5}, \varphi_{i,5})\}$, $P_2 = \{(r_{i,6}, \theta_{i,6}, \varphi_{i,6}), \ldots, (r_{i,10}, \theta_{i,10}, \varphi_{i,10})\}$, $P_3 = \{(r_{i,11}, \theta_{i,11}, \varphi_{i,11}), \ldots, (r_{i,15}, \theta_{i,15}, \varphi_{i,15})\}$, and $P_4 = \{(r_{i,16}, \theta_{i,16}, \varphi_{i,16}), \ldots, (r_{i,20}, \theta_{i,20}, \varphi_{i,20})\}$. We define feature values for the radius, inclination, and azimuth of each marker. A single feature value is represented as an $(S-1)$-digit ternary number (in this example, a 3-digit ternary number). That is, this time series data can be represented as 87 ternary numbers. This means that a fundamental movement or a pause is represented by an 87-dimensional feature vector.

The feature values are computed through a quantization process. The quantization is based on the values of the radius, inclination, and azimuth of each marker. A feature vector F is defined as Eq. (5).

$$F = (Q(r_1, \Theta_r), Q(\theta_1, \Theta_\theta), Q(\varphi_1, \Theta_\varphi), \ldots, Q(r_{29}, \Theta_r), Q(\theta_{29}, \Theta_\theta), Q(\varphi_{29}, \Theta_\varphi)). \tag{5}$$

Here, the function Q is defined as Eq. (6).

$$Q(\alpha_i, \Theta) = \sum_{t=1}^{S-1} 3^t \cdot q(\mu(\alpha_i, t+1) - \mu(\alpha_i, t), \Theta). \tag{6}$$

In this equation, $\boldsymbol{\mu}(\boldsymbol{\alpha_i}, \boldsymbol{t})$ is the mean value of $\boldsymbol{\alpha_i}$ of the frames included in $\boldsymbol{P_t}$. Note that $\boldsymbol{\alpha_i}$ can be the radius, inclination, or azimuth. That is, $\boldsymbol{\alpha_i} \in \{\boldsymbol{r_i}, \boldsymbol{\theta_i}, \boldsymbol{\varphi_i}\}$. For example, $\boldsymbol{\mu}(\boldsymbol{r_i}, 1)$ is the mean value of radius in $\boldsymbol{P}_1$, namely, $\{\boldsymbol{r}_{\mathbf{i},\mathbf{1}}, \boldsymbol{r}_{\mathbf{i},\mathbf{2}}, \boldsymbol{r}_{\mathbf{i},\mathbf{3}}, \boldsymbol{r}_{\mathbf{i},\mathbf{4}}, \boldsymbol{r}_{i,5}\}$. The quantization function $\boldsymbol{q}$ is given by Eq. (7).

$$q(m, \Theta) = \begin{cases} 0 & \text{if } m \leq -\Theta \\ 1 & \text{else if } m \geq \Theta \\ 2 & \text{otherwise.} \end{cases} \tag{7}$$

The quantization function q returns 0, 1, or 2 depending on the value m and a threshold Θ. Note that Θ_r, Θ_θ, and Θ_φ are the thresholds for radius, inclination, and azimuth, respectively.

In the case that the radius continuously and fully increases, $\mu(r_i, t+1) - \mu(r_i, t)$ will be larger than the threshold Θ_r. The quantization function returns 1 in such a case. Conversely, when the radius continuously and fully decreases, the quantization function will return 0. If the change of radius is small, it will return 2. Therefore, the quantized value indicates the tendency of the change of radius. Of course, the tendency of the change of inclination and azimuth can also be obtained through the quantization function.

The function Q produces an $(S-1)$-digit ternary number. For example, when $S = 4$, if the radius of the first marker constantly and fully decreases, q always returns 0 and thus Q yields a 3-digit ternary number 000_3 (equivalent to the decimal number 0). If the radius first increases, then decreases, and again increases, Q yields 101_3 (equivalent to the decimal number 10). The value Q returns ranges from 000_3 to 222_3, namely, 0–26 in decimal representation. As a result, only 435 bits (approximately 55 bytes) are required to represent a fundamental movement or a pause since a 3-digit ternary number is described in 5 bits. This is a quite compact representation. Note that the size of a feature vector varies depending on the parameter of k and S. It is necessary to experimentally determine appropriate values of k and S.

In our previous work, we introduced similar quantization method [7]. However, its quantization function is different from that of the proposed method. The quantization function of the previous work uses only representative frames. A representative frame is the frame located in the center of each part P_i. As for the radius, for example, r_1, r_2, r_4, and r_5 are not used to compute the feature value from P_1 since the representative frame in P_1 is the third frame. It seems to be sensitive to

outliers. We thus improved the feature value by using the mean value computed from all the frames in each part.

3.3 Feature Selection

The quantization-based dimensionality reduction considerably reduces the amount of motion data. However, the quantized data still have the redundancy because the movements (i.e., the time series) of some of markers are not so useful to describe fundamental movements and pauses. Removing the data of such markers leads to further conciseness. In addition, analyzing the usefulness of each marker will result in the discovery of important movement.

In this section, we propose a feature selection method by estimating the usefulness of the time series of the radius, inclination, and azimuth of each marker. Before the description of the feature selection method, let us explain the denotation.

- C … Number of classes
  The class means the type of fundamental movements. For example, when there are seven types of fundamental movements and a pause, the number of classes is eight $(C = 8)$.
- T … A training set
  The usefulness of the time series is estimated through a kind of machine learning. A set of training examples is thus needed for the learning. Note that a training example is defined as a pair of a class label $c(c \in \{1, \cdots, C\})$ and an 87-dimensional feature vector F described in Sect. 3.2.
- $N_{\alpha_i}(v, c)$ … Number of training examples that the class labels are c and the feature values of α_i are v
  Note that $v \in \{000_3, \ldots, 222_3\}$ when $S = 4$. Since v ranges from 0 to $3^{S-1} - 1$ (in decimal representation), Eq. (8) holds for each α_i.

$$\sum_{c=1}^{C} \sum_{v=0}^{3^{S-1}-1} N_{\alpha_i}(v, c) = |T|. \tag{8}$$

The proposed method selects useful features on the basis of the distribution of N_{α_i}. N_{α_i} can be regarded as a two-dimensional histogram and $N_{\alpha_i}(v, c)$ corresponds to a bin of the histogram. Here, we define a normalized bin b_{α_i} by Eq. (9).

$$b_{\alpha_i}(v, c) = \frac{N_{\alpha_i}(v, c)}{\sum_{j=0}^{3^{S-1}-1} N_{\alpha_i}(j, c)}. \tag{9}$$

The denominator corresponds to the number of training examples having the class label $\boldsymbol{c}$. This normalization mitigates the influence caused by the bias of the number of training examples among all the classes.

Based on this histogram, we define the usefulness U_{α_i} for α_i as Eq. (10).

$$U_{\alpha_i} = \frac{\sum_{v=0}^{3^{S-1}-1} B_{\alpha_i}(v)}{\sum_{v=0}^{3^{S-1}-1} I_{\alpha_i}(v)}. \tag{10}$$

In this equation, $\boldsymbol{B}_{\boldsymbol{\alpha_i}}$ and $\boldsymbol{I}_{\boldsymbol{\alpha_i}}$ are given by Eqs. (11) and (12), respectively.

$$B_{\alpha_i}(v) = \begin{cases} \sum_{j=1}^{C} \left(\max_c b_{\alpha_i}(v,c) - b_{\alpha_i}(v,j) \right) & \text{if} \quad \max_c b_{\alpha_i}(v,c) > 0 \\ 0 & \text{otherwise.} \end{cases} \tag{11}$$

$$I_{\alpha_i}(v) = \begin{cases} 1 & \text{if} \quad \max_c b_{\alpha_i}(v,c) > 0 \\ 0 & \text{otherwise.} \end{cases} \tag{12}$$

$\boldsymbol{B}_{\boldsymbol{\alpha_i}}$ indicates how useful $\boldsymbol{\alpha_i}$ is. $\boldsymbol{B}_{\boldsymbol{\alpha_i}}(\boldsymbol{v})$ is maximized when the feature values of $\boldsymbol{\alpha_i}$ of the training examples, which have a certain class label $\boldsymbol{c}$, are $\boldsymbol{v}$ and those of the other training examples are other than $\boldsymbol{v}$. In such a case, it is very easy to distinguish the examples having the class label $\boldsymbol{c}$ from the other examples. On the other hand, $\boldsymbol{B}_{\boldsymbol{\alpha_i}}(\boldsymbol{v})$ is minimized (becomes 0) when the numbers of the training examples, whose feature values of $\boldsymbol{\alpha_i}$ are $\boldsymbol{v}$, are same for all classes. In this case, it is impossible to accurately classify the examples.

If there is no example whose feature value of $\boldsymbol{\alpha_i}$ is $\boldsymbol{v}$, $\boldsymbol{B}_{\boldsymbol{\alpha_i}}(\boldsymbol{v})$ is defined as 0. Note that $\max_c \boldsymbol{b}_{\boldsymbol{\alpha_i}}(\boldsymbol{v}, \boldsymbol{c})$ equals 0 in that case and that $\boldsymbol{I}_{\boldsymbol{\alpha_i}}$ is used to ignore that case.

We select the features depending on the values of the usefulness. In the case of selecting 10 features, for example, the features are sorted in descending order of the usefulness and then top 10 features are selected.

4 Experimental Evaluation

4.1 Overview of Experimental Evaluation

The experimental evaluation is conducted focusing on Japanese traditional tea ceremony. Several types of fundamental movements and pauses in Japanese traditional tea ceremony are described on the basis of the proposed representation. In order to evaluate the representational ability of the proposed method, we set up a classification problem and compute the classification accuracy.

The classification problem includes the discrimination of seven types of fundamental movements (shown in Fig. 2a–g) and the pauses (shown in Fig. 2h) that are considered to be important in Japanese traditional tea ceremony [4]. These

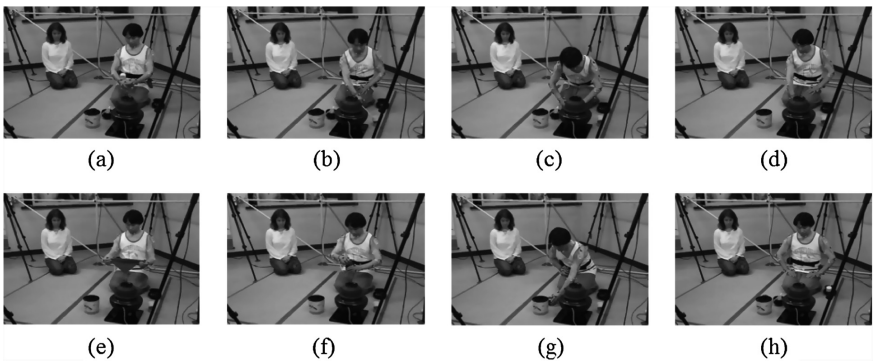

Fig. 2 Scenes in Japanese tea ceremony: **a** taking Hisyaku up, **b** putting Hisyaku down, **c** bowing, **d** putting a tea container down in front of a host, **e** Fukusa-sabaki, **f** purifying a tea container, **g** putting a tea container down in front of a water jug, and **h** an example of pause

movements and pauses are observed in the preparation phase of making a cup of tea. First, the host takes a Hisyaku, which is a ladle for scooping water, up (a), and puts it down (b). Next, he bows to the guest (c). He then puts a tea container down in front of him (d) and opens Fukusa, which is a sheet of cloth, to fold it (e). This action is called Fukusa-sabaki. He then purifies the tea container (f) and puts it down in front of a water jug (g). The pauses (h) appear several times typically between a movement and the subsequent movement.

4.2 Experimental Settings

The data set used in this experiment consists of 120 examples including eight classes as shown in Table 1. This is the same data set as used in our previous work [7].

The parameters k and S described in Sect. 3.2 were set to 40 and 4, respectively. The thresholds Θ_r, Θ_θ, and Θ_φ were set to 0.15, 0.0015, and 0.0015, respectively. These values were determined based on the result of the preliminary experiment, although the details of the preliminary experiment are omitted due to space limitation.

In order to construct a classification model, we used J48 implemented in Weka 3.6.13 [8]. It is the Weka implementation of C4.5 algorithm [9] which produces

Table 1 The numbers of examples of fundamental movements and pauses

Movement (Class)	Number of examples	Movement (Class)	Number of examples
(a)	13	(e)	37
(b)	24	(f)	10
(c)	7	(g)	9
(d)	11	(h)	9

decision trees. In this experiment, we restricted the type of decision trees to binary trees and performed a 10-fold cross validation.

4.3 Experimental Result

The classification result is evaluated by the F-measure of each fundamental movement (a)–(g) and the pause (h). The F-measure is computed by Eq. (13) using recall and precision defined as Eqs. (14) and (15), respectively. In these equations, X_c and x_c denote the set of examples whose class labels are c and that classified into the class c, respectively.

$$\mathrm{F-measure} = \frac{2 \cdot \mathrm{recall} \cdot \mathrm{precision}}{\mathrm{recall} + \mathrm{precision}}. \tag{13}$$

$$\mathrm{recall} = \frac{|X_c \cap x_c|}{|X_c|}. \tag{14}$$

$$\mathrm{precision} = \frac{|X_c \cap x_c|}{|x_c|}. \tag{15}$$

The average F-measure of the fundamental movements (a)–(g) and the pause (h) is shown in Fig. 3. The number of features selected varies from 1 to 87. Note that using 87 features corresponds to the case that the feature selection is not used, namely, all the features are used.

Figure 3 indicates that about half of features are redundant since the F-measure with 43 features (0.756) is very close to that with 87 features (0.768). This result shows the effectiveness of the feature selection.

Next, we compare the F-measure between the proposed method and our previous method [7]. The F-measure for each fundamental movement (a)–(g) and the pause

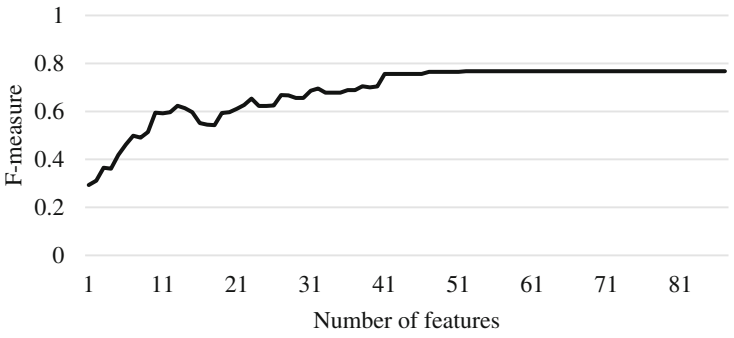

Fig. 3 Average F-measure

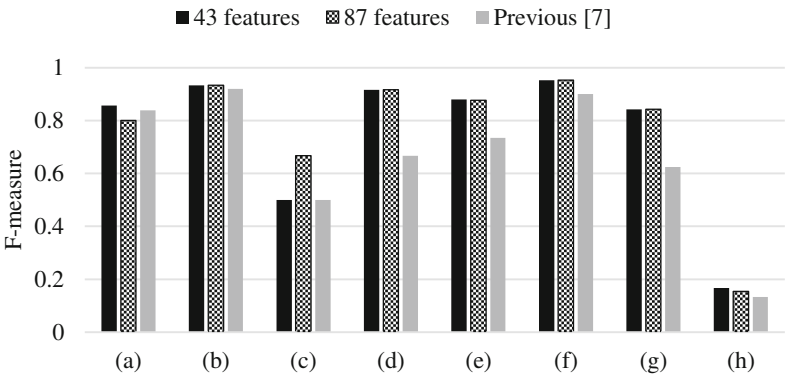

Fig. 4 F-measure for each fundamental movement and pause

(h) is shown in Fig. 4. In this figure, "43 features" and "87 features" means the F-measure of the proposed method with 43 selected features and with all 87 features, respectively. "Previous" means the F-measure of our previous work.

5 Consideration

5.1 Conciseness of Representation

As described in Sect. 3.2, the proposed method can represent a single fundamental movement or a pause in 435 bits without feature selection. This is fully concise but the required data size is the same as that of our previous method [7]. For further conciseness, we propose the feature selection method.

The experimental result shown in Fig. 3 shows that using half of features is sufficient. Therefore, the data size can be reduced to 215 bits This can be a remarkable advantage for developing large-scale archives.

5.2 Representational Ability

Figure 4 indicates that the proposed method outperforms our previous method in all the fundamental movements and the pause. This is due to the improvement of the quantization method. However, the F-measure of the pause is still very low. This problem should be resolved in the future work.

Comparing the result with and without feature selection, the F-measure does not decrease except for the fundamental movement (c). This fundamental movement is different from the others in the point that no instrument (such as Hisyaku and

Fukusa) is used in the movement. Some of the features eliminated by the feature selection may be needed for this type of fundamental movement.

5.3 Computational Efficiency

We make a comparison between the proposed method and our previous method [7] in the time required to perform the experiment described in Sect. 4.

When the feature selection is not used, the time required by the proposed method is approximately 103 % of the time required by our previous method using a commonly-used personal computer. The required time slightly increases because of the difference of the quantization method.

By introducing the feature selection, the time required by the proposed method (using 43 selected features) is approximately 97 % of the time required by our previous method. The reduction of the number of features leads to the decrease of required time. The feature selection is, therefore, effective to improve computational efficiency as well.

5.4 Useful Features

The feature selection not only improves the computational efficiency but also clarifies the usefulness of each feature. Table 2 shows the top 10 features of the usefulness. All of them are related to the angle. Specifically, the azimuth tends to be regarded as useful features. As for the positions of the markers, six features out of ten features are associated with left arm or left hand. Considering this result, analyzing angular movement around left arm or left hand may lead to the understanding of the important movements in Japanese traditional tea ceremony.

Table 2 Usefulness of top 10 features

Rank	Feature	Usefulness	Rank	Feature	Usefulness
1	θ_8	2.191	6	θ_9	1.928
2	φ_{28}	2.085	7	θ_7	1.870
3	φ_{23}	1.988	8	φ_3	1.808
4	φ_4	1.987	9	φ_{25}	1.679
5	φ_{29}	1.951	10	φ_6	1.641

6 Conclusion

For the purpose of archiving traditional skills, an efficient representation of the fundamental movements and pauses in the traditional skills was proposed. The proposed representation is quite compact due to the dimensionality reduction of the motion data. In addition, we proposed a feature selection method to further reduce the amount of data and to discover important features.

The experimental result using the data set of Japanese traditional tea ceremony clarified that the representational ability of the proposed method is better than that of our previous work. Moreover, we confirmed that the feature selection made the computation more efficient compared with the previous work. The result of the feature selection indicated that the angular movements around left arm and left hand were discriminative. This could be a clue to the understanding of the important movements in Japanese traditional tea ceremony.

Although most of the fundamental movement were appropriately represented by the proposed method, the pause was not precisely represented. Improving the representation of the pause is included in the future work. Additionally, evaluating the proposed method for a wide variety of traditional skills is also in the future work.

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Consideration of Appropriate Photo Image to the Conversation of the Elderly and Youth by Using Facial Expression Analysis

Miyuki Iwamoto, Noriaki Kuwahara and Kazunari Morimoto

Abstract Conversation is a good preventative against behavioral problems in the elderly. However, caregivers are usually very busy tending to patients and lack the time to communicate extensively with them. In order to overcome such problems active "listening volunteers" have more opportunities to communicate with the elderly, but the number of skillful volunteers is limited. Therefore, we investigated conversational support systems which can help inexperienced volunteers; such systems typically have included content such as photographs, videos, and music, and in our case we primarily used photos. We predicted that whether, and how much, frustration and discomfort the young adult volunteers experienced through such conversations depended on the category of the photo. We measured dissatisfaction and discomfort during conversations by using an expression analysis sensor. Furthermore, we took the data obtained by measuring dissatisfaction and discomfort through obtained from non-contact devices (expression analysis) as an object of comparison and evaluation.

Keywords Elderly · Media · Dementia · Conversation · Expression analysis

1 Introduction

Japanese society is currently facing the problem of having a "super-aging" population [1]. The population over 65 years old, also called Baby-Boomers, is now over 30 million and it is anticipated to be 35 million in 2018 [2].

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The rate of households consisting of old couples and old singles is increasing. In some cases such individuals may pass an entire day without speaking a word, which can lead to a disuse of cognitive functions and a heightened risk of dementia and/or depression.

We need to understand such physical and psychological characteristics in our communication with aged people. For example, we must respect the damage to their pride at losing their visual, auditory, and cognitive functions. Experts such as clinical psychologists, therapists, or listening volunteers may be able to deal with these issues in their communication efforts. However, their numbers are insufficient to meet the current needs.

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While the younger generations are accordingly expected to be talking partners for aged people, there is a problem in that they are unfamiliar with how to communicate with the elderly because so many of them grew up in small families without grandfathers or grandmothers.

There have been some attempts to solve the problem by using a picture or a video as a trigger for a conversation [3–5]. However, there is no research into the mental load placed upon the partnering students/ volunteers. That means the research up to this point has been focused on communication support systems to improve the QOL of the aged people, and the mental load of the young partners has been neglected.

Many caregivers and volunteers untrained in listening often feel a mental burden or inability to generate quality conversation in these situations. There is some research on promoting conversation between patients and caregivers or volunteers, or among patients, providing topics and sharing photos or videos (e.g. [3–5]). This work has focused on the so-called “reminiscence technique,” which is effective for control-ling dementia in order to reduce the mental load placed upon the partnering students/ volunteers. We used such information media (see below) which provided topics and communication-supporting contents.

The selected media in general included photos, videos, and music of unknown levels of effectiveness regarding both the mental load felt by caregivers and the quality of communication between patients and caregivers. We then examined the difference in the mental load as well as the quality of communication between the patients and the caregivers/volunteers when they used photos versus when they used video as communication support contents to arrive at the best medium for facilitating communication [6, 7]. We revealed what category is the more ideal as the contents but we did not mention the photos in the category.

We will investigate the differences in the mental states and communication quality of elderly people and their younger conversation partners when photos have used to support communication, and determine the best medium for this purpose.

2 Experiment

2.1 Summary

For this research young adults (caregivers and volunteers) performed a dialogue with elderly patients face-to-face, with the assistance of photos as visual aids. We examined by category of photograph what influences there are in the passing of time be-tween caregivers continuing a conversation. We also looked at whether there is a burden felt through the conversation, and if there is a difference in the timing of when the burden has felt.

A camera (line-of-sight device) had used to capture the expressions of the elderly patients throughout the sessions. The expressions of the elderly were then analyzed from the video recordings.

The purpose of this experiment is to create a conversation environment such that young adults (caregivers and volunteers) and elderly couples/elderly singles can feel minimal burden in each category of photos. Also, it is to verify the quality of the burden the young adults feel during the conversation, when one is felt, so that we can eventually establish a contents database for constructing our system.

2.2 Evaluation Item

The participants in the study answered a series of questions in the form of a 5-stage subjective evaluation after each conversation. For the questionnaire, in addition to the questions we asked in the experiments we have conducted up to now, we asked whether a sense of burden was felt during the 10 min of conversation. The proportion of the conversation during which they were smiling was measured for the elderly patients. From the interactive support experience, “Lives during the Showa Era,” “electrical appliances,” and “art” were added to the contents database.

As for the subjects, one young adult interviewed three patients and estimated an average of the mental load he or she felt, excluding personal compatibilities. The young adult indicated the degree of mental load felt on the stress check board every minute. A check sheet that was programmed into another PC (Fig. 1) was located in a way that the elderly patients could not see. The stress check sheet represented facial expressions on a 1–7-scale, with the face corresponding to “1” meaning that there was an absence of any burden (stress) to continue the conversation, and the face corresponding to “7” meaning that the person felt a great deal of burden. A camera was used to capture the resident’s expressions and actions throughout the sessions. We compared these to see which photographs brought him or her pleasure or joy. Facial expressions were correlated with emotions analyzed in a previous study [7].

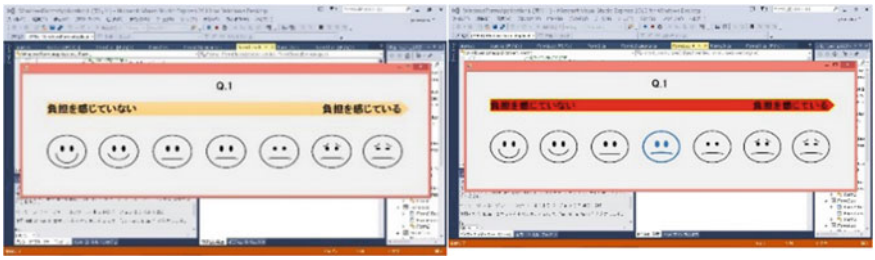

Fig. 1 Stress check sheet

2.3 Subject

The young adult conversation partners were 2 students, aged 23–25 years old.

The elderly patients were 3 senior ladies, ranging in age from 80 to 90, with each suffering from mild dementia.

2.4 Experiment Environment

The layout of the experiment is shown in Figs. 2 and 3.

We borrowed a room in the nursing home, in which we placed chairs side by side.

We used a laptop PC in which photos categorized as explained above were uploaded to support a 10 min conversation.

We carried out checks on the degree of burden felt through the conversation by the students.

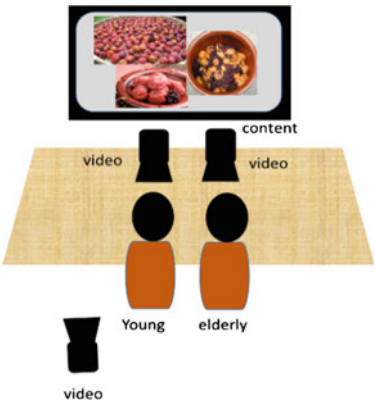

Fig. 2 The layout of the experimental environment

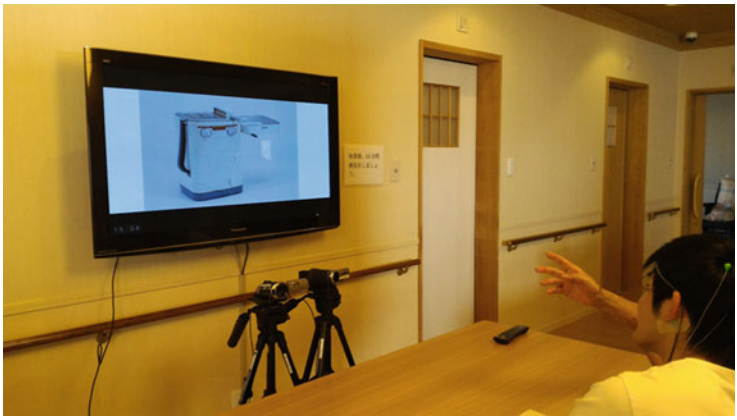

Fig. 3 Experimental environment

2.5 The Contents of the Questionnaire

The participants answered questions in the form of a 5-stage subjective evaluation after each conversation. The questions consisted of Q1–Q10 (for the young adults) and Q1–Q9 (for the elderly patients) (see Tables 1 and 2).

2.6 Experimental Methods

The subjects talked while viewing a photo or a movie via the PC.

We prepared 10 photos for each of the categories of "food," "events," "play," and "Home Appliance," which were shown during the flow of the conversation.

Table 1 Post-experiment evaluation (young adults)

Number	
Q1	Could you communicate naturally?
Q2	Was the conversation exciting?
Q3	Were there any interesting topics?
Q4	Was your partner easy to talk to?
Q5	Did you feel a good rapport with the elderly persons by the end of the conversation?
Q6	Were you interested your partner?
Q7	Were you interested in what your partner said?
Q8	Did you feel any stress while communicating with your partner?
Q9	Would you like to talk to your partner again?

Table 2 Post-experiment evaluation (elderly)

Number	
Q1	Could you communicate naturally?
Q2	Was the conversation exciting?
Q3	Were there any interesting topics?
Q4	Was your partner easy to talk to?
Q5	Did you feel a good rapport with the partner by the end of the conversation?
Q6	Were you interested your partner as an individual?
Q7	Do you feel closer to your partners than you did before the partner?
Q8	Were you interested in what your partner said?
Q9	Did you feel the nostalgia of the topic in conversation?

These photos is switched automatically every minute. The partner young adults indicated the degree of mental load he or she felt on the stress check board every minute. The stress check sheet was hidden from the patient's eyes. Our purpose was to check the mental load of the partner in the conversation, not to expose their complaints to the elderly. Thus, the partner could point at a value without worrying about offending the elderly patient, enabling them to judge honestly. The sheet was sometimes shown in the middle of their conversation but they continued to talk while pointing at the applicable value on a minutely basis.

They then answered the questions on the questionnaire through the 5-stage subjective evaluation each time after the experiment.

A camera (nod/line-of-sight) was used to capture the expressions of the elderly people and young adults throughout the sessions. The expressions of the elderly people and young adults were finally analyzed from the video recordings.

3 Results

The results of the experiment described in Sect. 2.6 are shown. Figure 4 shows the amount of stress accumulated for each photo image category.

The horizontal axis represents each respective photos category, respectively, and the vertical axis represents the accumulation totals from the numerical stress check

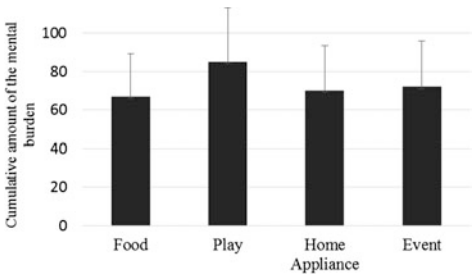

Fig. 4 Stress levels based on image type

sheet. This offers a comparison of the young adults' stress levels for each category of photos, or in other words, a comparison of the burden the young adults felt to continue the conversation as the conversation support content changed. Only the younger subjects' mental stress levels are shown.

The greatest degree of stress was experienced when images depicting "play" were shown. Within the "Food," "Event," and "Home Appliance" categories, we found that there was an almost uniform degree of burden (stress). The results of t-test, there were no significant differences. In addition, the result of the analysis of variance in the all categories, all category were not a large difference.

Figure 5 shows the results of the young adults' questionnaire. The vertical axis represents the numerical rating value from 1 to 5 for each question. The horizontal axis shows the questions Q1–Q10 for each category.

A more detailed examination of the results of Q8 is shown in Fig. 6.

There is a tendency that gave high in questions of positive to the partner of the conversation of Q4, Q5, Q7.

Figure 6 shows the results of the question of whether one felt stress during a conversation that is asked by the questionnaire.

The all question had positive results for the categories of "food". On the other hand the opposite trend was seen in "Event". In conversations about "Event" we found that the young adults frequently felt stress.

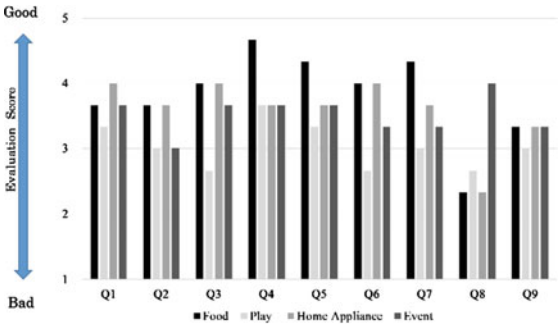

Fig. 5 Results—young adults questionnaire

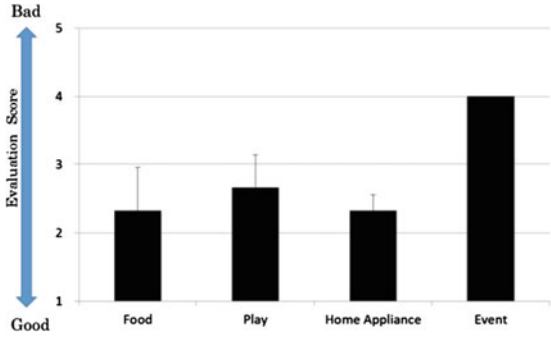

Fig. 6 Question 9—stress level by image category (1 = no stress. 5 = extremely stressful)

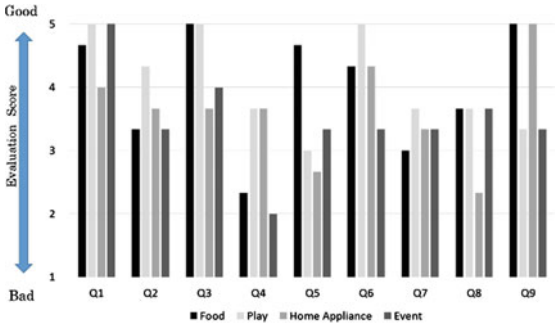

Fig. 7 Results—elderly patients' questionnaire

Figure 7 shows the results of the questionnaire for the elderly people. The vertical axis represents the numerical rating value from 1 to 5 for each question. The horizontal axis shows the questions Q1–Q9 for each category. A more detailed examination of the results of Q9 is shown in Fig. 8.

The question had positive results for the categories of "Food" and "Play," but the opposite trend was seen in "Home Appliances". According to the results for Q4, there was a tendency that they did not speak much when asked about their hobbies and interests.

Question 9 asked the elderly patients whether the conversational support materials made them feel sentimental regarding the past. The responses were favorable in the categories of "Food," and "Home Appliances".

In Fig. 9, we show the results of the relationship between stress and the expression of young adults. The horizontal axis is the score of the stress check sheet, and the vertical axis represents the degree of smile. Smile degree is expressed from −100 to 100.

In the photograph of each sheet, it was found that the stress is concentrated in the 2. In the "Event," and "Play" have been found that some photos felt 3 or more stress. Smile degree is less than zero photos, it was three piece in the "Event," four piece in the "Play," two piece in the "Food," and Three piece in the "Home Appliances".

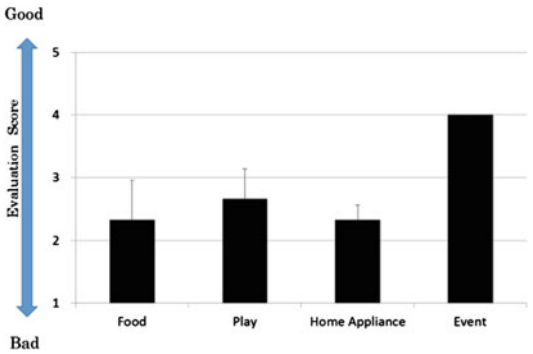

Fig. 8 Question 9—felt sentimental regarding past

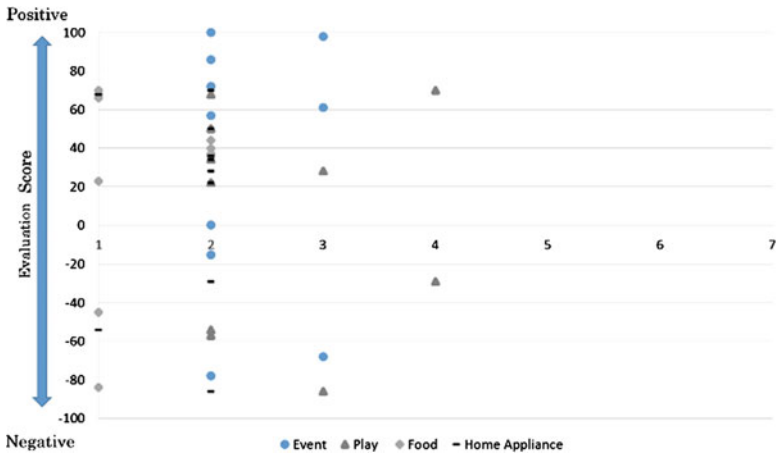

Fig. 9 The relationship between stress and the expression of young adults

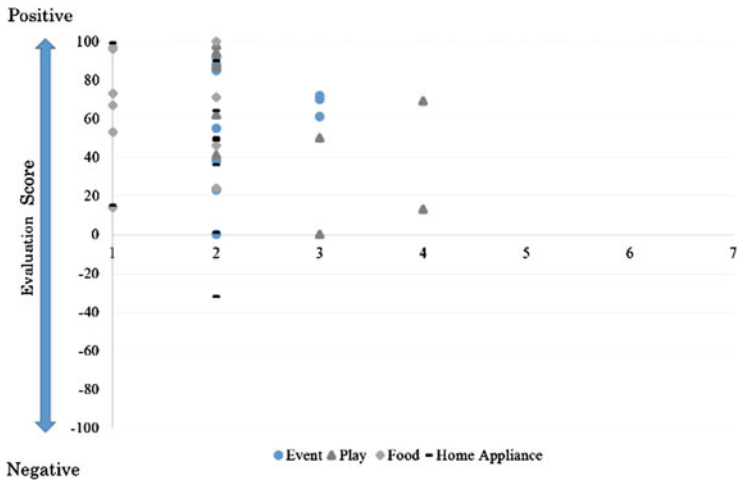

Fig. 10 The relationship between stress of young adults and the expression of elderly people

In Fig. 10, we show the results of the relationship between stress of young adults and the expression of elderly people. The horizontal axis is the score of the stress check sheet, and the vertical axis represents the degree of smile. Smile degree is expressed from −100 to 100.

In the photograph of each sheet, it was found that the stress is concentrated in the 2. In the "Event," and "Play" have been found that some photos felt 3 or more stress. Smile degree is less than zero photos, it was only one piece in the "Home Appliances".

4 Discussion

We discovered large differences in young adults responses, based on the categories of images shown. Young adults exhibited stress when images from "Event" were shown depending on whether the elderly persons were fond of that event the degree of interest varied widely.

For categories like "Food" and "Events" that were easy to discuss by both groups, the young adults felt much lighter mental burdens. "Home Appliances" and "Food" images made the elderly persons feel nostalgic, making it easy to converse with them. The elderly persons and young adults were able to discuss both changes during the past and now; it was believed that young adults were able to enjoy themselves, without feeling any mental stress. We discovered that in subjective and objective assessments the students felt a heavier mental burdens when discussing topics they were less familiar with, like "Event".

5 Conclusion and Future Topics

5.1 Conclusion

In all evaluation, it was found that when the conversation occurred with a category where there was less commonality between the young people and the elderly, the burden of the young people increases. Regardless of age, it was found that with things that are familiar in the present environment that can be a category of mutual interest between the young adults and the elderly. For example, the food that young adults buy at the supermarket, the elderly can make by themselves. Young adults learning how to make something from the elderly and the elderly teaching young adults is considered a good way for them to happily talk to each other.

Therefore, it is considered that discussing topics from categories that are familiar to both groups regardless of age reduces the mental burden on young adults.

5.2 Future Topics

It is necessary that we make a similar experiment in other categories and will increase the categories that are appropriate for the system.

We must examine in the future the mental burden of the young adults and elderly in utterance or in searching the topics.

We anticipate to construct a supporting system which changes the contents of the category properly adopted to the situation to reduce the mental burden of the young adults and the elderly.

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Development of the Micro-Silk Through the Breeding of Transgenic Silkworm

Kyu-Beom Kim, Min-Ju Kim and Kang-Min Choi

Abstract The purpose of this research is to develop the micro-silk through the breeding of the transgenic silkworm. First of all, to construct transformation vector system of silkworm, we did cloning the sericin promoter in silkworm and sorting the selection marker gene (in order that sorting the transformation silkworm) and then cloning again. Second, we analyzed the fibroin gene of silkworm and IGF-1 gene of human After cloning. Then, we made and analyzed transformants of silkworm which gene expression as IGF-1 of human and the fibroin of silkworm. We inserted the protein expression vector which IGF-1 of human and the fibroin of silkworm into silkworm eggs using the microinjection. Using PCR and Southern blot methods, we analyzed expression vector in DNA level. In addition, we analyzed it using the RT-PCR methods in order to confirm gene expression in RNA level. The protein expression was analyzed in protein level through the western blot and ELISA methods. Through transformation on two separate occasions on spring and summer, we determined growth and ecology between Uzbekistan silkworm and Korean transformation silkworm. Lastly, we compared fabric of Uzbekistan silk, Chinese silk and Japanese 6A which we developed. Also we analyzed sericin content, strength and elongation and thickness of transformation silk single yarn.

Keywords Transgenic silkworm · Sericin · IGF-1 · RT-PCR method

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DOI 10.1007/978-3-319-41661-8_4

1 Introduction

In the ongoing market, competitiveness of a certain product is one of the most important quality required to survive in the global market. So obtaining better quality and high yield of silk fiber from a single cocoon has been a major interest among people in this field for many decades [1–3].

In order to improve the quality of the silkworm cocoons we applied our biological technology which resulted in getting high quality micro-silk which width is less than 1 den [4, 5]. This micro-silk was obtained from a transgenic silkworm prepared by in vivo electroporation of expression vector into the silkworm [6].

At the same time, we were able to obtain high yield of IGF-1 (Insulin-like Growth Factor-1) from this transgenic silkworm in the sericin part also made from an expression vector including human IGF-1 clone.

IGF-1 is a hormone similar in molecular structure to insulin. It plays an important role in childhood growth and continues to have anabolic effects in adults. A synthetic analog of IGF-1, mecasermin, is used for the treatment of growth failure. So the use and need of IGF-1 is increasing in medical use and also in cosmetic market.

All the biotechnological research and qualifying the obtained silk fabric were done in Korea, and growing the transgenic silkworm was done through co-work with Uzbeck Scientific-Research Institute of Natural Fibers.

2 Transgenic Silkworm

Silkworm produces silk protein composed of heavy-chain fibroin, light-chain fibroin, sericin and P25. At 5th instar, the silkworm shows dramatic expression of fibroin which result in 25 % of its total body weight. Using this strong expression system of the silkworm we were able to overexpress required protein. In this research, we used this special characteristic of the silkworm to produce human IGF-1 and micro-silk containing tussah fibroin.

2.1 Human IGF-1 Cloning

To express and purify IGF-1 more efficiently, we cloned IGF-1 to be expressed in the sericin part of the silkworm since sericin is hydrophilic and soluble. The cloning vector of IGF-1 was prepared as Fig. 1 (Fig. 2).

Through in vivo electroporation the prepared vectors were inserted inside the pupae.

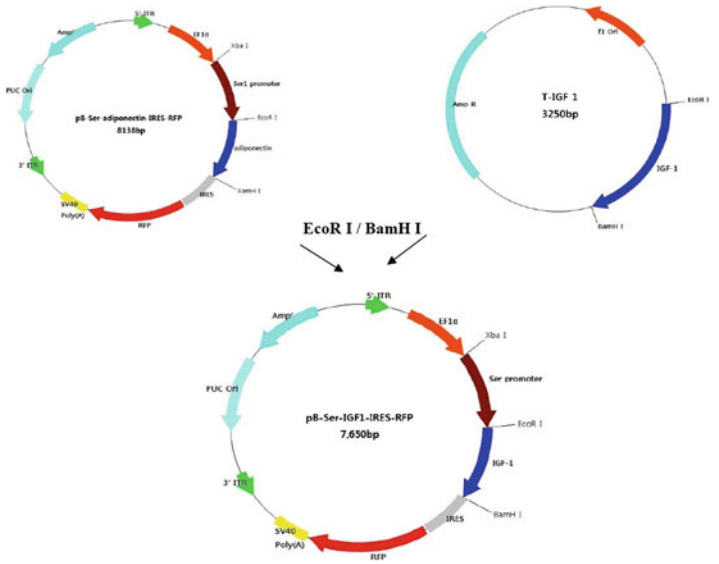


Fig. 1 Preparation of pB-Ser-IGF1-IRES-RFP vector

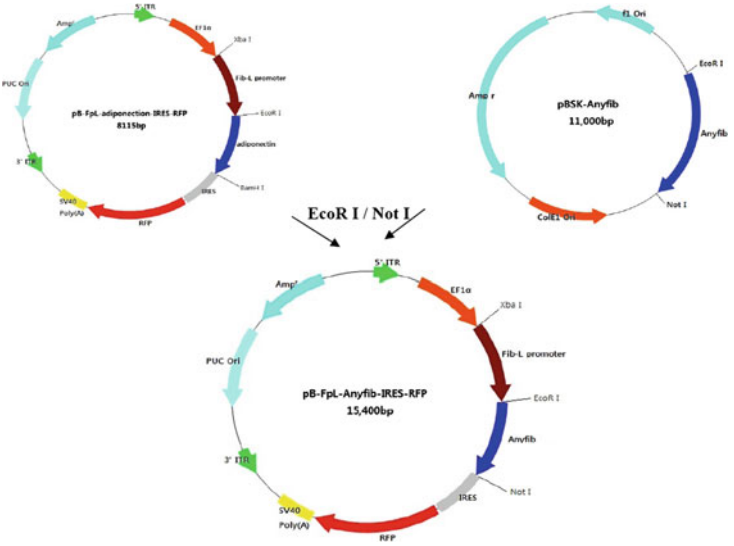


Fig. 2 Preparation of pB-FpL-Anyfib-IRES-RFP vector

2.2 *Verification of the Expression IGF-1 and Tussah Fibroin from the Transgenic Silkworm*

Verification of IGF-1 and Tussah fibroin were performed by genomic PCR method and DsRed fluorescence detecting method. Also to identify the amount of expressed IGF-1, we used ELISA detecting method.

Through genomic PCR we could verify that among 86 silkworms, 58 expressed Tussah fibroin as shown in Fig. 3.

Also, among 113 silkworms, 75 expressed IGF-1 as shown in Fig. 4.

Fluorescence of expressed human IGF-1 and Tussah fibroin were detected as shown in Fig. 5 using spectroscope.

Since one of the major purpose of this research is to obtain human IGF-1 enough to use it as an ingredient of cosmetic anti-aging face cream, we determined the amount of human IGF-1 expressed in the silk worm using ELISA assay. From this experiment we could see that average 200 ng of IGF-1 was expressed per 1 g of cocoon as shown in Fig. 6.

From this positive result we were able to make sample of cosmetic anti-aging cream (Fig. 7).

2.3 *Verification of the Quality of Silk Yarn from Transgenic Silkworm*

We verified the quality of the transgenic silkworm yarn by comparing with Anthrea Yamamai, Anthrea Yamamai-1, Kum Ok Jam, Baek Ok Jam, and Chinese silk yarn (Table 1).

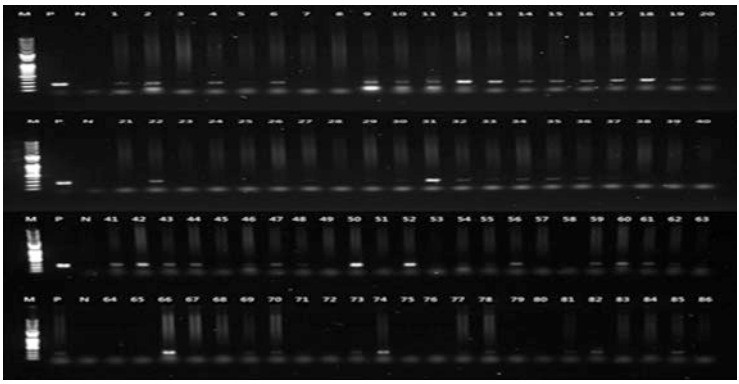


Fig. 3 Genomic PCR of transgenic Tussah fibroin. M: 100 bp plus marker, P: positive control-vector, N: negative control-Baekokjam, lane 1-86: transgenic Tussah fibroin

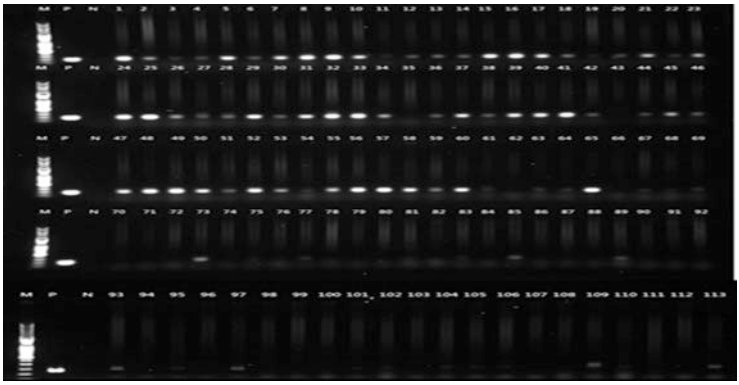


Fig. 4 Genomic PCR of human IGF-1 transgenic silkworm. M: 100 bp plus marker, P: positive control-vector, N: negative control-Baekokjam, lane 1-86: transgenic Tussah fibroin

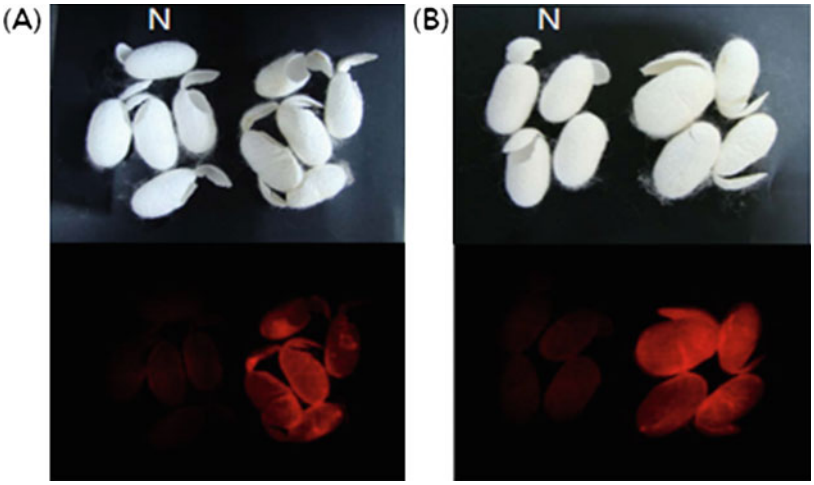
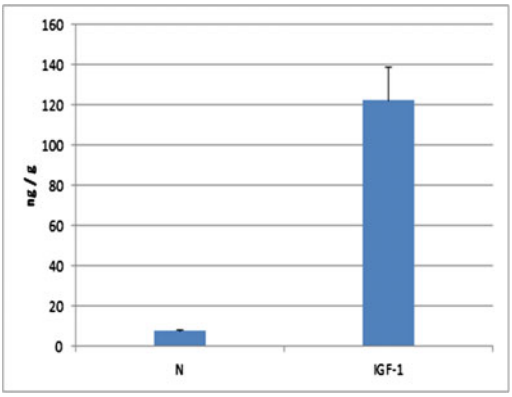


Fig. 5 Fluorescence detection of transgenic silkworm. **a** Human IGF-1 silkworm, **b** Tussah fibroin silkworm, N: negative control-Beak ok jam silkworm

Fig. 6 ELISA assay of cocoon extraction. N: negative control—Beak ok jam, IGF-1: Extract of human IGF-1 cocoon



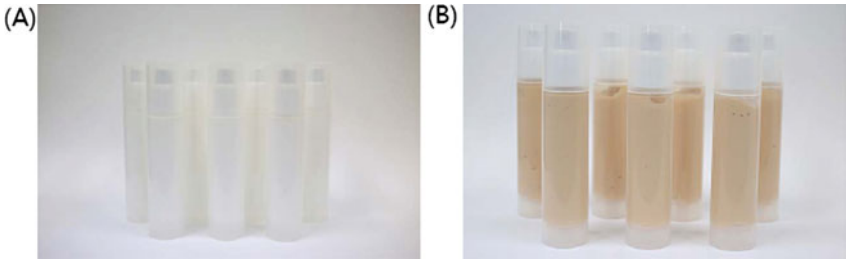


Fig. 7 Sample of cosmetic sample containing human IGF-1 **a** Emulsion **b** Cream

Table 1 Characteristic of 7 different raw silks

No.	Variety	Tenacity (gf/den)	Elongation at break (%)	Fiber fineness	Boiling-off ratio (%)
1	Antheraea Yamamai	6.58	30.50	0.927	26.6323
2	Antheraea Yamamai-1	6.45	28.10	0.939	27.4935
3	IGF-1	6.67	27.40	0.837	29.7555
4	IGF-1(Korea)	6.30	28.10	0.891	28.7668
5	Baek Ok Jam	6.41	25.40	1.041	29.2498
6	Kum Ok Jam	5.55	25.00	0.938	28.5813
7	21Den (China)	5.59	23.90	0.983	22.7287

Yarn of IGF-1 showed highest solidity. Tenacity, elongation showed good quality comparing to other commonly used silk yarn. Those transgenic silkworms produced very fine fiber.

3 Conclusions

In order to improve the quality of the silkworm cocoons we applied our biological technology which resulted in getting high quality micro-silk which width is less than 1 den. This micro-silk was obtained from a transgenic silkworm prepared by in vivo electroporation of expression vector into the silkworm.

At the same time, we were able to obtain high yield of IGF-1 (Insulin-like Growth Factor-1) from this transgenic silkworm in the sericin part also made from an expression vector including human IGF-1 clone.

The silkworms that were inserted with modified DNA vector successfully expressed required micro-silk fiber and IGF-1.

Finally, we compared fabric of Uzbekistan silk, Chinese silk and Japanese 6A which we developed. Also we analyzed sericin content, strength and elongation and

thickness of transformation silk single yarn. Transgenic silkworms produced fiber with higher strength, tenacity, and elongation comparing to other commonly used silk fiber.

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Study on Design Elements of Cardinal Direction Based on Cognitive Analysis

Min Ju Kim, Kaznari Morimoto and Noriaki Kuwahara

Abstract The cardinal direction is used in various situations such as road sign and information sign. It should be designed in order to improve the efficiency and accuracy of information transmission. Therefore it is required to design to understand the human cognitive characteristics and attention function. The purpose of this study is to clarify the design elements of the cardinal direction based on cognitive processes. Results showed that for all groups, that is easy to understand in accordance with an increase in the character information but it takes time to understand that information. As a result of the integrated evaluation of two types of experiment, the use of the letter N meaning the north direction in any of the types was proved to lead to better easy to understanding.

Keywords Design elements · Cognitive · Visibility · Cardinal direction

1 Introduction

There is a need for a variety of information for movement in the life and the city. There are maps and information signs one of the most useful means of obtaining the information for the mobile. For travelers from overseas, it is inevitable to get the movement information of the town from the information media, such as maps and information signs.

As one of the signs, cardinal directions can provide directional guidance and necessary information on moving in the streets, on the roads, or in buildings, etc. In particular, since there are many visitors from other cities on mountain trails and

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in tourist areas, they often rely on guidance maps with cardinal directions drawn. Although the importance of a cardinal direction is especially high in unfamiliar land, it is also important in scenes close to life. Therefore, cardinal directions are used in various forms in guide maps and at public places with an unspecified large number of people such as on the ground of sidewalks directly after walking up from an underground station, on the evacuation route maps of subways, and on the guide maps of buildings, etc.

Visibility evaluation of pictograms and sign design is used surveys and SD method. The impression evaluation has been carried out, such as likeability and beauty.

Study of sign systems have been made mostly on the present condition of pictograms or signs. Studies related to sign systems until now are mainly about the spatial condition of pictograms and signs. However the study of information contents display for a better perspicuity of cardinal directions is not enough. To clarify the design elements during the design of intuitively easy-to-understand cardinal directions, this study has carried out subjective evaluation experiments. First, the existing cardinal directions were collected, and the design elements of each cardinal direction were extracted. Then, evaluation experiments were conducted on the understandability of each element.

Card et al [1]. It has been described in conjunction with the temporal aspects of user behavior for the basic principles of the user of the information processing.

Figure 1 is a Human processor model. It is a cognitive modeling method used to calculate how long it takes to perform a certain task. The Model Human Processor, developed by Card is a design tool that is used for creating an effective user interface. It described an analogy between the processing and storage facilities in a computer system with the perceptual, cognitive, memory and motor activities of a computer user.

It was modeled to a series of human information processing process by sensory information from the eyes and ears are inputted, recognizes it, the output instruction is issued through the motor system. According to the model human processor by Card et al. Process is considered to be repeatedly executed in parallel in recognition of the cardinal direction figures, (the reading of the orientation represented by the cardinal direction graphic) perception, cognition (judgment the north shown in figure cardinal direction), (press the reaction button) movement.

In this study it came out to perform the position on the basis of the findings of the Card et al. As can be seen from the model human processor of Card et al. to clarify the reaction time is consistent with the revealing cognitive time.

The purpose of this study is to clarify the design elements of the cardinal direction based on cognitive processes. The goal of a previous report was to identify important factors for the development of an intuitive cardinal direction, and conduct subjective evaluations and reaction time to extract structural design elements necessary for its planning. In this paper we propose a in order to analyze the relationship between the intuitiveness of a cardinal direction and the time leading up to a reaction time, the coefficient of each group's reaction times was examined and the rating value of an intuitive cardinal direction design gained from the subjective analyses.

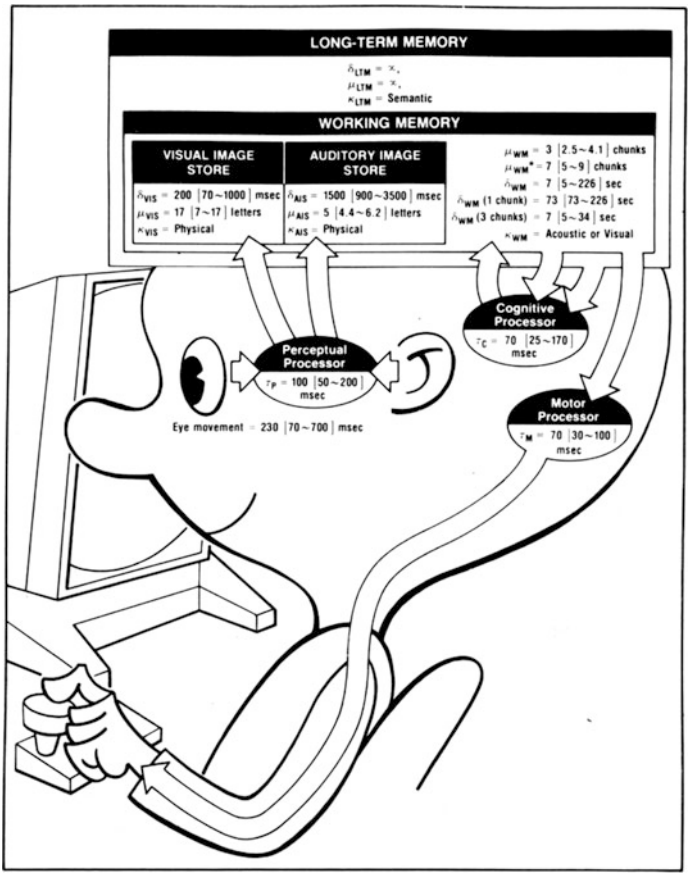


Fig. 1 Model Human processor (card et al. 1983). Humans are information processors *Input* seeing and hearing most important to HCI, *Processors* cognitive, perceptual, and motor, *Output* wrist, arm, leg, etc. movements

2 Method

Cardinal directions for evaluation are shown in Fig. 2. These cardinal directions were created after adding the basic shapes and orientation information, and considering symmetry and others.

The subjects were 40 college students in their 20 or 30s (male: 20 people, female: 20 people).

Experiment I is understandability of cardinal directions. In order to investigate easy-to-understand cardinal directions based on the shapes shown in Fig. 2, a paired comparison method was used to evaluate. The sample used for evaluation was drawn based on the design components. The experiment was rated by paired

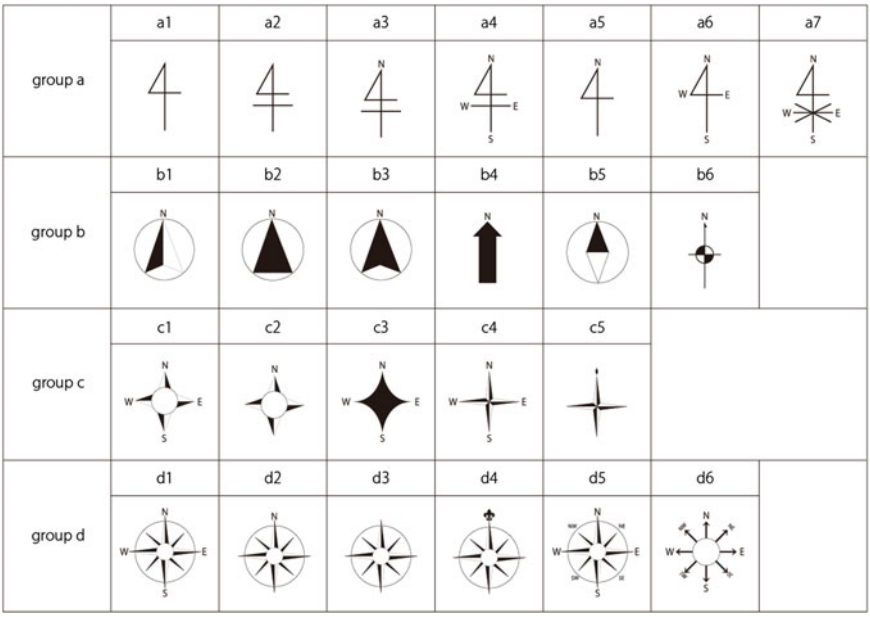


Fig. 2 Example of cardinal directions used for subjective evaluation test

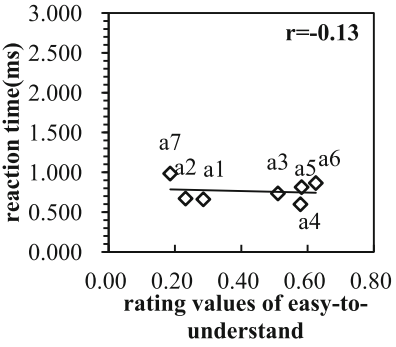
comparison method (Thurstone's Paired Comparison). As the judge of evaluation was easy and the reliability and validity were high, this method was chosen. The experimental subjects were required to answer which cardinal direction was easier to understand while giving two stimuli on the left and right.

Experiment II that Subjects were first shown the symbol "+" in the middle of the screen to center their gaze. After three seconds the "+" symbol disappeared and a direction indicator appeared. The subjects were asked to press "enter" as soon as they recognized where north was on the indicator.

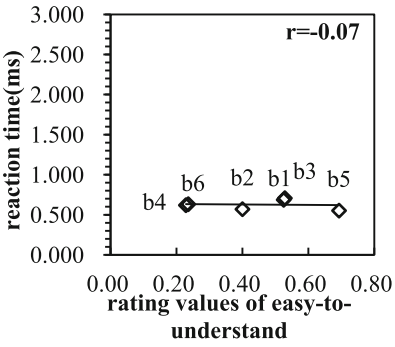
3 The Results

3.1 From the Relationship Between Assessment of Rating Values of Easy-to-Understand and Reaction Times

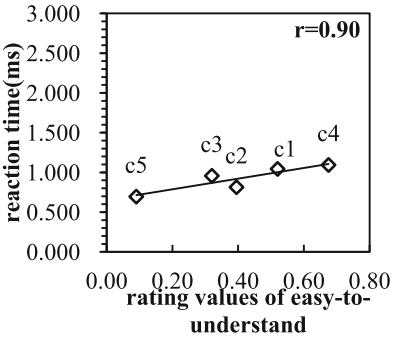
In order to analyze the relationship between the intuitiveness of a compass and the time leading up to a reaction (reaction time), the coefficient of each group's reaction times was examined and the psychological scale value of an intuitive compass design obtained from the subjective analyses. Results are shown in Fig. 3. The lateral axis is for the scale value, the vertical axis denotes reaction time. For group



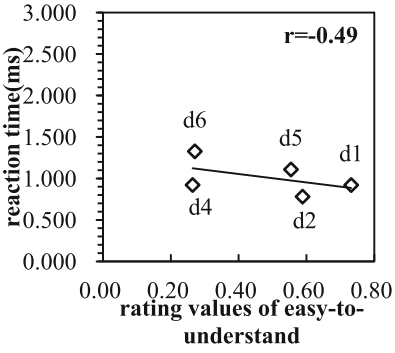
(Fig.3-1)



(Fig.3-2)



(Fig.3-3)



(Fig.3-4)

Fig. 3 Reaction times and assessment scale values obtained through subjective assessments

a, it was not possible to confirm a correlation between the psychological scale value and reaction times. ($r = -0.13$, $p < 0.01$). It was not possible to confirm a correlation also in group b ($r = -0.07$, $p < 0.01$). A high negative correlation for group c ($r = 0.90$, $p < 0.01$), and a strong correlation in group d ($r = -0.73$, $p < 0.01$) was found. For all groups, with the exception of d, low correlations confirmed that paying close attention and processing information consciously as opposed to the opposite makes a difference in the reaction time to the intuitiveness of a cardinal direction.

Results showed that for all groups, low correlations prove that paying attention and processing information consciously as opposed to the opposite makes a difference in the reaction time to the intuitiveness of a cardinal direction. The subjective evaluation if there were four pointers indicating four directions, it would be better to display all the four directions. However, for the reaction time was when the pointer only pointed north and four pointers, the cardinal direction was faster to understand when just “N” was present.

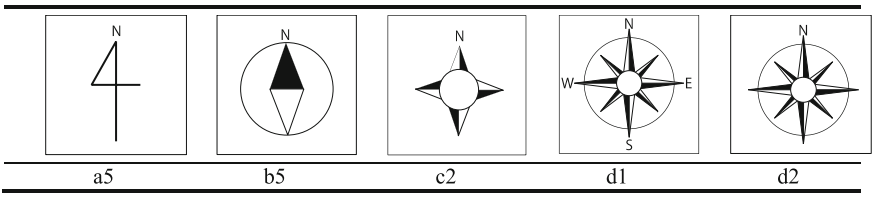


Fig. 4 The most easily to understand cardinal direction

3.2 Design Elements of Cardinal Direction Based on Cognitive Analysis

In Experiment I and II, a5, b5, c2, d1, d2 which was evaluated as the easiest to understand. (Figure 4)

a5 have character information added to the shape of number 4. This shape has easy to understand 4 direction and direction indication. b5 was rated to be easier to understand as it had a symmetric shape and pointed both upward and downward.

c2, the shape of having four directions including east (E), west (W), south (S), and north (N), and consists of a circle and north character information indicate. a5 and c2, which were evaluated as easy to understand, had the common feature of using characters to indicate directions. That is it shows a clear four directions and north character information. d1 and d2 uses the arrow shape indicating 8 directions as the basic shape, including east (E), west (W), south (S), north (N), northeast (NE), southeast (SE), northwest (NW), and southwest (SW). The character information of 4 directions was better even when the shape elements had 8 directions.

Results showed that for all groups, the faster confirmation of the direction was easy to understand cardinal direction. In order to promote the understandability, cardinal directions should be similar to type a5, b5, c2, d1, d2 with one direction and less character information. It is known that the existence of character information can affect the evaluation of understandability greatly. In order to promote the understandability, cardinal directions should be similar to type a5, b5, c2 with two or four directions and north character information. Furthermore, form of guidelines indicated explicitly the north and south.

4 Conclusion

The purpose of this study is to clarify the design elements of the cardinal direction based on cognitive processes. The goal of a previous report was to identify important factors for the development of an intuitive cardinal direction, and conduct subjective evaluations and reaction time to extract structural design elements necessary for its planning.

In this paper we propose a in order to analyze the relationship between the intuitiveness of a cardinal direction and the time leading up to a reaction time, the coefficient of each group's reaction times was examined and the rating value of an intuitive cardinal direction design gained from the subjective analyses.

In order to investigate how the character information and shape elements of each type can affect the understandability of the targets, the paired comparison method of Thurston was used to conduct a subjective survey. Furthermore in order to investigate.

From the results, three features of the cardinal directions with higher understandability were concluded.

1. From the overall results of all the four types, the character N indicating north direction was believed to be able to increase the understandability. It is inferred that maybe the character N is the first information that can be recognized when looking at a cardinal direction.
2. The faster confirmation of the direction was easy to understand cardinal direction.
3. In order to promote the understandability, cardinal directions should be similar to type a5, b5, c2 with two or four directions and north character information.

It is believed that the factors determining form of guidelines indicated explicitly the north and south the otherwise guidelines indicated east (E), west (W), south (S), north (N). It is known that the existence of character information can affect the evaluation of understandability greatly. Future work is the relationship between visibility and psychological state through cardinal direction is material for future study.

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Perceptions on Clothing by Elderly Females

Saori Kitaguchi, Mio Matsumoto, Tetsuya Sato and Kanji Kajiwara

Abstract The perception on clothing of elderly female were compared with that of youth, especially focusing on the sense of cool. The information were collected through the questionnaires given to the groups of elderly females in their 60, 70, and 80s and also to the female in their 20s for a comparison. In terms of the color taste, opinions and feelings about clothes, the sense of "cool" seems to be received in a different way between the youth and the elderly. However, when their lifestyle (behavior and information sources) were concerned, the perception of the 60s was closer to 20s. The 70 and 80s were divided by two groups. It could be by the sensitivity to information.

Keywords Clothing · Elderly females · Perceptions

1 Introduction

Fashion is now a main daily topic among the youth, but the concept of fashion is relatively new in Japan. European style has become popular after the 1950s, but at home still people preferred a traditional Japanese style as relaxing and comfortable. Fathers and children had worn a suit or European-style uniform, but mothers normally wore "kimono" even for shopping and other outdoor activities as seen in the film of Director Yasujiro Ozu "Tokyo Story". Color television broadcasting started in the mid-1960 in Japan, and the European style has become a familiar scene in a daily life through the TV programs. A first Japanese street fashion group appeared in the 1960s, and was referred to by the name of the street as "Miyuki-zoku" where it was originated. European fashion became a matter of fact in our life, and, for example, the youth reacted quickly to adapt the mini-skirt or the mod scene. Since

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the 1970s, fashion has become a lubricant for the youth forming the groups according to a street fashion specific to individual towns around Japan [1].

Before the 1970s, fashion was a thing which should be despised and the youth were more interested in the political movement. That is, the youth at that time were more active in the external life and less interested in themselves. The students' revolt gradually faded away, and the youth lost their interest in the external life. They retreated behind walls and enclosed themselves in their inner life as referred to as "otaku" which literally means a home-stricken. Those "otaku" people were isolated from the outer world and absorbed in their imaginary world through the virtual reality created by the computer games. They have also created their own imaginary world as comics ("manga"), and started to communicate each other virtually. The communication eventually resulted in grouping (or grooming), and they started gathering together by wearing characteristic costumes specific to the group (either a costume appearing in their creation or favorite manga heroes/heroines) in order to distinguish from other groups.

A first fashion magazine for young female appeared in 1971, indicating the fashion became a main concern of young female around that time. A street fashion emphasized in this fashion magazine redefines the purpose of fashion as not to dress-up but to enjoy oneself by addressing "kawaii" as a main theme. Although there was a strict dress code in the traditional Japanese style as the European style, the meaning of the dress code was completely lost by mixing Japanese and European styles in the 1950s. The street fashion developed by itself as it is in Japan by the complete ignorance of the dress code. Here the Japanese street fashion to be cool is nothing serious and free from the meaning of style [2] but should retain some extent of elegance as specified as "kawaii" [3].

The female elderly in their 80, 70 and 60s were around 20 years old in the 1950, 1960 and 1970s, respectively. They experienced the drastic change of the fashion scene in Japan as the youth at that period. That is, fashion for those elderly was an exotic object at first, but they accepted fashion without any social and/or cultural prejudice. Thus the cultural attitude to fashion is distinctively different from that in Europe where fashion is closely related with sociological context [4]. The present study focuses on the sense of cool in the elderly in comparison with that of the youth through their color taste, opinions and feelings about clothes and also lifestyle.

2 Methods

The analysis was broadly drawn from a series of questionnaires given to the groups of elderly females in their 60, 70, and 80s. The same questionnaires were also distributed to the female in their 20s for a comparison. Each age group consisted of 20 females, giving a total sample size of 80 participants. All participants were Japanese.

The questions in the questionnaires were given in Appendix. The questions were mostly concerned with (1) *color*; (2) *types of clothes*; (3) *feelings*, (4) *important aspects* and (5) *lifestyle (behavior and information sources)*. The subjects were asked to select colors from White; Grey; Black; Red; Pink; Orange; Yellow; Brown; Green; Blue; Navy; Purple; Gold; Silver; Beige and Others in the case of the questions with regard to *color*. For *types of clothes*, the choices were Friendly; Lively; Casual; Mature; Youthful; Refined; Fun; Safe/Standard; Nice; Beautiful; Cute; Fresh; Cool; Feminine and Others. For *feelings*, the choices were Quiet; Easiness; Comfortable; Confidently; Relaxed; Satisfied; Balanced mood; Happy and Others. The choices for *important aspects* were Brand; Color; Appearance; Shape/Design; Material; Price; Function; Easy care; Environmental friendly; What others think; Add to the charm and Others. The participants were asked to choose first- and second- choice accordingly to each question.

3 Results and Discussion

The participant responses were summarized by age groups. When compared the color taste of the elderly groups with that of the youth as shown in Fig. 1, both generations listed "pink" as a favorite color, and the "pink and red" together constitute approximately 35 % of the favorite colors in both generations. The youth list "orange" as a favorite color but not the elderly. Interestingly the youth attribute "red", "pink" and "orange" as colors which the elderly does not prefer, while the elderly favors "red" and "pink". The youth think "purple" and "beige" as suitable colors for the elderly, but the elderly are not in favor in those colors. This mismatch in the color taste may indicate that the youth have a fixed idea for the colors suitable for the elderly as traditionally accepted, but the elderly are rather similar to the youth which means more influenced by the media including the fashion magazines.

The "pink" is supposed to be a "kawaii" color, and is considered as "cool" according to recent fashion magazines in Japan, and in this respect the youth regard the elderly as not cool. Even among the elderly, there seems a different tendency for favorite and least favorite colors, where the 60s exhibit a lower ratio of the least favorite colors for achromatic black and grey in comparison with the 70 and 80s. This tendency is probably due to the fashion color trend in the 1970s.

The colors of the clothes they often wear are mostly achromatic or the colors they feel safe and standard. However, the elderly have more chromatic or distinct colors such as "orange", "pink", "brown" and "blue" or "navy", while the youth have more achromatic colors including "white", "grey", and "black". The elderly are more independent of choosing colors, but the youth consider more to be safe and standard (not distinct) in their group.

In contrast, the clothing colors which they would like to wear involve many chromatic colors in both generations. The youth prefer "red", "yellow", "orange", and "blue", where achromatic colors ("white", "grey" and "black") are less favored.

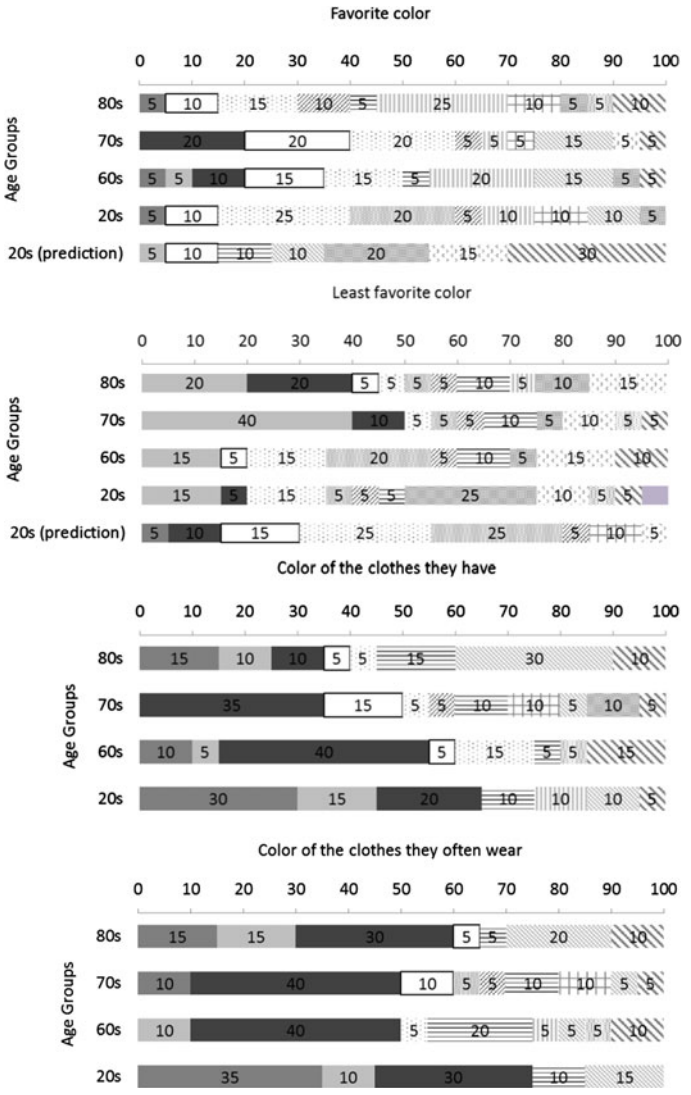

Fig. 1 Color selections of the participants

This color trend incidentally fits to the 2016 fashion colors "coral", "wine red", and "indigo". The elderly list more variety of colors for their clothes, and "purple" seems their best choice although they seldom wear "purple". Other colors are "red", "pink", orange", "green" and "silver", which somehow reflect the fashion trend colors around 2000 (about 15 years ago).

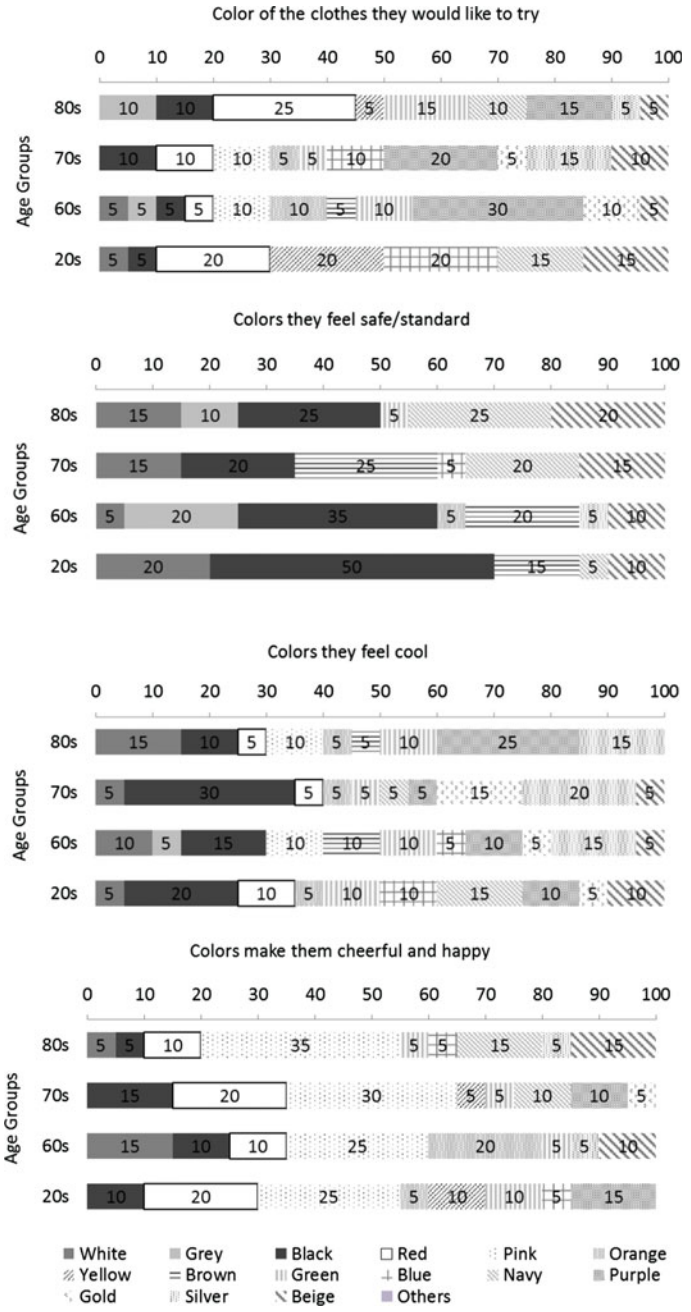

Fig. 1 (continued)

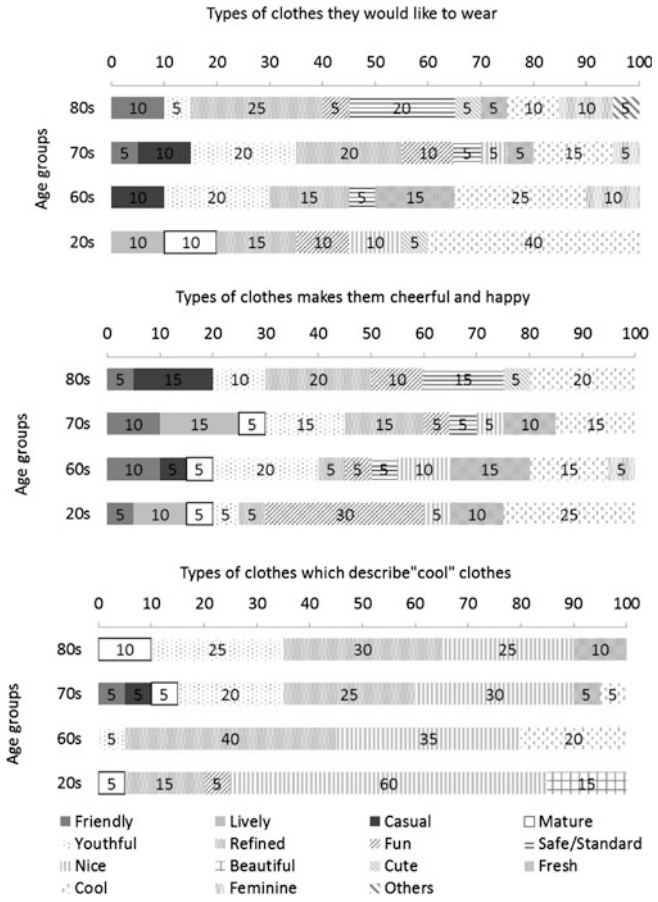

Fig. 2 Types of clothes

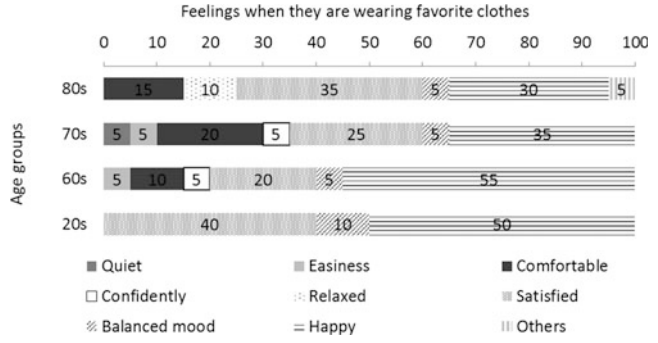

Fig. 3 Feelings

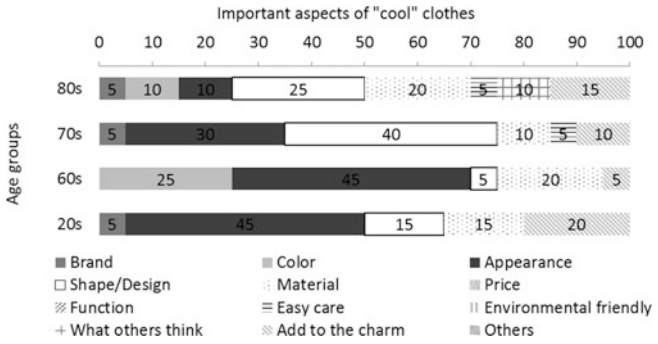

Fig. 4 Important aspects

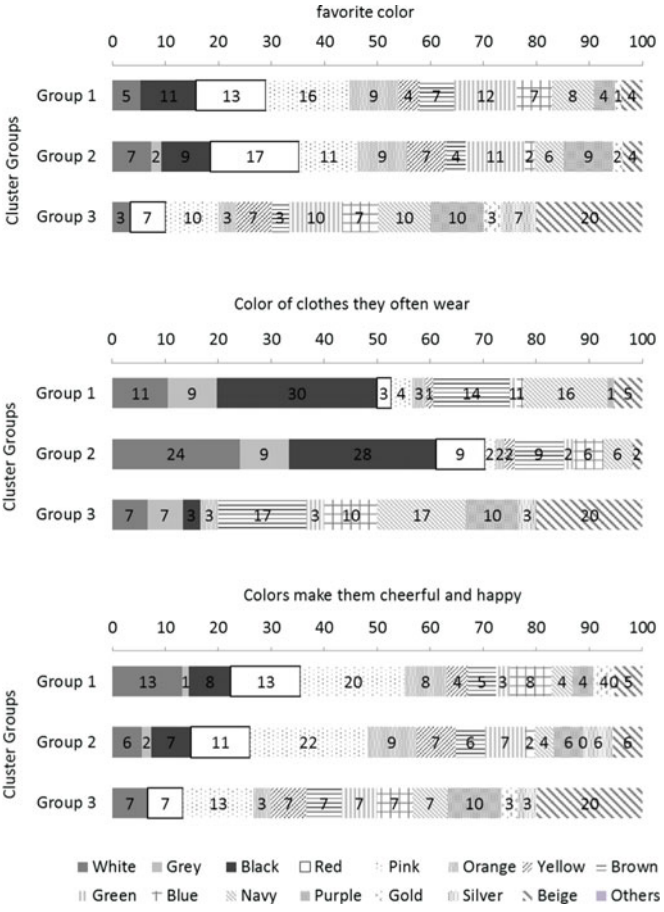

Fig. 5 Color selections of each cluster groups

The Japanese feel safe when they belong to a certain group. A group could be formed by sharing a similar fashion, a similar activity, a similar problem or anything common. A group could be composed of several people or even more. They go around together for shopping, eating and other entertainments. Each group has its own identity and should be distinguished from other groups. This is one reason to have the clothes of colors which they feel safe, and not colors which they like. In this respect, the analysis may confirm that the youth have a strong sense of identification, but the elderly are free from this sense and/or isolated from the society. The colors which they dislike may reflect more their real feeling. As remarked above, the youth are still influenced by the traditional commonsense that the elderly should not be cool.

As for a general concept for a cool color, all generations exhibited a similar tendency consisting of the variety of colors including achromatic "black" and "white". Here "purple" is also considered as a cool color in all generations, especially for the 80s, but "pink" and "silver" are not cool for the youth. The youth regard "navy" as cool. Those cool colors do not necessarily reflect the colors they wear or they would like to wear. The concept of "cool color" is also changing from "pink" or pastel colors in the 1970s to achromatic "black" and "white" at present in all generations.

Regarding to the types of clothes, the elderly would like to wear "refined" clothes (especially in the 80s) and youthful clothes (especially in the 70 and 60s). The 80s concern more the safe/standard clothes rather than a harmony with other people to have a sense of identification. The youth describe their preference as "cool" and "refined (decent)" clothes. Here the decency is somewhat related to "dress-up" and the "cool" is probably rooted in their sense of fashion. The elderly feel "refined (decent)" as cool but "cool" means just a nice cloth for the youth. Both generations describe cool clothes as just "nice". For the youth, "beautiful" clothes are also cool, while "refined" becomes an important factor to be a cool cloth for the elderly. The 70 and 80s consider "youthful" as a factor of cool, but "youthful" does not appear in the 60s and the youth in the factors of cool probably because they their spirit is still young. All generations, the youth in particular, describe "cool" just as "nice", indicating there is no fixed concept for "cool" as an aesthetic sense yet (Fig. 2).

All generations feel happy and satisfied when they wear a favorite cloth as shown in Fig. 3. The "comfortable" seems to be an important factor for a favorite cloth for the elderly. However, the "appearance" and "shape/design" become an important factor for "cool" clothes (Fig. 4). The elderly concern the materials as well for cool clothes, but "color" seems less important for a "cool" cloth except in the 60s.

In summary, the sense of "cool" is received in a different way between the youth and the elderly. The sense of cool for the youth is concerned with the aesthetic sense frequently redefined in the fashion magazines and other media to articulate the body [5], while the elderly have their own sense of refinement through their experience and have developed the sense of cool independently of translating

fashion in a daily life. A slight influence of the fashion of their younger days could be traced in the sense of cool in the elderly, but it will require more detailed comparative investigation by contrasting the fashion of that period when the elderly were in their late teens and early 20s to conclude how we acquire a sense of cool.

The hierarchical cluster analysis with squared Euclidean distance and the Ward's method were applied to analyze the similarity of participants towards the sense of cool as a whole. For this analysis, the answers of all the questions (Appendix) were used. Therefore, this results include not only color taste and awareness of the clothes but also the behavior and information sources. The results indicated the participants could be clustered into three distinct groups. The first group is mostly composed of the youth (15 people from the 20s) and 15 people from the 60s, and also contains a small number of the 70s (6 people) and 80s (2 people). The second group contains 5 people from the 20s, 1 person from the 60s, 10 people form the 70s and 11 people from the 80s. Then in the third group 3, 0 people from the 20s, 4 people from the 60s, 4 people form the 70s and 7 people from the 80s. The distance between the first and second group is short, and the third group forms an isolated cluster.

Some of the color selections of the each groups were given in Fig. 5. Although the response pattern to the questionnaires about colors reveals little difference, the third group could be characterized by the indifference to information from the discussion on each answering pattern. There is only one 20s in this group, and the rest are from the 60, 70 and 80s. The first group consists of people in the 20 and 60s who are sensitive to information and act accordingly. The second group is moderately sensitive to information but tries to translate fashion within its capacity.

The present analysis confirms that the elderly are less concerned with available information, but there are still the elderly sensitive to information.

4 Summary

The perception on clothing of elderly female were compared with that of youth, especially focusing on the sense of cool. The information were collected through the questionnaires. In terms of the color taste, opinions and feelings about clothes, the sense of "cool" seems to be received in a different way between the youth and the elderly. However, when the behavior and information sources were concerned, the perception of the 60s was closer to 20s. The 70 and 80s were divided by two groups. It could be by the sensitivity to information. However, in order to discuss details of the perception of elderly females, more comparative investigation are required by contrasting the fashion of that period when the elderly were in their late teens and early 20s.

Appendix: The Summary of the Questions in the Questionnaire

Favorite color
Least favorite color
Color of the clothes you have (clothes for outside of the house)
Color of the clothes you often wear (clothes for outside of the house)
Color of the clothes you would like to try (clothes for outside of the house)
Do you distinguish your clothes wearing inside the house from outside of the house?
Color you feel safe/standard color
Important aspects of the safe/standard color
Important aspects of the safe/standard clothes
Color you feel “cool”
Types of clothes which describe “cool” clothes
Important aspects of “cool” clothes
Which one is more important for your clothes: “cool” or functions
Type of clothes you would like to wear
Color of clothes make you cheerful and happy
Type of clothes make you cheerful and happy
Important aspects of the clothes make you cheerful and happy
Feeling when you are wearing favorite clothes
Color suitable for adaptive clothes
Important aspects of adaptive clothes
How much do you spend for your clothes per month?
How often do you buy clothes?
How/Where do you get information about clothes?

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Interactive System Supporting Children Pleasurable Learning

Wafa Almukadi and Lucas Stephane

Abstract This paper deals with tangible objects intended for improving young children education in the classroom. Aligned with recent trends that embed interactivity and connectivity in physical objects, our study augments traditional wooden toy blocks with sensors detecting movement, location and alignment as well as providing visual and aural positive feedback when a good result is attained. Several prototypes were designed and tested with children for basic spelling, vocabulary and basic math exercises. Results obtained are positive and encouraging to continue improving the proposed tangible system.

Keywords Tangible objects · Tangible user interfaces (TUI) · Children · Learning · Human-Centered design (HCD) · Play · Pleasure · Augmented

1 Introduction

Tangible User Interfaces (TUI) are an emerging field of Human-Computer Interaction (HCI) research that is gaining attention especially in children learning for the last two decades [1]. Young children have great interest in manipulating physical objects during hands-on activities while they develop thinking through

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playing [2]. Interactive digital technologies become part of our daily lives and children enjoy and use them intuitively. TUI are a key dimension of the emerging technology in children learning, since they blend the gap between physical action and digital representation that can keep children engaged in playful learning [3].

Playing is essential in children learning and development, supporting physical, motor, and cognitive development. Furthermore, it contributes to children social and emotional development [4]. While children play they can think, explore, express, establish relationships, develop behavioral control, enjoy and learn. However, in school it is difficult to keep children engagement and curiosity to learn [5, 6].

Thus, TUI can increase children engagement and curiosity by providing affective and pleasurable designs stimulating children's attention and emotion [3] TUI can benefit children learning by providing natural interaction that requires little cognitive effort, enabling children to focus more on the task and underlying domain [7]. They provide a computing environment with a variety of embodied interactions and different types of feedback that match different learner styles [8]. Moreover, TUI enable children to collaborate with their friends face-to-face [9], and provide real fun experiences facilitating learning.

This paper presents an augmented interactive prototype for children in the age-range of 5–8 for facilitating learning and enhancing classroom environments. It augments learning activities helping children to increase academic proficiency in math and language. In particular, it supports basic math addition and subtraction up to 10, and 3-letters vocabulary. The prototype can be used as a tool to help children increase their opportunities to practice skills in authentic environments and take more control over their learning. The proposed interactive tabletop system is composed of TUI connected to a computer displaying textual, visual, and audio formative feedback.

The system provides a transparent surface, tangible blocks with unique fiducial markers and a web-camera. The objects are detected by the camera and decoded by the reacTIVision framework, that sends object data via LusidOSC [10]. Object manipulation is used as an input in the application, programmed in Processing. The system was designed in several iterations for requirements, specifications and experiments to ensure both teachers and children's acceptance and effectiveness.

The work reported in this paper was evaluated three times: first, a pilot study with 9 children (5 boys and 4 girls) in a school classroom; second, a comparative study between the proposed system and traditional toy blocks conducted with 18 children (8 boys and 10 girls) in controlled groups; third, the same comparative study repeated with 6 children having special learning needs. Results obtained so far showed that TUI could increase children's engagement, collaboration, fun, and enhance overall learning.

2 Design Rationale

Effective education technologies need to be designed on what we know about how humans learn. There are several educational theories that encourage interaction and collaboration. Constructivism [11] argues that learning and knowledge are generated through interactivity where human can interact with their experience and ideas. Constructionism [12] states that learning and knowledge are generated while humans are interacting with things that are tangible and shareable. In addition, social constructivist [4] proposed that cognitive development is emerging through practical activity in a social environment. In addition, playing is essential in children lives where they can develop abstract meaning separate from the objects in the world [4]. Furthermore, positive emotion is fundamental in children learning [6] which can increase children engagement, creativity, curiosity, motivation and interest in learning [13]. From that we can illustrate that designing an effective education technology to facilitate learning needs to consider simulation where human can develop mental models of their knowledge, at the same time social interaction with objects that can model human concepts. These could be surrounded with playful atmosphere where children can learn intuitively in pleasurable moods.

As a suggestion of effective education technology we designed a Math-Vocab interactive tool. In this tool we adopt the TUI concept that supports digital-tangible interactivity with human and environment [8]. As a case study, we choose two main skills that children need to learn, i.e. reading and math. The system is designed as a tool where children can practice reading and spelling 3-letter words, as well as basic math. Practice in spelling helps children build their language discoveries of letters and words to become conventional readers and writers [14]. At the same time, language skills are supported by cognitive, social, and emotional development [14]. For math learning, the ELPS approach [15] suggests that children go through four phases when learning: E stands for experience and practical activities, L stands for language of mathematics, P stands for pictures to represent mathematical ideas, and S stands for the use of symbols. The system represents the ELPS approach with multisensory practical activities. However, in the current stage the system doesn't provide pictures or diagrams for mathematical concept.

3 Background and Related Work

In the literature there are great examples of work that focus on TUI toward young children. Spelling bee [16] is an augmented physical block which offers a novel way for small children to learn spelling. Another interesting example [9] introduced a tabletop system with TUI in the classroom environment for children to learn addition concepts. The system engaged the students in playful activities adding numbers and performing calculations while they started challenging each other and competing for fastest results. PageCraft [17] is a tangible interactive storytelling

system that associates tangible props with text and visuals displayed on the screen. A storytelling [18] is another example that demonstrates children excitement while using physical objects to learn new vocabulary and discuss about possible and different solutions. Spelling Cube [19] is an interactive system for learning spelling designed for children that provides spatial awareness of the facets and orientation of neighboring i-Cubes. Many other interesting examples can be found in the extensive review proposed by O'Malley and Fraser [20].

The main difference of the Math-Vocab system with respect to the mentioned applications is that it addresses two main learning skills that are language and math. Most of the TUI applications focus on one domain, either language or one concept of math. However, Math-Vocab is a portable low cost tangible interactive system that provides a collaborative playful environment where children can practice active learning with pleasurable design.

4 System Design

The system design is based on the human centered design (HCD) principles that stimulate moving from single-agent models of cognition to multi-agent models of socio-cognitive interactions [21]. Regarding the outside-in approach [21], affective design integrates dynamic simulations that enable the incorporation of potential users in the loop where designers should start from the purposes and operations toward means and engineering. It typically consists in iterative loops that include ideation, prototype development, formative evaluation and validation [22–24]

The Math-Vocab system has several iterative design loops that will be discussed in the following section.

4.1 Physical Artifact Design

The Math-Vocab system is designed as a portable lightweight interactive tool using low cost components with embedded computation capabilities. It is easy to install, easy to move around in the room and it doesn't take too much space. The system is composed of (Fig. 1):

- A transparent box that has a useful surface where children could play with the tangible objects. A black foam board has been added on the playing surface to define the playing area
- Tangible objects are toy blocks that have optical markers with unique IDs
- A web-camera (Logitech HD webcam C615) for optical marker recognition is placed at the bottom of the box
- A laptop runs the reacTIVision framework and applications software

Fig. 1 Math-Vocab system components

4.2 First Design Iteration

At this stage the system has 3 augmented blocks representing 12 letters. Fiducial markers with unique IDs representing different letters were attached to the four sides of each block. Thus, Block 1 has the letters: C, F, H, and B. Block2 has the letters: A, U, O, and E. And Block3 has the letters: T, G, N, and X. The blocks enable to compose 23 different meaningful 3-letter words: *cat, fat, hat, bat, act, hug, hut, hot, cut, tab, fun, hen, fan, can, tub, bag, bug, hog, bog, cot, fox, fog, box*.

At this stage, the scenario was designed to support learning alphabets, vocabulary and spelling only. In this scenario children have to align the 3 blocks on the table surface for building 3-letter words. When obtaining a meaningful word such as "Hen" the message "You got the word HEN" is provided, augmented with feedback both visual, e.g. an image corresponding to the word, and aural, e.g. playing clapping sounds (Fig. 2).

For assessing usability and acceptability, the system was tested with 21 people from different categories: HCD, behavior analysis, as well as teachers and children. In addition, the system had a pilot test at local school with 9 children between 5 to

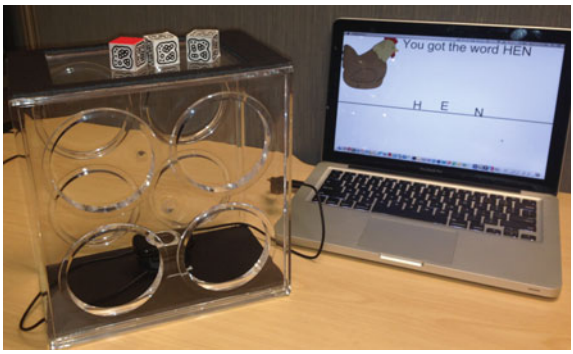

Fig. 2 Aligning up 3 blocks building up "HEN" word

8 years old (5 girls and 4 boys). The experiment results will be listed in the evaluation section.

4.3 Second Design Iteration

In the previous stage, novelty of game interaction seemed to have an effect on improving learning and engagement. In this stage we wanted to test the effect of the TUI itself in the learning process. In the 2nd design iteration, the system has 25 augmented blocks as follows: 12 letters: "A, B, C, E, F, G, H, N, O, T, U, X", 10 numbers: "0, 1, 2, 3, 4, 5, 6, 7, 8, 9" and 3 symbols: "+,−, =". In addition we developed two math applications for practicing basic addition and subtraction. In order to avoid interference from other variables such as colors, we decided to keep the blocks only black and white (Fig. 3). At this stage, we called the system Black Blocks [25].

4.3.1 Usage Scenarios and Game

At this stage the system has three different scenario games. The First scenario is called "Build Word". The goal of this scenario is to support the learning of alphabets, vocabulary and spelling which are the keys to learning how to read and write. In this scenario children have to align 3 blocks on the tabletop surface for building 3-letter words. When obtaining a meaningful word such as "Cat" the message "You got the word CAT" is displayed, augmented with both visual and aural feedback (e.g. an image corresponding to the word and clapping sounds) (Fig. 3). The system supports the same 23 words of the 1st design iteration. To get a right word, children have to place 3 blocks in the right order and align them horizontally. However, if children align 3 objects that do not form a word, for example: "BFG", nothing will happen, i.e. no negative feedback is provided. When children compose a right word, they need to remove the current blocks and find new blocks for a different word. Thus they self regulate themselves in the task. The

Fig. 3 On the *left*, manipulating augmented blocks on top of the surface. On the *right* the feedback displayed on the screen

overall principle is to encourage children to explore at their own pace further possibilities and thus motivate them to absorb new vocabularies.

The 2nd scenario is called "Forward exercise". In this scenario two random numbers between 1 and 5 appear on the screen. The children have to pick the corresponding blocks and also an operator, either "+" or "−", and place it between the two number cells displayed on the screen. Then they need to place the block corresponding to the result after the equal symbol (Fig. 4). If children get the problem right, a "good job sound" is played together with a message showing "good addition/subtraction" accordingly. Children then have to remove all the blocks from the surface and another pair of random numbers will appear. If they place a minus sign between two numbers so that the first number is less than the second number such as "1–5", then the system will display a message saying "sorry, can't solve this problem". According with the Florida Common Core State Standards, children at that age are not yet introduced to negative numbers. The goal of this scenario is to enhance children's creativity, allowing them to build and discover the mathematical problem, and to go *from components to results.*

The 3rd scenario is called "Backward Exercise". In this scenario a single random number between 1 and 10 appears on the screen. Children have to pick an operator either "+" or "−" and place it between the two number cells. Then they have to select two number blocks that, through the operator, should lead to the result number appearing on the screen, and align them before and after the operator. If children successfully solve the problem, a "good job" message is played together with a message displaying "good addition/subtraction" accordingly (Fig. 5). The goal of this scenario is to help children build the mathematical problem, and allow them to *move from results to components*. It enhances children flexibility in learning and thinking by figuring out what makes the number, and informs children that numbers can have several components, for example: number 7 can be 4 + 3, or 5 + 2, or 6 + 1, or 9 − 2, or 8 − 1 and so on.

Fig. 4 Forward Exercise. On the *left*, two random numbers displayed on the screen 7 and 2. In the *middle*, the user placed + to practice addition and placed block 9 as an answer to the problem. On the *right*, the screen after solving the problem

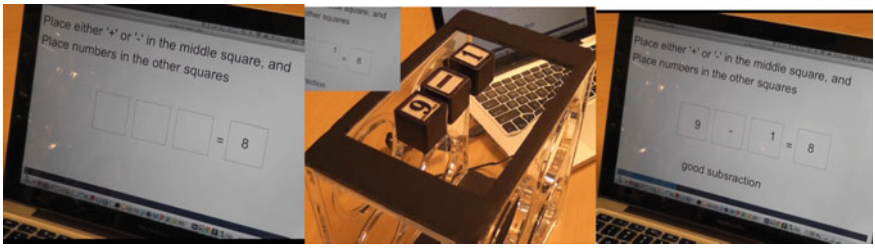

Fig. 5 Backward Exercise. On the *left*, the random number displayed on the screen is 8. In the *middle*, the user placed—to practice subtraction then placed block 9 and block 1 as an answer to the problem. On the *right*, the screen after solving the problem

5 Evaluation

Four evaluations have been conducted so far on the prototype. The first evaluation involved expert walkthroughs that were conducted with 21 experts of HCD, behavior analysts and teachers. The main objective was to assess the overall system usability, efficiency, and provide recommendations on how to improve the design and the software. The second evaluation involved prototype testing with 9 children aged 5 to 8 in a local school. The third evaluation involved comparative prototype testing with traditional toy blocks in 2 controlled groups, with 9 children in each group. The forth evaluation involved prototype testing with six children of ages 6–8 with special learning needs.

5.1 Expert Walkthrough Evaluation

The experts were asked to play with the system in order to uncover any potential violations of usability standards in the design, as well any recommendation for improvement. Overall, the experts found the design of the game applications intuitive and engaging and pointed out only minor problems with the font size, letters alignments and picture position and size. Regarding the physical design of the system, the experts found it ergonomic, lightweight, of suitable size, and pleasurable. Before moving to the seconded evaluation, changes based on the expert suggestions and observations were implemented.

5.2 Pilot Evaluation

The experiment took place in a local school in a children classroom. A group of 9 first grade children aged 6–8 (4 boys and 5 girls) participated. The goal was to

observe children's interactions with the system, and their motivation to learn vocabulary and spelling. The experiment investigated whether the system increases learning, supports collaboration, and engagement. As a baseline the children were asked to write on paper all 3-letters words they knew. They had 15 min to complete this task. After that, the interactive system was introduced to the children, and they were asked to play with it to get as many 3-letter words as possible. The tangible cubes were introduced as a novelty and children needed to discover the letters and build the words. Children were allowed to use the system for 30 min. At the end children had 10 min to complete a Smiley Ometer [26] evaluation form.

Children were happy playing with the system and enjoyed working together. They used the system easily without asking for help. They preferred using the system than pencil and paper. Children discussed with each other about some words such as "hog" while they were pointing to the picture and explaining the meaning. Children also suggested that they would like to learn new topics (e.g. music) using the system. The system increased children playfulness and engagement, and that became clear when they asked us to leave the system in their classroom.

5.3 Comparative Evaluation

The study took place in two separate rooms, one for the traditional Wooden Toy Blocks Group, and the other for the Black Blocks Group. Eighteen children (8 boys and 10 girls) aged between 5 and 7 years participated to the study. 9 children were assigned to each group taking into account the diversity of their ages. The study had three sessions: Scenario 1 (build 3-letter words) for 12 min long, Scenario 2 (forward math problem) for 9 min long, and Scenario 3 (backward math problem) for 9 min long. In order to balance the method and cancel any influential factors, Group 1 used the toy blocks with the same design of Black Blocks (covered with black tape and only one effective side with no fiducial). Group 2 used the interactive Black Blocks system. The two groups were separated into two different rooms to avoid distraction, noise as well as interferences between the two groups. The same "algorithms" were applied to both groups. For the Toy Blocks Group, random numbers were manually blind-picked from a bag.

Then children were shown the system all at once at the start, explaining how they could interact with the system. In the beginning of each session, we had to describe the task to the children and play a training example for them to ensure understanding. Two adults observed and managed the study sessions in each room. In each group, two children manipulated the system at once. As soon as a correct word was found or a math problem solved, a new pair of children started to manipulate the system for their next task.

Table 1 summarizes the exploration performance results. For Scenario 1, we can see that compared to the Wooden Toy Blocks Group, the performance of the Black Blocks Group improves by 33.33 % when using the Black Blocks system. For Scenario 2, Black Blocks Group performance improves by 11.76 % when using the

Table 1 Key results from the experiment

Session	Time	Toy block group	BlackBlocks group
BuildWord	12 min	12 words	18 words
Forward Exercise	9 min	15 problem solved	17 problem solved
Backward Exercise	9 min	22 problem solved	22 problem solved

Black Blocks system. For Scenario 3, there is no difference between the Black Blocks Group and the Wooden Toy Blocks Group.

5.4 Comparative Evaluation with Special Learning Needs

The experiment was located at Morgan's multi sensory wonderland with 6 children with special needs aged between 6 and 8 (4 boys and 2 girls). Individually, each child entered a room and asked to choose between the math game and the spelling game. 4 children chose the math game, one child chose the spelling game, and one child chose both games. The children were asked to do the same exercise on paper first. The reason for that was to compare children behavior and interaction between the interactive system and the traditional paper and pencil. With paper and pencil children were too distracted and unengaged. This was clear while they were staring at the door, playing with their hair, and with the pencil. The children were quiet and didn't talk at all. Four children took 10 min to complete the paper exercise. Two children didn't complete the exercise and didn't want to. On the other hand, when children used the interactive system they started to talk and to ask questions. Two children asked about the camera and about the fiducial markers and were curious about how the system works. Children were focusing on the task and liked to play with the system. After finishing the exercise, children filled the evaluation sheet of Smiley Ometer. The children found the system easy to use and preferred to use it to paper and pencil. Figure 6 shows the children playing with the interactive system in the three studies.

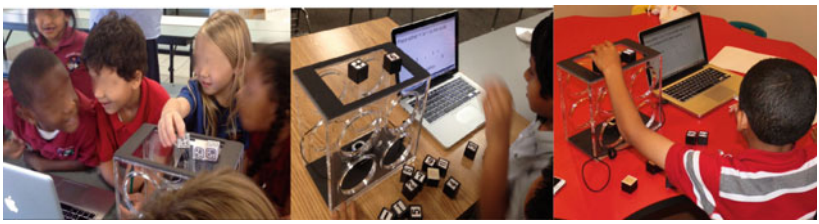

Fig. 6 Children playing with the system. On *left* 2nd evaluation, in the *middle* 3rd evaluation, on the *right* 4th evaluation

6 Conclusion

This paper discussed both the design and evaluation stages for a system of tangible interactive objects for children education in the classroom. We performed an iterative design and evaluation process for maximizing the quality of user experience. Each iteration enabled us to refine the system based on user feedback and requirements. The evaluations were also refined and adapted to the target population. Our tangible system seems to provide better overall results across the various children groups. Further efforts will enable us to improve the tangible system and to carry out additional comparative research for determining the optimal tangible configuration, e.g. physical objects versus tangible surfaces and virtual objects.

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Which Design Seems Easy to Use? An Analysis of Individual Differences in Mental Models

Yukiko Nishizaki, Toshihisa Doi and Toshiki Yamaoka

Abstract We investigated whether the influence of age and individual differences in mental model construction level affect the evaluation of appearance and functionality when users select household electrical appliances based only on appearance. Results showed that older (age 66–80) adults emphasized usability more than young (age 20–34) adults did. Moreover, users with high proficiency in mental model construction focused more on usability than did those with less advanced mental models.

Keywords Usability · Mental model · Individual differences · Age

1 Introduction

One of the most important factors influencing product selection is ease of product use. According to web research conducted in 2007 by the Japanese Institute of Design Promotion, the four most relevant design elements were aesthetics, functionality, originality, and usability. These results suggested that appearance, as reflected in the role of aesthetics, and practicability, as indicated by factors such as originality, functionality, and usability, are important in the evaluation of a pro-

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duct's saleability. Furthermore, the elements that users emphasize when they buy products are functionality, product appearance, price, and usability. If users are to purchase new products, it is important that the product designs consider not only appearance and cost but also usability.

However, usability is judged, in part, through duration of use. Thus, users cannot actually judge usability when they select a product, leading them to judge the product by surface characteristics and its apparent usability. Therefore, products that need to be usable must have an appearance that conveys usability so as to appeal to consumers who shop on the web or from a catalogue.

Other hand, product evaluation is likely to differ among individuals. Product appearance influences preferences, and the design that is liked by all people has never existed. Additionally, there may be individual differences in the balance of importance between appearance and practicability.

Products designed with usability in mind will be appreciated far longer than products designed without this consideration. Individual differences in human cognitive functions and experiences also play a role. It is not surprising that some products prove easy to use for some, but not easy for others. There are also individual differences in users' ability to operate products competently. In using complicated devices that employ a graphical user interface (GUI), such as TV remote control devices, digital cameras, and car navigation systems, we tend to employ a complex mental model of the electronic equipment [1]. Thus, the degrees of perfection of a user's mental model of a product have an effect on the level of apparatus operation that the user can achieve [2].

When purchasing devices based on visual information alone, such from the web or a catalogue, without actually handling the product, users must imagine and evaluate product usability on their own. The selection may, therefore, involve judgments based on apparent usability, which is unavoidably influenced by individual differences in the degrees of perfection of one's mental model. Many studies have assessed the apparent usability of designs for household electrical appliances [3, 4], but the role of individual differences among potential users has not been examined.

In this research, we used an online survey to investigate whether individual differences in mental model construction level affect the relative salience of apparent usability and aesthetics in evaluating products. We hypothesized that users whose mental model construction level was low might not evaluate product functionality correctly and would place greater importance on product appearance. Alternatively, they might attach little importance to appearance, focusing primarily on functionality. The results were expected to reveal differences in evaluation based on the nature of the product, users' familiarity with the product, and/or user age.

2 Electric Appliance Operation and Individual Differences in Mental Model

The mental model is a representation of implicit knowledge that represents an external thing or event. Developing a mental model for a particular event or object has been shown to improve learning [5] and to facilitate coping in response to problems [6]. Moreover, if the degree of perfection of a user's mental model of the electronic equipment is high, the user operates the product smoothly even when new appliances are used [2]. However, it remains unclear whether the mental model affects the process of evaluating a product that is known only visually and not through its actual operation.

If the mental model of the apparatus is well constructed, the user's behaviors toward the apparatus might be understood systematically. In other words, the user may be able to make optimal use of the information provided, and may be able to perform a systematic judgment, even when evaluating a product by visual cues alone.

3 Method

3.1 Participants and Methodology

We administered an online survey to 300 adults (150 men, 150 women, average age 50.09 years old, range 20–85 years old) who lived all over Japan and were enrolled as participants with a Japanese research company as of November 2015. The data of these 300 people had no missing values, and all of them completed the survey within the required time. The participants were given points as determined by the research company for remuneration.

3.2 Contents of Questionnaire

Evaluation Task. Four electrical appliances (rice cooker, telephone, coffee maker, camera) were evaluated based on their apparent usability and aesthetics. Six images of different types of each appliance were prepared. All images showed products that were commercially available on the Internet in October 2015. A preliminary pre-survey was conducted with 40 university students to determine which electrical appliances would be used. In the pre-survey, in addition to the four products mentioned above, a TV wireless remote control, a microwave oven, and a faucet were used, as these seemed appropriate for a choice based on usability. We investigated individual differences in product preference. As a result of this pre-study, we decided to use the four products mentioned above in this

Fig. 1 Example of selection images for the rice cooker. From arrays such as this, one of the six items was chosen as the most-wanted item, and one as the least-wanted item, in each category

investigation because they demonstrated large individual differences in product choice. In addition, the six representative types of each electrical appliance differed in price range so as to control for price and the focus on similarity in function.

For the evaluation task, participants were first asked to rate their familiarity with each electrical appliance on a four-point scale. Then, they were instructed to indicate the item that they most wanted and the one that they least wanted among the six types of each electrical appliance (Fig. 1).

Participants were then instructed to respond to eight evaluation questions about most- and least-wanted type of each product category. The questionnaire included four questions about usability and four about aesthetics for each product. As an example, the evaluation questionnaire for the rice cooker is presented in Table 1. Questions U1–U4 were about product usability, and A1–A4 were about aesthetics. Participants answered each question using a four-point scale (excellent, good, fair, poor) (see Figs. 2 and 3).

Table 1 Evaluation questions for the rice cooker

U1	It seems as though it would be easy to open and close the cover.
U2	It seems as though it would be easy to understand the assembly operation
U3	It seems as though it would be easy to understand function switching
U4	It seems as though it would be easy to serve rice from this cooker
A1	It is distinctive relative to the others
A2	The appearance is refined
A3	The material looks good
A4	The quality looks of a high level

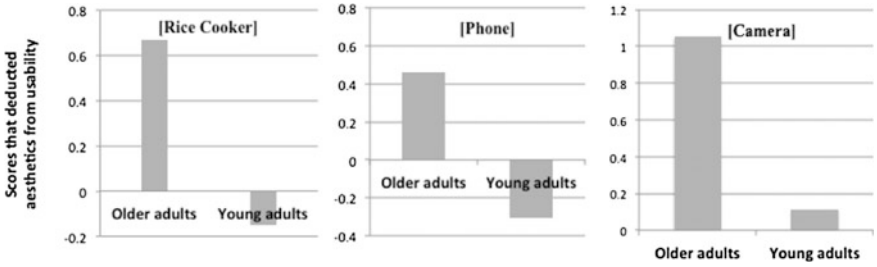
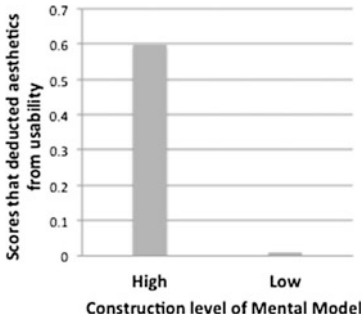


Fig. 2 Differences between the aesthetics scores and usability scores among familiar users for the rice cooker, phone, and camera

Fig. 3 Differences between the aesthetics scores and usability scores among familiar users for the rice cooker, phone, and camera



Individual Differences in Construction Level of Mental Model. "The Level of mental Model Building Measurement Scale in a User Interface" [2] was used. This scale, which consists of 17 items, was developed for the purpose of measuring the degree of perfection of one's mental model for easy operation of electronic equipment. The following are examples of questions included in this scale: "I can understand the kind of process this apparatus works by" and "I can understand the function from the instructions or the names of the parts of an apparatus". The relationship between scores on this scale and individual differences in the operation of actual apparatus was confirmed. Therefore, it can be considered a reliable index

to measure individual differences in the construction level of mental models, although it constitutes a subjective evaluation by the user.

Other Questions about User Characteristics. Using a four-point scale, participants were asked about the frequency of their PC use, whether they used a smartphone, and the level of their interest in interior design and art.

Presentation Order of Questions. The first page of the questionnaire requested demographic information such as age and sex. This was followed by questions regarding participants' familiarity with these products. Then, they were asked to indicate which of the products of each type they most and least wanted. The presentation order, as well as the positions of the four products and six types of each, were randomly assigned. Next, "The Level of mental Model Building Measurement Scale in a User Interface" was administered. Finally, the participants selected two (the most- and least-wanted) products in each category of electrical appliance. The questionnaire ended with questions about other user characteristics.

4 Results

4.1 Scoring of the Evaluation Task

Responses to the four questions about usability (U1–U4) were totaled to create the usability score, and the sum of responses to the four questions about aesthetics (A1–A4) constituted the aesthetics score. Each question had a maximum score of 4 points, so the maximum usability and aesthetics scores were 16 points each.

The usability and the aesthetics scores for the most-wanted product in each of the four electrical appliance categories are shown in Table 2. Participant age and familiarity with each product are also given. Participants who had a positive answer (1–2 points) for familiarity were considered the familiar group, and those with a negative answer (3–4 points) were the non-familiar group. Table 3 shows the numbers of participants in each group.

Table 2 Mean usability/aesthetics scores for four electrical appliances

	Familiar				Non familiar			
	Usability		Aesthetics		Usability		Aesthetics	
	Older adults	Young adults	Older adults	Young adults	Older adults	Young adults	Older adults	Young adults
Rice cooker	12.51	11.44	11.84	11.59	11.77	10.57	12.25	10.54
Phone	12.36	10.61	11.31	10.5	10.81	10.16	11.81	10.89
Coffee maker	11.77	11.15	12.48	11.87	11.19	10.77	12.06	10.96
Camera	12.12	11.07	11.65	11.37	11.58	10.56	10.67	10.53

Table 3 Number of participants in each group

	Familiar		Non familiar	
	Older adults	Young adults	Older adults	Young adults
Rice cooker	133	113	17	37
Phone	134	54	16	96
Coffee maker	71	39	79	111
Camera	95	75	55	75

4.2 Effects of Age and Individual Differences in Construction Level of Mental Model

We examined the question of how important usability was in product choice. The dependent variable assumed that the differences between the usability score and the aesthetics score. First, the effect of age was analyzed by comparing scores for usability and aesthetics between older adults and young adults. Furthermore, we divided the age groups into those who were familiar and unfamiliar with each electrical appliance and analyzed the effects accordingly.

The results revealed significant differences between older adults and young adults in evaluations of the rice cooker ($t = -3.09$, $df = 244$, $p < 0.002$), phone ($t = -2.55$, $df = 186$, $p < 0.01$), and camera ($t = -2.04$, $df = 168$, $p < 0.04$). These results, presented in Table 2, show that older adults were more likely to rely on usability than were young adults. No significant differences were found for the coffee maker. Fewer young adults were familiar users of coffee makers compared with older adults, and this may explain the differences between their scores.

Next, individual differences in the level of the mental model construction were analyzed. Significant differences were found in the level of mental model construction only for the rice cooker ($t = -2.20$, $df = 244$, $p < 0.03$).

The mean score of "The Level of mental Model Building Measurement Scale in a User Interface" was 53.98 points. We divided two different construction level of mental model groups, one was high mental model constructed group (54 points or more) and other was low mental model group (53 points or less).

There are significantly differences in high mental model construction users and low ones only evaluation of a rice cooker ($t = -2.20$, $df = 244$, $p < 0.03$). The result was shown in Table 3. High mental model group's way of evaluation to electrical appliances was focus on its usability strongly. There were not significantly differences in those scores in a phone, a camera and a coffee maker.

5 Conclusion

When users appraised the electrical appliance, such as a rice cooker, telephone, and camera using visual images, older adults, as compared to younger adults, evaluate its usability. Moreover, users whose mental model is well constructed evaluate a rice cooker from a perspective of usability. These results vary according to familiarity with the electrical appliance targeted. In other words, differences between usability and aesthetics become apparent when users estimate the usability of familiar appliances.

Individual differences in the mental model measured by "The Level of Mental Model Building Measurement Scale in a User Interface" only occurred when the rice cooker was evaluated, but not when the coffee maker, phone, or camera were evaluated. This scale for the mental model of electrical appliances is similar to the user interface of a digital camera. The mental model of a rice cooker might be similar to these. Some reasons why no differences were observed for the three appliances are considered. Operating a coffee maker is simple and does not require a complex mental model. The camera has characteristics important for a hobby but did not influence individual differences in the mental model. Unexpectedly, many young adults were unfamiliar with phone (not a cell-phone or a smartphone) use. A future study should examine the relationship between individual differences in mental models and electric appliances, including rebuilding of the mental model index, after considering the level of familiarity.

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Presenter Supporting System with Visual-Overlapped Positive Response on Audiences

Keiko Yamamoto, Kyoko Kassai, Itaru Kuramoto and Yoshihiro Tsujino

Abstract When we speak in public, we sometimes fail to speak well because of anxiety and strain. To solve such a problematic situation, we propose a method of overlapping positive response on audiences, and implement the system which overlaps an image of smiling pumpkin with nodding on each audience using video see-through HMD. As the result of an experimental evaluation of the proposed system, it is found that this system can reduce the anxiety and strain compared with the situation that scowling audiences are in view. It is considered that the result comes from two facts: (1) participants' anxiety and strain increase in case that audiences or pumpkins are scowling, and (2) they decrease in case that audiences or pumpkins are smiling. In addition, it is found that the feeling of relief and satisfaction, which are factors of reducing the anxiety and strain, are more improved in smiling pumpkins than smiling audiences.

Keywords Social anxiety · Presentation · Visual overlapping · HMD

1 Introduction

People often have needs to speak in public, i.e. self-introduction, speech in a party, and oral presentation in a conference. When we speak in public, we sometimes cannot speak well because of anxiety and strain. It is a serious problem for presenters who get nervous easily with audiences. To address this problematic situation, first,

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we survey the causes of this kind of anxiety and strain with other people. We found that this problem is called social anxiety and the causes are divided into two categories; (1) personal ones and (2) the existence of other people themselves or the relationship with them.

To solve the problematic situation in presentations, we focus on the latter one and propose a method of visual-overlapping positive response on audiences. This is because the social anxiety comes from the existence of other people and/or the valuation from them. In this paper, we propose a system in which the users can make their presentations with lower social anxiety. We then evaluate the effectiveness of this system comparing to four conditions.

2 Proposed System

We implement the system which overlaps an image of smiling and nodding pumpkin on each audience using a video see-through HMD with a camera. When the user makes a presentation, he/she puts on the device so that he/she can only see overlapping pumpkins on audiences (see Fig. 1). The reason for the use of pumpkin is because there is a popular phrase "Relax as if the audiences were all pumpkins" in Japan [1]. Furthermore, smiling on frontal face has an effect for giving the impression of "kindness", "congenialness", and "companionable" [2], and virtual avatar with a nodding response helps two remote talkers in communication [3]. Miki et al. [4] identify that seven kinds of negative behaviors of the audiences affect the anxiety of the performer who has the social anxiety. The presenters who get the anxiety easily in presentation had better to hide these negative behaviors. Therefore, we adopt smiling and nodding pumpkins on the audiences.

Figure 2 shows the overview of the system. The user wears a HMD with a camera and a microphone during his/her presentation. He/She can see smiling pumpkins instead of the audiences by visual-overlapping using face detecting technology in OpenCV [5]. At the timing of the short breaks of his/her talk, the smiling pumpkins are nodding, that is, the system senses user's voice using Microsoft Speech API5 [6] and changes images of an animated nodding smiling pumpkins (see Fig. 3).

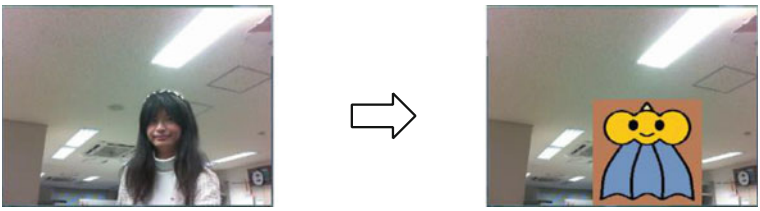

Fig. 1 Audience covered with an image of a smiling pumpkin

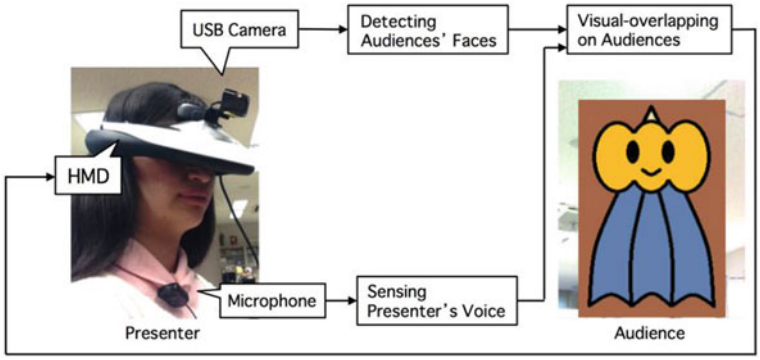

Fig. 2 Overview of the proposed system

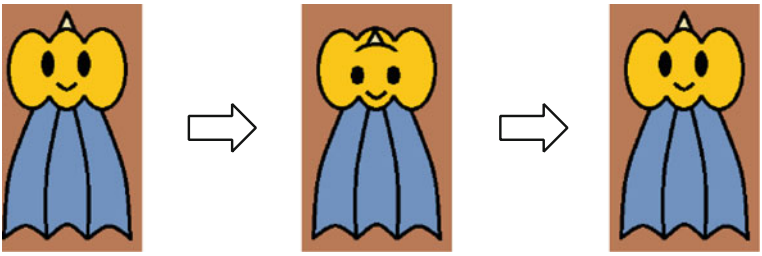

Fig. 3 Image of an animated nodding and smiling pumpkin

3 Related Work

There are some activities and researches which aim to reduce the social anxiety. One of the methods is "Icebreaker." Yanagida [7] defines it as the exercise that intends to help all of the participants to begin the process of the activity like debate, discussion, and so on, initiatively and smoothly. However, it is difficult to introduce icebreaker into the beginning of the presentation.

Arimitsu [8] identifies the strategies in 'agari' eliciting situations. 'Agari' is a Japanese noun (the verb form is 'agaru'), referring to broad experiences including 'stage-fright', 'choking under pressure' and 'social anxiety'. However, he did not evaluate the effect of the strategies.

Some presenter supporting systems were also proposed. Kurihara et al. [9] proposed a presentation training system. This system observes a presentation rehearsal with a microphone and camera to analyze a presentation by combining speech and image processing techniques. The speaker can get recommendations for improving the delivery of the presentation, such as "speak more slowly" and "look at the audience." Their goal is to improve a delivery of it by reducing inappropriate

basic behavior patterns. On the other hand, our goal is to reduce the social anxiety of the presenter not in the training but in the actual presentation.

Okada et al. [10] proposed a wearable MC (master of ceremony) system that solves some problems on the stage using wearable computing technologies. This system has functions to support MCs, such as a robust voice tracking function for the scenario understanding, a human interface for unimposing interaction, and a function to grasp the atmosphere in the event. This system can support MCs only, but our system can support all of the presenters on the stage.

Nagai et al. [11] developed speech-driven embodied entrainment systems "InterPointer" and "InterVibrator" which support embodied interaction and communication for both a lecturer and audiences in distributed environment. InterPointer is a pointing device with a visualized response on the tip in the same timing as the listener's nodding response. InterVibrator is a vibration device for a vibratory response in the same way. Unlike our goal, their goal is to make a feeling of togetherness with a lecturer and audiences deep.

Nakayama et al. [12] tried to control biological condition by presenting false biological contents from the health care system. They pointed out the possibility of the reducing the tension by giving the false information to make the actual heart rate lower, but they do not evaluate how much the false information makes it lower.

Hagiwara et al. [13] proposed a supporting system for people who can not talk gazing at the others' eyes. The users can train their social skills of talking little by little using see-through HMD. On the other hand, our users can be supported in the actual presentation by the system.

4 Evaluation

4.1 Method

To evaluate our system, we conduct an experimental evaluation with four conditions; the eleven participants have short presentations with a HMD in front of (a) audiences overlapped with smiling pumpkins (Smiling-Pumpkins), (b) audiences overlapped with scowling pumpkins [Scowling-Pumpkins (see Fig. 4)], (c) smiling audiences (Smiling-Audiences), and (d) scowling audiences (Scowling-Audiences).

Figure 5 shows the overview of the experimental setup. We ask cooperators as the audiences to make each face expression according to each condition and we put AR markers on them for face detection in this evaluation.

At first, they evaluate six pairs of presentations which are in different conditions. This evaluation is based on Japanese-adaptation version of the STAI (State-Trait Anxiety Inventory [1]) form with 4 levels of answers (-2: I agree on the former one strongly than the latter one in the question item, -1: I agree on the former one weakly than the latter one in the question item, -1: I agree on the latter one weakly than the former one in the question item, -2: I agree on the latter one strongly than the former

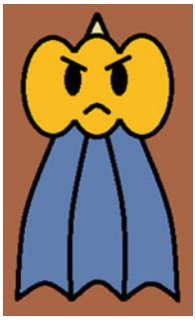

Fig. 4 Image of a scowling pumpkin

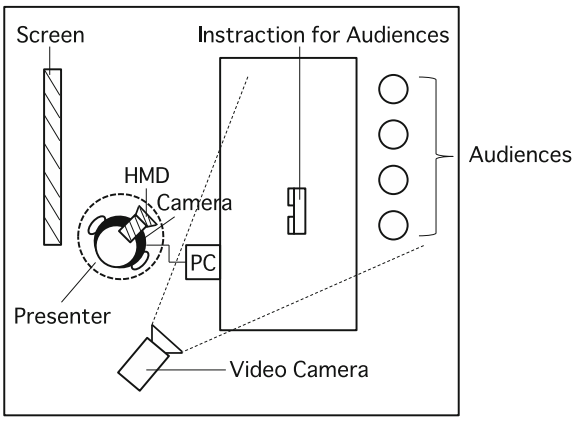

Fig. 5 Overview of the experimental setup

one in the question item). After that, we have interviews with them about the differences of the feeling from each facial expression of the audiences and pumpkins.

4.2 Result and Discussion

Table 1 shows the pairs of conditions where there are significant differences on the STAI's total score of all participants analyzed with Scheffé's paired comparison. Figure 6 shows the average preference degree of each condition in the result of all participants. As these results of the evaluation, it is found that Smiling-Pumpkins can make participants' social anxiety significantly lower than in case that the audiences or pumpkins are scowling. Therefore, visual-overlapping positive reaction on audiences is effective for reduction of the social anxiety in presentation situation.

Having more detailed analysis, there are no significant differences between Scowling-Pumpkins and -Audiences and between Smiling-Pumpkins and -Audiences. It means that visual-overlapping pumpkins on audiences alone is not effective for reduction of the anxiety. In addition, the anxiety with Smiling-Pumpkins

Table 1 Result of STAI's total score

Conditions	Scowling-audiences	Smiling-audiences	Scowling-pumpkins	Smiling-pumpkins
Scowling-audiences	–			×
Smiling-audiences		–		
Scowling-pumpkins			–	×
Smiling-pumpkins	○		○	–

○ means the anxiety under the left condition is significantly lower than the upper condition
× means the anxiety under the left condition is significantly higher than the upper condition
Blank means there are no significant difference between the left and upper conditions

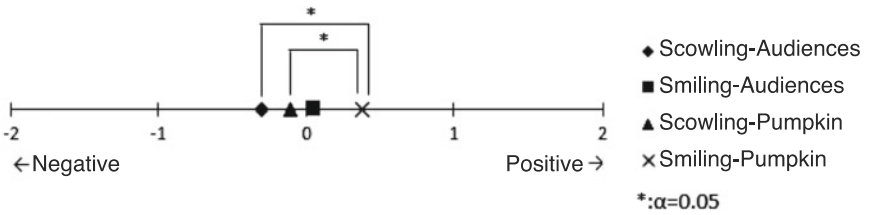

Fig. 6 Average preference degree of each condition in the result of all participants

is significantly lower than Scowling-Pumpkins and there is no significant difference between Smiling- and Scowling-Audiences. It means that visual-overlapping positive reaction is effective for reduction of the anxiety only if the presenter's awareness of audiences becomes less by visual-overlapping. Furthermore, it is found that both positive reaction and visual-overlapping on audiences are needed for reduction of the anxiety because the anxiety with Smiling-Pumpkins is significantly lower than Scowling-Pumpkins and -Audience and there is no significant difference between Smiling- and Scowling-Audiences and Smiling-Audiences and Scowling-Pumpkins.

In the interview with the participants, all participants answered that they could distinguish the difference of pumpkins' face expressions and eight out of the eleven participants felt that the impressions of the audiences had changed by the face expressions of pumpkins. Furthermore, the eight participants answered that they got a favorable impression by Smiling-Pumpkins.

These mean that the proposed system can reduce the anxiety and strain compared with the situation that the scowling audiences are in view. As the result of additional factor analysis, it is found that the feeling of relief and satisfaction, which are factors of reducing the anxiety and strain, are improved in the case of smiling pumpkins more than the case of smiling audiences.

5 Conclusion

In this paper, we presented a method of overlapping positive response on audiences to reduce the social anxiety of the presenter with the audiences, and developed the system which overlaps an image of smiling pumpkin with nodding on each

audience using video see-through HMD. As the result of an experimental evaluation of the proposed system, it is found that this system can reduce the anxiety and strain compared with the situation that scowling audiences are in view. It is considered that the result comes from two facts: (1) participants' anxiety and strain increase in case that audiences or pumpkins are scowling, and (2) they decrease in case that audiences or pumpkins are smiling. In addition, it is found that the feeling of relief and satisfaction, which are factors of reducing the anxiety and strain, are more improved in the case of smiling pumpkins than the case of smiling audiences.

As the future work, we plan a further evaluation to analyze the difference between Smiling-Audiences and Smiling-Pumpkins, and try to investigate the relation between the social anxiety and audio stimulus from audiences.

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Affective Design Factors Derived from an Analysis on Body Shape and Waist Size of Male Workers and Design Concept of Work Pants of Large Waist Size

Kanako Ohsawa, Kazunari Morimoto, Yoshinari Gyoba, Minju Kim and Masanobu Nishimura

Abstract Body shape changes induced by metabolic syndrome have become an issue in recent years in Japan. However, studies on work pants for metabolic male workers with so-called "apple-shaped" bodies remain rare on the ground. We developed a new work pant pattern to fit for them, especially the physical features of the "apple-shaped" bodies. The new pattern had two characteristics about a crotch point and a front waist/back waist differential. It was indicated that the features of the new pattern were effective through the evaluation tests. In addition, we proposed a concrete work pants design for metabolic male workers with the features. The design was devised about three characteristics.

Keywords Work pants · Pattern · Crotch point · Metabolic syndrome

1 Introduction

Ensuring the safety and ease of work are essential functions required of work pants. The design of work pants that meet these requirements is very difficult and depends in large part on the experience of the manufacturer. Studies about the design of work pants have been driven forward by recent advance in anthropometric technologies, including three-dimensional measurements. However, no study has so far addressed design components from the viewpoints of sensory aspects, such as the comfort of wearing slacks, which has a direct effect on making work easier.

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Body shape changes induced by metabolic syndrome have become an issue in recent years. In Japan, males with metabolic syndrome and with potential metabolic syndrome increase sharply in number from their 30s; one in every two males in their 40s and upward is estimated to fit that description. However, the design of general clothing items that take account of body shape changes due to metabolic syndrome has only been seen in a handful of shirt products, and studies on work pants for workers with so-called "apple-shaped" bodies remain rare on the ground.

2 Purpose

Fitness to the body shape is a key factor in pant patterns that affects the comfort of putting on and wearing work pants. In this study, a new pant pattern is developed to fit the physical features of the so-called "apple-shaped" bodies, which involve outstanding abdominal protrusion. Such physical features are expected to result in a characteristic crotch (rise) shape and a characteristic differential between the front waist size and the back waist size. This study aims at developing a pattern that fits the physical features of "apple-shaped" bodies, finding out what design concepts of pants are preferred by workers, and at proposing a model pant design for workers with "apple-shaped" bodies.

3 Research

A questionnaire given to approximately 230 male wearers of work pants asked what qualities they liked and disliked about the work pants they often wore. The most common qualities appreciated by the respondents included (1) reasonable prices, (2) mobility, (3) durability. In addition, they were found to have strong demand for design excellence and comfort of wearing.

Next, work pants that are actually marketed were surveyed. The study found that work pants on the market included a wealth of varieties, ranging from loose and spacious models to slender and fitting ones. The diversity is even broader when the presence or absence of tucks and the types and locations of pockets are also taken into account. But the study also found that wearers of extra-large sizes were not in a situation to choose their favorite designs, because users with increased waist sizes that are attributable solely to abdominal protrusion were limiting the design options of the pants they bought for reasons of tightness around the abdomen. In other words, making the products available in larger sizes in simple terms of grading is not expected to fix that problem, particularly in the case of slender designs. That leaves models with relatively loose silhouettes as the only options available to those wearers.

Three patterns of work pants on the market were studied. Below, these will be called A, B and C. Pattern A has a loose silhouette; Pattern C is a slender type; and Pattern B is moderately loose and lies midway between Patterns A and C (Fig. 1).

Fig. 1 Three patterns of work pants on the market

The three models were found to have different crotch shapes. Pattern B, which was designed to alleviate tightness on the hips in a stooped posture, is characterized by a round crotch curve. Pattern C, the slender type, has a smaller width of the rise (measured provisionally at 10 cm above the crotch line) than Patterns A and B. The rise width, which corresponds to the depth of the human body, strongly affects the comfort of wearing and the silhouette, and must be large enough to accommodate any increased body depth.

The location of the crotch point, where the front and the back of the crotch meet, was found to be biased toward the front of the rise in all three models, with the bias ratios being roughly the same. All three work pants models are available up to extra-large sizes, but Pattern C was found with the shortcoming mentioned above.

4 Evaluation Tests

4.1 Test 1. Method

Findings of the status quo survey was used to develop new pants pattern intended to accommodate abdominal protrusion, a physical feature of "apple-shaped" bodies. The pattern was designed with a deeper rise, with a crotch point located more to the back than in standard models, and with a front waist/back waist differential that better fits the actual body shape. 9 sample pants were provided, combining three different crotch point locations and three different front waist/back waist differentials, to study any influence of those pattern characteristics on the practical comfort of wearing. The sample pants were designed with a real waist size of 95 cm.

The subjects of the test were asked to wear the 9 sample pants one after the other, to engage over a total duration of one minute in walking, crouching and leg-lifting movements, and then to answer questions thereafter regarding 10 evaluation items on the comfort of wearing. Apart from this, they were also asked to choose the most comfortable of the 9 sample pants to wear, with the least sense of

tightness, in the upright posture and the crouched posture, respectively. The subjects were 9, and they were asked to put on the 9 sample pants in randomly varying orders during the test. They had been measured anthropometrically beforehand.

4.2 Test 1. Result

Three of the subjects had abdominal circumferences that measured larger than the waist of the sample pants. Two of them had abdominal circumferences about 5 cm larger, with one of them complaining of tightness around the waist and the abdomen in all samples except for Sample 8, and the other complaining of the same in all samples except for Samples 6 and 9. A third subject, who had an abdominal circumference about 2.5 cm larger, complained of tightness around the waist and the abdomen in all samples. By contrast, the subject with the smallest abdominal circumference, who had about 7 cm in waist ease, complained of tightness around the waist and the abdomen only in Sample 3.

Many of the subjects said Sample 2 had mobility problems. Their subjective evaluations of the comfort of wearing varied with crotch point location and with front waist/back waist differential, which indicated that those factors were likely key to the comfort of wearing. Samples 4, 6, 8 and 9 were cited by relatively many as comfortable pants to wear.

In the test involving the choice of the most comfortable of the 9 sample pants to be in, Samples 5, 8 and 9 were named No. 1 by more than one subject in the upright posture. Samples 5, 6 and 9 were picked up by more than one in the crouched posture. These findings showed that pants with the front waist about 5 or 7 % larger than the back waist, and with the front accounting for a relatively large portion of the rise, tended to obtain higher marks.

4.3 Test 2. Method

To study the effectiveness of the characteristics in the pattern developed, two new sample pants, Sample A, of a pattern with characteristics crotch point location and front waist/back waist differential, and Sample B, of a standard pattern were made for use in an evaluation test on the comfort of wearing. Those sample pants were with a real waist size of 95 cm, the same as in Test 1. The parameters of Sample A, the crotch point location and the front waist/back waist differential ratio were set to fall within the range of the corresponding parameters in Samples 5, 6, 8 and 9 of Test 1. Sample B was designed with a crotch point location being roughly the same as in conventional products and with a zero differential between the front waist and the back waist.

The subjects were 37 male, aged between 24 and 65, with waists measuring 90 cm or more at the belt position. They had "test wear": shorts, a T-shirt and socks, on during the test, and wore a belt when they put on the sample pants.

The subjects were measured for 21 anthropometrical items during the test. A Martin anthropometer was used to measure 18 of them: a parameter that has to do with the design of our new characteristics; four circumferences; four breadths; four depths; four heights; and the crotch length at the belt position. An Omron Healthcare Co., Ltd., body composition monitor was used to measure the remaining three items: the weight, the BMI and the body fat percentage (Table 1).

4.4 Test 2. Result

At least one of the subjects complained of tightness in eight of the items that they were asked to assess when they put on the samples. As a whole, more subjects complained of tightness, and to larger degrees, in Sample B (conventional pattern) than in Sample A (new pattern). Table 2. shows the result of subjective evaluations of the comfort of wearing. Some 59.5 % of all subjects said they preferred Sample A, whereas 24.3 % said they liked the conventional Sample B better.

In the anthropometrical measurements, the 37 subjects were found to have waist circumferences ranging between a minimum of 90.2 cm and a maximum of

Table 1 The combination of pattern characteristics in the sample pants

	Front waist 3 % larger than back waist	Front waist 5 % larger than back waist	Font waist 7 % larger than back waist
Crotch point located conventionally	Sample 1	Sample 4	Sample 7
Crotch point located some 14 % toward back	Sample 2	Sample 5	Sample 8
Crotch point located some 25 % toward back	Sample 3	Sample 6	Sample 9

Table 2 The result of subjective evaluations of the comfort of wearing (Numbers)

		upright posture								crouched posture						feel discomfort in the crotch	
		waist		hip		thigh		lower leg		waist		hip		thigh			
tightness ↑ tight	level 5																
	level4						1										
	level3		1		1				1		1				2		
	level2								1	2	2	1	2	1	1	1	
	level1			1		1						2	1	4	4		
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B

100.5 cm, roughly up to 5 cm larger or smaller than the pants, but larger waist circumferences were not found to correlate with a sense of tightness. They had buttocks circumferences ranging from 98.0 to 112.2 cm, whereby the shortfalls of 21.6 to 7.4 cm below the pant size (119.6 cm) represented the hip ease. The minimum thigh circumference was 52.0 cm and the maximum was 63.0 cm, wherein the differences of 14.5 to 3.5 cm from the pant size (66.5 cm) constituted the thigh ease. Larger buttocks and thigh circumference measurements were not found directly to correlate with a sense of tightness, either.

One of the subjects complained of tightness around the waist and the abdomen in the upright posture. This subject, who measured 100 cm around the waist, said the tightness around the waist, which he sensed in Sample B (conventional type), was gone in the upright posture and was alleviated in the crouched posture when he was in Sample A (new type). This subject was physically characterized by his waist circumference being little different from his buttocks circumference, and he had large breadth-to-depth ratios of more than 80 % both at the belt (waist) position and at the hips. In addition, he had a relatively small weight, a comparatively large abdominal depth at the belt position, and a relatively small hip breadth, among all subjects of the test.

The anthropometric measurements of the subjects, except for the heights and the thigh-related items, allowed them to be categorized into four groups by physical shape corresponding primarily to the parts of pants from the thighs up. The average anthropometric measurements for the four groups are shown in Table 2. All subjects in Group 4, including the above-mentioned one, gave higher marks to Sample A (new type).

The average anthropometric measurements by subject group shows that those in Groups 2 and 3 weigh about 10 kg more, and have broader thighs and lower legs, than those in Groups 1 and 4. By contrast, those in Groups 1 and 4 weigh less and have smaller thighs and lower legs, but have larger abdominal depths. Groups 1 and 4 are thought to represent types with abdomens protruding outstandingly relative to their physical builds. Only one of all subjects in Groups 1 and 4 gave higher marks to Sample B.

Many of the subjects commented that there was no big difference in the tightness they sensed in the two samples, except that Sample A (new pattern) likely fit their bodies better, with none of the sense of slackness around the hips that they sensed in Sample B (conventional type), and allowed them to have trimmer silhouettes as they wore it.

Figure 2. shows photos of a Group 4 subject wearing the samples. This subject measured 92 cm around the waist at the belt position and 98.7 cm around the buttocks. His waist was likely fitting to the pants, but his buttocks circumference was smaller than the hip size of the samples, so he showed visible excess around the hips. That excess resulted in slackness, particularly around the gluteal furrow, but the slackness appeared alleviated in Sample A.

Sample A Sample B

Fig. 2 Wearing state of sample pants (In a case of Group 4 subject)

5 Discussions

The leading body shape change that is symptomatic of metabolic syndrome is a growth in abdominal circumference, which is conspicuous primarily on the front side of the body due to protrusion of the abdomen. A pronounced increase in abdominal circumference due to a protruding abdomen is not thought to go along with growths in other parts of the body, including, among other things, in the hips, thighs and lower legs. The Group 4 subject highlighted in the outcomes of Test 2 shows anthropometric features that fit that description.

When body shape changes induced by metabolic syndrome obliges the wearer to use extra-large sizes, using the increased waist size as a reference point for fitting pants ends up in excess in other body parts, leaving him without a sense of an appropriate size. The abdominal protrusion is the primary factor that was taken into account in the design of the pattern developed in this study.

Characteristically, the crotch point location was moved more to the back than in conventional models, because it was thought that abdominal protrusion could bring the body's crotch point at odds with that of the pants. Correspondingly, the back piece is less broad around the hips than in conventional models. The subjects presumably used to wear pants of smaller sizes before their body shapes changed due to metabolic syndrome, which is likely another reason the new pattern fit their bodies.

A study showed that work pants on the market generally have a larger waist in the back piece than in the front piece. The waist size was designed to be larger in the front piece than in the back piece in the pattern developed in this study. Test 2 failed to single out the most effective front/back differential values, but its outcomes, combined with the results of Test 1, suggest that 0–7 % front/back differentials are appropriate.

6 Model Pants Design

This study proposed new design factors to produce pants for males with metabolic syndrome, and shows a concrete design with the factors in this chapter. Figure 3. shows the difference between the metabolic body shape and standard body shape in side views. About the metabolic body, the width with some % is taken in the front. And the belt location is moved to alleviate tightness on the stomach. It is the same location of Kimono (Japanese wear) belt when a male wears Japanese Kimono.

Figure 4. shows the male in a stooped posture. For the male with "apple-shaped" body, the movement to stoop is not only to bend down but to pull strong the back part of the pants. The movement to stoop affects the sense of tightness. As it is also the movement of opening his crotch, it makes a power of being pulled in the center of the crotch. To lessen the power, the new model has more width in the front than the conventional one, and produces a proper space in the back.

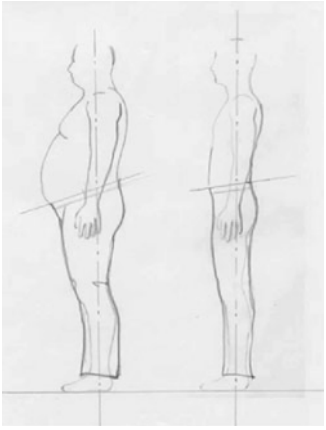

Fig. 3 The difference in the body type and pants silhouette

Fig. 4 The relations between the attitude and pants in a crouched pose

Fig. 5 The example of produced pants design

Figure 5. shows the design of the produced pants. The cloth is two-tone color, dark color in the wide front and light one in the back, which makes him look slimmer. This visual effect of the tone adjustment still can alleviate the sense of tightness.

7 Conclusion

The studies on work pants design for workers with metabolic syndrome "apple-shaped" bodies remain rare on the ground. Wearers of extra-large sizes were not in a situation to choose their favorite designs, loose silhouettes as the only options available to those wearers. They used extra-large sizes to fit the increased waist size without a sense of an appropriate size.

We developed new work pants pattern to fit the physical features of the "apple-shaped" bodies in this study. The new pattern had two features. First, a crotch point located more to the back than in standard models. Second, it was larger in the front piece than in the back piece about a front waist/back waist differential. It was indicated that the features of new pattern were effective through the evaluation tests. We proposed a concrete work pants design for workers with metabolic syndrome "apple-shaped" bodies with the features. The design was devised about three characteristics. First, the belt location was moved to alleviate tightness on the stomach. Second, the new design had more width in the front than the conventional one to be easy to stoop. Third, two-tone color worked visual effect.

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Adaptive UI for Enhanced Music Experience

Irwin Tay Khai Cheng and Swee Lan See

Abstract With the increasing popularity of digital music player applications, it is not difficult to find such app used by smartphone users. However, the current user interface (UI) design of these mobile music apps is often too rigid and unable to engage users for prolonging pleasurable entertainment. There is, therefore, a need to improve the aesthetics of this UI to enhance user experience and to keep and sustain customer loyalty. This paper will share feedback from 50 participants on existing music player applications' UI design, and explore the relationship between user's personality and preference (such as music genre) for better UI design of mobile music app. The research aims to predict the trend of these variables and would like to propose a customizable UI design of a mobile music app prototype.

Keywords Adaptable UI design · Human-Centred UI design · User experience · Mobile music application

1 Introduction

Music application players are in great demand since the mobile technology revolution in the 21st century. With Spotify or Pandora being the most popular choice, they have dominated the Google Play and Apple Store. Just in 2014, the two music listening applications have generated more than 70 % of the revenue of the top ten apps on IOS and Google Play, the audience being catered to is ever-growing [1]. The user interface (UI) design, however, is not yet fully able to adapt itself to accommodate the users' needs. UI designs provided for the users are what they get and it will not be able to satisfy the diverse needs of the population. An online survey was conducted to determine the users' current feedback on the UI design of their music application. 50 random participants aged 16–48 were asked to do an

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online survey. The results showed that 60 % of the participants indicated 'No' when they were asked if the UI design of their mobile music application understood them while 22 % of the participants indicated 'I don't know'.

A customizable and adaptable UI design, on the other hand, benefits both the customer and the developer- it caters to different customers and if the customer does not like the proposed design by the application, the customer has the freedom to change the UI design. Furthermore, according to Menton's Theory of Engagement and Boredom, users are more inclined to experience boredom as a result of prolonged repetitive visual design [2].

Therefore, this research study investigated the relationships between different human factors.

- Emotions versus Music Genres
- Colours versus Music Genres
- Personality Type versus Typeface Design
- Typeface Design versus Music Genres
- Emotions versus Colours

The aim is to conclude the relationships between the factors and combine the factors together to propose multiple estimated UI designs to cater to diverse personalities of users.

2 Methodology and Materials

2.1 Methodology Used

50 random participants aged 16–48 were invited to complete an online survey to understand more about the research problem. Of the 50 random participants, 15 random participants were asked to come down for a user study to understand the relationship between the mentioned factors. The user study compromises of a DISC personality test, listening to music of three contrasting genres: Light, Heavy, and Electro, an interview session on the feedbacks they have on the three different music, and lastly a survey to investigate the remaining factors. Literature review was done to study the relationship between emotions and colours.

2.2 DISC Personality Test

DISC personality test was chosen for its simplicity in concept [3]. The combination of traits results in four main possibilities that correspond to four letters: D, I, S and C. The letters represent: D for Dominance, I for Influence, S for Steadiness, and C for Conscientiousness. Rohm had categorised the four behavioural tendencies to

help us characterise people. They are Outgoing, Reserved, Task-oriented, and People-oriented [4]. D dominant people will be outgoing and task-oriented, I dominant people will be outgoing and people-oriented, S dominant people will be reserved and people-oriented, and lastly C dominant people will be reserved and task-oriented. In this research, we categorised the personality of the participants by their dominant personality traits. Hence, this showed a better picture of the relationship between one's personality and other factors.

2.3 User Study

The three different music genres were chosen as they are of distinct music genres; Light contrasts with Heavy and Electro stands on its own due to the digital music evolved from the digital era. To ensure a degree of uniformity and non-biaseness in the choice of sound examples, the following criteria were established: each excerpt should be between 3 to 4 min and it should not contain lyrics, dialogue, or sound effects (ambience sound, etc.). It was also stressed that the goal was to choose examples that could convey the target emotion to the general listener in an optimal way. The questions asked during the interview were:

- How do you feel when you were listening to the music?
- What images came to your mind when you were listening to the music?
- What kind of colours do you think associated with the music?
- Do you like the music? Why?

In the survey, 5 typeface designs were chosen.

Figure 1 shows the five different typeface designs used in the survey. The five typeface designs were chosen as they exhibit a wide range of physical characteristics. Each typeface design varies from their stroke pattern, stroke weight, ascender, descender, etc. However, in this research, for the purpose of simplicity and clarity, the description of the typeface design is categorised by the roundness, softness, cursiveness, boldness and sharpness of the design trait.

Fig. 1 Five different typeface designs used in survey

2.4 Emotions

Plutchik's Theory of Emotions [5] stated that there are eight primary basic emotions which a human has. The eight emotions are of bipolar pairs: Joy-Sadness, Trust-Disgust, Fear-Anger, and Anticipation-Surprise. In this research, Plutchik's model was used to categorise the wide range of complex emotions indicated by the participants. The reason why Plutchik's model was used will be explored in the further section in *Emotions versus Colours*.

3 Results and Discussion

3.1 Online Survey

50 sets of results were analysed. Approximately 56 % of the respondents indicated that the UI design of the mobile music application they are using is not able to accustom to the music and their emotion while the 15 % of the participants indicated 'I don't know' as their option. In addition, 60 % of the participants responded a 'No' when they were asked whether the UI design of their mobile music application understands them and 22 % stated 'I don't know' for the same question. Approximately 54 % of the respondents responded 'No' to whether if they could customise the UI design of their mobile music application while 29 % indicated 'I don't know' to the question. The results showed that concurrent users of mobile music application have no control over the aesthetics of the UI and there is a limited effort made by the UI to understand the user.

3.2 User Study

Emotions versus Music Genre. 15 participants were interviewed.

Light Genre. 12 participants (80.0 %) said they felt peaceful, pleasant, and at ease when they were listening to the music. 6 participants (40.0 %) felt sad and sorrowful when they were listening to the music. 3 participants (20.0 %) indicated both.

Heavy Genre. 9 participants (60.0 %) felt a sense of annoyance and anger while listening to the music. 6 participants (40.0 %) felt excited and hyped up when listening to the music.

Electro Genre. 8 participants (53.3 %) indicated that they were intrigued by the music. 6 participants (40.0 %) felt annoyed and irritated by the music. 4 participants (26.7 %) stated they were hyped up by the music. 3 participants (20.0 %) indicated they felt both intrigued and hyped up by the music.

Fig. 2 Emotions versus Music Genre

The emotions stated by the participants were classified into the basic eight emotions. Figure 2 shows a radar graph of the relationship between the basic emotions and the 3 different music genres. The Light music mainly evokes emotions from the Joy and Sadness pair. Electro music gives off emotions close to the left spectrum of the radar while Heavy music primarily displayed emotions of Anger, Disgust and Joy.

Colours versus Music Genre. The 15 participants were asked what colour do they think associates with the music.

Light. 9 participants (60.0 %) stated Blue, 8 participants (53.3 %) stated White, and 7 participants (46.7 %) stated Light Yellow. 4 participants (26.7 %) indicated all three colours while 2 participants (13.3 %) indicated both Blue and White only and 1 participant (6.7 %) indicated both White and Light Yellow only.

Heavy. 12 participants (80.0 %) stated Red while 10 participants (66.7 %) indicated Black. 3 participants (20.0 %) responded both Red, Gold and Black. 6 participants (40.0 %) said both Red and Black.

Electro. It is difficult to pinpoint an exact colour from the result as the most of the participants gave varying answers. However, 5 (33.3 %) of the participants mentioned that the colours resemble a disco night club setting, colours such as Neon Pink, Slivery metal, Flashing White lights. The rest of the colours mentioned were: Reddish-Brown, Brown, Yellow, Blue, White, Dark Green, Green, Grey, Sand-Brown, Dark Blue, Lime Green, Neon Yellow, Purple and Pink.

Personality Type versus Typeface Design. The significance of the chosen typeface designs is also due to the relationship between its physical traits and music genre [6].

We have identified the different personality of the participants. The results are categorised according to their styles: Advocate (ISC), Concluder (DI), Chancellor (DIC), Precisionist (CS), Inquirer (SDC), Persuader (ID), Designer (CD), and Peacemaker (SC) [7]. Each style was classified in terms of the dominant traits present in them. For example, a person with a style of Advocate will have I, S, and

Table 1 Choices made by participants of different personality traits

Dominant personality traits	Top choice	Second choice	Third choice
ISC	Trench	Magneto	Blackadder
DI	VTKS rude metal	Magneto	Moonlight shadow
DIC	Moonlight shadow	Blackadder	VTKS rude metal
CD	Blackadder	Trench	Moonlight shadow
ID	Trench	Moonlight shadow	Blackadder
CS	Moonlight shadow	Blackadder	Trench
SC	Trench	Magneto	Moonlight shadow

Table 2 Trend of preferred typeface design quality by each personality trait

Personality trait	Typeface design quality
D (Dominance)	Soft and bold
I (Influence)	Soft, round and bold
S (Steadiness)	Round
C (Conscientiousness)	Cursive

C dominant personality traits. In this research, we have decided to use the following terminologies: Roundness, Sharpness, Softness, Cursiveness, and Boldness to describe the typeface design. The trench has a soft and round design, Blackadder has a soft and cursive design, Moonlight Shadow has a bold and cursive design, Magneto has a bold, sharp and soft design, and lastly VTKS Rude Metal has a bold and sharp design.

Table 1 shows the preferred typeface design by different personality traits. By observing the dominant traits of each personality, it is possible to construct a link between the personality traits: D, I, S, and C to the feature of typeface design. For example, ISC and ID dominant personality traits showed a common dominant personality trait I and a common top choice. A trend can be estimated whereby we can associate the I dominant personality trait with the Round and Soft typeface design quality.

Table 2 shows the trend of the preferred typeface design quality plotted based on the data collected with respect to their personality trait.

Typeface Design versus Music Genre. The 5 typeface design chosen in this research have its association with the 3 music genre chosen. Blackadder and Moonlight Shadow were selected due to its curvy nature which associates with classical music genre. Magneto and Trench were selected as it associates with the techno, electro music genre. VTKS Rude Metal was selected due to its sharp edges that are associated with heavy metal or rock music genre [6].

Table 3 classified the typeface design quality present in the 5 typeface design chosen and the music genre associated with the typeface design.

Table 3 Estimated Music Genre associated with Typeface Design Quality

Typeface design quality	Music genre
Soft	Instrumental
Bold	Pop, dubstep
Round	Indie, techno
Cursive	Classical, instrumental
Sharp	Metal, rock

3.3 Literature Research on Emotions and Colours

Emotions versus Colours. One of the first few researchers who set the foundation of the relationship between emotions and colours is Johann Wolfgang von Goethe. His work "Color Theory" (Zur Fabenlehre 1808–1810) [8, 9], wrote about the connections between colours and emotions.

Goethe's work formulated the fundamental understanding of the connections between emotions and colours. Figure 3 shows the classification of colours with emotions or colours. The categorisation of emotions is not neat and does not account for all emotions. Goethe primarily described the colours with examples such as Nature, which may cause uncertainty or biasesness for other people. In addition, his work is concerned with one valued colour as output for an emotional state [9] as seen in Table 4. The colours are not accounted for the intensity of the emotions felt. As the results garnered from this research had varying emotions, it was difficult to classify the colours to the emotions without basic emotions to categorise the emotions.

Plutchik's Theory of Emotions [5] has defined that a human has 8 basic emotions, of which, they are of bipolar pairs. In his later work, he pointed out that the classification of the 8 basic emotions is analogous to the colours on the colours

Fig. 3 Goethe's colour wheel [9]

Table 4 Goethe colour summary [9]

Color	Positive trait	Negative trait	Emotion
Yellow	Purity pleasant	Unpleasant (green, "unreinen")	Joy
Yellow-red	Energetic,	Irritating	Powerfull
Red-yellow	Energetic, warmth, passive		Happiness
Blue	Comfort	Void cold	Sadness
Red-blue	Active	Restless	Discomfort
Blue-red	More active	More restless	Same as red-blue, but more negative
Red	Seriousness, dignity, grace/charm		Faith
Green	Calm, neutral		Calm

wheel [10]. Hence, this makes the categorisation of emotions with colours easier than Goethe's work.

Figure 4 shows the Wheel of Emotions done by Plutchik. The different intensities of the colours account for the different intensity of the emotions experienced by the person. For example, a person can feel happy, excited, or overjoyed. The emotions all fall under the category Joy and the varying intensity of the emotions can be accounted through Plutchik's model.

In this research, participants had given a variation of emotions. For example, when participants felt that they were 'at east', the internal state of their mind was in submission and acceptance. Therefore, it can be classified that the emotional state of the participants as 'Acceptance' in Plutchik's Wheel of Emotions. In Plutchik's Wheel of Emotions, 'Acceptance' is a just a variation in the intensity of the emotion 'Trust', hence, we can classify the emotion 'at ease' as the basic emotion of 'Trust' in Plutchik's Wheel of Emotions.

3.4 UI Design Proposal

The results allow us to propose a few UI design combination catered to specific types of people, assuming there was no hidden factor in the decision making of the participants.

Table 5 shows the estimated combination of the UI design catered to specific people through the study of the relationships between multiple factors. The anomalies were not accounted for since the little we have is not conclusive to explain the anomalies. Hence, the anomalies were dismissed to keep the prediction as close to the stereotype and general population.

Fig. 4 Plutchik's wheel of emotions [10]

Table 5 Proposed UI Design for specific personality

Combination	Personality type	Typeface design quality	Colour theme	Preferred music genre
1	Introverted, soft spoken (C)	Cursive	Yellow, orange, blue, light green	Instrumental, light
2	Outspoken, leader (DI)	Bold and Round	Dark orange, blue-green, yellow, red	Indie, pop, rock
3	Supportive, reserved (S)	Round, cursive	Orange, blue-green, yellow	Indie, instrumental

4 Prototype of the Music App, Mousik

Before the user uses the music app, they will be given a questionnaire to complete. This questionnaire is used to estimate the dominant personality type of a person. The application can then propose an estimated UI design for the user. The questionnaire will be of similar structure to that of DISC personality test [11].

If the user did not like the proposed UI design, they can customise the design in the settings function. In the upcoming prototype of the music app, the users can choose from D, I, S, and C UI Design. These designs are crafted to match the personality traits of D, I, S, and C. Hence, even when the proposed UI design for the users failed, the users will still be able to customise it themselves.

5 Accuracy and Future Developments

A limitation in the research is that the sample size is too small to cater to the general population. Therefore, the results of the research may be inaccurate to some people. After an incremental in sample size has been tested, the prototype of the music application can be tested for its accuracy too.

Different combination of the four letters: D, I, S, and C can be introduced in the application in the future. This is because not every user has only one dominant trait. Users might have two or more dominant traits such as DI, SC, etc. Hence, this will enhance the accuracy of predicting the users' actual personality as well as increase customisable options for the users to customise from.

The application also aims to accustom to the emotions of the user via the visual (colours) as the application is playing music. Since users will experience different emotions through different music genre, the application can change the colour theme of the UI design in order to match the emotions experienced by the users. Therefore, visual stimuli can enhance users' experience.

6 Conclusion

The rigid UI designs of music applications are prevalent in music applications and this is supported by the online survey this research had conducted. Users do not have the ability to change what they want to see, and a minimal attempt was made by the music application to accustom the aesthetics of the UI to suit different people. This research had conducted a user study to determine the relationships of the human factors in order to propose a few estimated UI design catered to specific people. However, due to limited time and sample size, the results are not able to accurately gauge for the general population, but only the stereotypes. Thus, improvements can still be made to increase the database of the application in order

to understand the diverse personalities present in this global village. Furthermore, the application aims to adapt itself to match with what the user is feeling when listening to a certain music by varying the colour of the UI design.

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Using Holograms to Increase Interaction in Museums

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Abstract Holographic Technology has made huge strides over the past few years. The range of applications is practically endless and we envisage seeing major investments in the coming years. The main aim of this project was to create virtual 3D agents capable of behaving in a believable manner and display them within a real 3D model of a megalithic temple called "Hagar Qim" (http://heritagemalta.org/museums-sites/hagar-qim-temples/). These holographic humans are not only visually appealing with clear animations but must also behave in a psychologically sound and autonomous manner, meaning that they would be their own beings, not controlled by a user and their actions relate to the context of the world they are situated in. In order to achieve a high degree of autonomy and believability, the holographic humans developed in this work are self-determined with their own reactive plan of actions to organize their Neolithic daily routines, just like our ancestors did. In order to produce such believable behaviour, computational motivation models based on human psychological theories were explored. Each holographic human is also self-aware and adheres to its own biological needs. Furthermore, visitors are able to interact and communicate with the holographic humans via a mobile device. The system was tested by a number of people in order to test the subjective concept of believability of the system as a whole. On the whole we were extremely satisfied with the positive feedback obtained whereby 96 % of respondents found the exhibit believable. There was also a 90 % agreement that this platform would be suitable in a museum context since it would immerse visitors within this context whilst helping them learn in a fun and interactive way.

Keywords Human computer interaction · Intelligent agents · Mobile technologies · Holographic displays · Believable systems

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1 Introduction

Museums can be defined as cultural hubs, which serve the purpose of retaining and/or restoring various cultural aspects as well as educating citizens. Unfortunately, most of the present museum experiences are static and non-engaging. The rise of modern interfaces such as holographic displays can be used to enhance the user experience of museum exhibits and in so doing; museums may once again become a prime attraction [1].

Artificial Intelligence systems have developed to pilot complex virtual agents around different landscapes. We have seen them mainly in game development studios where traditional techniques such as finite state machines, rule-based systems and genetic algorithm to express intelligent behaviour have been used. However, since most of these approaches depend on user interaction, if the interaction is missing, the agents will remain idle creating a non intelligent zombie effect [2] awaiting for some sort of trigger. Additionally, with today's highly detailed reconstructions of the real world in virtual worlds, having these agents rely on user interaction would not suffice to create a believable platform. Therefore, virtual agents must be self-sustaining and able to follow their own agenda, living their own lives as real human beings, altering their plans when they need to and not only when a user interacts with them [3].

We must also keep in mind that agent autonomy should not be confused with agent automation. The former means allowing an agent to make its own decisions whilst the latter means controlling the actions of the agent through automated means [4]. This makes them very different from each other. On the other hand, behaviour believability of virtual agents is yet another complex concept because an agent can be autonomous but not believable. Multiple researchers all define the term "believable behaviour" in different ways, ranging from modelling different human psychological traits such as coping with emotions [5] or modelling anticipation [6] to having different simulation levels of detail defined in order to keep believable consistency within systems [7]. Others model different emotions and emotional models based on the changes in the environment in order to change the internal emotional state of the agent and consequently produce human-like behaviour [8]. Avradinis et al. goes a step further and argue that believability is not to be confused with realism even though the two are closely related. Realism, they argue has to do with the reconstruction and visual effects of the real world whilst believability is concerned with the actions of the virtual agent being consistent and sound with the environment the agent is in [3].

Therefore believability is concerned with the generation of behaviour that would be consistent to the agents' internal states and personality. This according to De Rosis et al. is how a believable agent should act in order to be consistent and coherent with the unwritten laws that govern the virtual world [9]. Furthermore, Ortony [10] and Dautenhahn [11] elaborate that believability does not necessarily imply complex behaviours but rather the agent's behaviour must match what would be expected of it from the user to allow users to easier relate to the agents. This calls

upon a motivational approach which mimics natural intelligence. Through different psychological models, it is noted that humans have basic biological needs that

These virtual agents need to constantly satisfy their needs, according to Maslow's Needs theory [12] and because of this, they react accordingly to the current situation of the world they live in. We have seen various approaches based on this idea such as Avradinis et al. [3], Liu et al. [13], Krümpelmann el al. [14], and Chen et al. [15]. These develop motivational architectures where internal numerical scales are updated through the environment. Once these levels dip under a certain threshold, the agent temporarily differs from their current agendas to satisfy their needs. This produces believable routines as it would result in similar patterns to those of humans. The model implemented in this system also includes a social aspect whereby real users can communicate with the virtual agents whilst they're acting out their daily routine. Apart from this, we will be using a holographic device to render these agents in a real model of a Neolithic temple. This holographic platform was used in a museum setting in order to provide information and educate visitors about the life of these holographic humans.

In essence, out project seeks to create the architecture for our virtual agents, in order to make them act in a believable way by performing natural daily routes. We will also create a mobile interface thought which; museum visitors can interact with our holographic humans. This further contributes to the believability aspect, since users can have limited social interaction with these agents. Finally, the system will give life to our agents by projecting a holographic overlay on the physical model thus creating a virtual environment where our virtual agents can live. We will finally evaluate the educational aspect of such an exhibit.

2 Methodology

2.1 Agent Behavior

As previously stated in this paper, the approach used to base the motivational architecture on is similar to those implemented by Avradinis et al. [3], De Sevin et al. [2] and Aydin [16], which implement Maslow's hierarchy of Needs. The humans would be fitted with basic biological needs, namely, hunger, thirst, boredom and energy. These would be represented as integer scales and would be updated while the humans explore the virtual world. Since the project seeks to display the daily routine of life in Neolithic times through believable autonomous agents, coupled with these internal needs, the humans would also have different jobs pertaining to those times which they act out when they are not seeing to their needs. Just like Neolithic times, each agent will have his own specific role in the tribe and would perform a selection of activities. Men would focus more on the labour intensive jobs such as farming and stonework whilst the women would focus on cooking and crafts. Each job would have its own rate of change that is applied to the internal levels; e.g. laborious jobs are more draining than for example, simply

sitting and crafting pots. Although the humans would have individualistic needs, they help each other perform jobs and all play an important role in the survival of the tribe.

Other behaviours would be included in the agents such as sitting on rocks and stopping to speak to one another while they are exploring the environment. These behaviours would further contribute to the believability factor as it displays the social aspect of the humans as well as show that they too get tired.

Furthermore, the agents would be fitted with a boredom level so that they would be motivated to change activity after a period of time performing the same activity. Similar to the internal needs, it will be represented as an integer scale and will be the motivational factor for the agents to perform different jobs. Therefore, there is a correlation between the needs and motivational aspect, as agents become more motivated to satisfy their needs. The architecture is designed in such a way so that the agents would be aware of the others within the world and at every step, they would know which activities the others are performing so that it intelligently selects an activity that is not being carried out. This is done to allow the user of the system to view as many different activities at any point in time as well as to increase the intelligence and believability of the agents.

With all the above definitions in place, the architecture as displayed in Fig. 1 would have to be implemented in order to get the desired believable behaviour. The

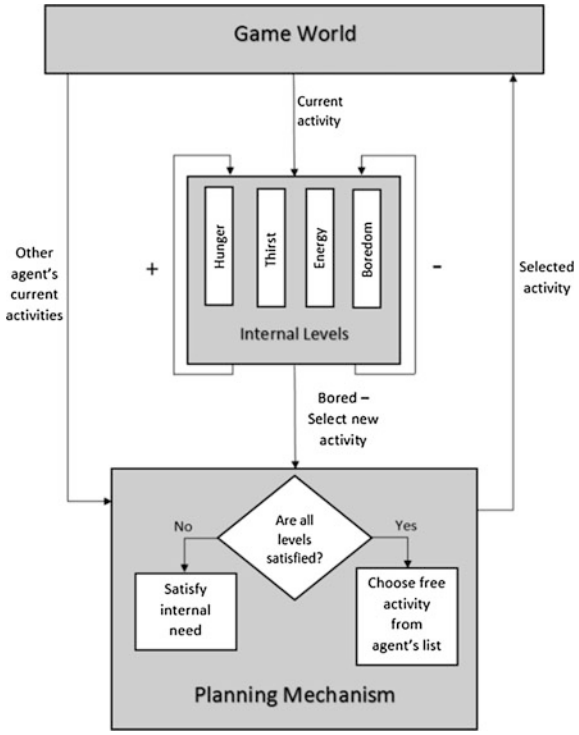

Fig. 1 Human motivational architecture design. *Source* Ref. [17]

agent architecture would interface with the world environment in order to obtain the rate of change of internal levels according to the activity being performed. The internal levels would constantly be updated in real time. Once the agent is performing an activity, the boredom level begins to decrease and once this reaches zero, the agent would prompt the planning mechanism to select a new activity. This would first consult the internal levels of the human and if any of them would have passed a certain threshold, then the next plan would be to satisfy the basic needs. If the needs do not need immediate attention, then the planning mechanism would check the current state of the game world in order to see what activities are being performed by the other agents and selects one, from a predefined list of jobs that would be assigned to that human. This activity would be one, which is not being performed by any other virtual human. It would be ideal to include a form of memory in order not to choose the same activity consecutively. Furthermore, it may be the case that the level reaches a state that needs immediate attention whilst the agent is performing a certain activity. In this instance, the planning mechanism would give priority to this fundamental need and interrupts the current activity to plan a path in order to satisfy that need.

The planning mechanism will not compile long-term plans that dictate the whole plan of the day but rather simply selects the next activity, which the person will perform. It is designed in such a way in order to cater for the reactivity of the system and not simply script the daily plans of the humans. The plans would change when the user interacts with the system via a mobile device and asks the agent to demonstrate different activities. This would result in interrupting another agent who may be performing the selected activity and therefore the interrupted human would have to once again select a new activity. Therefore, the current state of the environment would have to be checked once again and a new action (which would be in-line with the set of jobs the agents can perform) that no one would be doing at that particular time would have to be selected on the fly.

2.2 The Interface

The interface of the system would offer a platform through which the observer would interact and communicate with the virtual humans. It would allow the user to get a clearer picture of the agents' actions and what life in Neolithic time entailed (as can be seen in Fig. 2). This would add character and life to the holographic display. Therefore, this needs to be easy to use but sophisticated enough to capture the intelligence of the agents. This interface would not only be used to communicate with the agents and having them explain what they would be doing in the scene, but would also allow the user to issue commands and request the agents to perform different activities on demand.

The interface would also be used to highlight the social aspect of the humans, as they would make reference to other humans within the scene while interacting with the user. Additionally, it provides a platform to manifest the agents' personalities,

Fig. 2 Examples of the mobile interface. *Source* Ref. [17]

which are key factors when modelling human life. The interface is text based where the user selects an agent. The agent then explains that current job he or she would be performing in a narrative manner. A number of different activity buttons would be available to the user. These correlate to different activities, which the agent can perform. When a user selects an activity the agent would stop what they are doing and go perform the selected activity. When changing activity, the displayed screen also changes to explain the new activity. Additionally, the interface is capable of interrupting other agents if they are performing the selected activity to make way for the agent that is interacting with the user. Furthermore, if this command is not available, the agent would still be self-motivated and can still change job. This would automatically update the interface's display, implying that the interface must be in constant communication with the virtual world. It also extends the agents' motivational architecture as it may interrupt daily plans and they would have to act on the fly and make the necessary changes to cater for the activities selected through the interface.

Since the interface would issue commands, it must not give the impression that the user is controlling the agents, but rather, the two parties are engaging in a conversation where the agents would only be helping the viewer get a clearer picture of what life was like in those days by acting out the options that the viewer desires to see. In fact, while the agents are satisfying their internal needs, the interface must not provide the option of selecting different activities to respect the autonomy of the agents.

The agents' memory capabilities and intelligence are also manifested through this interface by keeping track of the previous interactions and using sentiments such as "welcome back" when the agent is reselected. Also, the agents would take into consideration the environment and if they are just waking up they would say "good morning" along with information about the activity. These both contribute to the believability of the system as it makes the agents more relatable. The stories developed would be key in aiding the educational aspect of this system, as it would further elaborate on points that would not be clear from just simply observing the system.

2.3 The Virtual World

The virtual world would essentially be a holographic overlay (as can be seen in Fig. 3), projected over a physical model of Hagar Qim. The model would also be used in the computational environment to get the appropriate mapping between the two platforms. This would allow the agents to explore the computational environment in a manner that is consistent with the physical outline of the model.

Different activities are also assigned to different areas within the temple to make the project as realistic as possible e.g. the sacrificial alter will be used by the priests, the fields around the temple will be used for the harvesting, etc. The virtual world would have to provide a sufficiently diverse environment for the agents to explore. It must also be consistent with the theme it is portraying. Therefore simple grass and dirt textures would be used to depict the holographic flooring of the temple. Additionally, since agents would be situated in this environment and they would be acting out their daily routines, the passing of time needs to be catered for in the world to be in-line with the different stages of the routines. Periodically, the world needs to have a sun setting and a sun rising to mimic the change of days. This would not only add realism but also provides an opportunity to display more behaviours within the agents as they would be aware of this change of light and would be forced to light up some torches in the environment, just as they would have done in reality.

Finally, the visual appeal of the humans and the way they perform the different activities must be consistent with the Neolithic theme and use simple primitive tools. The simulation must also display the correct brightness and orientations in order to be consistent with the holographic overlay and orientation of the physical model thus maintaining a coherent system.

Fig. 3 Typical daytime scene of the temple. *Source* Ref. [17]

3 Evaluation

Due to the subjective nature of believability, evaluation could not be done through any computational means. Consequently, the involvement of empirical testing through a questionnaire was essential. Various users had to use and interact with the system themselves, after which they were requested to fill in a questionnaire. This method of evaluation is suggested and carried out by other researches such as Martinho et al. [6] and Alfonso [18] whose work also involved the creation of a believable agent. To truly test if their system achieved their aims, they too had a number of different users from all walks of life using their system and after responding to a questionnaire.

Following the footsteps of these researchers, thirty test subjects viewed and interacted with the system for around ten minutes, after which a questionnaire was filled in. These encompassed varying ages, the youngest being ten years old whilst the eldest was sixty-six. The designed questionnaire focused on five main topics; the believability of the behaviour displayed, the usefulness and value of the created interface, the realism of the world and animations, the effect of the holographic overlay and lastly, the educational aspect and the system's applicability for a museum. By testing for these, we could determine whether the three main aims of the project were achieved. The tabulated results could be found in Fig. 4.

Starting off with the believability and clarity of the system, most respondents found that the agents within the system behaved in a believable manner as they all performed different yet typical activities essential for their survival but also had their own needs and emotions. The users added that the needs system is what completed the system since without it; the humans would have autonomously and repetitively done jobs without achieving any visible aims. One criticism was faced in this aspect in the fact that it did not totally encompass all the aspects of Neolithic life as the humans did not age, reproduce or adhere to nature's callings such as

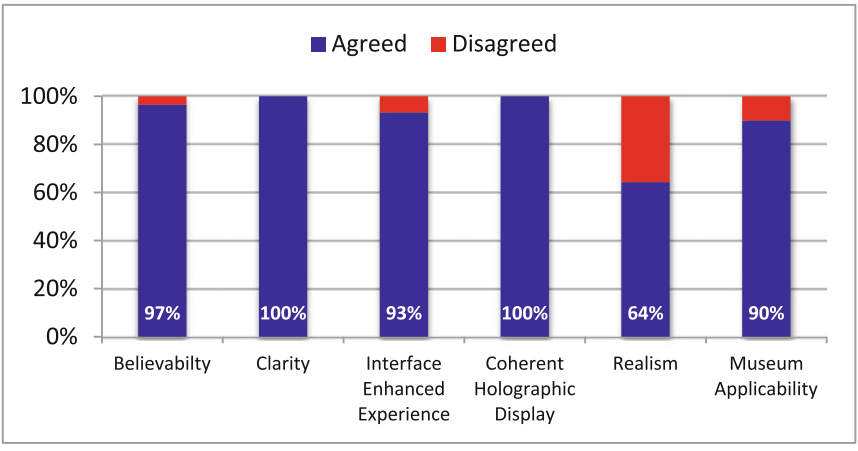

Fig. 4 Chart showing results obtained from questionnaire. *Source* Ref. [17]

emptying their bladder, which is also part of natural human behaviour. However, the finished product matched the expectations, which users had on Neolithic life, and therefore was considered to be believable with a high percentage.

The interface was well received across all the ages and added value to the system as all of them enjoyed communicating with the sophisticated holographic humans. However, some had problems identifying the different personalities. This is not vital for the system however it is an additional design factor that would add to the whole experience. The personalities presented through the interface may not have been adequate enough for some people to relate to them completely or they felt that the natural language was too scripted and had a negative impact on the believability of the personalities. Better sophistication on the model that drives the text produced could have been implemented to enhance the variations in the text produced. The holographic display received positive feedback when the users were asked if the overlay added value and life to the static three-dimensional model of the temple. The exact mapping of the overlay with the physical model created one whole coherent system, as the activity of the stonework seemed to directly interact with the stones of the actual physical model whilst the physical stones in the model would also block the walking animations.

However, some heavy criticism was directed towards the realism of the world created and the animations of the humans. Some of the animations, while managing to capture the image of Neolithic men, were not realistic enough as they were either not very detailed or were lacking in variety. Additionally, many agreed that the environmental effects such as the lighting of the torches and the dimming of the light at nighttime were not noticeable. Moreover, most testers felt that the animations were necessary in order for the humans to actually be identified as humans. Although there was a mixed feeling, the majority stated that their behaviour was not enough since they must also look like humans in order to perceive them as believable humans. Finally, from the data gathered, users would appreciate such a system in a museum setting. They were also able to get a better understanding of life in those days and thereby, confirming the educational aspect of the project.

4 Conclusion and Future Work

In conclusion, the main aim of creating a sophisticated computational model to manifest believable behaviour was achieved with satisfactory results. The reactive motivational architecture developed manifested behavioural patterns that were perceived as believable and relatable by 96 % of the thirty people who used the system. The agents matched the expectations of the users and they were able to relate to and interact with the holographic humans on an intellectual level.

Additionally, the second aim of this project was achieved through the development of the mobile interface. This provided a basis to develop the social aspect of the agents by exhibiting different personalities and interests. It further improved the narration behind the system to help educate viewers and provide a better insight on

the daily routine of Neolithic men and the hardships, which tribes in those days had to face without the luxury of contemporary technologies. This interface achieved satisfactory results, as there was a 100 % agreement that the interface added value to the project and allowed the virtual humans to be interpreted as social beings. Although the system was definitely beneficial, further research should be put into developing better-sophisticated interfaces to bring out the personalities of the humans in an effective way.

Although the visual appeal of the system faced criticism, on the whole we can conclude that the study was successful. The graphical world only served as a base to manifest believable behaviour and the objectives of this project focused mainly on the generation of believable social agents rather than creating detailed reconstructions of the world. Therefore, it may be concluded that by achieving the aims presented in this work, virtual agents may be perceived as believable humans and may serve as a platform to educate people in a new innovative way. The agents' daily patterns matched the expectations of the viewers and even surpassed them by educating every visitor and giving them a better understanding of what life was like in those days simply by observing and interacting with these intelligent agents.

However, besides extending the framework to include more activities, there is still room for further research into how virtual agent behaviour could be improved to encompass complex long term aspects of natural intelligence and catering for higher levels of Maslow's theory. Moreover, the literature covered in this project together with the results achieved, indicate that further research needs to be put into the generation of sophisticated interfaces to reflect the intelligence and personalities of the agents.

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Human Friendly Applications of Functional Fibers in Aging Society

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Abstract A characteristically high population of bedridden elderly in Japan is due to the infrastructural and systematical difference in the elderly care houses in Japan and other countries, and has been causing a big social problem such as odor in elderly home, care burden. The application of functional fibers as the phthalocyanin-processed fabric fiber to reduce the odor in the room, generated from bedridden elderly. The phthalocyanin-processed fabric was applied to the elderly suffering from a hand contracture. A grip rod made of the phthalocyanin-processed fabric was designed for a contracted hand. The clinical test was performed by applying a prototype of a grid rod to the contracted hands and observed the smell and fungus disease of the contracted hands. As the odor was reduced, the fungus disease also disappeared after a week. The same fabric was applied to cover a urinary catheter bag, which is normally placed besides the bed. Urine contains ammonium and bodily wastes as the source of odor. When the urinary catheter bag was covered by the phthalocyanin-processed fabric, the odor was considerably reduced after an hour and almost to the level of slightly noticeable smell after 5 h.

Keywords Contracted hands · Odor · Bedridden · Functional fibers · Urinary catheter bag · Phthalocyanin-processed fabric

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1 Introduction

The elderly population in Japan has reached the ratio 20 % of the total population where one of five persons is over 65 years old [1]. As getting older, the elderly become often immobilized by the stroke due to the diseases including cancer, acute myocardial infarction, and cerebral stroke. In consequence those elderly are bedridden and promote dementia.

The bedridden elderly in most cases had a cerebrovascular accident and foot fracture, causing a contracture of limb and subsequent paralysis. The deterioration of the body function induces other symptoms including incontinence and skin infection as bedsore and ringworm fungus disease. The increasing number of bedridden elderly is causing a big social problem in various aspects. Since those elderly cannot move enough by themselves, the soft tissues such as muscle and skin around joints lose elasticity and become tense, resulting in the contracture of the fingers shown in Fig. 1. The contracture is caused by the disturbance of the excursion of a joint, and is classified into two types of (1) the flexion contracture in the flexion keeping state and (2) the extension contracture in the extension keeping state. A hand is kept tightly clutched in the flexion contracture so that the palm has not breath and is getting sweaty most of the time (see Fig. 1). In consequence the palm is getting smelly and eventually develops a skin disease like athletic foot in the some cases. The cases of Trichophyton propagation or fungal infection complication have been reported when the contracture degree is getting worse [2, 3].

The examples will be shown as an application of functional fibers to reduce the foul smell in the room, generated from bedridden elderly who are obliged to spend all the day on the bed and take the activity of daily living including meals, bathing, grooming, clothing and excretion. The overwhelming number of bedridden elderly results in insufficient care for those people as represented by infrequent bathing and unsatisfactory handling of excretion. In consequence, the foul smell has become a major headache in the elderly houses and hospitals. Here the pollution due to foul smell in those care facilities is generated by the inhabitants themselves.

The offensive odors are also generated around the beds from excretion of the bedridden elderly. The most prominent unpleasant odor in the room is excretion [4, 5].

Flexure contracture Extension contracture

Fig. 1 Contracted hand

Attempts have been made to reduce odor in the hospital and elderly facilities using deodorant wallpaper, deodorant curtains and ventilation fans. However, it has been reported that such offensive odors were hardly removed by those devices due to their insufficiency for deodorization. The energy cost is high to achieve a sufficient effect of deodorization. Here again we apply the deodorant functional fiber by designing a cover for a urinary catheter bag. This simple idea turned out to be effective to shut the foul smell at its origin.

2 Samples and Methods

2.1 Deodorant Fiber

Metalphthalocyanin is known to function as an oxygen-donor artificial enzyme which functions similarly as hemin in a living body. The fabric made of this phthalocyanin-processed cotton yarn exhibits greenish to blue color depending on the types of metal. In the present experiment, iron-phthalocyanin was used for a primary deodorant and anti-bacteria agent. Cotton knit fabric was bleached cationized and processed with Fe-phthalocyanin tetracarboxylic acid to form an ionic bond. The fabric was immersed further in copper sulfate aqueous solution in order to enforce the deodorant effect in some cases. Because of four carboxylic acid groups, the fabric is slightly acidic. The anti-bacteria effect of the Fe-phthalocyanin-processed fabrics is summarized in Table 1. Those functional fabrics were kindly provided by Daiwabo Neu Co.,ltd.

2.2 Methods

A grip rod to be applied to a contracted hand was designed (see Fig. 2) and made of the Fe-phthalocyanin-processed knit fabric. The clinical test was performed by applying a prototype of a grid rod to the contracted hands and observed the smell and the fungus disease. A grip rod was put on the contracted hand of total 11 patients aging from 75 to 100 years old as shown in Fig. 2, and the deodorant effect

Table 1 Comparison of living bacteria before/after incubation for various samples

Sample fabric	Incubation time (hr)	A number of living bacteria (number)	Activity of bacteriostasis
Untreated	18	7.6×10^6	–
Fe-phthalocyanine—processed	0	9.6×10^3	2.7
	18	6.4×10^3	
Fe-phthalocyanine—processed with copper	0	8.0×10^3	3.7
	18	5.0×10^2	

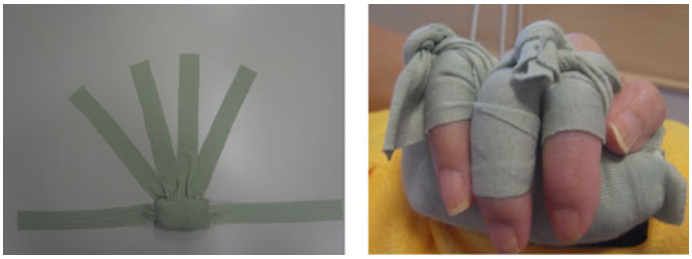

Fig. 2 Grip rod

of a grid rod was evaluated subjectively in terms of the intensity of smell by the six grades odor intensity measurement method (0: odorless, 1: very weak, 2: weak, 3: easily detectable, 4: strong, and 5: very strong) and the degree of the odor hedonics by the nine grades odor hedonics indication method (−4: extremely unpleasant, −3: very unpleasant, −2: unpleasant, −1: rather unpleasant, 0: neutral, 1: rather pleasant, 2: pleasant, 3: very pleasant, 4: extremely pleasant). The evaluation was made by 5 persons who passed the sense of smell test with the T&T olfactometer reagent [6]. The state of diseased skins was examined visually by the skin special doctor.

The Fe-phthalocyanin-processed fabric was also applied to make a cover for a urinary catheter bag, which is normally put beside the bed. The staffs of the elderly care center examined the smell around the bed with a urinary catheter bag everyday subjectively, and recorded its change (Fig. 3).

Fig. 3 A urinary catheter bag with a deodorant cover

3 Results and Discussion

A first example is the application of deodorant fiber to the elderly suffering from a hand contracture. The bedridden elderly in most cases had a cerebrovascular accident and foot fracture, causing a contracture of limb and subsequent paralysis. The deterioration of the body function induces other symptoms including incontinence and skin infection as bedsore and ringworm fungus disease. The clinical test was performed by applying a prototype of a grid rod to the contracted hands and observed the smell and the fungus disease. As the foul smell (mostly of aliphatic acids produced by the bacterial decomposition of secreted sebum) was reduced, the fungus disease also disappeared after a week. The results are summarized below (Fig. 4) for the reduction of smell after the application of a grid rod (Fig. 5).

On the other hand, the degree of the odor hedonics was slightly unpleasant at beginning but became almost neutral after 4 days when the smell intensity became very weak. The foul smell from the contracted hand is due to ammonia and lower fatty acid (acetic acid, butyric acid, and isovaleric acid) originated from sweat and decomposed sebum in the contracted hand where the skin is always moist by

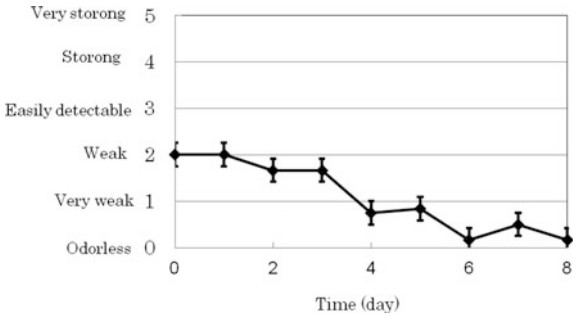

Fig. 4 The change of the smell intensity of contracted hands

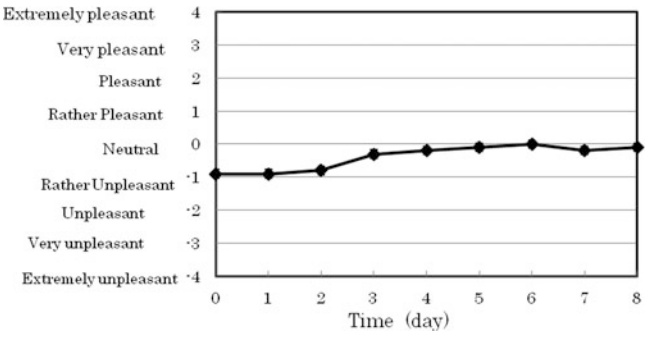

Fig. 5 Change of the degree of the odor hedonics

Fig. 6 Skin condition infected by *Trichophyton* fungus of the contracted hand

consistent perspiration. The subjective evaluation confirms a positive effect of deodorization of both acidic and alkaline smelly substances which could be oxidized by Fe-phthalocyanin and copper into non-smelly substances.

The moist and warm atmosphere in the contracted hand promotes *Trichophyton* fungus propagation. Figure 6 on the left demonstrates the skin condition of the palm of the contracted hand. As shown in Table 1, Fe-phthalocyanin-processed fabric possesses an anti-bacteria activity by mild oxidation. That is, this functional fabric is expected to be effective to suppress the propagation of *Trichophyton* fungus.

The skin condition infected by *Trichophyton* fungus was observed after applying a hand grip. The skin was getting drier and revitalized after 8 days as shown in Fig. 6 on the right. Although the skin was moist and reddish for first 2 days, the skin exhibited a symptom of recovery after 3 days of the application of a hand grip and the reddish skin resumed a healthy color in 5 days. After 8 days, the skin was diagnosed as in its healthy state.

A second example is the application of the same fabric to the urinary catheter bag, which is normally placed besides the bed. The design and application of the urinary catheter bag cover is shown in Fig. 3. Urine contains ammonium and bodily wastes (including undigested drugs) as the source of a foul smell. When the urinary catheter bag was covered by the Fe-phthalocyanin-processed fabric, the foul smell was considerably reduced after an hour to weak smell and almost to the level of slightly noticeable smell after 5 h. The effect of the urinary catheter bag cover was confirmed to last for 500 h. bu smell monitoring.

4 Conclusion

The reduction of foul smell improved the room environment and promoted more human friendly atmosphere. We have shown only two examples, but there are various functional fibers available now and the well-designed application of those functional fibers is expected to improve our living environment.

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Part II
Kawaii/Affective Value Creation

A Perceptual Study of Robot Design in the Japanese Robot Anime Series, "Mobile Suit Gundam"

Naoto Hayashi and Masashi Yamada

Abstract This study focused on the impressions of robot design in the Japanese robot anime series, "Mobile Suit Gundam". In Experiment 1, the impressions of robot design were measured using semantic differential method. Results of the factor analysis showed that the impressions of the robot design were illustrated by a three dimensional space, which was spanned by "Massiveness", "Coolness" and "Roundness". "Moe" is one of the most important keywords in robot design. The results of a multiple-regression analysis showed that Moe was felt deeply for a massive, cool and box-shaped robot. In Experiment 2, the differences between robots of scale models and super-deformed models were investigated. The results showed that the scale models were designed to be cool and the super-deformed models were designed to be cute.

Keywords Gundam · Moe · Anime · Robot design · Semantic differential method

1 Introduction

In recent years, Japanese animated movies (anime), video games and cartoons have been called "Cool Japan" contents and have been exported overseas. Among these contents, "Mobile suits Gundam" series, which has successively been produced for over 30 years, has represented Japanese anime. In addition to the anime, Gundam series contents have been made into various products, e.g., plastic models, character goods, and video games. In 2014, cumulative sales of Gundam related contents reached 800 million dollars [1]. Among these contents, plastic models of the robots which appeared in the series, called "Gun-pla" robots, are very popular in Japan. The popularity of the Gundam series may deeply correlate with the design of the

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robots, which have appeared in the contents. Therefore, the correlation between the robot design and impressions of the robots which appeared in the Gundam series were clarified, using Gun-pla robots.

The Gundam series is divided into two parts by the characteristics of the stories. One is the "Universal Century" series and the other is the "Another Gundam" series: The Universal Century series express complicated human emotions. In these stories, young characters struggle to find why they are fighting and become adults through their struggles. In the Another Gundam series, virtuous and vicious characters are clearly separated and they battle with their robots. In these stories, the virtuous characters win in the end, like conventional robot anime. In the present study, the differences of the impressions of robot design between the Universal Century and the Another Gundam series were investigated.

For robot anime, "Moe" is one of the most important keywords. Moe is written as a Chinese-Japanese character which implies burning, and is used in the case when one is excited by an artificial metal robot. Sometimes the same pronunciation of "Moe" is used for the different idea of cuteness or "kawaii" in Cool Japan contents. However, for this case Moe is written with a Chinese-Japanese character which implies sprouting of plants. In the present study, the relationship between the Moe, which represented excited feelings, and the impressions of robot design were investigated.

Usual Gun-pla robots, which possess the same proportion of the body parts of the robots which appeared in the anime, are called "scale (SC) models". As well as SC models, "Super-deformed (SD) models" which possess proportionally small bodies to the heads are also popular. In the present study, the effects of the deformation were also clarified.

2 Experiment 1

2.1 Methods

In Experiment 1, 52 Gun-pla robots were used as stimuli. The robots were driven by the protagonists or rivals in the Gundam series and all robots were SC models. Twelve students from the Kanazawa Institute of Technology participated in the experiment. The participants sat on a chair and were requested to look at each Gun-pla robot placed on a table, then they were allowed to hold it in their hands freely for three minutes. Then, the participants rated their impressions of the robot using 22 semantic differential scales listed in Table 1 [2]. The scales were bipolar seven-step scales, e.g., "very powerless", "fairly powerless," "slightly powerless", …, "very powerful". The scales appeared on a response sheet in a random order for each combination of participants and stimuli. The participants also rated the degree of Moe using a seven-step scale. The stimuli were presented in a random order for each participant. The experiment was performed in a dark room with an artificial sun lamp.

Table 1 Semantic differential scales and their factor loadings in Experiment 1

SD scales			Factor		
			Massiveness	Coolness	Roundness
Static	–	Dynamic	*0.887*	0.160	−0.158
Fragile	–	Tough	*0.927*	0.087	−0.273
Small	–	Massive	*0.940*	−0.118	−0.239
Thin	–	Thick	*0.958*	0.073	−0.109
Light	–	Heavy	*0.935*	0.125	−0.208
Slow	–	Fast	*−0.815*	0.272	0.113
Dull	–	Sharp	*−0.704*	0.215	−0.486
Cheap	–	Expensive	−0.038	*0.869*	0.297
Weak	–	Strong	−0.133	*0.790*	−0.287
Powerless	–	Powerful	0.327	*0.882*	0.164
Simple	–	Vivid	−0.103	*0.742*	0.417
Boring	–	Exciting	−0.073	*0.806*	0.435
Clunky	–	Cool	0.300	*0.921*	−0.005
Box-shaped	–	Round	0.036	0.152	*0.859*
Soft	–	Hard	0.431	0.046	*−0.758*
Real	–	Unreal	−0.324	0.325	*0.708*
Inorganic	–	Organic	−0.071	0.170	*0.780*
Crude	–	Fine	−0.492	0.653	0.158
Ugly	–	Beautiful	−0.432	0.589	0.267
Masculine	–	Feminine	−0.478	0.063	0.547
Old-fashioned	–	Stylish	−0.695	0.354	0.512
Futuristic	–	Traditional	0.280	−0.329	−0.647

2.2 Results and Discussion

Numbers −3 to 3 were given for each of the seven categories on the semantic differential scales. The rated scores were averaged over the participants and the obtained mean values were used for factor analysis with the principal factor method and varimax rotation. Table 1 shows the resulting factor loadings. The results of the analysis showed that the three-factor solution accounted for 78 % of the data variance. The three factors are labeled "massiveness", "coolness" and "roundness" respectively, after the scales which show large absolute values in the loadings for these factors. Figure 1 shows each stimulus with its factor scores on the three-dimensional space spanned by massiveness, coolness and roundness. In Fig. 1, triangle symbols indicate the robots for the Universal Century series, and circle symbols indicate the Another Gundam series.

Figure 1 shows that the impressions of robots are quite different between the Universal Century and the Another Gundam series. In fact, the results of *t*-tests showed that the robots for the Another Gundam series are significantly lighter and

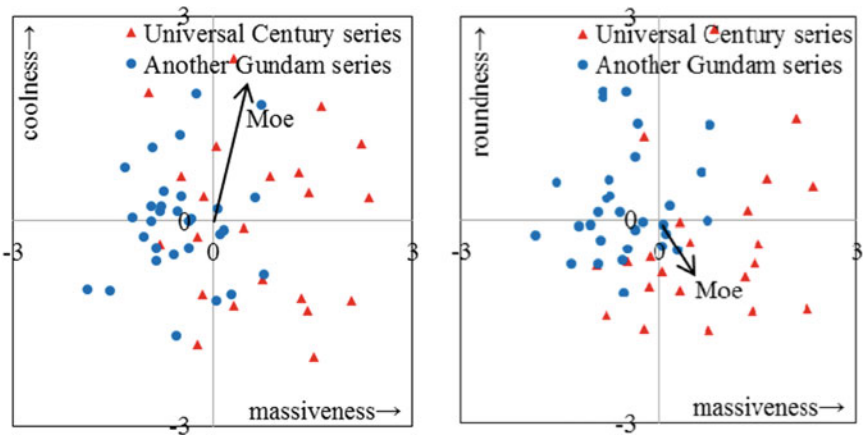

Fig. 1 Impressions of Gan-pla robots for the Universal Century series and the another Gundam series. The *right panel* shows the Massiveness—Coolness plane and the *left panel* shows the Massiveness—Roundness plane

rounder than for the Universal century series ($p < 0.05$). These results may imply that the robots in the Universal Century series were designed to represent suffering of the heroes from the struggle in massive and box-shaped bodies of the robots. For the Another Gundam series, the robots may be designed with light and smooth bodies for coolness.

A multiple-regression analysis was applied, using factor scores of "massiveness", "coolness" and "roundness" as explanation variables, and the degree of "Moe" as an objective variable. The results showed that the coefficient of determination, R^2 was larger than 0.7. The resulting regression line is shown as a vector in Fig. 1. The results show that Moe was felt deeply for a massive, cool and box-shaped robot.

3 Experiment 2

3.1 Methods

Sixty Gun-pla robots were used as stimuli in Experiment 2. Half numbers of the robots were scale (SC) models and the other half were super-deformed (SD) models. All of the robots were driven by protagonists in the Gundam series. Fifteen students from the Kanazawa Institute of Technology participated in Experiment 2. The participants were requested to rate their impressions of each robot, using 24 seven-step bipolar scales listed in Table 2. The other experimental methods were the same as in Experiment 1.

Table 2 Semantic differential scales and their factor loadings in Experiment 2

SD scales			Factor		
			Coolness	Massiveness	Vividness
Crude	–	Fine	*0.767*	−0.471	0.314
Cheap	–	Expensive	*0.832*	−0.080	0.462
Clunky	–	Cool	*0.861*	−0.010	0.263
Dull	–	Sharp	*0.805*	−0.371	0.063
Weak	–	Strong	*0.800*	0.123	0.503
Unfamiliar	–	Familiar	*−0.755*	0.081	−0.107
Coercive	–	Conciliatory	*−0.855*	−0.211	−0.313
Scary	–	Cute	*−0.932*	0.095	−0.003
Angular	–	Round	0.019	*−0.704*	0.140
Static	–	Dynamic	0.035	*0.781*	0.248
Fragile	–	Tough	−0.104	*0.939*	−0.086
Small	–	Massive	−0.206	*0.883*	−0.266
Thin	–	Thick	−0.548	*0.795*	−0.003
Light	–	Heavy	0.077	*0.936*	−0.107
Simple	–	Vivid	0.419	0.001	*0.879*
Boring	–	Exciting	0.550	−0.042	*0.805*
Real	–	Unreal	0.109	−0.301	*0.901*
Traditional	–	Futuristic	0.118	−0.327	*0.810*
Ugly	–	Beautiful	0.657	−0.419	0.404
Loutish	–	Stylish	0.462	−0.665	0.483
Powerless	–	Powerful	0.681	0.184	0.655
Slow	–	Fast	0.487	−0.637	0.450
Soft	–	Hard	0.389	0.658	−0.205
Inorganic	–	Organic	0.164	−0.495	0.458

3.2 Results and Discussion

The rated scores were averaged over the participants and the obtained mean values were used for factor analysis with the principal factor method and varimax rotation. Table 2 shows the resulting factor loadings. The three factors are labeled "coolness", "massiveness" and "vividness", respectively, after the scales which show large absolute values in the loadings for these factors.

Figure 2 shows each stimulus using factor scores on the three-dimensional space spanned by coolness, massiveness and vividness. In Fig. 2, triangle symbols indicate SC models and circle symbols indicate SD models. In Fig. 3, triangle and circle symbols show the centroids for SC and SD models with standard deviations, respectively. The results of *t*-tests showed that SD models were more massive and less cool than SC models, in the significance level of $p < 0.05$. A multiple-regression analysis was applied, using factor scores of "coolness",

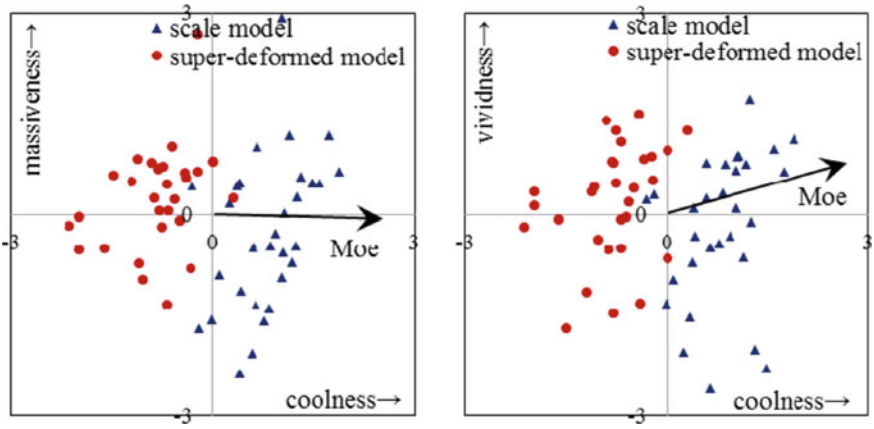

Fig. 2 Impressions of scale (SC) models and super-deformed (SD) models. The *right panel* shows the Coolness—Massiveness plane and the *left panel* shows the Coolness—Vividness plane

"massiveness" and "vividness" as explanation variables, and the degree of "Moe" as an objective variable. The results showed that the coefficient of determination, R^2 was larger than 0.8. The resulting regression line is shown as a vector in Fig. 2. The results show that Moe was felt for a cool robot of SC model.

Factor loadings in Table 2 show that a negative direction of the coolness dimension can be interpreted as cuteness. Therefore the results in Figs. 2 and 3 show that the scale models are designed as cool, and super-deformed models are designed as cute or "kawaii" in Japanese.

The largest difference between the design of a scale model and a super-deformed model is the ratio of the head size to the body size. In general, the growth of human

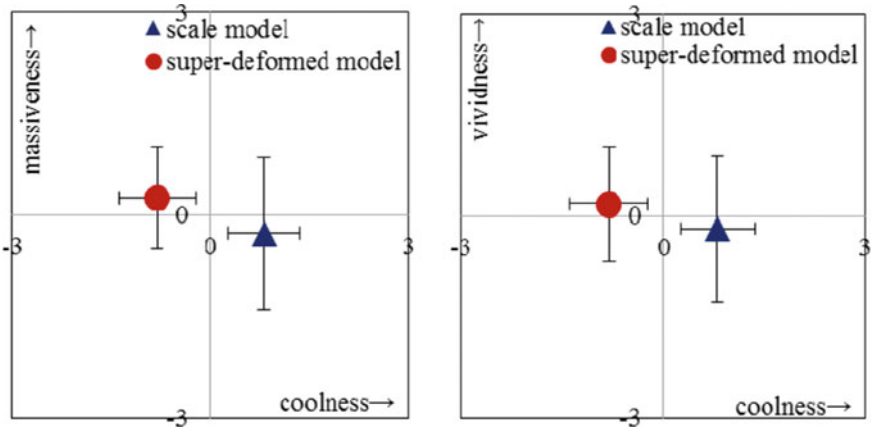

Fig. 3 Centroids with standard deviations for SC models and SD models

beings and animals is deeply related to the proportion of the head size to the body size: A baby has a relatively small body compared to the head, and an adult has a relatively big body compared to the head. A baby is perceived as cute or "kawaii" and an adult is perceived as cool.

The results suggest that the SC models are designed to be perceived as cool using the same proportion of the body parts of the robots which appeared in the anime. On the other hand, the SD models are designed to be perceived as cute, using baby-like bodies.

4 Conclusion

In the present study, the impressions of robot design appearing in the Japanese robot anime series, "Mobile Suit Gundam" were investigated using Gun-pla. Experiment 1 clarified that the robots for the Universal century series were designed with massive and box-shaped bodies. On the other hand, the robots for the another Gundam series were designed with light and smooth bodies.

In Experiment 2, it was clarified that the SC models of Gun-pla, which possess the same proportion of body to head as in the anime, were perceived as cool. The SD models of Gun-pla, which are designed with relatively small bodies to the head sizes, were perceived as cute.

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A Perceptual Study of Monster Design in the Context of Cool Japan Contents

Riu Yanagida and Masashi Yamada

Abstract In the present study, impressions of monster design in the series of Pokémon games were investigated with semantic differential method. In the Pokémon games, a player selects a buddy monster out of three monsters. In the experiment, the buddy monsters and the other monsters in five different versions were used as stimuli. Most of the monsters in first phase monsters in Pokémon metamorphose into second and last phases. The results showed that the monsters in the first phase were cute but powerless and not sharp. Proceeding to the latter phases, the monsters metamorphose into more powerful and sharper but less cute. The results also showed that the buddy monsters were designed as cuter than the other monsters. Moreover, the relationship between colors and impressions of Pokémon were investigated in the present study. The results showed the colors of Pokémon partly correlated to the impressions of potency and cuteness.

Keywords Pokémon · Monster design · Semantic differential method

1 Introduction

In recent years, animated movies, video games and cartoons are called "Cool Japan" contents. The Japanese Ministry of Economy, Trade and Industry is taking steps to expand exports of Cool Japan contents. The ministry points out "Poket Monsters (Pokémon)" as an example of successfully exported Cool Japan contents. Pokémon Red Version and Pokémon Green Version, role-playing games developed by Game Freak, were published by Nintendo for Game Boy in 1996. After these versions, a series of Pokémon games has been continuously released by Nintendo. The cumulative sales of Pokémon games reach to more than 270 million yen, all

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over the world. Moreover, the contents of Pokémon spread to a wide range of related businesses, e.g., anime, toys stationary goods. The cumulative sale of these media-mix business reach to more than 4.3 trillion yen [1].

In Pokémon games, players collect monsters and raise them through battles. Most of cute monsters in the first phase metamorphose into second and third phases throughout the game. The players may be bewitched by cute monsters in Pokémon games. In the present study, the differences in the impressions monsters among different phases were investigated, using semantic differential method [2].

In a Pokémon game, a player selects a buddy monster out of three monsters. They are called starter monsters ("Gosanke" in Japanese). The art director of monster design in the Pokémon series, Ken Sugimori told that the design for the three starter monsters is the most difficult, because cuteness is especially very important for them [3]. In the present study, impressions of monster design in the series of Pokémon games were also investigated.

In the last step of the present study, the relationship between the impressions of monsters and the colors used for the monsters were investigated.

2 Experiment 1

2.1 Methods

In Experiment 1, pictures of 77 monsters in the first phase, appeared in 'Red and Blue Versions (released in 1996)' [4], 'Gold and Silver Versions (1999)' [5], 'Ruby and Sapphire Versions (2002)' [6], 'Diamond and Pearl Versions (2006)' [7], 'Black and White Versions (2010)' [8] and 'Pokémon X and Pokémon Y (2013)' [9], were used as stimuli. In addition to the 77 monsters, 78 monsters in the second and 81 monsters in the last phases were also used as stimuli. These 236 pictures were picked up from a smartphone application, Pokédex for iOS. Fourteen students from the Kanazawa Institute of Technology participated in the experiment. Each

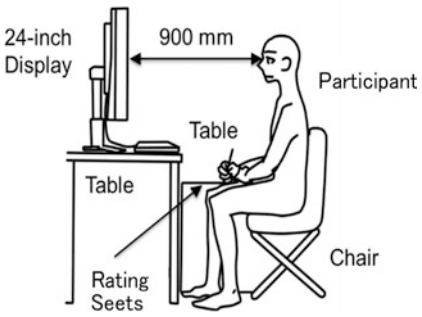

Fig. 1 Apparatus and environment in Experiment 1

picture was presented with a gray background on a computer display, EIZO FlexScan SX2462W-PX. The participants sat on a chair and were requested to look at each picture on the display as shown in Fig. 1. Then, they were requested to rate their impressions of the monster robot using 23 semantic differential (SD) scales listed in Table 1. The scales were bipolar seven-step scales, e.g., "very weak", "fairly weak", "slightly weak",…, "very strong". The scales appeared on a response sheet in a random order for each combination of participants and stimuli. They answered whether they know the monsters. The experiment was performed in a dark room.

Table 1 Semantic differential scales and there factor loadings in Experiment 1

Scale			Factor		
			Potency	Cuteness	Sharpness
Strong	–	Weak	*0.765*	−0.051	0.340
Dependable	–	Irresponsible	*0.815*	0.066	0.332
Heavy	–	Light	*1.088*	0.050	−0.354
Dauntless	–	Sturdy	*0.931*	−0.077	−0.055
Powerful	–	Powerless	*0.862*	−0.048	0.198
Vigorous	–	Vigorless	*0.852*	−0.023	0.200
Tough	–	Tender	*0.996*	−0.073	−0.276
Unfamiliar	–	Familiar	−0.227	*0.815*	−0.077
Scary	–	Amiable	−0.326	*0.714*	−0.182
Gloomy	–	Gheerful	0.093	*0.889*	0.109
Ugly	–	Beautiful	−0.082	*0.727*	0.511
Hateful	–	Cute	−0.161	*0.833*	−0.155
Slow	–	Fast	−0.436	−0.154	*0.986*
Jnsophisticated	–	Sophisticatec	0.083	0.311	*0.702*
Clunky	–	Cool	0.354	0.287	*0.725*
Dull	–	Sharp	−0.339	−0.303	*0.981*
Cold	–	Warm	0.068	0.686	−0.016
Aggressive	–	Calm	0.311	−0.473	0.493
Quiet	–	Active	0.134	−0.003	0.621
Hard	–	Soft	0.561	−0.339	−0.122
Messy	–	Neat	−0.535	0.267	0.269
Flamboyant	–	Sober	0.472	0.292	0.447
Cumulative Contribution Rate (%)			49.500	69.000	78.000

2.2 Results and Discussion

Numbers −3 to 3 were given for each of the seven categories on the SD scales. The rated scores were averaged over the participants and the obtained mean values were used for factor analysis with the principal factor method and promax rotation. Table 1 shows the resulting factor loadings. The results of the analysis showed that the three-factor solution accounted for 78 % of the data variance. The three factors are labeled "potency", "cuteness" and "sharpness" respectively, after the scales which show large absolute values in the loadings for these factors.

The monsters were divided into six groups; the starter monsters in the first, second and lase phases, and the other monsters in the first, second and last phases. The factor scores were averaged over the monsters in the same group. The centroid of each group was plotted in Fig. 2. Figure 2 shows that the monsters in the first phase is perceived as cute but powerless and not sharp. Proceeding to the latter phases, the monsters metamorphose into more powerful and sharper but less cute. This is true both for the starter monsters and the other monsters. The results of one-way ANOVAs and multiple-comparison tests showed significant differences between different phases in "potency" and "sharpness" in the significance level of $p < 0.01$. In cuteness, significant differences were observed between the first and second phases and between the first and last phases ($p < 0.01$). The changes of the impressions corresponded to the change in proportion ratio of head to body size, reflecting the growth of human beings and animals. In fact, the ratio was almost 1:2 for the first phase, but it changed to almost 1:3 and 1:4 for the second and third phases, respectively, for most of the monsters.

Figure 2 also showed that the starter monsters in the first phase were perceived as cuter and rounder than the other monsters in the first phase. In fact, results of *t*-

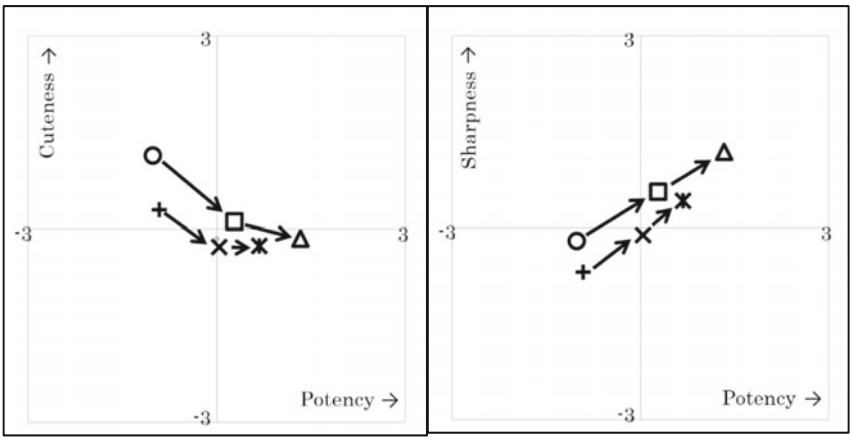

Fig. 2 Impressions of monsters in Pokémon. The *left* and *right* panels show Potency–Cuteness Plane and Potency-Sharpness planes, respectively. *Circle*, *square* and *triangle* marks show the impressions of the first, second and last phases, respectively. Plus, cross and asterisk marks show the impressions of the other monsters in the first, second and last phases, respectively

tests showed that the starter monsters were cuter and rounder significantly than the other monsters in the first phase ($p < 0.01$). This is consistent to the discourse of the art director, Ken Sugimori. Proceeding to the latter phases, the starter monsters metamorphosed into more powerful and sharper monsters in comparison with the other monsters. In fact, the starter monsters were sharper than the other monsters in the second phase, and were powerful and sharper in the last phase ($p < 0.01$). Players of usual roll-playing games realize his/her maturity by increase of numbers of play level, hit points or magic points. In the case of Pokémon games, a player can realize his/her maturity watching the buddy monster's metamorphoses. This may be a large factor of why the Pokémon series charms children and is very popular.

One-ANOVAs were performed for the different versions. The results showed that the monsters in 'Gold and Silver Versions' were cuter than the other versions. In Gold and Silver Versions, many "Baby Monsters", which possess a large ratio of head to body size, appeared. This may illustrate why the monsters in the Gold and Silver Versions were perceived as cuter than the other versions. The results of ANOVAs showed that the impressions of monsters did not changed systematically, over 19 years, except for the Gold and Silver versions.

It was suggested that the colors used in the monsters correspond to the hue circle proposed by Albert Munsell [10] in the potency-cuteness plane: A monster with high potency tend to be colored red and a monster with low potency tend to be colored green. A cute monster tend to be colored yellow and a monster which is not cute tend to be colored purple. The correlation between the colors and the impressions was examined in Experiment 2.

3 Experiment 2

3.1 Methods

The 360° in the potency-cuteness plane are divided into twelve areas of 30°. Five monsters which placed in outer position in each area were selected. For each monster, three colors which covered large areas were chosen. The picture of each monster was presented on a computer screen. The screen also presented three colors. Ten students from the Kanazawa Institute of Technology participated in Experiment 2. The participants were requested to select one color, which represented the monster, out of the three colors.

3.2 Results and Discussion

The color selected by largest number of participants was defined as the representing color of a monster. The represent colors of the monsters were shown in Fig. 3. The

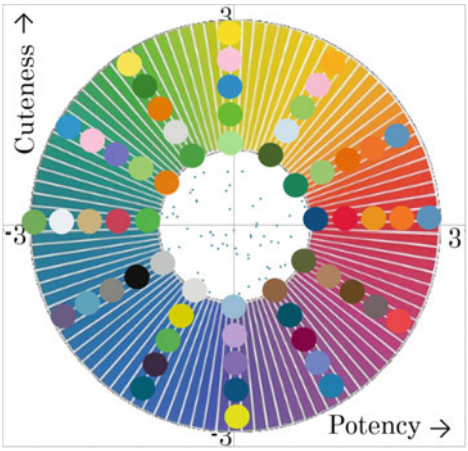

Fig. 3 The results of Experiment 2. Each *circle* shows the representing color of a monster. The background shows the hue circle proposed by A. Munsell

hue values in Munsell system of the representing colors were measured. The twelve-divided hue colors of Munsell system was reversed and the color red set on the positive position on the potency axis as shown in Fig. 3. Then, it was examined if the hue value of the representing color of a monster coincided with the twelve-divided aria of the monster placed. The case, where the representing color of a monster was placed in that area or next areas, was counted as the coincidence. The results showed that the coincidence of the color within three areas accounted for almost half cases. These results suggested that the impressions of the monster were determined not only by colors but also shapes and the other design factors.

4 Conclusion

In Experiment 1, impressions of monster design in the series of Pokémon games were investigated with SD method. The results showed that the impressions of monster design did not changed systematically, through different versions. The monsters in the first phase were cute but powerless and not sharp. Proceeding to the latter phases, the monsters metamorphose into more powerful and sharper but less cute. Proceeding to the latter phases, the starter monsters metamorphosed into more powerful and sharper monsters in comparison with the other monsters. The maturity of the monsters may, at least partly, expressed by the change of the proportion ratio of head to body size. In Pokémon games, a player can realize his/her maturity watching the buddy monster's metamorphoses. This may be a large factor of why the Pokémon series charms children and is very popular.

In Experiment 2, the correlation between the colors and the impressions was examined. The results suggested that the designers of the monsters used the colors effectively with the other design factors, at least partly.

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Proportion of Facial Features for Constructing a "Moe" Character

Yudo Iijima, Yuki Wada and Masashi Yamada

Abstract In the present study, a perceptual experiment was conducted using synthesized faces as stimuli. The results showed that the impression space of the faces were spanned by "childishness", "potency" and "potency", and the multiple-regression analyses showed that a cute and childish character evokes Moe emotion, but a cute and mature character does not. On the other hand, "potency" does not affect Moe, beauty and preference. In the next step, the length and width of the faces, the width between both cheeks, and the vertical and horizontal length of eyes were measured. Then, regression analyses with the second order curves were performed, using the ratios of the parameters as independent variables and the degree of Moe and beauty as criterion variables. The results showed quantitatively that a Moe character has a rounder face and widely opened eyes than a beautiful character.

Keywords Moe · Semantic differential method · Factor analysis · Multiple-regression analysis

1 Introduction

Animated movies (anime), video games and cartoons have been highly developed in Japan, and treated as subculture contents. However, in recent years, these contents are called "Cool Japan," and Cool Japan contents are recognized as an export-oriented manufacture of Japan. In fact, the Japanese Ministry of Economy, Trade and Industry supported overseas operations of Cool Japan contents under a supplemental budget of 34.4 billion yen in 2012 [1].

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"Moe" is one of the most important keywords in the Cool Japan contents. Moe characters play important roles in most of the contents of Japanese anime, video games and cartoons. Most of the Moe characters are pretty girls and they evoke Moe emotion in viewers of the contents. Sometimes Moe is misunderstood as a kind of immoral sexual emotion like paedophilia. However, Moe does not include direct sexual emotion. One of the most authoritative journals, "Kokubungaku (Japanese Literature)" published a special issue of Moe in 2008 [1]. This issue contained fourteen papers which discussed Moe from viewpoints of philosophy, aesthetics and literature. To conclude their discussion, Moe contains an ambivalent emotion: One wants to be intimate with her (it) but recognizes that it is quite difficult to realize. Moreover, females can feel Moe for young female characters, and sometimes females and males may feel Moe for male characters, also. Similar philosophical and aesthetic discussion on Moe has frequently taken place in articles in books and magazines. However, no experimental study has been carried out on Moe.

We know that we do not feel Moe for ugly characters, but sometimes we feel no Moe even for beautiful characters, through our daily lives. Therefore, we requested a professional designer to provide face designs of a typical "beautiful" character and "Moe" character in the present study. Then we arranged various faces manipulating parameters of several components of the face. Using these faces as stimuli, a perceptual experiment was conducted.

2 Experiment

2.1 Stimuli

To construct faces, the character creation system in the PC game "PHANTASY STAR ONLINE 2" was used. Using this system, various components of the face (e.g. hair style, face shape, size of eyes and size of nose) can be manipulated. In this system, hair style, type of irises and type of makeup can be chosen from several alternatives. Except for these three components, each parameter can be varied from −100 to 100°. Using this system, a professional character designer provided two faces of characters: One is a typical Moe character. We call it Basic Moe Character (BMC). And the other is a typical character who is beautiful but we do not feel Moe for it. We call it Basic Beautiful Character (BBC). These two faces are shown in Fig. 1.

Sixteen characters were synthesized by morphing processes between the BMC and BBC. In one series, the hair style was fixed in "angel wings" (hair color was fixed in pink), which was used in the BMC. The type of irises was common in the BMC and the BBC. Therefore this type was used for the irises in this series. The type of makeup was fixed as "no makeup," which was used both in the BMC and BBC. Using the parameters of the other components, the values of the parameters in the BMC were set at Step 0 and the values in the BBC were set at Step 4. Then, Steps 1–3 were synthesized by morphing with linear interpolation. Steps 5 and 6

Basic Moe Character Basic Beautiful Character

Fig. 1 Two basic characters designed by a professional designer

were similarly synthesized by extrapolation. In addition, Step-1 and -2 were similarly synthesize by extrapolation. In these steps, the eye opening was larger and shape of the face was rounder than the BMC. The face of the Step 4 was different from the BBC in the hair color and style, but Step 1 was exactly the same as the BMC. Therefore eight new faces were synthesized in this series. Similarly, the BBC was set at Step 0, and the BMC was set at Step 4. Then, the other eight faces were synthesized using the same hair style as the BBC. In this series, hair style was fixed in dark-brown mid-length "suave."

Moreover, 32 characters were also synthesized by varying the value of one of the parameter of face shape, layout of facial parts, eye opening or nose length. In these processes, the morphing process as described above was used. Then, in total 50 faces were prepared for the perceptual experiment as stimuli (Table 1).

2.2 Procedure

Thirty-two students (24 males and 8 females) from the Kanazawa Institute of Technology, ranging from 20 to 24 years old, participated in the experiment. The participants looked at each of the 50 characters and then they were requested to rate

Table 1 Stimuli used in the perceptual experiment

Varied component(s)	# of stimuli
Base	2
Shape of the face	8
Configuration of facial parts	8
Eye opening	8
Nose length	8
Morphed with all parameters	16
Total	50

Table 2 Semantic differential (SD) scales and there factor loadings

SD scale			Factor		
			Childishness	Cuteness	Potency
Real	–	Unreal	0.971	0.009	0.044
Childlike	–	Mature	−0.931	−0.094	0.277
Gentle	–	Showy	0.929	0.206	0.255
Banal	–	Unique	0.916	−0.200	0.239
Mixed	–	Neat	−0.881	0.423	−0.036
Unimpressive	–	Impressive	0.861	0.080	0.368
Rustic	–	Elegant	0.860	0.391	0.254
Dark	–	Bright	0.837	0.443	0.281
Quiet	–	Active	0.834	0.102	0.491
Round	–	Sharp	−0.811	−0.203	0.225
Irritating	–	Healing	0.055	0.974	−0.164
Ugly	–	Eye pleasing	−0.285	0.948	−0.025
Calm	–	Agitated	0.325	0.926	−0.098
Boring	–	Fascinating	0.347	0.921	−0.022
Loutish	–	Stylish	−0.191	0.919	0.045
Uncute	–	Cute	0.379	0.897	−0.180
Cowardly	–	Imposing	0.210	0.095	0.935
Powerless	–	Powerful	0.247	−0.154	0.927
Frail	–	Burly	−0.047	−0.287	0.892
Contribution rate			0.443	0.315	0.178

the impressions of them, using 19 seven-step bipolar scales listed in Table 2, e.g., “very showy”, “fairly showy”, “slightly showy”, …, “very gentle” (C. E. Osgood, G. J. Suci, & P. H. Tannenbaum, 1957). The order of the scales was determined in a random way for each combination of character and participant. The participants were also requested to rate the degree of Moe, the degree of beauty of the character and the degree of preference to the character, using seven-step scales. The characters were presented through the 24.1-inch display (EIZO, FlexScan SX2462W). The distance between the eyes of the participants and the display was fixed at 70 cm.

3 Results and Discussion

Numbers −3 to 3 were given for each of the seven categories on the SD scales. The mean value was calculated from the participants’ responses for each combination of scale and stimulus. Then factor analysis was performed for these mean scores with the principal factor method and varimax rotation. The results showed that a

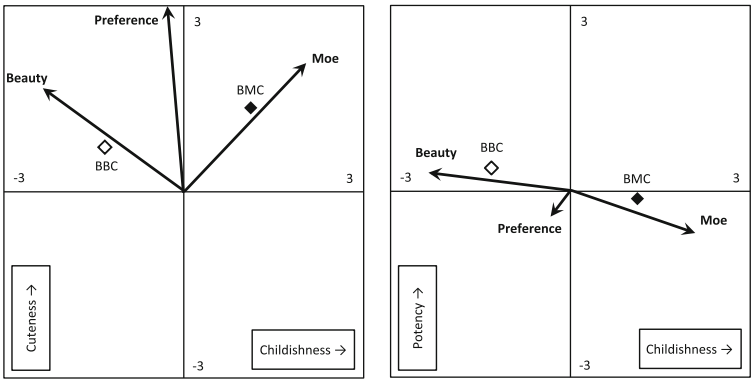

Fig. 2 Results of multiple-regression analyses. The vectors show degrees of Moe, beauty and preference

three-dimensional space accounted for 93.6 % of data variance. Table 2 shows the resulting factor loadings for the 19 SD scales. The three factors are labeled "childishness", "cuteness" and "potency" respectively, after the scales which show large absolute values in the loadings for these factors. The characters were plotted on the "childishness—cuteness" and the "childishness—potency" planes, in Fig. 2. In Fig. 2, the white and black diamond marks show the BMC and BBC, respectively.

In the next step, multiple-regression analyses were applied to investigate the differences between Moe and beauty. Factor scores of the "childishness", "cuteness" and "potency" were used as explanation variables, and each of degree of Moe, beauty and preference was used as a criterion variable in each analysis. The results showed that the coefficient of determination, R^2 was larger than 0.9, for the degree of Moe, beauty and preference, respectively.

Figure 2 shows the multiple-regression lines for the degrees of Moe, beauty and preference as vectors. Figure 2 shows that the "cute" face is preferred and evoke Moe emotion or is recognized as a beautiful woman. Figure 2 also indicates the factor, which differentiate Moe and beautiful faces: If a "cute" character is also perceived as "childish", it is recognized as a Moe character. And if a "cute" character is perceived as "mature", it is recognized as a beautiful woman. On the other hand, "potency" does not correlate with degrees of Moe, beauty and preference, significantly.

The observation of plots of the stimuli in the three-dimensional space suggested that face shape and eye opening of the faces are especially important for Moe emotion and the perception of beautiful woman: A character which shows round face shape and widely opened eyes tend to evokes Moe emotion. And a character which shows sharp face and narrowly opened eyes tend to be perceived as a beautiful woman.

To examine determine the hypothesis described above, nine stimuli along the regression line of Moe and the other nine stimuli along the regression line of beauty

were picked out. The hair style of each of the 18 faces was replaced by the very short one. Then, the length and width of the faces, the width between both cheeks, and the vertical and horizontal length of eyes were measured as in Fig. 3. Ratios of length to width of the face, width between both cheeks to the length of the face, horizontal width of the eye to face width and vertical width to horizontal width of the eye were calculated. Then, regression analyses with the second order curves were performed, using the ratios as independent variables and each of the degree of Moe and beauty as criterion variable (Fig. 4).

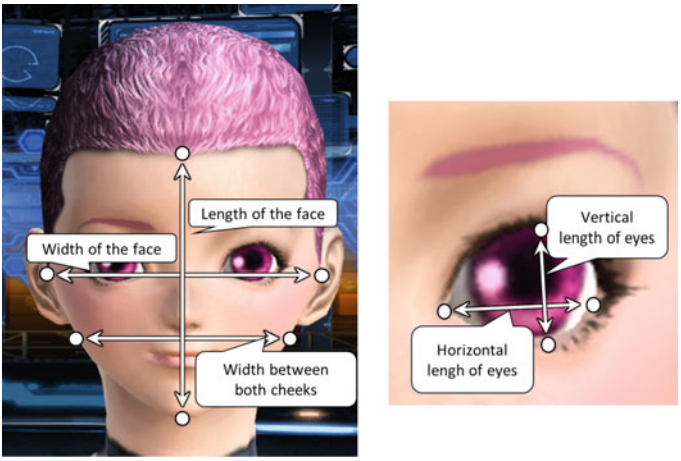

Fig. 3 Measurement of distances between the points in the face

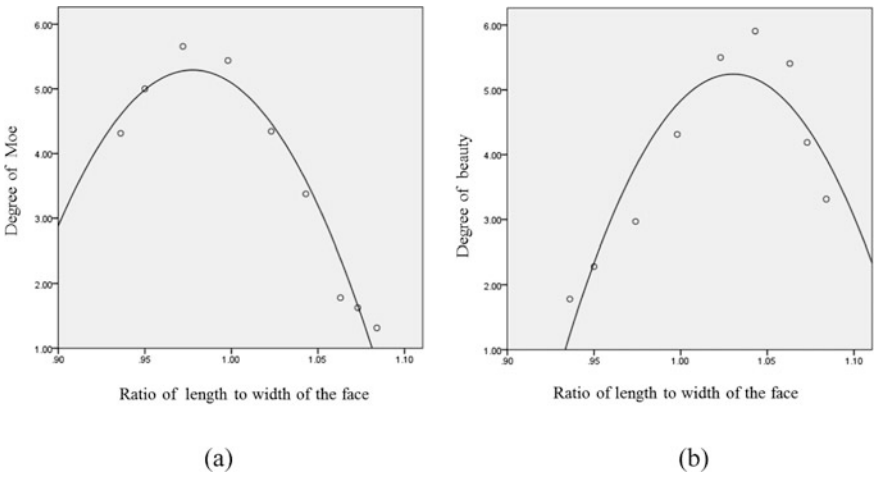

Fig. 4 Degrees of Moe (**a**) and beauty (**b**) were plotted as a function of the ratio of length to width of the face. *Empty circles* show actual measurement values and the *solid lines* show the estimation curves

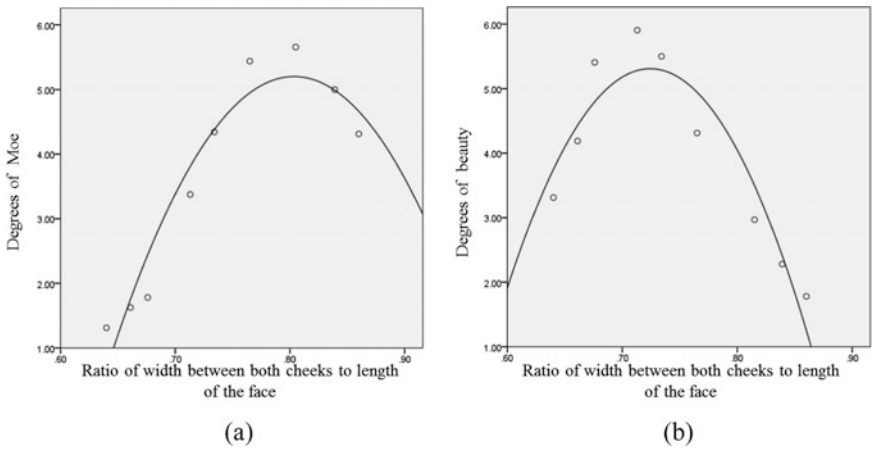

Fig. 5 Degrees of Moe (**a**) and beauty (**b**) were plotted as a function of the ratio of between both cheeks to length of the face

Figure 4a plots the degree of Moe as a function of the ratio of length to width of the face. The ratio with the apex in the regression curve was determined as the best ratio for Moe. And the range of the ratio which corresponds to the Moe degree above 4.0 points was determined as the range for Moe. Similarly, the best ratio and ratio range for beauty was determined as shown in Fig. 4b. The best ratio and the ratio range for Moe and beauty was also determined using width between both cheeks to the length of the face (Fig. 5), horizontal width of the eye to the face width (Fig. 6), and vertical width to horizontal width of the eye (Fig. 7),

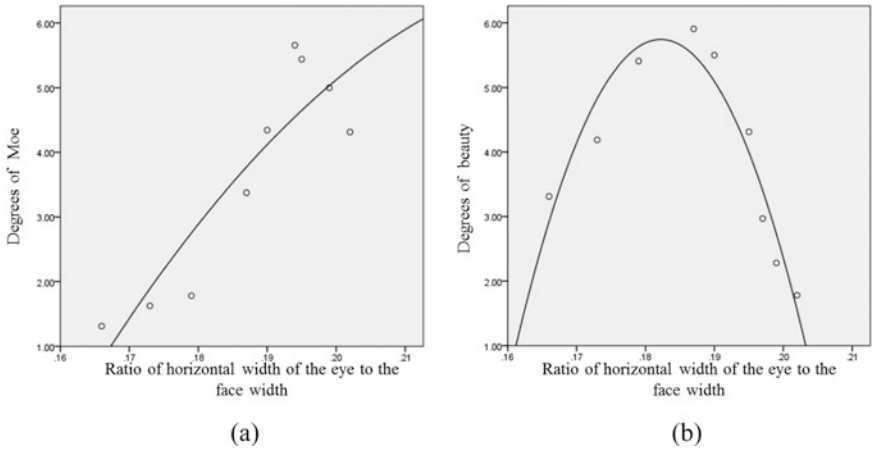

Fig. 6 Degrees of Moe (**a**) and beauty (**b**) were plotted as a function of the ratio of horizontal width of the eye to the face width

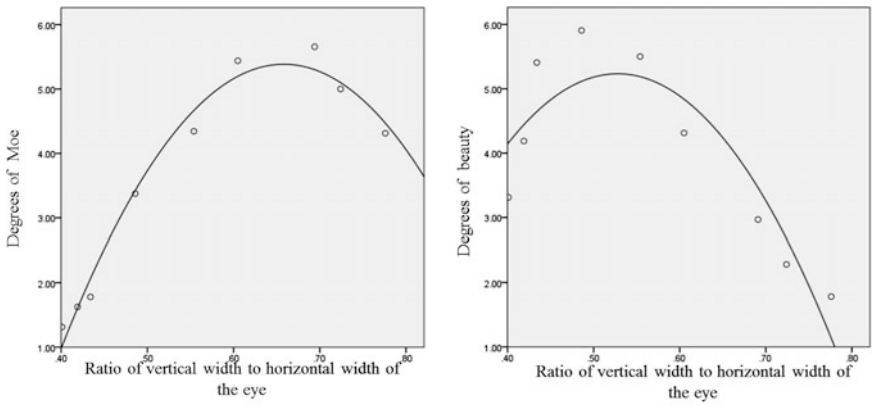

Fig. 7 Degrees of Moe (**a**) and beauty (**b**) were plotted as a function of the ratio of vertical width to horizontal width of the eye

Table 3 The best ratio and the ratio range for Moe and beautiful characters

Ratio	Moe		Beauty	
	Best ratio	Range	Best ratio	Range
Length of the face/width of the face	0.98	0.92–1.03	1.03	0.98–1.08
Width between both cheeks/length of the face	0.8	0.72–0.89	0.72	0.65–0.80
Horizontal width of the eye/face width	–	–	0.18	0.17–0.19
Vertical width of the eye/horizontal width of the eye	0.66	0.51–0.80	0.53	0.39–0.66

respectively. Table 3 shows the resulting values of the best ratios and the ratio range for Moe and beauty. Table 3 shows that a Moe character has a rounder face and widely opened eyes than a beautiful character.

4 Conclusion

In the present study, various faces were synthesized using the character creation system of the PC game, "PHANTASY STAR ONLINE 2". The perceptual experiment using the synthesized faces showed that the impression space of the faces were spanned by "childishness", "potency" and "potency", and the multiple-regression analyses showed that a cute and childish character evokes Moe emotion, but a cute and mature character does not. On the other hand, "potency" does not affect Moe, beauty and preference.

In the next step, the length and width of the faces, the width between both cheeks, and the vertical and horizontal length of eyes were measured. Then, regression analyses with the second order curves were performed, using the ratios of the parameters as independent variables and the degree of Moe and beauty as criterion variables. The results showed quantitatively that a Moe character has a rounder face and widely opened eyes than a beautiful character.

Acknowledgments The present study was partly supported by KAKEN (2556011).

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Impression of Characters in the Japanese Magical Girl Anime Metaseries, "Pretty Cure"

Shizuka Oosawa and Masashi Yamada

Abstract In the present study, the impressions of 94 figures of heroines appeared in "Pretty Cure" metaseries were investigated using semantic differential method. The set of 94 figures contained three different types of models. The results showed that the impression space was spanned by three factors, stylishness, activity and cuteness. The stylishness was deeply affected by the proportion ratio of head to body size, and the activity was deeply affected by the figure size, itself. Other than the figure size, it was suggested that colors cover the figures also affect the activity. The cuteness or degree of "Kawaii" did not depend on only one factor. It was suggested that the complex interaction of many factors determine the degree of cuteness.

Keywords "Pretty Cure" metaseries · Figure · Semantic differential method · Factor analysis · "Kawaii"

1 Introduction

In the present study, recent years, animated movies (anime), video games and cartoons produced in Japan are called "Cool Japan" and recognized as an export-oriented manufacture of Japan. In these contents, "Kawaii" is one of the important keywords. "Kawaii" characters, heroines in "Pretty Cure" as well as Carry PamyuPamyu and Hello Kitty, are very popular all over the world. The Japanese idea of "Kawaii" is translated as "cute", "pretty", "lovely" and so on in English, and cannot be defined simply. It is said that the idea of "Kawaii" has roots in Japanese classic literature like "Makuranosoushi" and "The Tale of the Bamboo Cutter"

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written in Heian period. In these literatures, “Kawaii” implied something tiny or weak [1].

In recent years, deformed plastic models and figures of characters are popular in Japan. They possess relatively large heads and small bodies with short limbs. Such baby-like shaped models give “Kawaii” impressions. Yamada and his colleagues (2015) show that a monster which possessed relatively large heads and small bodies were perceived as cuter than an adult-like shaped monster [2]. The results of Yamada et al. suggest that the proportion ratio of head to body size is an important factor for the perception of cuteness or “Kawaii”.

“Pretty Cure” is a magical girl anime metaseries produced in Japan. The metaseries continue over ten years. In this series, heroines who fight against evil with their magical power, are designed as “Kawaii” characters, although they are not designed with baby shapes. The special issue of “Kawaii in Japan” in a monthly magazine “Pen” introduced “Pretty Cure” as one of the contents that represents the “Kawaii” culture in Japan [3].

Character figures of the heroines appeared in “Pretty Cure” are widely sold and very popular in Japan. There are three types of figures. “Scale (SC) models” possess the same body proportion of the heroines which appeared in the anime. The ratio of head to body size is almost 1:6.5 for the SC models. “Super-deformed (SD) models” possess proportionally large heads and short limbs. Among the SD models, “large SD (LSD) models” are almost the same size as the SC models, and “small SD (SSD) models” are almost half the size of the SC models. The ratio of head to body size is almost 1:4.1 and 1:2.5 for the LSD and SSD models, respectively.

In the present study, the correlation between the body proportion and the perception of “Kawaii” was investigated, using these different types of character figures of the “Pretty Cure” heroines.

2 Experiment

2.1 Methods

Thirty-three heroines appeared in the “Pretty Cure” metaseries. Unfortunately, only 28 heroines are produced and sold as SC models. Therefore, 28 SC, 33 LSD, and 33 SSD models are prepared as stimuli in the experiment. The body parts of the SC and LSD models can be moved and set them in different postures. However the body parts of the SSD models cannot be moved. Therefore, the body parts of the SC and LSD models are set at similar pastures of the SSD models. Each character figure was sat on a turntable placed on a table in a different random order for different participant.

Thirteen students (six males and seven females) participated in the experiment. The ages of the participants ranged from 20 to 23 years old. They sat on a chair and were requested to look at each figure turning on the turntable. Then the participants were requested to rate their impressions for the figure, using 25 seven-step bipolar semantic differential (SD) scales listed in Table 1, e.g., very dark, quite dark,

Table 1 Semantic differential scales used in the experiment and there factor loadings

SD scales			Factors		
			Stylishness	Activity	Cuteness
Ugly	–	Beautiful	0.84	−0.11	0.19
Loutish	–	Stylish	0.96	0.06	−0.11
Uncool	–	Cool	0.95	0.14	0.00
Childlike	–	Mature	0.86	0.00	−0.42
Boring	–	Fascinating	0.83	0.29	0.35
Thin	–	Thick	−0.89	−0.08	0.12
Light	–	Heavy	−0.72	0.16	0.02
Powerless	–	Powerful	0.70	0.62	−0.01
Round	–	Sharp	0.85	0.21	−0.33
Realistic	–	Fantastic	0.72	0.22	0.13
Old	–	New	0.74	0.19	0.39
Flaccid	–	Magnificent	0.51	0.73	−0.17
Weak	–	Strong	0.27	0.86	−0.17
Static	–	Dynamic	−0.41	0.81	0.12
Aggressive	–	Calm	−0.11	−0.87	0.30
Glum	–	Gay	0.04	0.92	0.18
Humble	–	Vivid	0.28	0.78	0.38
Passive	–	Active	0.19	0.92	0.01
Uncute	–	Cute	0.04	−0.19	0.90
Unfriendly	–	Friendly	−0.15	0.05	0.82
Sleepy	–	Excited	0.44	0.63	0.51
Mixed	–	Neat	0.18	−0.63	−0.01
Dark	–	Bright	0.05	0.61	0.64
Bathetic	–	Unique	0.64	0.56	0.17
Sober	–	Showy	0.54	0.61	0.39
Cumulative contribution ratio (%)			36.41	66.52	79.72

slightly dark, …, very bright [4]. In addition to the 25 SD scales, the participants rated the degree of preference for each stimulus using a single polar seven-step scale. The experiment was carried out in a dark room using daylight colored lights of 110 lx.

2.2 *Results and Discussion*

Numbers −3 to 3 were given for each of the seven categories on the SD scales. The mean value was calculated from the participants' responses for each combination of scale and stimulus. Then factor analysis was performed for these mean scores with the principal factor method and varimax rotation. The results showed that a three-dimensional space accounted for 79.7 % of data variance. Table 1 shows the

factor loadings of the scales for the three factors. Table 1 shows the resulting factor loadings for the 25 SD scales. The three factors are labeled "stylishness", "activity" and "cuteness" respectively, after the scales which show large absolute values in the loadings for these factors.

The factor scores were averaged over the SC, LSD and SSD models, respectively. Figures 1, 2 and 3 show the centroids for the three types of models with standard deviations. Figures 1, 2 and 3 show the stylishness—activity, stylishness—cuteness and activity—cuteness planes, respectively.

Figure 1 indicates that the SC models are perceived as stylish but the SSD models are perceived as loutish. The LSD shows the intermediate level of the stylishness. In fact, the results of one-way ANOVAs and Tukey's multiple-comparison tests showed significant differences between every pairs of different models in the significance level of $p < 0.05$. These results imply that as degree of deform increases, the degree of stylishness decreases.

Figure 1 also shows that the SSD models are perceived as less active than the SC and LSD models. The results of one-way ANOVAs and Tukey's multiple-comparison tests showed significant differences between the SSD and SC, and between the SSD

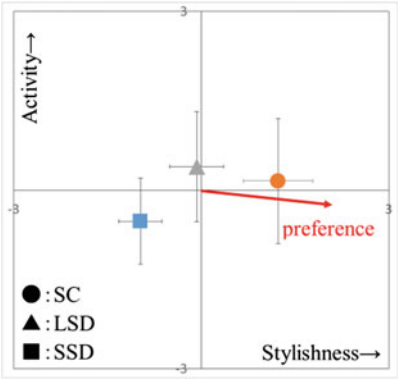

Fig. 1 Centroids with standard deviations for the SC, LSD SSD models on the stylishness—activity plane

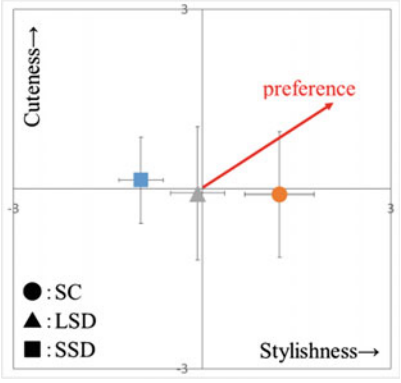

Fig. 2 Centroids with standard deviations for the SC, LSD, SSD models on the stylishness—cuteness plane

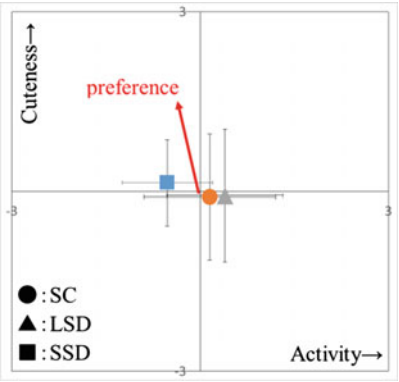

Fig. 3 Centroids with standard deviations for the SC, LSD, SSD models on the activity—cuteness plane

and LSD models in the significance level of $p < 0.05$. There was no significant difference between the SC and LSD models. The feature, which was common in the SC and LSD models and different between the SSD and the other two models, was the size of the figures, itself. Therefore, the results imply that the activity is deeply affected by the figure size: A small model is perceived as less active than a large model. The observation of the plots of all stimuli in Fig. 1 suggested that the figures painted in warm colors were tend to be perceived as active and the figures painted in cool colors were tend to be perceived as not active. This implied that the activeness was also affected by colors other than the figure size.

Figures 2 and 3 shows no significant differences among different models in the cuteness ($p < 0.05$). Moreover, the cases were not observed that figures for specific heroines were perceived as cuter than the other heroines. However, it was observed that a figure covered in bright colors or shaped in a round form tend to be perceived as cute. The cuteness may be affected by complex interactions of the form, color, shape and the other factors.

In the last step of the analysis a multiple-regression analysis was performed using the factor scores as independent variables and the degree of preference as a criterion variable. The coefficient of determination R^2 was 0.68. The multiple-regression line is shown in Figs. 1, 2 and 3 as vector. The vector shows the preference if deeply correlated with the stylishness and cuteness: The results showed that a stylish and cute figure is preferred, and the activity did not correlate with the preference, significantly.

3 Conclusion

In the present study, the impressions of 94 figures of heroines appeared in "Pretty Cure" metaseries were investigated using SD method. The results showed that the impression space was spanned by three factors, stylishness, activity and cuteness. The stylishness was deeply affected by the proportion ratio of head to body size,

and the activity was deeply affected by the figure size, itself. Other than the figure size, it was suggested that colors cover the figures also affect the activity. The cuteness or degree of "Kawaii" did not depend on only one factor. It was suggested that the complex interaction of many factors determine the degree of cuteness. The results shown in the present study contribute to designing not only figures but also characters in various kinds of contents.

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Evaluation of Levels of Kawaii Ribbons Among Genders and Generations of Japanese and Saudi Arabians

Enayyah Barnawi and Michiko Ohkura

Abstract Kawaii is a Japanese word that represents one critical kansei value in Japan. Generally, it is translated into English as cute, lovely, or adorable. However, it has a deeper meaning since it also represents an element of Japanese culture and not just a word with a single meaning. Kawaii expression have become familiar to many people around the world, including the young generations of Saudi Arabians. This research observes levels of kawaii and examines the differences and similarities of kawaii levels among genders and generations of Japanese and Saudi Arabians. Also, we divided our targets of evaluation into Japanese, Saudi Arabians in Japan, and Saudi Arabians in Saudi, to examine the impact a new culture might have on the selection of Saudi Arabians in Japan. Using the analysis results of the collected data, we compared the selection tendencies of levels of kawaii ribbons between Japanese and Saudi Arabians.

Keywords Kawaii ribbons · Pattern · Color · Japanese · Saudi Arabians in Japan · Saudi Arabians in Saudi

1 Introduction

In recent years, kansei engineering became crucial in industrial fields. The Japanese Ministry of Economy, Trade and Industry (METI) believes that a special type of positive economic value is created when industrial production is derived from

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kansei [1]. This declaration motivated researchers to study different kansei values, including kawaii values.

The term kawaii has been used in Europe and the rest of the world since the 1990s when such items of Japanese popular culture as manga, extravagant street fashions, and video games began to be exported [2]. Kawaii can be considered a 21st century transnational piece of culture that has been disseminated outside of Japan's borders [2]. It is a word with a positive meaning that can be translated into English as cute, lovely, or adorable [3, 4]. However, it represents an important element of Japanese culture rather than just a word with a single meaning.

Kawaii culture has been introduced into many countries, including Saudi Arabia.

To some extent, it has already become a familiar expression among Saudi youth. Even though the word kawaii is used globally, the same images for it don't have to be adapted worldwide. Cultural differences, geographical differences, and other factors impact how people worldwide adapt kawaii expression. Kyoko Koma argued that research is required to determine how kawaii culture is seen and interpreted as a reflection of globalized culture/orientalism in individual foreign countries [2].

Many researches have studied kawaii from different points of view. Such kawaii attributes as color have been studied [5] as well as the relationship between kawaii attributes and industrial products [6] and kawaii feelings evoked by textures [7]. Kawaii feelings have been categorized into relaxing and exciting while looking at photos [8]. Some research evaluated kawaii design in Japan and different cultures in term of cars and fashion attire [9].

This study observes the levels of kawaii rather than evaluating its attributes to determine the differences and similarities of the selection tendencies among genders and generations of Japanese Saudi Arabians. The targets of this study were classified into: Japanese, Saudi Arabians in Japan, and Saudi Arabians in Saudi. By this classification, we aim to clarify that to which extent a new culture could affect the way people adapt kawaii. Focusing on the effect of living in Japan, we compare the selection tendencies of the Saudi Arabians living in Japan and that of those living in Saudi Arabia. The evaluation's object was ribbons with different colors and patterns. Our evaluation method was a web-based questionnaire system that was developed and distributed in both countries.

2 Background of Kawaii Ribbons

In 2012 a study evaluated kawaii ribbons among genders and different ages in Japan [10]. The participants were men in their 20's and women in their 20's, 40's, and 50's. The result identified that colors and patterns had significant effect on kawaii evaluation. Also, the selection tendencies were almost the same between men and women in their 20's. However, the ranks of orange and purple were higher in women than in men. On the other hand, the selection tendencies were almost the same between women in their 40's and 50's and women in their 20's. However, the

ranks of achromatic color were higher in women in their 40's and 50's than in women in their 20's.

3 Methodology

3.1 Kawaii Ribbon Candidates

In our study we have one ribbon shape, three patterns, and seven colors for a total of 21 ribbon candidates (Fig. 1). The shape and patterns were selected from a reference [11]. Six colors were selected from the results of previous research and an achromatic color was added.

3.2 Ribbon Comparison Method

Our experiment only compared ribbons with identical patterns and different colors (Fig. 2) and ribbons with identical colors and different patterns (Fig. 3). The total number of compared ribbons was 84 and each ribbon appeared eight times.

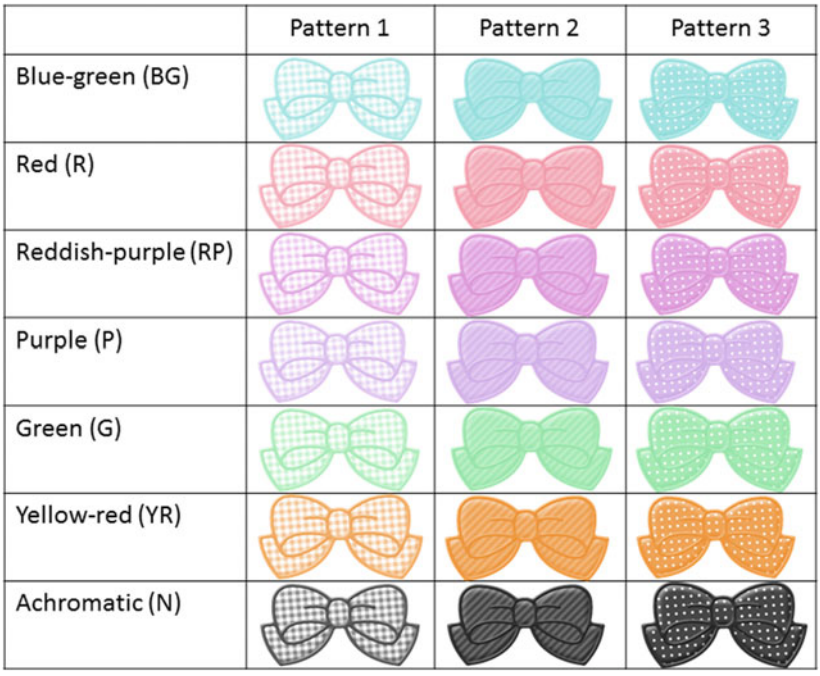

Fig. 1 Kawaii ribbon candidates

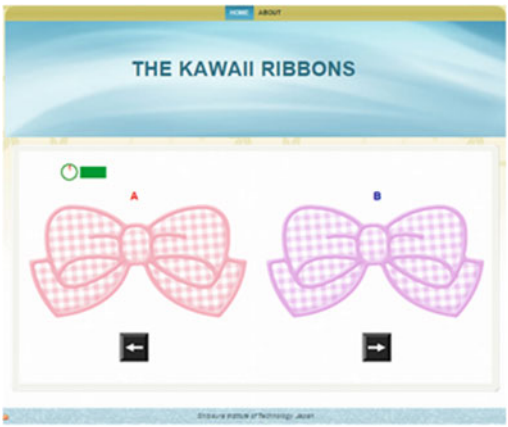

Fig. 2 Pairs with identical patterns and different colors

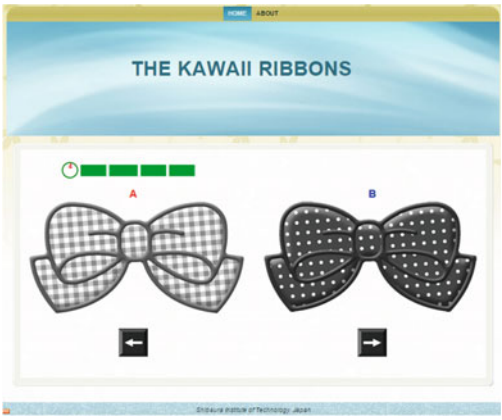

Fig. 3 Pairs with identical colors and different patterns

3.3 Overview of Web Questionnaire System

For our experiment, we developed a web questionnaire system (using PHP and MySQL) that is accessible worldwide through such web browsers as Internet Explorer and Google Chrome. To guarantee more accurate results, the questionnaire was designed to be only conducted on a PC or laptop (not on mobile phones) to avoid potential differences in screen brightness.

3.4 Web Questionnaire System Schema

Our web questionnaire system was divided into three main sections.

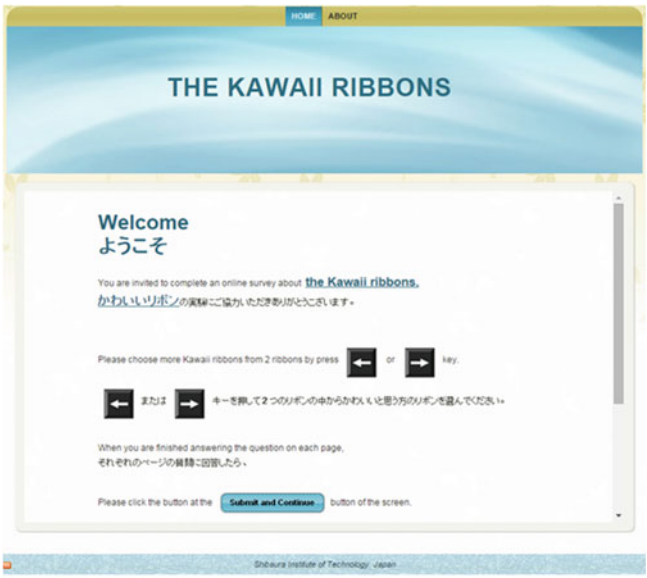

Fig. 4 English and Japanese instructions page

Section 1. Represents the first part of the system, consists of the following pages:

- English and Japanese instructions page: This first page explains the experiment, including the necessity of using keyboard arrows to make the selections during the comparisons (Fig. 4).
- Arabic instruction page: this page summarizes all the information and instructions that the Saudi, non-English speaker participants need to complete the questionnaire.
- Ethical agreement page: this page served as a consent document that explains the experiment's purpose, the required time to finish it, handling of the results, etc. The participants indicated their agreement by pressing "submit" to proceed to the questionnaire.
- Selection page of participant attributes: gender, age group (20–29, 30–39, 40–49, 50–59, and 60–69), and country.
- Instructions about ribbon selection page: on this page the participants are informed that since each ribbon pair will only appear for five seconds and then it will disappear, they need to make their selection quickly.

Section 2. Represents the main part of the system: the comparison process.

Section 3. Which is the last part of the web questionnaire system, is a 5-scale questionnaire about the selection reason (5: strongly agree, 4: agree, 3: natural, 2: disagree, 1: strongly disagree).

- Q1: Kawaii designs
- Q2: Kawaii colors
- Q3: Kawaii whitish ribbons
- Q4: Total impression
- Q5: First impression

The data were collected by distributing links to the system in Saudi Arabia and Japan.

The collected data were saved in a database, and the necessary results were extracted by MySQL.

4 Result

4.1 Participants

Japanese and Saudi Arabian men and women from different age groups participated in our web questionnaire system. We had two categories for the Saudi Arabian participants, Saudi Arabians living in Japan and Saudi Arabians in Saudi. The reason is that we want to examine the impact a new culture might have on the selection of Saudi Arabians living in Japan. We got a total of 71 males and females participated in our experiment: ten Japanese females and 16 Japanese males both in their 20's, ten Saudi females living in Japan and 16 Saudi males living in Japan both in their 20's and 30's, six-teen Saudi females in Saudi and three Saudi males in Saudi both are from different age groups. However, we discarded the data we obtained from Saudi males in Saudi because the number of participation was not sufficient.

4.2 Questionnaire Data for Each Participant Group

Each participant was shown a total of 84 pairs (one pair at a time) and told to select the most kawaii one within five seconds. Figures 5, 6, and 7 illustrate the selection tendencies of the five groups (Japanese males and females, Saudi males and females in Japan, and Saudi females in Saudi). The total number of cumulative comparisons of each ribbon was 80 for the Japanese females and Saudi females living in Japan, and 120 for the Japanese males, Saudi males in Japan, and Saudi females in Saudi. The vertical axis shows the ribbon types, and the horizontal axis shows the number of selections.

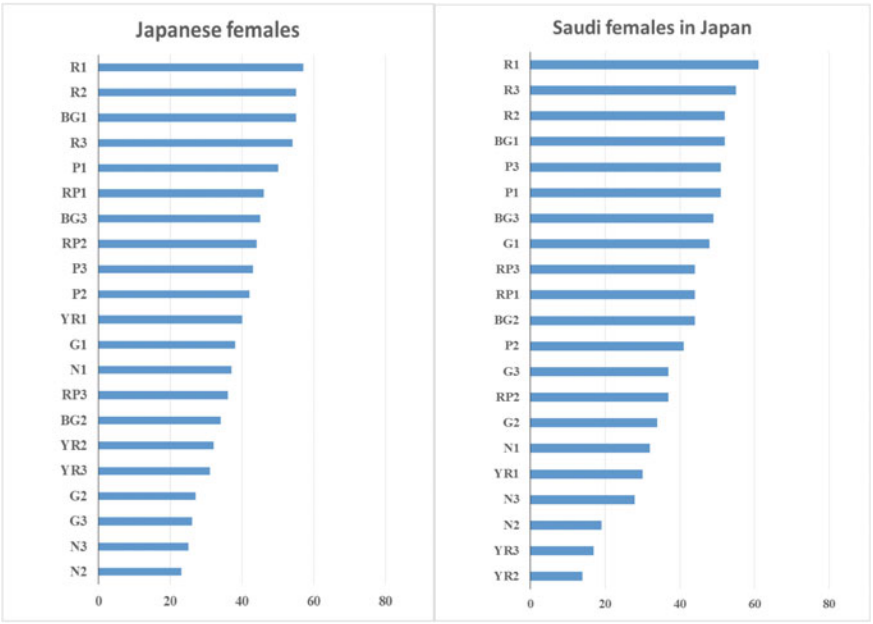

Fig. 5 Cumulative data of numbers selected for each ribbon (*Japanese females and Saudi females in Japan*)

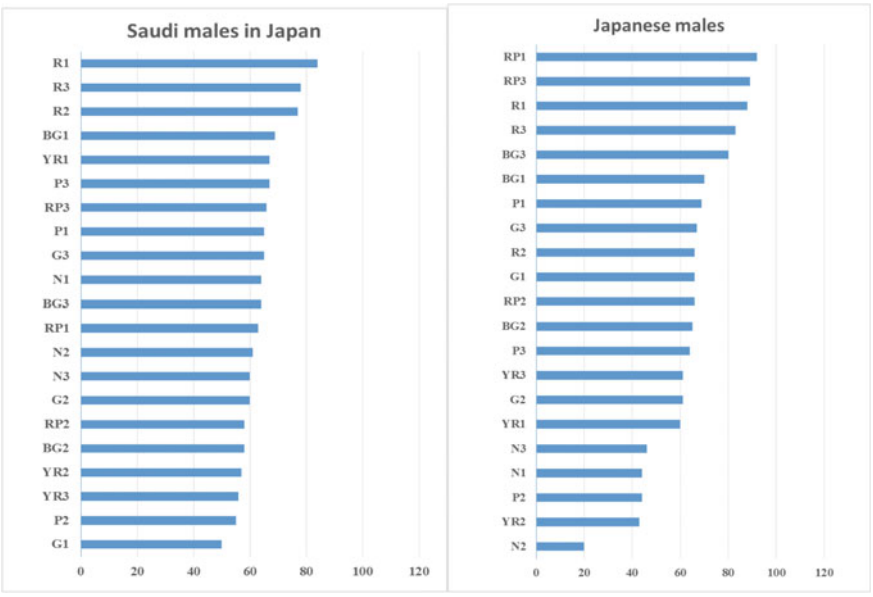

Fig. 6 Cumulative data of numbers selected for each ribbon (*Saudi males in Japan and Japanese males*)

Fig. 7 Cumulative data of numbers selected for each ribbon (*Saudi females in Saudi*)

4.3 Results of 2-Factor Analysis of Variance

All of the cumulative data shown in Figs. 5, 6, and 7 were separately analyzed. The colors and patterns served as factors in the 2-factor analysis of variances. The results of each group are in the following sections:

Japanese Females. Pattern and color had a main effect at a 5 % significance, but there was no significant effect in the interaction of the two factors. For a low-level test, we got the following tendencies of the averaged scores of the kawaii degree:

- Color: R > P>BG > RP > YR > G>N
- Pattern: Pattern 1 > Pattern 3 > Pattern 2

Saudi Females in Japan. Pattern and color had a main effect at a 5 % significance, but there was no significant effect in the interaction of the two factors. For a low-level test, we got the following tendencies of the averaged scores of the kawaii degree:

- Color: R > BG > P>RP > G>N > YR
- Pattern: Pattern 1 > Pattern 3 > Pattern 2

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- Color: RP > R>BG > G>P > YR > N
- Pattern: Pattern 3 > Pattern 1 > Pattern 2

Saudi Males in Japan. Color had a main effect at a 5 % significance, but pattern had no significant effect. Also, there was no significant effect in the interaction of the two factors. For a low-level test, we got the following tendencies of the averaged scores of the kawaii degree:

- Color: R > BG > P&RP > N>YR > G
- Pattern: Pattern 1 > Pattern 3 > Pattern 2

Saudi Females in Saudi. Color had a main effect at a 5 % significance, but pattern had no significant effect. Also, there was no significant effect in the interaction of the two factors. For a low-level test, we got the following tendencies of the averaged scores of the kawaii degree:

- Color: R > RP > P>G > BG > N>YR
- Pattern: Pattern 3 > Pattern 1 > Pattern 2

The result showed that the red color (R) was selected in the top-three by all five groups. On the other hand, the orders of yellow-red (YR) and achromatic color (N) were low in all five groups. Also, all five groups agreed the pattern 2 is the least kawaii pattern. Japanese females, Saudi females in Japan, and Saudi males in Japan, identified pattern 1 as the most kawaii. However, Japanese males and Saudi females in Saudi identified pattern 3 as the most kawaii. The results also showed that the selection tendencies of the top kawaii ribbons are almost the same among Japanese females, Saudi females in Japan, and Saudi males in Japan, however it is totally different for the bottom selected ribbons.

4.4 Results of 3-Factor Analysis of Variance

Pattern, color, and country served as factors in this analysis. We performed a detailed analysis (top-three, bottom-three, and over all data analysis) for Japanese females and Saudi females in Japan, we addressed the similarities and differences in their selection tendencies and offered possible explanations for these tendencies in [12]. We also performed the 3-factor analysis for Saudi females in Japan and Saudi females in Saudi, we found a main effect at 5 % significant in the two way interaction between country and color. On the other hand, the analysis results for Japanese males and Saudi males in Japan showed a main affect at 5 % significant in the two way interaction between country and color, and country and pattern.

4.5 Analysis of Selection Reason

Figures 8, 9, 10, 11 and 12 show the histograms of the 5-scale questionnaires for all five participant groups. The majority of the five groups agreed that designs and colors were kawaii. On the other hand, more than half of Japanese females, half of Japanese males and Saudi females in Saudi put importance on whitish ribbons. For the total impression and first impression, Japanese males, Saudi males in Japan, and Saudi females in Saudi put more emphasis on their total impression of their kawaii observations rather than the first impression. For Saudi females in Japan and Japanese females, both put importance on their total and first impression equally.

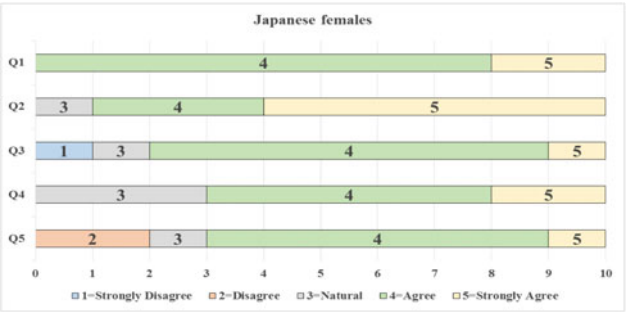

Fig. 8 Histogram of 5-scale questionnaire (*Japanese females*)

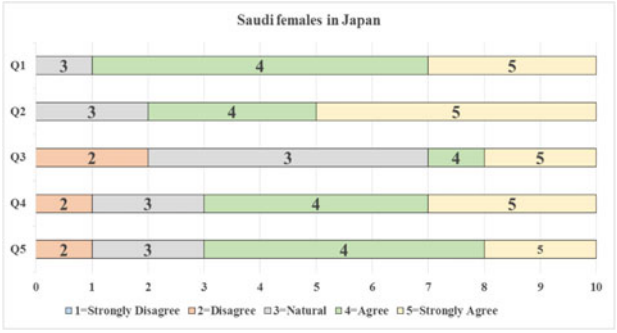

Fig. 9 Histogram of 5-scale questionnaire (*Saudi females in Japan*)

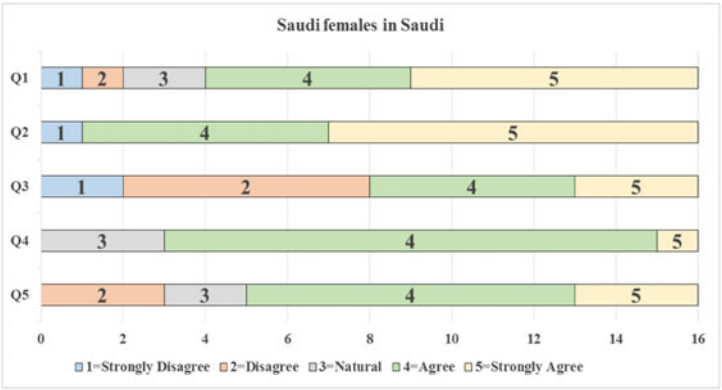

Fig. 10 Histogram of 5-scale questionnaire (*Saudi females in Saudi*)

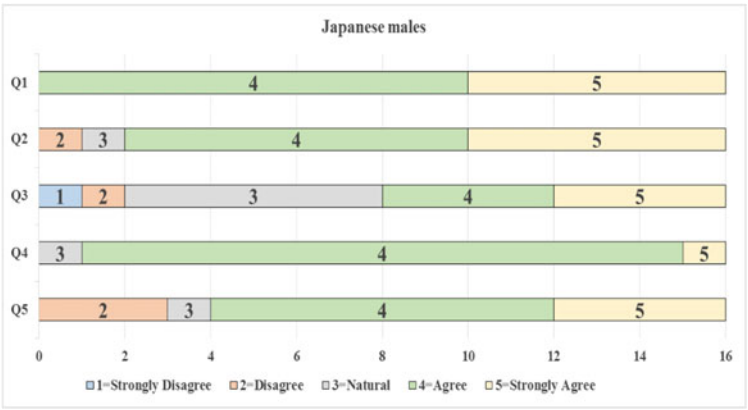

Fig. 11 Histogram of 5-scale questionnaire (*Japanese males*)

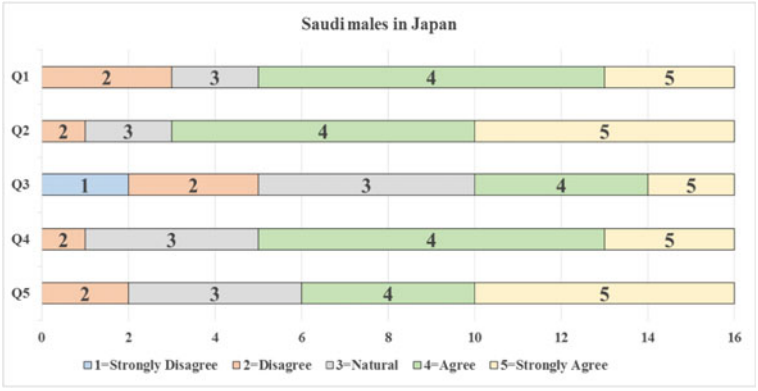

Fig. 12 Histogram of 5-scale questionnaire (*Saudi males in Japan*)

5 Discussion and Conclusion

In this paper, we represented our attempt to discover the similarities and differences in the selection tendencies of kawaii levels among genders and generations of Japanese and Saudi Arabians and address the cultural and environmental impact on these tendencies. We selected a ribbon as our evaluation object because ribbons are generally considered to be kawaii. We wanted to determine the effect of different colors and patterns on a ribbon's kawaii level.

From the cumulative data and the results of 2&3-factor analysis of variances, we obtained the followings:

- The red color (R) appeared in the top-three selected kawaii colors for all the five groups.
- All five groups agreed that pattern 2 is the least kawaii pattern.
- The orders of yellow-red (YR) and achromatic color (N) were low in all five groups.
- Our analysis results showed that there is a significant difference in the selection tendencies between Saudi females in japan and Saudi females in Saudi. On the other hand, the tendencies of Japanese females and Saudi females in japan are almost the same.
- Both Japanese females and Saudi females in japan selected (R1) red with pattern 1 as the most kawaii ribbon, and both had R, BG, and P in the top-three selected colors. They also agreed that pattern 1 is the most kawaii pattern.
- Saudi females in Saudi chose (R3) red with pattern 3 as the most kawaii ribbon, and they had R, RP, and P as their top kawaii colors. For pattern, they chose pattern 3 as the most kawaii pattern unlike the other two female groups.
- We found a significant difference in the selection tendencies of Japanese males and Saudi males in Japan.
- Japanese males chose (RP1) reddish-purple with pattern 1 as the most kawaii ribbon, and they had RP, R, and BG as their top kawaii colors. They identified pattern 3 as the most kawaii pattern just like Saudi females in Saudi.
- Saudi males in Japan chose (R1) reddish-purple with pattern 1 as the most kawaii ribbon—just like Japanese females and Saudi females in Japan-, and they had R, BG, and P&RP as their top kawaii colors. They identified pattern 1 as the most kawaii pattern just like Japanese females and Saudi females in Japan.

These results are summarized as follows:

- The selection tendencies for Saudi male in Japan is quite similar to the tendencies of Japanese females and Saudi females in Japan.
- The similar observation of the most kawaii ribbons and the most kawaii pattern for Japanese females and Saudi females in Japan, and the different one for Saudi females in Saudi, proves that a new environment or culture have a significant impact on kawaii observation.
- The difference in the selection tendencies between Japanese males and Saudi males in Japan proves that Saudi males adapt kawaii differently compared to Japanese males. The authors suggest that may be because kawaii is basically a

feminine-nature value, and considering the nature of men, even a new environment didn't affect the selection tendencies of Saudi males in Japan like the way it affected the selection of Saudi females in Japan.

Based on the obtained results, we clarified that kawaii observation varies among genders and generations of Japanese and Saudi Arabians.

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The Study of Kawaii Feeling by Using Eye Tracking

Tipporn Laohakangvalvit, Ikumi Iida, Saromporn Charoenpit and Michiko Ohkura

Abstract Kansei value has been considered as one of the important factors in the manufacturing in Japan. Kawaii, which is a positive adjective that has such positive meaning as cute or lovable, becomes more important as a kansei value. Currently, there are researches that evaluate kawaii feeling by employing various biological signals. However, the eye tracking has not been conducted in detail yet. Therefore, we employed it in our research to find the relationship between kawaii feeling and eye movement. Previously, we performed an experiment on the preferences of kawaii illustrations by selecting one of the six kawaii illustrations. However, we could not perform detailed analysis due to the complexity of eye movement and the calibration-free data. Therefore, we improved the experiment method by randomly showing only two illustrations at a time selected from the six. From the analyzed result, we clarify the relationship between kawaii feeling and eye movement.

Keywords Kansei value · Kawaii · Eye tracking

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1 Introduction

Kansei engineering is a consumer-oriented methodology for product development. It has been considered as the important part in a broad range of the manufacturing in Japan for more than twenty years. It was defined as "the translating technology of a consumer's feeling (Kansei) and image for a product into the physical design elements" [1]. Kansei value that has been added to the product can improve the ordinary products to have an economic value. According to the benefit of kansei value, the Japanese Ministry of Economy, Trade and Industry (METI) proposed it as a new value axis which is the fourth most important characteristic of industrial products after function, credibility, and cost in 2007 [2]. The examples of kansei value toward the products that have been widely applied such as enjoyment, coolness, and user friendliness. In addition, Kawaii has also been proposed as kansei value. It has such positive meanings as cute, lovable, and charming. It has an important role in the worldwide success of many products such as Hello Kitty and Pokemon [3, 4]. According to this success, kawaii is considered as a key factor for the product design and development in the future. The researches have been conducted to explore such kawaii attributes to design kawaii products as shapes, colors, sizes, texture and tactile sensation [5]. Furthermore, the researches on kawaii feeling evoked by those kawaii attributes have been studied in a systematic way in which the biological signals were employed such as heart beats and brain waves [6]. However, using eye tracking to study on kawaii feeling has not been conducted in detail yet. Eye tracking has been widely used in various research fields including emotion, human-computer interaction, and product development. Those researches revealed that the eye tracking can be used to recognize the emotional states and the preferences of human. For example, the design of such daily-life products as wristwatch and mobile phone were evaluated by using eye tracking to explore the product components that attract user's attention [7, 8]. Therefore, eye tracking is considered to be the effective biological signal that can be used to evaluate the mental states or implicit needs of people.

In our research, we employed eye tracking to evaluate the kawaii feeling. The objective was to find the relationship between kawaii feeling and eye movement. Previously, we performed an experiment on the preferences of kawaii illustration which recorded the eye tracking while the participants were choosing one of the six kawaii illustrations on a display [9]. The result clarified the differences between the most preferred and the most kawaii illustrations and the differences in preferences between genders. However, the eye tracking result recorded from the calibration-free eye tracking device was not accurate enough for the detailed analysis to clarify the relation between kawaii feeling and eye movement. The reason was the six illustrations were shown at the same time which caused the complexity of the eye movement.

To solve the problem of the previous experiment, we improved the experiment method by showing only two illustrations at a time randomly selected from the six. The two illustrations were enlarged from the previous experiment to show the

details more clearly. Also, all of the participants were asked to calibrate their eyes before starting the evaluation of the illustrations. Then they were asked to choose one of the two illustrations on the display and their eye tracking was recording during the process. For the last part, they were asked to answer the questionnaire on their opinions about the reason of choosing the illustrations, the most kawaii and the most preferred illustrations. From the experimental results, we analyzed the eye tracking data, cumulative kawaii scores, and the questionnaire results. This paper describes our experiment to clarify the relationship between kawaii feeling and eye movement.

2 Experimental Method

2.1 Web Questionnaire System

A web questionnaire system was modified from the system used for the evaluation of kawaii ribbons [10]. The system used six illustrations, No. 1 to No. 6 as shown in Fig. 1, as visual stimuli. They were originally drawn to eliminate the preference bias that may occur in the illustrations of well-known or previously-known cartoon characters.

The six illustrations were displayed in pairs. Thus, the total number of compared pairs was 30 pairs. Since the participants of this research were only Japanese, the content of the system was all described in Japanese language. The structure of the system is described as follows:

1. Top page: Explanation of the questionnaire
2. Selection of participant's general demographic information: Gender and age.
3. Explanation of selection of illustrations: The illustrations were displayed in pairs for 5 s. Selection of more-kawaii illustrations should be performed by using keyboard's left or right arrow key.
4. Selection of illustrations: The illustrations were displayed and selected for 30 pairs in random order for each participant. An example of screenshot of this page is shown in Fig. 2.

Fig. 1 The illustrations

Fig. 2 Example of page for selection of illustrations

5. Questionnaire: Three questions based on participant's opinion were asked including the reason for selecting the illustrations (free description), the most kawaii illustration, and the most preferred illustration.

After the participants submitted the questionnaire, the system showed the final page to inform that the questionnaire was finished. The results of the selection of illustrations and questionnaire were saved to the database.

2.2 Experimental Setup and Procedures

Figure 3 shows the experimental setup. The web questionnaire was accessed from the eye tracking system through a web browser, i.e. Google Chrome, in which its system was running on a separated PC due to the limited resource. The eye tracking system employed EyeTech TM3 non-intrusive eye tracker (EyeTech Digital Systems, Inc.) and QG-PLUS software (DITECT Co., Ltd.) to record the eye movement and display the eye tracking data. A 19-inch LCD monitor with a resolution of 1280 × 1024 pixels was used in this experiment.

The experimental procedures were as follows:

1. Participants sat on the chair in front of the PC.
2. Participants read the explanation sheet.
3. Experimenter performed the eye calibration of the participants
4. Experimenter showed the web questionnaire and started recording the eye tracking.
5. Participant selected the illustrations for 30 times.
6. Participant answered the questionnaire.
7. Experimenter stopped recording the eye tracking.

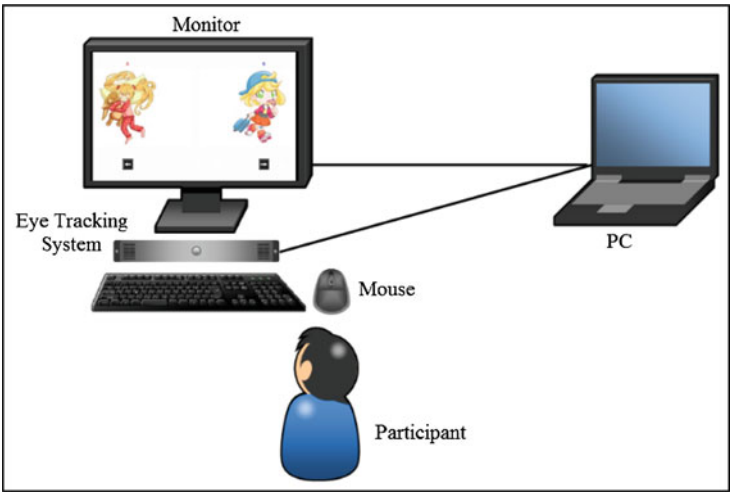

Fig. 3 Experimental setup

3 Experimental Method

3.1 Participants

The experiment was performed with 38 volunteer participants (14 males in their 20's, 10 females in their 20's, and 14 females in 65 years old or more). However, only 21 eye tracking data (7 males in their 20's, 8 females in their 20's, and 6 females in 65 years old or more) were successfully collected.

3.2 Result of the Selection of Illustrations and Questionnaire

The cumulative data were collected from 38 participants including the kawaii scores, the number of participants who selected the most kawaii illustrations, the number of participants who selected the most preferred illustrations, and the reason for selecting the illustration. From these cumulative results, the ranking was done as shown in Tables 1, 2, and 3 respectively.

From the analysis of results, the first ranking tendencies between the kawaii scores and the selected most kawaii illustrations were similar; illustration #3 and #4 (males 20's), #2 (females 20's), and #1 (females 65 or more). In addition, the first ranking tendencies of the selected most preferred illustration were the same for all three participant groups which were illustration #4.

Table 1 Ranking based on cumulative kawaii scores

Group	Ranking of illustration ⟨Kawaii score⟩					
	1st	2nd	3rd	4th	5th	6th
Male 20's	#3⟨90⟩	#2⟨79⟩	#4⟨73⟩	#6⟨63⟩	#5⟨59⟩	#1⟨56⟩
Female 20's	#2⟨69⟩	#4⟨60⟩	#1⟨51⟩	#3, #6⟨41⟩		#5⟨38⟩
Female ≥ 65	#1⟨99⟩	#3⟨77⟩	#6⟨69⟩	#2⟨67⟩	#4⟨63⟩	#5⟨45⟩

Table 2 Ranking based on selected most kawaii illustrations

Group	Ranking of illustration ⟨Number of participants⟩					
	1st	2nd	3rd	4th	5th	6th
Male 20's	#3,#4⟨4⟩		#6⟨3⟩	#2⟨2⟩	#5⟨1⟩	#1⟨0⟩
Female 20's	#2⟨4⟩	#3, #6⟨2⟩		#4, #5⟨1⟩		#1⟨0⟩
Female ≥ 65	#1⟨4⟩	#3, #6⟨3⟩		#2, #4⟨2⟩		#5⟨0⟩

Table 3 Ranking based on selected most preferred illustrations

Group	Ranking of illustration ⟨Number of participants⟩					
	1st	2nd	3rd	4th	5th	6th
Male 20's	#4⟨5⟩	#3⟨3⟩	#2, #5, #6⟨2⟩			#1⟨0⟩
Female 20's	#4⟨5⟩	#2⟨4⟩	#6⟨1⟩	#1, #3, #5⟨0⟩		
Female ≥ 65	#4⟨6⟩	#3⟨3⟩	#1, #2⟨2⟩		#6⟨1⟩	#5⟨0⟩

Next, we analyzed the reasons of selecting the illustrations collected from the questionnaire. Most reasons were specified on the eye size, face shape, and hairstyle. Some other reasons mentioned about color, gesture, costume, facial expression, and the baby shape of the illustrations.

3.3 Result of the Eye Tracking Data

Based on the rankings of cumulative results, we recalculated and ranked them from only 21 participants whose eye tracking data were successfully recorded in order to use them with the analysis of eye tracking data.

In general, the eye tracking data from the total of 30 pairs should be used for the analysis. However, the results showed that the selections were performed only during the first few times that the participants watched the illustrations. This result affected to the latter selections that the participants took shorter times to select the illustration based on their previous decisions instead of the consideration of illustrations that were currently displayed. Figure 4 showed an example of the total duration to decide which had negative linear relationship or gradually decreased as the number of times to select the illustrations increased. The eye tracking data from

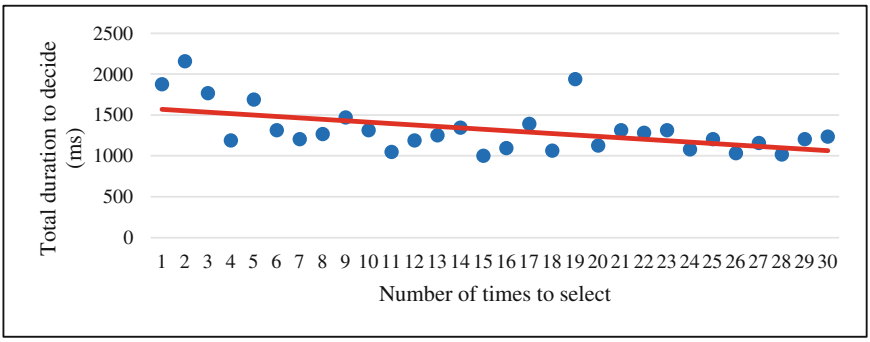

Fig. 4 Example of total duration to decide versus number of times to select

Fig. 5 Example of AOIs

these selections were considered to be unrelated to the kawaii feeling. Therefore, the eye tracking data of the first 15 pairs of illustrations was used for the analysis.

To analyze the eye tracking data, we employed "fixation" and "Area of Interest (AOI)". The fixation is defined as the state of the eye when it remains still or looks at the same spots over a period of time (threshold). The value of threshold was set to be initial value at 0 ms. The AOI is defined as the area used to include or exclude certain areas from analysis. For the analysis of this experiment, we defined two AOIs for left-side illustration and right-side illustration as shown in Fig. 5. The AOIs were created as ellipse based on the illustration with the largest width and height (#4). Then all of the other illustrations applied the same shape and size so that the area for analysis of all illustrations were balanced.

We analyzed eye tracking data by employing five eye tracking metrics for this experiment. The results of each eye tracking metric were described in the following sections.

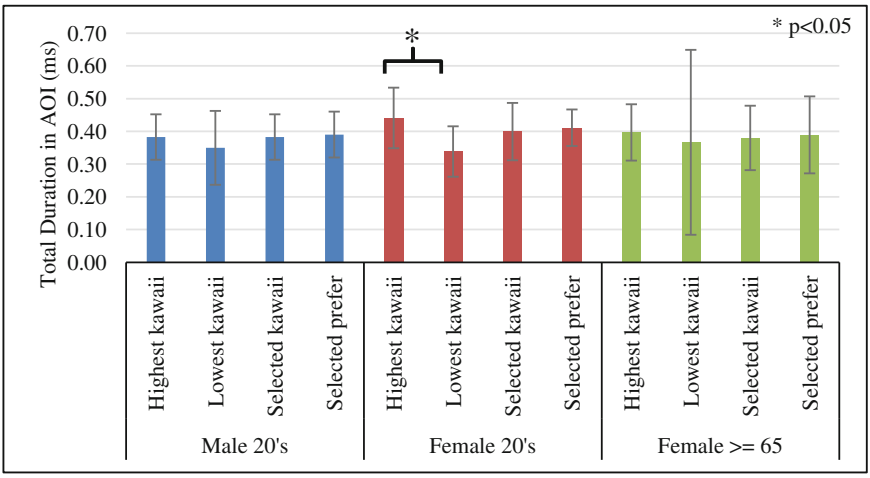

Fig. 6 Total duration in AOI versus illustration groups of females in their 20's

3.3.1 Total Duration in AOI

(Sum of durations of all fixations that hit in AOI) We analyzed the total duration in AOI with two factors which are the participant groups and the illustration groups from the cumulative results including highest kawaii score, lowest kawaii score, most selected kawaii, and most selected preferred. The total duration in AOI among illustration groups were analyzed for both all participants and grouped participants. Paired t-test was run to determine whether there was a statistically significant mean difference between the total duration in AOI among four groups of illustrations. The result showed that there was a significant difference in total duration in AOI between illustration with highest kawaii score and that of lowest kawaii score ($p < 0.05$) for females in their 20's. For other illustration groups and other participant groups, there were no significant differences in total duration. The result of average total duration in AOI is illustrated in Fig. 6.

3.3.2 Total Number of Fixations

(Sum of all fixations that hit in AOI in which the fixation threshold is 200 ms) We analyzed the total number of fixations with two factors which are the participant groups and the illustration groups. The statistical analysis was performed with the same method as the one for total duration in AOI in Sect. 3.3.1. The result of all participants from paired t-test showed that there was a significant difference in total number of fixations between highest kawaii score and lowest kawaii score ($p < 0.05$) and between most selected kawaii and lowest kawaii score ($p < 0.05$), as illustrated in Fig. 7. Furthermore, the result of grouped participants from paired

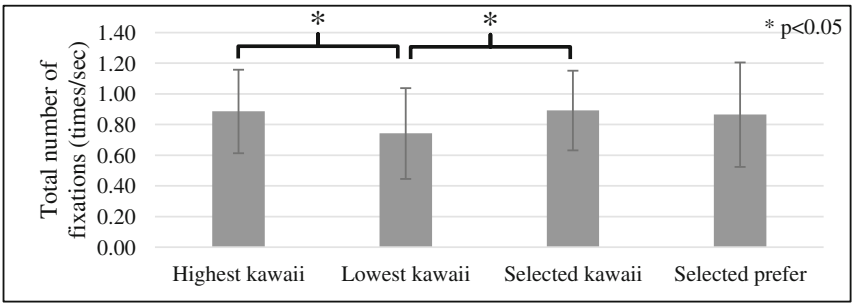

Fig. 7 Total number of fixations versus illustration groups of all participants

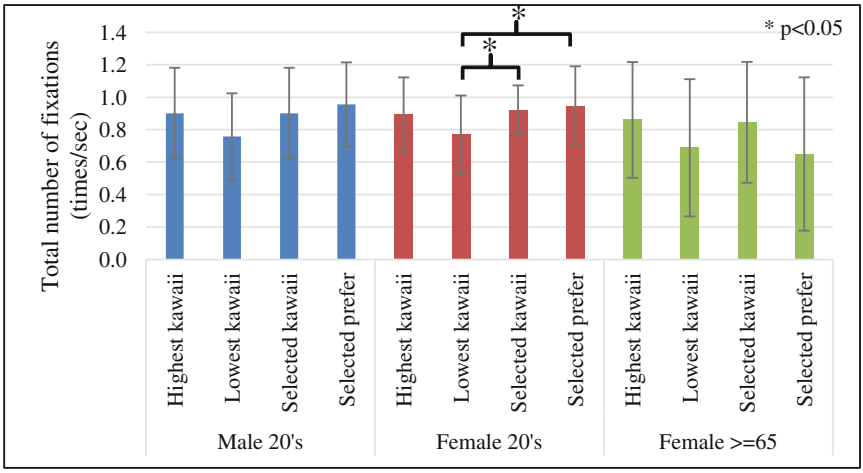

Fig. 8 Total number of fixations versus illustration groups and participant groups

t-test showed that there was a significant difference in total number of fixations between most selected kawaii and lowest kawaii score ($p < 0.05$) and between most selected preferred and lowest kawaii score ($p < 0.05$) for females in their 20's. For other groups of illustrations and other participant groups, there were no significant differences in total number of fixations. The result of average total number of fixations is illustrated in Fig. 8.

3.3.3 Number of Transitions Between AOIs

(Sum of times that the eye moves between AOIs for each pair of illustrations. The movement of one fixation in an AOI to another fixation in the other AOI was counted as 1 transition) We analyzed number of transitions between the two AOIs

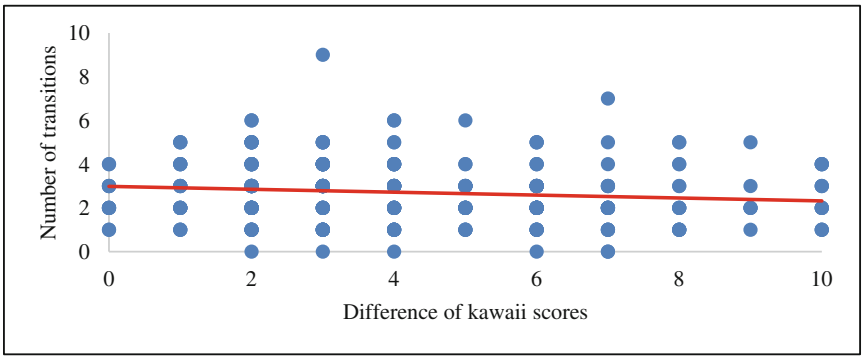

Fig. 9 Number of transitions between AOIs and difference of kawaii scores of all participants

for all participants and each participant group. As we considered each pair of illustration, the difference of kawaii scores between them were calculated from the cumulative data and used for this analysis. A Pearson product-moment correlation was run to determine the relationship between the number of transitions and the difference of kawaii scores. The result showed that there was a negative correlation between the number of transitions and the difference of kawaii scores, which was statistically significant ($p < 0.05$). The scatterplot between these two variables, as illustrated in Fig. 9, shows that they have a linear relationship with negative correlation.

Furthermore, we analyzed this index for each participant group. The results showed similar tendencies as in the result of all participants for both males in their 20's and females in 65 years old or more that there was a negative correlation between the number of transitions and the difference of kawaii scores with statistically significant ($p < 0.10$). The result of females in their 20's did not show the statistically different for the correlation. However, it also had a similar tendency as in other participant groups that was a negative linear relationship between the number of transitions and the difference of kawaii scores.

3.3.4 Number of Matching Between the Last-Fixation Illustrations and the Selected Illustration

We collected and analyzed the number of matched and unmatched for each pair of illustrations between the last-fixation illustrations and the selected illustration from cumulative data. Paired t-test was run to determine whether there was a statistically significant mean difference between the number of matched and unmatched for each participant groups. The result from each participant group showed that there was significant difference in number of matching between the last-fixation illustrations and the selected illustration ($p < 0.01$). The results were illustrated in Fig. 10.

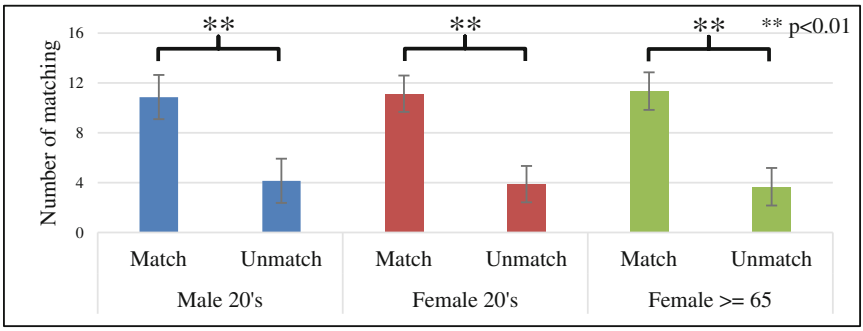

Fig. 10 Number of matching between last-fixation illustration and selected illustration

4 Discussion

From the analysis of rankings based on cumulative results, they showed the similarity of the first and last ranking tendencies between the results of cumulative kawaii scores and selected most kawaii illustrations. In addition, the first ranking tendencies of selected preferred illustrations were similar for all participant groups.

The analysis of eye tracking included five eye tracking metrics. The analyzed results were as follows:

- *Total duration in AOI* of females in their 20's showed significant difference between illustrations with highest and lowest kawaii scores. It showed that females in their 20's tended to look longer on the kawaii illustrations, while other participant groups showed average attention to all illustration groups.
- *Total number of fixations* of all participants showed significant difference between the illustrations with highest kawaii scores and selected kawaii illustrations versus the illustrations with lowest kawaii scores. The illustrations with highest kawaii scores and selected kawaii illustrations had larger number of fixations.
- *Total number of fixations* of females in their 20's showed significant difference between selected kawaii illustration and illustration with lowest kawaii score, and between selected preferred illustration and illustration with lowest kawaii score. It showed that females in their 20's tended to look more frequently on the kawaii and preferred illustrations.
- *Number of transitions between AOIs* versus the difference of kawaii scores had a significantly negative correlation for all participants, males in their 20's, and females in 65 or more. For females in their 20's, the result also showed negative tendencies which were similar to other participant groups.
- *Number of matching between the last-fixation illustrations and the selected illustration* showed that there was significant difference in number of matching between them for all participant groups. The larger number of matching showed that the participants tended to look lastly at the illustrations they selected.

5 Conclusion and Future Work

This article introduces our improved experiment from our previous study [9] on the study of kawaii feeling by using eye tracking. We performed the experiment by using the web questionnaire system along with the eye tracking system. The recorded eye tracking data was used to clarify the relationship between kawaii feeling and eye movement.

We obtained the results that the females in their 20's tended to long longer and more frequently on the kawaii and preferred illustrations. Moreover, all participants tended to take longer time to compare the pairs when their kawaiiness were similar. In addition, all participants tended to look lastly at the illustration they selected. Finally, all participants tended to focus on the head area at the first time they looked at the illustrations.

During this experiment, we had faced with some problems which might cause the difficulty to collect and analyze the eye tracking data as listed below.

- The same illustrations displayed on the same position during two continuous pairs.
- The participants did not have default eye position before they started seeing each pair of illustrations.
- Some participants used mouse instead of keyboard during the selection of illustrations which might cause slower eye movement and more cognitive workload on hand-eye interaction.
- Ceiling light and sunlight had the effect to the device which made it failed to calibrate or track the eye movement.

For future work, we will improve the experiment based on these problems. More number of eye tracking data will be collected and used for further analysis between kawaii feeling and eye movement.

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A Soft-Computing Approach for Quantification of Personal Perceptions

Luis Diago, Julian Romero, Junichi Shinoda, Hiroe Abe and Ichiro Hagiwara

Abstract Soft-computing forms the basis of a considerable amount of machine learning techniques which deals with imprecision, uncertainty, partial truth, and approximation to achieve practicability, robustness and low solution cost. This paper describes an application developed to understand what means a picture (portrait) to be *Iyashi*. The neuro-fuzzy quantification allowed extracting a set of 35 rules that describe the meaning of the word *Iyashi* to hundreds of users. Facial expressions of the subjects and their brain signals during the evaluation of the images have been explored to validate the obtained rules. The developed system allows discovering the rules that describe the preferences of users while exploring the space of possible design parameters so that the system predictions match the preferences of users. Interactive genetic algorithms (IGAs) have been used for the implementation of a color recommendation system following customer's preferences. The combination of color and geometric shapes is also explored.

Iyashi is a Japanese word used to describe a peculiar phenomenon that is mentally soothing, but is yet to be clearly defined.

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Keywords Human perceptions · Customer preferences · Neuro-fuzzy quantification · IGA

1 Introduction

The creation of artificial recognition systems of emotional states has attracted the attention of many researchers in the last years due to the necessity of including costumer's preferences about a product into perceptual design elements [1–3]. Hence current researchers try to develop quantitative models for predicting users' first impressions of aesthetic qualities. Although it is not yet known what exactly influences this first impression of appeal, colorfulness and visual complexity have been repeatedly found to be the most noticeable design characteristics at first sight. Building on these findings, this paper introduces two applications we have developed to quantify personal perceptions. In the first application we try to understand what means a picture to be aesthetically pleasant for the user. A set of fuzzy rules is extracted from the evaluation of the users about a small database of facial portraits. The second application focuses on color simulation based on the combination of Interactive Genetic Algorithm (IGA) with Artificial Neural Networks (ANN). Optimally colored images are presented to de user according to user's preference. The first application is introduced in Sect. 2 and the second application is introduced in Sect. 3. Section 4 shows preliminary results combining above methods into a 3D modeling application including color ad geometric shapes. Section 5 concludes the paper and discuses some path for future works.

2 Neuro-Fuzzy Quantification of Facial Perceptions

Artificial neural networks (ANN) are nonlinear techniques which typically provide one of the most accurate predictive models perceiving faces in terms of the social impressions they make on people. However, they are often not suitable to be used in many practical application domains because of their lack of transparency and comprehensibility. In our previous works [1], a new neuro-fuzzy method was proposed to investigate the characteristics of the facial images perceived as *Iyashi* by one hundred and fourteen subjects. *Iyashi* is a Japanese word used to describe a peculiar phenomenon that is mentally soothing, but is yet to be clearly defined. In order to gain a clear insight into the reasoning made by the nonlinear prediction models such as holographic neural networks (HNN) in the classification of *Iyashi* expressions, the interpretability of the proposed fuzzy-quantized HNN (FQHNN) is improved by reducing the number of input parameters, creating membership functions (MFs) and extracting fuzzy rules from the responses provided by the subjects about a limited dataset of 20 facial images. The experimental results in [1] show that the proposed FQHNN achieves 2–8 % increase in the prediction accuracy

compared with traditional neuro-fuzzy classifiers while it extracts 35 fuzzy rules explaining what characteristics a facial image should have in order to be classified as *Iyashi*-stimulus for 87 subjects. Motivated by the need to validate the rules obtained from computer models, we plan to create and analyze models from three points of view: the stimulus image, the facial expressions of the subject who evaluates the images and the brain signals of the observer during the evaluation.

2.1 Stimulus Images

Psychological researchers use diverse methods to investigate emotions [4–6, 8–10]. These procedures range from imagery inductions to film clips and static pictures. One of the most widely used stimulus sets is the International Affective Picture System (IAPS) [5] a set of static images based on a dimensional model of emotion [7]. The image set contains various pictures depicting mutilations, snakes, insects, attack scenes, accidents, contamination, illness, loss, pollution, puppies, babies, and landscape scenes, among others. However, while many samples are desirable for estimating the response of a person more accurately (e.g. how much the person likes a product), in a real world situation, only a small number of samples needs to be obtained because of the efforts required for the persons to provide their responses from many samples. Hence in our previous works we use a small dataset to teach the machine to classify the facial images in the same way that people perceive them. Figure 1 shows the 20 images used to investigate the meaning of *Iyashi* in our previous research [1].

Above facial expressions are represented by feature vectors composed by twenty parameters considering the area of the right eye (p1), left eye (p2), nose (p3), mouth (p4), face (p5), right eyebrow (p6) and left eyebrow (p7). Distances between different elements of the face (p8–p23)are also considered (See details in [1]). Sixty-three MPEG feature points are used to compute above parameters and seventeen normalized features (x1,…, x17) used to find the relationship between induced emotions (e.g. Iyashi). Evaluations according to 114 subjects between 15 and 70 years old (102 Japanese and 12 non-Japanese, 47 females and 67 males) are shown in [1] together with the extraction of 35 rules describing the properties of the images. For this simple example, it should be noticed that each subject defines a different problem (i.e., different class distribution). Note that the naturally distinguishable classes in this paper are defined by the terms used in the context of the word Iyashi. As the meaning of Iyashi varies widely and is very individual, instead of focusing on the classification with a ground truth based on an average observer, we focus on developing an individual classifier and reporting the results of the classification accuracy and extracted rules for each subject. In [11] we presented a method to explore the properties of each image in Fig. 1, by transformation of the original images using radial basis functions (RBF). CSRBFs, firstly introduced by Wendland [12] are used for tuning facial parameters and mapping between facial

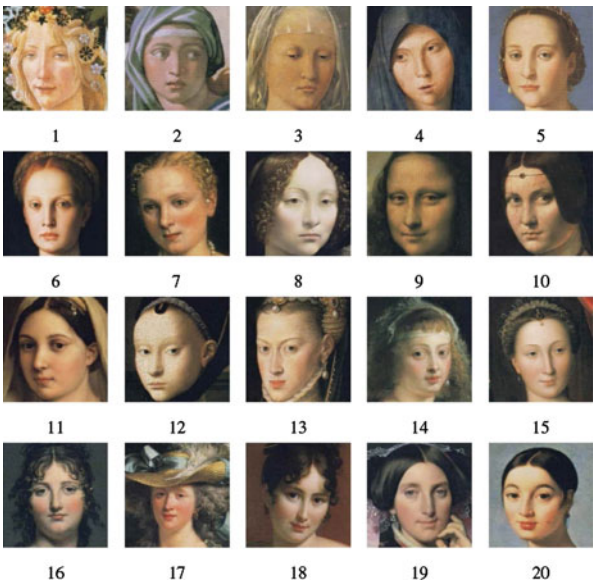

Fig. 1 Collection of 20 special paintings. Each stimulus is rated on the scale '0'-NO, '1'-DON'T KNOW, '2'-YES to express whether or not they feel the emotion in question from observed portraits

images within opposite classes. In this way we can evaluate the validity of the rules extracted from the computational models.

2.2 *Facial Expressions of the Subjects During the Evaluation of the Images*

The face is usually used to determinate the center of attention of someone in a specific object or frame of mind in a specific moment. One of the most common sources of information is the eyes behavior and its state. A specific state of the eyes could represent that the person is focusing in something or not. Also, in our recent work [13] we have proposed a simple and effective classifier in which the condition of the eyes of the subject is used to validate the fuzzy rules extracted from the computational models. The proposed classifier is based on the histogram shifting and the correlation between the shifted-histogram and a reference histogram computed by averaging the histograms of the open eyes in the BioID database.[1]

[1]Available at https://www.bioid.com/About/BioID-Face-Database.

The accuracy of the proposed classifier using the BioID dataset was 95.1496 % (3 % higher than the best of the Convolutional NN-classifiers using LeNet-like architecture). For live videos obtained during the evaluation of the portrait images in unconstrained environments using our previously proposed system [1], the proposed correlation-based classifier [13] can obtain up to a 66.6 % average accuracy in the extreme case of very dark lighting conditions. We are still conducting research to eliminate the influence of lighting conditions that produce shadows on the face during use of the proposed system in uncontrolled environments. Due to above illumination problems, we could not find a clear relationship between the state of the eyes and the evaluation of the portraits. In some cases the images assessed as 2 the user closed the eyes. Likewise for some images evaluated as 0.

2.3 Brain Signals of the Subjects

As mentioned before there are different ways to analyze emotions with a computer [8–10]. Some researches show that humans can recognize emotions from voice and faces with 70–98 % of accuracy and computer can classify facial expression with about 80–90 %. However it has to be noted that these results are obtained on very controlled circumstances, and could differ in ordinary situations [8, 9]. On the other hand, emotions are not always displayed on a facial expression. In psychology, an explicit separation is made between the physiological arousal, the behavioral expression (affect), and the conscious experience of an emotion (feeling). Facial expression and voice can be consciously adapted, and its interpretation is not objective. For this reason, research has been conducted to look for other physiological aspects that are more difficult to self-modify like the user's heart rate, skin conductance, and pupil dilation [8–10]. In the past decades, pioneer researchers have tried to apply EEG data analysis techniques developed in electrical engineering and information theory, including time/frequency analysis and Independent Component Analysis (ICA) [14, 15]. These techniques have revealed EEG processes whose dynamic characteristics are also correlated with behavioral changes. For example, short-term changes in spectral properties of the ongoing EEG in specific frequency bands may be correlated with cognitive processes, e.g. expectancy of a target stimulus and with visual awareness. To date, the majority of Brain–Computer Interface (BCI) systems relies on EEG recordings. In our previous work [16], NeuroSky's B3 Band was evaluated as a minimally invasive method to measure brain signal behavior (Alpha, Beta) of a subject during an evaluation of the 20 portraits. Also different algorithms to reduce data dimensionality were evaluated in order to improve the level of prediction of the HNN and the interpretability of the computational models (Fig. 2).

Fig. 2 Experimental condition for one of the subjects who participated in the experiments

3 Interactive Genetic Algorithm for Preference Modeling

Colors play an important role for customers in making decisions on what they like or dislike. Frequently, customers are overloaded by color combinations to consider and they may not have the time or knowledge to personally evaluate all these combinations in a product design. In our previous work [2] we proposed a color recommendation system which includes design concepts as rules constraining the interactive search made by genetic algorithms to follow customer preferences. As the search space is very large and it changes with contextual information, proposed system combines graph coloring techniques with artificial neural networks to keep color restrictions during system evolution and model the fitness function provided by customers. The proposed recommendation system is close to a content-based filtering system [17]. In content-based filtering, the system tries to match the content of product with user profile, both content of product and user profile are represented by keywords. However, proposed system is used to personalize the image of already existing product and instead of using keywords or a database of images to personalize the image of the product, the colors of the product are changed using an interactive learning process that follows customer preferences. Figure 3 shows the general flowchart of proposed system.

3.1 Graphical User Interface (GUI)

Graphical User Interface (GUI) creates four shapes randomly combining basic shapes with Constructive Solid Geometry (CSG) operations. These four shapes are presented to the customer to be evaluated. Customer provides his evaluation for each shape using the slides shown below each shape. Discrete scale in the range of 1–10 has been used in the experiments. After the user provided his evaluations,

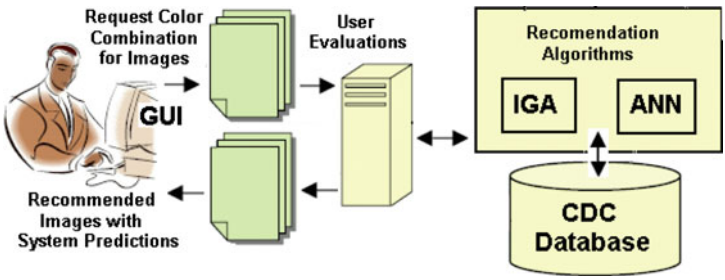

Fig. 3 Flowchart of Proposed System: The system includes four modules: Graphical User Interface (GUI), Interactive Genetic Algorithm (IGA), Artificial Neural Network (ANN) and a database of Color Design Concepts (CDC) (See description in the text)

GUI shows 4 new shapes with their respective evaluations predicted by the system. The customer corrects system's prediction introducing his evaluations, with the objective of improving the results. This procedure continues until the customer gets his preferred shape. In each step, shapes are evolved by the system using Interactive Genetic Algorithm.

3.2 Interactive Genetic Algorithm (IGA)

Interactive Genetic Algorithm (IGA) [18] is an optimization method in which the user evaluation is considered as the fitness function. IGA has been applied to predict a user's preference based on his subjective evaluation [19]. Authors proposed a new offspring generation method introducing clustering of selected individuals and generating offspring from each clusters. This approach has good points, because it was used to model unimodel and multimodel user's preference. But, the user has to evaluate each individual in every generation. For example, if IGA evolves 20 generations with populations of 20 individuals (as it is proposed in their paper [19]), the user should carry out 400 evaluations. Then, the bad point is given by the human tedium and fatigue caused in the evaluation process. In our proposed system, we have a small population of individuals that evolve using crossover, mutation and roulette selection operators. One individual in the population represents one shape as it is shown in Fig. 4. A genotype of an individual is a combination of three basic shapes (e.g. cube, sphere and cylinder) with CSG operations (e.g. intersect, subtract, union).

Several techniques have been used to reduce user fatigue during evolution [20–23]. The technique used to approximate fitness to the real value using a predefined model is called "fitness modeling". In this technique user's evaluation is replaced with lightweight approximations that adapts with the population. In many

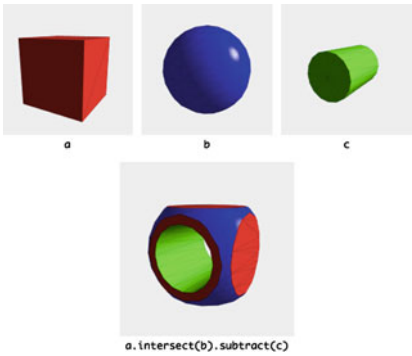

Fig. 4 Example of one individual in the population obtained from the combination of three basic shapes. **a** Cube, **b** sphere, **c** cylinder

researches, this modeling has been directly used in order to reduce the number of fitness calculation In most of the cases, it is very difficult to obtain a prefect fitness model due to the high dimensionality of input space. The fitness model should be used together with the real fitness to get the best approximation [23].

3.3 Artificial Neural Networks (ANN)

Fitness modeling methods includes three principal classifications [22]: fitness inheritance, fitness imitation, and partial evaluation. In fitness inheritance, the values are transferred from parents to children during crossover. In fitness imitation, individuals are clustered into groups based on distance metric; the fitness of central individual of each cluster is evaluated and assigned to all individuals in that cluster using some criteria such as Euclidean distance [23]. In partial evaluation, the fitness of some individuals is calculated exactly, while others are modeled or inherited [20, 21]. Ochoa and Soto [20] used Artificial Neural Networks (ANN) to improve the performance of costly GA related with the amount of evaluations. Also, Llora et al. [21] proposed to combine partial ordering concepts, notion of non-domination from multi-object optimization, and support vector machine to synthesize a fitness model based on user evaluation. As in our previous work, this paper uses ANN to model fitness function by partial evaluation in a real application where the objective function is unknown. In this application, fitness modeling with ANN is used in combination with the fitness provided by customer's evaluation. In each process of customer's evaluation the ANN is trained, the training cases are all shapes presented to and evaluated by the customer. The training builds an interpolation fitness function and all shapes generated by IGA are evaluated using this fitness function. After each ANN evaluation, the system shows the four best evaluated shapes that are represented by the first four individual in population. The customers can correct the evaluation according their preference, which feeds back ANN operations. As

procedure goes on, the history of evaluations made by the customer is increasing and ANN is trained with more training cases. Then, the evaluations made by ANN are more similar to the user preference. We implement a Multilayer Perceptron with 10 input neurons representing the parameters of the 3 shapes (cube, sphere and cylinder) plus three operations, L = 3 hidden layers and 1 output neuron that represents the ANN evaluation. The evaluation function of one shape-individual X is:

$$\mathrm{F}\ (\mathrm{X}) = \sum_{l=1}^{L=3} V_l * g\left(\sum_{k=1}^{S} W_{kl} * C_k\right), \quad \forall X \in P. \tag{1}$$

where, L is the number of hidden layers, V_l are weights of hidden layers, n is the number of inputs, W_{kl} are weight of inputs neurons, C_k are the values of inputs neurons and P is a set of individuals in population. In this cases C_k are the parameters of each shape and g(x) is the activation function defined as $g(x) = 1/(1 + e^{-ax})$. The value of a = 1 was used in the simulation.

4 Preliminary Results

The full recommendation system has been implemented using existing Javascript GA/EP library,[2] Synaptic javascript neural network library[3] and a Constructive solid geometry library for WebGL.[4] Figure 5 shows the final results obtained by one user of the proposed system after 5 generations. The mutation and crossover rate were 1.0 and 0.4 respectively and the IGA evolves 5 generations with populations of 20 individuals. The results of the evolution are tabulated in Table 1. The results show that in the first iteration the evaluation of the user is very low because the shapes are randomly created. In the second generation, ANN evaluations are above costumer's evaluations due to ANN has been trained with a few training cases. In following iterations costumer's evaluations are very similar and increase compared with previous generations. In the last generation, ANN evaluation is very similar to user's evaluations. Although the generated shapes are not good enough for the subject, during 5 iterations, the user only evaluated 20 shapes of 100 shapes generated by IGA, reducing the amount of user's evaluations at 80 % and some combinations of colors and shapes agreed with his preferences.

[2]Available at https://github.com/subprotocol/genetic-js.

[3]Available at https://github.com/cazala/synaptic.

[4]Available at http://evanw.github.io/csg.js/.

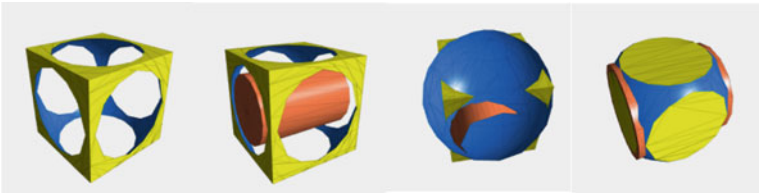

Fig. 5 Preliminary results for one user of the proposed system

Table 1 Comparison of the evaluations made by the subject and the artificial neural network (ANN) during the experiment

Generation	Shape	ANN	User
(Seed)	Shape 1	0	1
	Shape 2	0	1
	Shape 3	0	1
	Shape 4	0	7
1	Shape 5	8.83	9
	Shape 6	7.367	1
	Shape 7	7.321	7
	Shape 8	6.579	7
2	Shape 9	9.318	1
	Shape 10	8.909	9
	Shape 11	8.874	4
	Shape 12	8.554	9
3	Shape 13	9.62	2
	Shape 14	9.44	9
	Shape 15	7.171	1
	Shape 16	5.854	8
4	Shape 17	9.233	9
	Shape 18	9.084	2
	Shape 19	8.913	10
	Shape 20	3.762	2

5 Conclusions and Future Works

In this paper we have presented a color recommendation system that uses an optimization approach to model the preferences of the customers when selecting colors and shapes for a product. The system can learn directly from the evaluations of recommended designs and previous system predictions. The learning process uses a combination of IGA with ANN. IGA evolve to find the shapes closest to the likeness of person, and ANN model the evaluation function, avoiding human fatigue in the process of evaluating large numbers of images.

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The Effect of Immersive Head Mounted Display on a Brain Computer Interface Game

Yudai Iidal, Daisuke Tsutsumi, Shunichi Saeki, Yuya Ootsuka, Takuma Hashimoto and Ryota Horie

Abstract In recent years, technology of brain-computer interface (BCI) has been developed. One application of BCI is for entertainment, that is, BCI game. As ideas in science fictions, BCI game has potential extensibility in combination with virtual reality environment. However, implementation and evaluation of the combination have not been studied well. Thus in this study, we proposed the BCI game system composed of a simple EEG recorder, a smart tablet, a PC, and a immersive head mounted display. We conducted experiments and evaluate our hypothesis that the head mounted display (3D condition) is suitable for BIC game comparing with a flat display (2D condition). Results of a statistical analysis showed that beta/alpha ratio, which was used for controlling the game, in the 3D condition was significantly higher than one in the 2D condition. The results of questionnaires showed that 3D condition were superior to the 2D condition. In sum, we concluded that the immersive head mounted display is suitable for combining with BCI games.

Keywords Brain computer interface · Immersive head mounted display · Concentration · Beta/alpha ratio · Blink

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1 Introduction

In recent years, technology of a brain-computer interface (BCI) has been developed, and the technology has potential extensibility in combination with ubiquitous environments [1–3]. One application of BCI is for entertainment, that is, BCI game. BCI might provide a novel controller of games for both limb disabilities and healthy person. In science fiction, ideas that people dive into a virtual world and play games directly by brain activity has been frequently represented. As the ideas in science fictions, BCI has potential extensibility in combination with virtual reality environment. However, implementation and evaluation of the combination have not been studied well. Thus in this study, as the first step, we proposed the BCI game system in combination with an immersive head mounted display. We conducted experiments and evaluate our hypothesis that the head mounted display is suitable for BIC game comparing to a flat display.

2 Methods

2.1 System Configuration

In this study, we proposed a BCI game system composed of a simple EEG recorder, a smart tablet, a PC, and an immersive head mounted display. Figure 1 shows a system diagram of our proposed system. A homemade Android application running on a smart tablet (ASUS, Nexsus7) receives row signals from the simple EEG recorder (B-Bridge, Brain ATHLETE) via Bluetooth. The application detects beta/alpha rations and blinks from the row signals. Depending on the beta/alpha ratio and the blinks, the application generates one-byte commands, as explained below. The application sends the one-byte commands to a server running on a PC via TCP/IP. A game application developed by using a game development platform (Unity Technologies, Unity) is running on the PC. The server converts the one-byte commands to operating commands of the game application. In the game application, the operating commands controls an avatar. A flat display (LG Electronics Japan, 27EN43V-B) or an immersive head mounted display (Oculus VR, Inc., Oculus Rif) displays the advance of the game. In our proposed system, all of the components were available commercially at low cost.

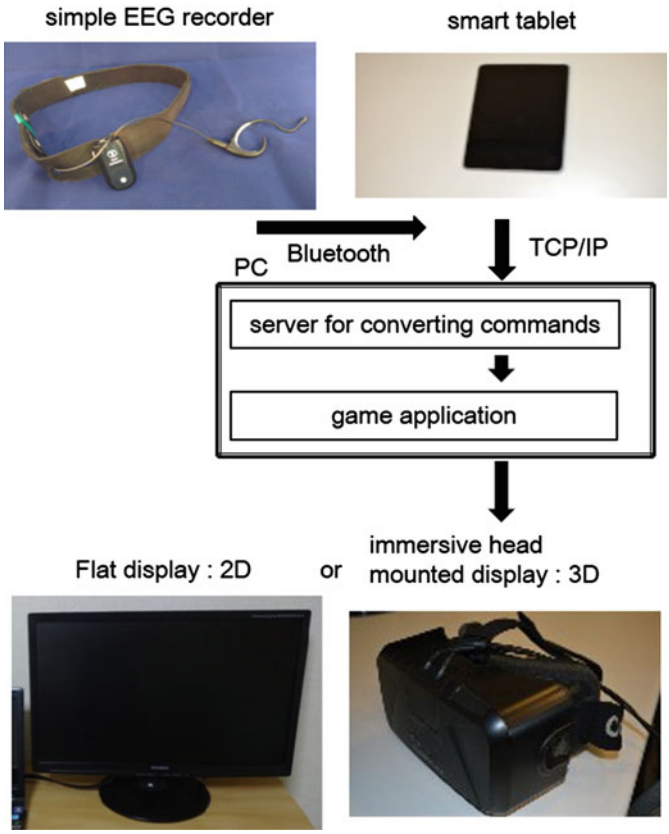


Fig. 1 A system diagram of our proposed system

2.2 BCI Game

We used the beta/alpha ratio as degree of concentration [1]. The beta/alpha ratio was reconstructed from the row signal by using FFT with a 1 s time window, and updated every 1/16 s. Figure 2 shows a typical time series of the beta/alpha ratio. The horizontal axis indicates sampling points. Sampling frequency is 512 Hz. Thus, the 100,000 point at the right end of the horizontal axis corresponds to about 195 s. The vertical axis indicates output values of the simple EEG recorder. Normally, the beta/alpha ratio fluctuates in the range less than about 1.2.

When a user concentrates, the beta/alpha ratio increases. When user blinks voluntarily and strongly, high amplitude appears transiently on the row signal. We detected the voluntary blink when p-p amplitude exceeded predefined threshold within a short time window (about 0.3 s).

In the game application, an avatar goes toward a goal with breaking obstacles. The avatar goes forward (A scene was shown in Fig. 3a) during the beta/alpha is

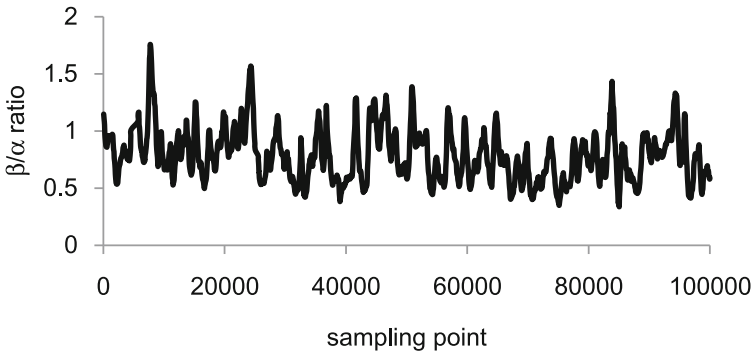


Fig. 2 A typical time series of the beta/alpha ratio

less than 1.3. When the beta/alpha ratio exceeds 1.3, the avatar kicks. When the voluntary blink is detected the avatar punches. When a wooden wall obstructs a way (shown in Fig. 3b), the avatar breaks the wall by a kick. When a rock obstructs a way (shown in Fig. 3c), the avatar breaks the rock by a punch. When the avatar reaches the goal, time taken from the start to the goal is shown (shown in Fig. 4).

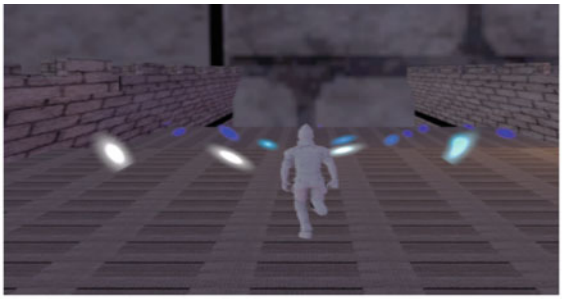
2.3 Displaying the Game

An upper panel of Fig. 5 shows a seen displayed on the flat display. We call a condition in which a user watches advance of the game by the flat display by 2D condition. The flat display was 27-inch with 1920 * 1080 resolution. A lower panel of Fig. 5 shows the same seen displayed on the immersive head mounted display. We call a condition using the immersive head mounted display by 3D condition. The immersive head mounted display was 1080 * 1200 resolution for each of both eyes.

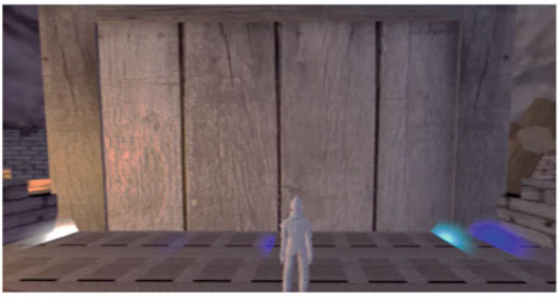
2.4 Experiments

We conduct experiments with nine subjects (8 males and one female). All subjects were instructed our experiment procedure and given written informed consent. In the 2D condition, the subjects sat on a chair in front of the flat display with wearing the simple EEG recorder. The flat display and a subject were at a distance of about 1 m apart. In the 3D condition, the subjects sat on the chair with wearing both the simple EEG recorder and the immersive head mounted display.

First, we measured EEG signals while a subject gaze a fixation point shown at the center of the flat display during 3 min. The data acquired in the 3 min was used as a baseline. Then, we measured EEG signals while the subject played the game in



(a) The avatar goes forward.



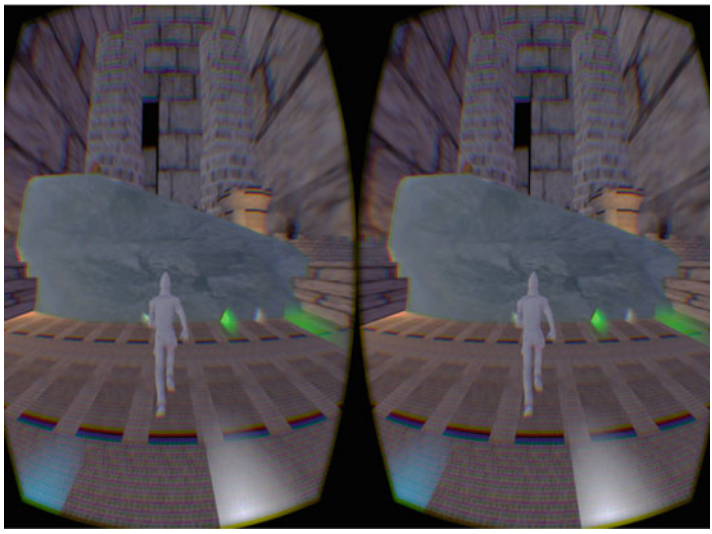
(b) A wooden wall obstructs a way.

(c) A rock obstructs a way.

Fig. 3 Events on the game. The avatar goes forward (*top*). When a wooden wall obstructs a way (*middle*), the avatar kicks and breaks the all. **c** When a rock obstructs a way (*bottom*), the avatar punches and breaks the rock

Fig. 4 Goal of the game

(a) The flat display.



(b) The immersive head mounted display.

Fig. 5 A seen displayed on the flat display (*upper*) and the immersive head mounted display (*lower*)

both 2D condition and 3D condition. Order of the conditions was counterbalanced. Four subjects played the 2D conditions first and then played the 3D condition. Four subjects played in reverse order. We excluded another one subject from analyses because the subjects could not reached the goal in the 2D condition.

After conducting the experiments, we asked the subjects to complete a questionnaire to answer four questions on operability, immersiveness, ease of concentration, and fun in 7-points Likert scales for both the 2D condition and the 3D condition. The questionnaire also had a free description field to write how subjects feel in the experiments.

3 Results and Discussion

Figure 6 shows the beta/alpha ratio averaged during the baseline period for each of the nine subjects. A horizontal axis indicates the subjects. A vertical axis indicates the averaged beta/alpha ratio. The averages were in the rage between 0.5 and 1.0 for all subjects. From the results, we assumed that we measured the beta/alpha ratios correctly for all of the nine subjects.

Eight subjects could reach the goal in both 2D condition and 3D condition. One subject, who is the fifth subject in Fig. 6, could not reach the goal in the 2D condition while the subject could reach the goal in 3D condition. The subject had the lowest value of the averaged beta/alpha ratio in Fig. 6. We speculated that it was difficult for the subject to increase the beta/alpha ration stably. As I explained above, we excluded the subject from analyses.

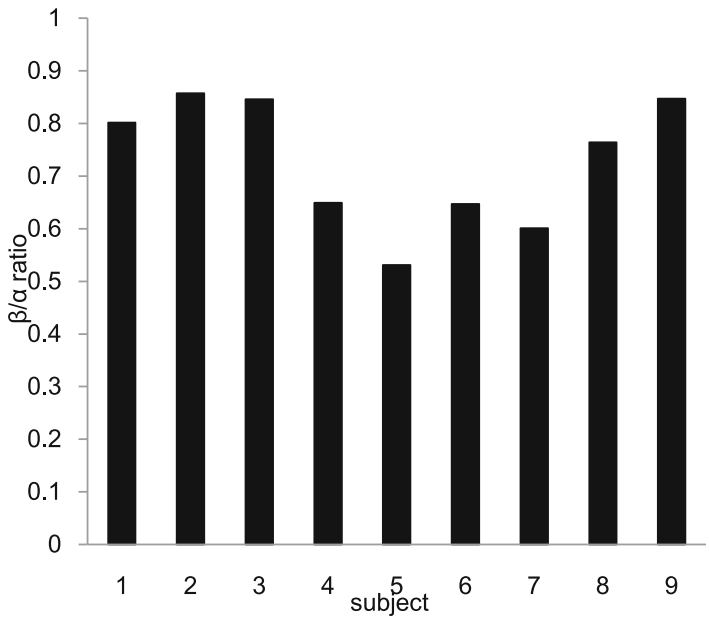


Fig. 6 The beta/alpha ratios averaged during the baseline period for each subject

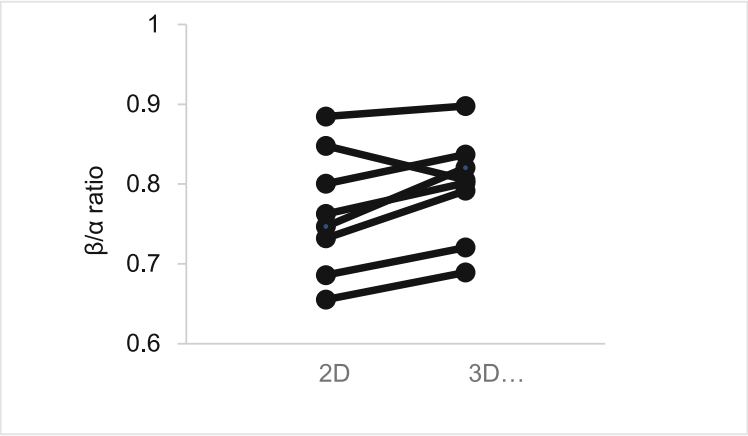


Fig. 7 Comparison of the beta/alpha ratios averaged during playing the game between the 2D condition and the 3D condition for each subjects

In Fig. 7, the beta/alpha ratios averaged during playing the game were compared between the 2D condition and the 3D condition for each of the eight subject. A paired t-test showed that the averaged beta/alpha ratio in the 3D condition was significantly higher than one in the 2D condition ($p < 0.05$ on both sides). From the result, we supposed that the immersive head mounted display enhances subject's concentration by providing the 3D virtual reality environment, and consequently increased the beta/alpha ratio. We speculated that the immersive head mounted display also enhanced the concentration of the fifth subject, who could not reach the goal in the 2D condition.

Table 1 shows scores of questionnaires averaged across the subjects in both 2D condition and the 3D condition. Results show the scores in the 3D condition were higher than the scores in the 2D condition in all questions, that is, operability, immersiveness, ease of concentration, and fun. From the results, we supposed that the immersive head mounted display is superior to the flat display for playing the BCI game.

Table 1 Scores of questionnaires averaged across the subjects

	2D	3D
Operability	4.4	5.2
Immersiveness	3.4	5.9
Ease of concentration	4.1	5.6
Fun	*5.1*	5.9

4 Conclusion

In this study, we proposed the BCI game system composed of a simple EEG recorder, a smart tablet, a PC, and an immersive head mounted display. In our proposed system, all of the components were available commercially at low cost. In the experiment, all subject could reach the goal when the subjects used the immersive head mounted display. The results of a statistical analysis showed that averaged beta/alpha ratio in the 3D condition was significantly higher than one in the 2D condition. The results of questionnaires showed that 3D condition were superior to the 2D condition in operability, immersiveness, ease of concentration, and fun. In sum, we concluded that the immersive head mounted display is suitable for realizing BCI games.

In future work, we investigate conditions which enhance concentration (beta/alpha ratio) in details. We also investigate mechanism of enhancing concentration from the view point of biofeedback [4, 5].

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Women's Negotiation Support System—As Affected by Personal Appearance Versus Use of Language

Kohei Suzuki, Hikari Tamada, Ryuichi Doizaki, Yumi Hirahara and Maki Sakamoto

Abstract In this study, we investigate the influence of Kawaii appearance on persuasiveness within the context of a negotiation, and propose a support system for advising women on their negotiation approach—with a focus on the negotiator's Kawaii appearance. As a result of this experiment, we were able to obtain the multiple regression equation indicating the importance of the three language factors (euphemistic, honorific and sympathy expressions) for impressions made during negotiations. Based on this multiple regression equation, we constructed a system which automatically suggests negotiation sentences appropriate for creating a certain desired impression. Our system is expected to be able to recommend the optimal negotiation sentences based on the user's personal and situational factors (such as Kawaii appearance, use of language, age, and relationship to the negotiation counterpart).

Keywords Negotiation support system · Human-systems integration · Personal appearance · Use of language

1 Introduction

In this study, we investigate the influence of Kawaii appearance on persuasiveness within the context of a negotiation, and propose a support system for advising women on their negotiation approach—with a focus on the negotiator's Kawaii appearance.

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Negotiation is a method for obtaining one's objectives, through a process of consensus building between people with differing preferences. In daily life, we negotiate with people such as superiors and colleagues at work, friends, neighbors, and family members. Negotiations take place between individuals as well as between organizations and governments.

Previous engineering studies for negotiation have investigated the use of negotiation strategies through simulation models, and game theory where the parties involved have equal power. These studies have focused on maximizing the satisfaction of the two parties by determining which strategies are numerically dominant. However, real-life negotiations are further complicated by psychological factors related to an individual's personal qualities, such as a kawaii appearance.

In this respect, recent sociological studies for negotiation have focused on such psychological factors. Among the four stages in the negotiation process; (1) pre-negotiation, (2) the negotiation itself, (3) the negotiation result, and (4) implementation, psychological impressions are most important in the (1) pre-negotiation stage. In the (1) pre-negotiation stage, the individuals interpret the negotiation details through psychological impressions, which color the understanding they bring to the negotiation table. They then enter the next stage, (2) the negotiation itself, after having organized and decided their feelings towards their negotiating partner and the relationship [1]. Moreover, when given contradictory information through verbal, visual, and audio communication, people tend to regard visual messages (e.g., facial expression) as more important than the relative impact of words, or tone of voice [2].

Furthermore, a previous study [3] investigating women's verbal impressions has revealed that people tend to prefer a woman to use a gentle approach by using honorific language and indirect expressions. In the Japanese language, the ending structure of a conversational sentence can have a distinctly feminine or masculine form. This ending structure of the conversational sentence also functions as an indicator of the speaker's intent, as well as the speaker's internal qualities [4].

In light of these previous studies, our study proposes a Kansei engineering method for supporting women's negotiation, through a new investigation which combines the impressions of appearance and the use of language, both of which are important factors in sociological negotiations. With the recent measures taken by the Japanese government for women's empowerment, we have particularly focused this study on identifying the optimal negotiation expressions for Japanese women.

2 Method

In this section, we describe the psychological experiment that we performed to quantitatively analyze the relationship between the personal appearance and the use of language.

2.1 Psychological Experiment

Participants. The evaluation group for the "Girlfriend" and "Female colleague" category consisted of seventeen paid university students, aged 20 to 25 years (17 men). As the evaluation group for the "Wife" and "Female superior" category, fifteen paid participants, aged 20–60 years (15 men) participated in this experiment.
Stimuli. We prepared pictures of three women with a range of appearance, and set various situations in which they negotiate with their male counterparts as a girlfriend, wife, female colleague, or female superior. Then we created twelve negotiation scenarios (four negotiation situations × three patterns of negotiation sentences). We showed the "Girlfriend" and "Colleague" scenarios to the seventeen university students, and the "Wife" and "Superior" scenarios to the other fifteen participants.
Procedure. We showed the male participants the three female pictures and the negotiation situation, and asked them to report how they felt about each picture on a seven-point SD scale for six affective factors (positive impression, extraversion, intelligence, conscientiousness, emotional stability, agreeableness) [6]. They then answered how they felt about each negotiation scenario (presented pictures and situation combined with negotiation sentences) on a seven-point SD scale for seven affective factors (positive impression, extraversion, intelligence, conscientiousness, emotional stability, agreeableness, degree of persuasion).

2.2 Results and Analysis

As a result of the experiment, we obtained 14,784 items of data (7 SD scales × 66 patterns of negotiation stimuli × 32 participants).

Through the two-way analysis of variance (factor A: appearance, factor B: affective scales) using average values for picture A to C in Table 1, we confirmed that picture A to C (Fig. 1) individually had significantly different impressions ($p < 0.001$) in six affective factors (positive impression, extraversion, intelligence, conscientiousness, emotional stability, agreeableness) ($F(10,465) = 6.023$, $p < 0.001$). We also conducted the two-way analysis of variance (factor A: effects of negotiation sentence, factor B: affective scales). As a result, we found the factor A: effects of negotiation sentence × factor B: affective scales interaction for picture A and C (A: $F(53,595) = 12.178$, $p < 0.01$, C: $F(53,470) = 3.346$, $p < 0.01$). By investigating the simple main effect, we found the respective significant differences ($p < 0.05$) in extraversion and emotional stability for picture A, and those in all six scales for picture C. Therefore, the results of the variance analysis and Table 1 showed that Kawaii women might worsen their impressions in negotiation by the use of language though their impressions were originally good, and Not Kawaii women could effectively improve their impressions in negotiation by the use of language though their impressions might be still lower than Kawaii women. On the

Table 1 Average values and variances for picture A/A+Negotiation to picture C/C+Negotiation

	Positive impression	Extraversion	Intelligence	Conscientiousness	Emotional stability	Agreeableness
A:Average value	1.66	1.97	0.969	0.375	0.313	0.969
A:Variance	1.31	0.822	1.28	1.26	1.42	1.20
A+Negotiation:Average value	1.17	1.26	0.862	0.811	0.813	0.943
A+Negotiation:Variance	1.52	1.36	1.45	1.32	1.31	1.41
B:Average value	0.0625	0.406	0.0938	0.406	0.219	0.219
B:Variance	1.22	1.19	1.12	1.19	1.29	1.18
B+Negotiation:Average value	0.561	0.697	0.416	0.427	0.439	0.495
B+Negotiation:Variance	1.34	1.26	1.33	1.24	1.18	1.24
C:Average value	−2.19	−1.06	−1.84	−1.47	−1.44	−1.63
C:Variance	0.896	1.70	1.11	1.22	1.34	1.52
C+Negotiation:Average value	−0.654	−0.292	−0.489	−0.381	−0.408	−0.425
C+Negotiation:Variance	1.56	1.58	1.53	1.42	1.34	1.48

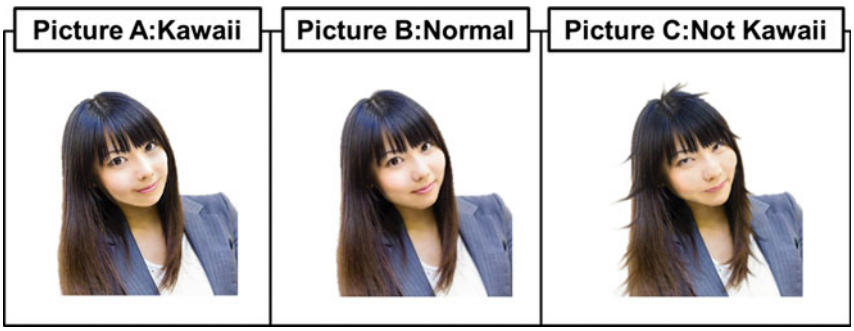

Fig. 1 Three pictures used in the experiment

other hand, the impressions made by women of normal appearance were not easily affected by their use of language.

We calculated the average rating values for each scale for all stimuli. By using the average rating values for the seven affective factors as the objective variables, and three language factors composing negotiation sentences (euphemistic expression, honorific expression, and sympathy expression) [5] as the predictor variables, we conducted mathematical quantification theory class I. Then we obtained the multiple regression equation indicating the importance of the three language factors (euphemistic expressions, honorific expressions, and sympathy expressions) for impressions made during negotiation. Table 2 shows an example of the multiple regression equation for the female negotiator. In the table, we colored the most important language factors for each affective scale. Table 2 indicates that polite use of language (euphemistic expressions) gives the male counterparts the impression

Table 2 An example of the multiple regression equation for female negotiator

	Euphemistic expressions	Honorific expressions	Sympathy expressions	R^2
Positive impression	0.116***	0.203***	*0.241***	0.873
Extraversion	0.125**	0.183***	*0.242***	0.969
Intelligence	0.163***	0.166***	*0.196***	0.810
Conscientiousness	*0.216***	0.177***	0.119***	0.794
Emotional stability	0.132***	*0.149***	0.146***	0.849
Agreeableness	0.129**	*0.213***	0.205***	0.858
Degree of persuasion	0.130***	0.190***	*0.230***	0.918

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

that the speaker is conscientious. Moreover, male counterparts tend to prefer feminine use of language from their female counterparts (honorific expressions and sympathy expressions). On the basis of the multiple regression equation, we constructed a system which automatically suggests negotiation sentences appropriate for creating a certain desired impression.

Furthermore, by using the average rating values for positive impression as the objective variables, and the other average rating values for extraversion, intelligence, conscientiousness, emotional stability, and agreeableness as the predictor variables, we conducted a multiple regression analysis. In Table 3, we show the respective results of the analysis for pictures A, B and C.

According to Table 3, extraversion is the most important quality for all types of woman (Kawaii, normal, and Not Kawaii) in making a positive impression on their negotiating partner. Only the Not Kawaii women can significantly improve their positive impression by the intelligent use of language. On the other hand, conscientiousness is also important for Kawaii and normal women in order to evoke positive impression, but not so for Not Kawaii women. In addition, only for Kawaii women, expressions demonstrating emotional stability tend to have a detrimental effect in making a positive impression on their negotiating partner.

3 System Construction

In this section, we describe the procedure for constructing the women's negotiation support system. Our system automatically recommends suitable expressions and negotiation sentences corresponding to the situation and the user's attributes. In Sect. 2, we obtained the multiple regression equation indicating the importance of the three language factors. Our system suggests the use of language that increases positive impression based on this multiple regression equation.

Our system is comprised of a user interface module, a negotiator attribute evaluation module, and a database of negotiation sentences. Figure 2 shows the construction of our system. In the user interface module, our system suggests the appropriate negotiation sentence and suitable language factors for composing the negotiation sentences (honorific, euphemistic, and sympathy expressions) based on the negotiator attributes input by a user. The user can input the four elements of sex, age, appearance and negotiation situation, with "female" being the default value for sex. For appearance, the user can input "Kawaii", "normal", or "Not Kawaii." And for the negotiation situation, the user can input "colleague at work", "boyfriend", "superior", or "husband."

The negotiation attribute evaluation module calculates the importance of the three factors of negotiation sentences (honorific, euphemistic, and sympathy expressions) in improving the negotiator's positive impression on their partner, based on her appearance and the situation. Then the module transmits the

Table 3 The results of multiple regression analysis for positive impression

Regression statistics	A	B	C						
Adjusted R^2	0.690	0.689	0.660						
Standard error	0.846	0.746	0.912						
Observations	689	663	664						
	Coefficients			Standard error			t-statistic		
	A	B	C	A	B	C	A	B	C
Intercept	0.0933*	−0.0333	−0.304***	0.0441	0.0333	0.0376	2.12	−1.00	−8.09
Extraversion	0.530***	0.620***	0.431***	0.0406	0.0366	0.0375	13.0	17.0	11.5
Intelligence	0.0769	0.0529	0.158***	0.0404	0.0360	0.0414	1.90	1.47	3.81
Conscientiousness	0.114*	0.126**	0.0590	0.0448	0.0392	0.0455	2.54	3.20	1.30
Emotional stability	−0.112*	0.0346	0.170***	0.0450	0.0404	0.0454	−2.50	0.857	3.74
Agreeableness	0.368***	0.144***	0.129**	0.0425	0.0406	0.0462	8.65	3.55	2.80

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

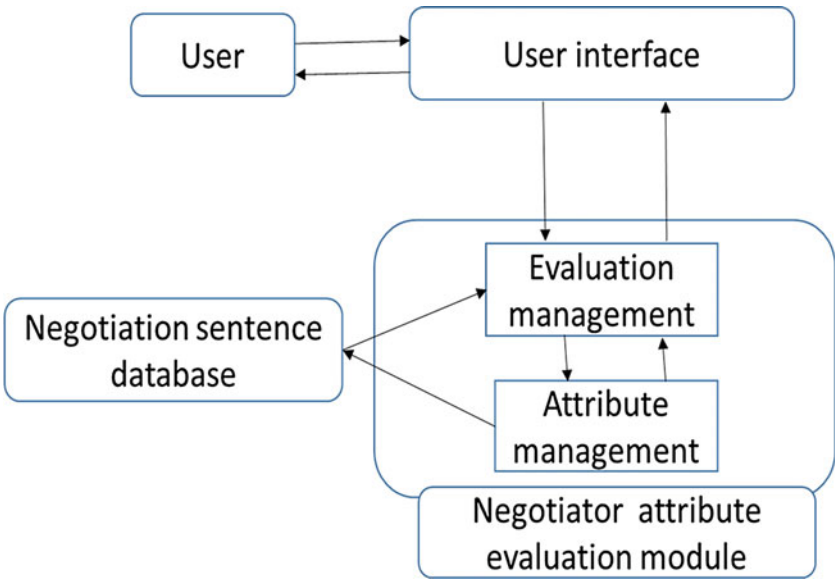

Fig. 2 Configuration diagram of women's negotiation support system

importance of negotiation factors to the database, and calculates the evaluation value for affective factors through the multiple regression equations obtained in the experiment. This module will then receive suitable negotiation sentences from the database and will send these sentences and the evaluation values of language factors to the user interface module.

In our system, the database will hold a collection of negotiation sentences. These sentences will be labeled as honorific, euphemistic, or sympathy expressions. For example, "Could/Would you please" is classified as a honorific expression, "Would you mind doing?" is classified as a euphemistic expression, and "I would be glad if you could" is classified as a sympathy expression. For example, if a user were to input the attributes "gender: female, appearance: Kawaii, and negotiation situation: boyfriend" into our system, the system will output sentences such as "I would be happy if you could" and "I will be glad if you would", along with the evaluation values of each of the three language factors. In this situation, the evaluation values calculated by our system based on the multiple regression equations show that sympathy expressions are suitable and honorific expressions are not. As a result, our system will extract negotiation sentences which include euphemistic expressions from the database and display them with the evaluation values. Figure 3 shows an example of the output from our system.

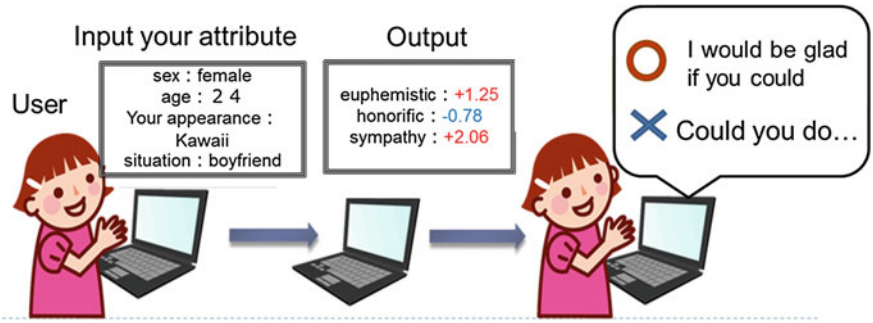

Fig. 3 Example of output from our system

4 Conclusion

In this study, we have constructed a system which automatically suggests negotiation sentences appropriate for creating a certain desired impression, and demonstrated how this system can be used to recommend suitable negotiation sentences.

We found that Kawaii women might worsen their impressions in negotiation by the use of language, in spite of the fact that the first impressions they made were originally good. We also found that the Not Kawaii women could effectively improve their impressions in negotiation by the use of language, though their impressions might still be less positive than those made by Kawaii women. On the other hand, the impressions made by women of normal appearance were not easily affected by the use of language. Extraversion is the most important for all types of woman (Kawaii, normal, and Not Kawaii) for making a positive impression on their negotiating partner. Only the Not Kawaii women can significantly improve their positive impression by the intelligent use of language. On the other hand, conscientiousness is also important for Kawaii and normal women (but not so for the Not Kawaii women) to evoke positive impression. In addition, only Kawaii women should avoid expressing emotional stability, as this tends to decrease the positive impression made on their negotiating partner.

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Evaluation of Feelings of Excitement Caused by Auditory Stimulus in Driving Simulator Using Biosignals

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Abstract In recent years, Japanese young people are exhibiting less interest in driving. Since we believe that their interest can be increased by in-vehicle systems, in this study, we prepared a driving course that features exciting scenes and measured the biological signals of participants while they drove a driving simulator. We focused on the excitement of driving scenes in experiments using a DS and evaluated the feelings of excitement by EEGs and ECGs. We concluded that SDNN and RRV indexes identify feelings of excitement. In this report, we describe a new experiment and analyze its results, which show the same tendency about feeling excitement between questionnaires and biosignals such as EEGs and ECGs.

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Keywords Human engineering · Biosignals · Driving simulator · Feeling excited

1 Introduction

In recent years, young people seem to be losing interest in driving [1]. Since we want to increase driving's attractiveness through in-vehicle systems, we prepared a driving course that featured exciting scenes and evaluated the biological signals of participants while they drove a driving simulator (DS) [2–4] and their feelings of excitement. In this report, we describe a new experiment and the analyze its results, which show the same tendency about feeling excited between questionnaires and biosignals such as EEGs and ECGs.

1.1 Experimental System

Figure 1 shows the experimental system setup. Our system has the following primary components: a driving simulator, biosignal measuring equipment, eye-tracking equipment, and PCs. We measured three biosignals: electrocardiogram (ECG), electroencephalogram (EEG), and eye-tracking. We employed two biological indexes from the ECG signals: SDNN and RRV [3–5]. SDNN denotes the standard deviation of the intervals between the R-waves (RRI) of the ECGs, and RRV denotes the ratio of the standard deviation of RRI and its average [6]. In addition, we employed the ratios of the alpha waves, the beta waves, and the beta

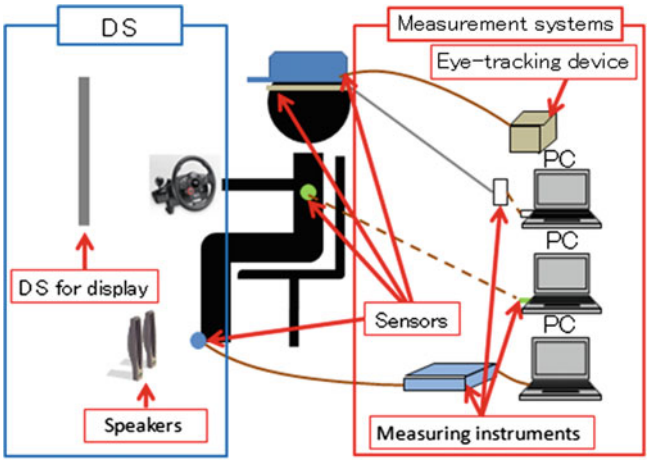


Fig. 1 Experimental system setup

Table 1 Biological signals and their indexes

Biological signals	Indexes
ECG	Alpha ratio average: decreases by feelings of excitement
	Beta ratio average: increases by feelings of excitement
	Beta/alpha average: increases by feelings of excitement
EEG	SDNN: decreases by feelings of excitement
	RRV: decreases by feelings of excitement
Eye-tracking	Pupil diameter ratio: increases by feelings of boredom
	Blink rate: decreases by feelings of excitement

waves divided by the alpha waves from EEG signals [5]. The biological signals and their indexes are given in Table 1.

1.2 Construction of Driving Simulator Course

We created exciting contents in which participants drove a DS through nine tunnels. Before its "exciting content," the course, which doesn't have sharp curves, has a monotonous section to reduce the arousal level of the participants. Our DS course has two "exciting contents," and Fig. 2 shows the structure of the course.

- Beautiful scene section (Fig. 3)
- Listening to music section (Fig. 4)

In the "beautiful scene section," we used the following two scenes after passing through the tunnels: cherry blossoms and autumn colors (Fig. 5). In one first

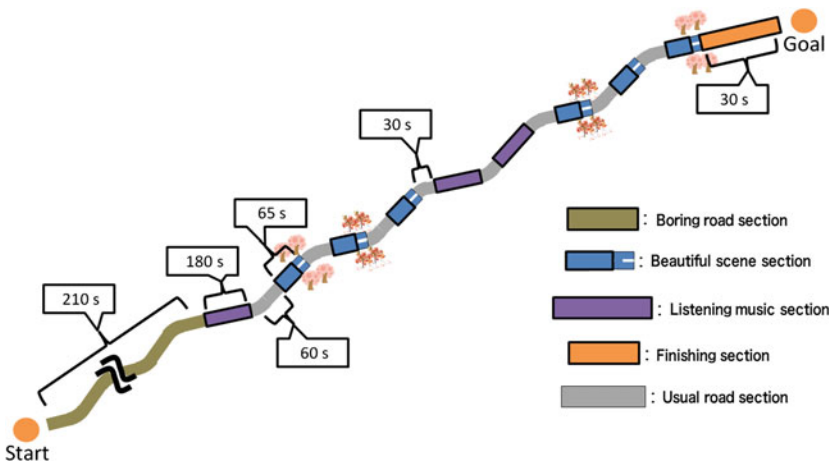


Fig. 2 Structure of driving simulator course

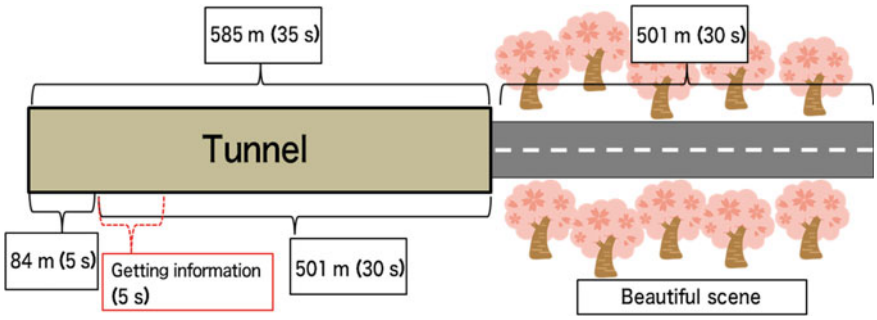


Fig. 3 Structure of "beautiful scene section"

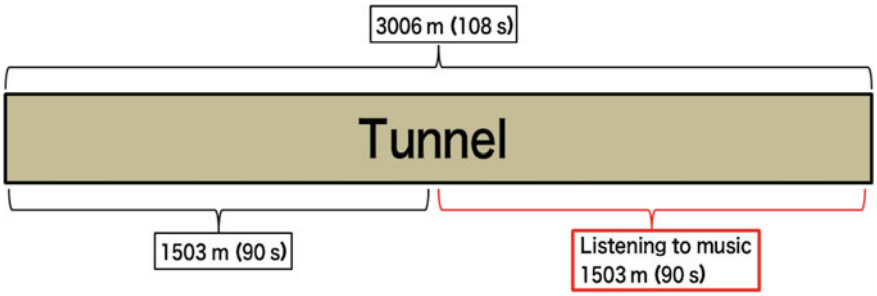


Fig. 4 Structure of "listening to music section"

Fig. 5 Example of scenes: cherry blossoms, autumn colors, ordinary landscape

condition, participants received short voice messages (information) related to the upcoming scenes after the tunnels while driving in them. In the second condition, participants did not receive such information.

In the "listening to music section," we prepared three bits of music selected by the participants themselves as exciting before the experiment. We edited the music to increase its volume in its climax based on the results of previous experiments [7]. The participants drive in the tunnels under two conditions. In one case, participants listened to exciting music (listening to music). In the other case, they did not listen to exciting music (no music).

1.3 Experimental Method

We conducted our experiment in the following five steps:

(i) We explained its content to the participants.
(ii) We placed the measuring instruments on them.
(iii) They practiced driving with the DS
(iv) They drove the DS and experienced its contents.
(v) We removed the measuring instruments.

We constantly measured the following three biosignals during the experiments:

- EEG
- ECG
- Eye-tracking

2 Experimental Results

2.1 Outline

We performed experiments with ten students in their twenties. In this report, we describe the results of listening to the music section. In the questionnaire results, most participants felt excited while listening to music. Figure 6 shows the number

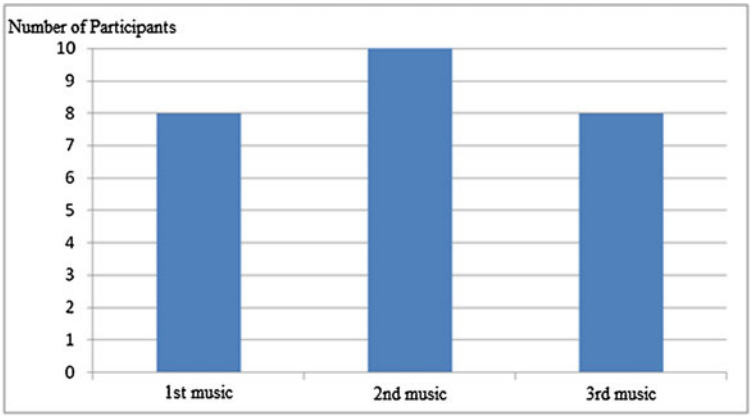


Fig. 6 Participants who answered "exciting" in each listening to music section

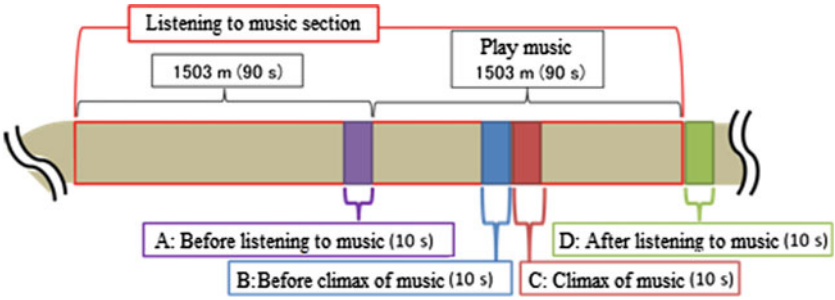


Fig. 7 Each analysis section of listening to music sections

of participants who answered "exciting" to each music section. We analyzed this section because we got interesting results for the first listening to music section. In this paper, we describe the analysis results using EEG and ECG signals.

We divided each biological signal time sequence into the following sections:

(a) Before listening to music: ten seconds before listening to music
(b) Before music's climax: ten seconds before its climax
(c) Music's climax: ten seconds from the start of its climax
(d) After listening to music: ten seconds after the music ended

Since we considered the results of A as the basis, we identified the differences between A and B, C or D for analysis. Figure 7 shows the number of each analysis part of listening to the music section.

2.2 EEG Results

Figure 8 shows the averaged beta/alpha values at the 1st listening to music section. We performed an analysis of variance of the sections for the participants who answered "felt excited" in the "listening to music section". The results show a significant main effect at the 5 % level. The following are the multiple comparison results:

- Section C > Section B ($p < 0.10$)
- Section C > Section D ($p < 0.05$)

From these results, we identified that listening to music excited the participants when driving.

Figure 9 shows the decision tree created by the C5.0 algorithm. We targeted the questionnaire answers at the 1st listening to music section and used the following elements for analysis using the C5.0 algorithm:

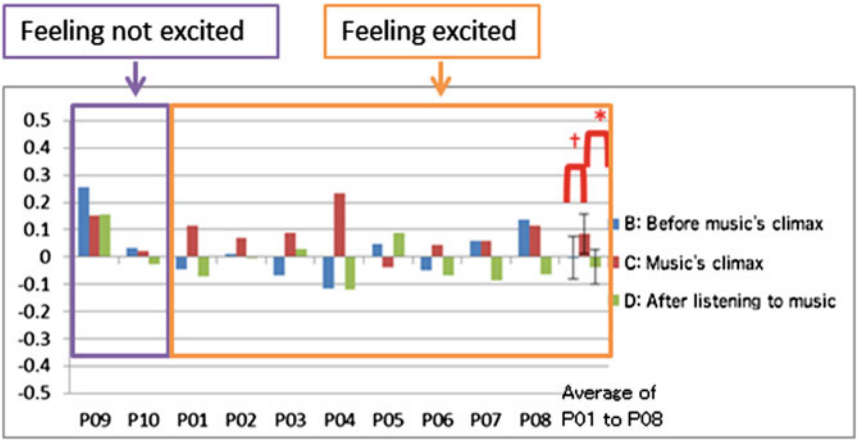
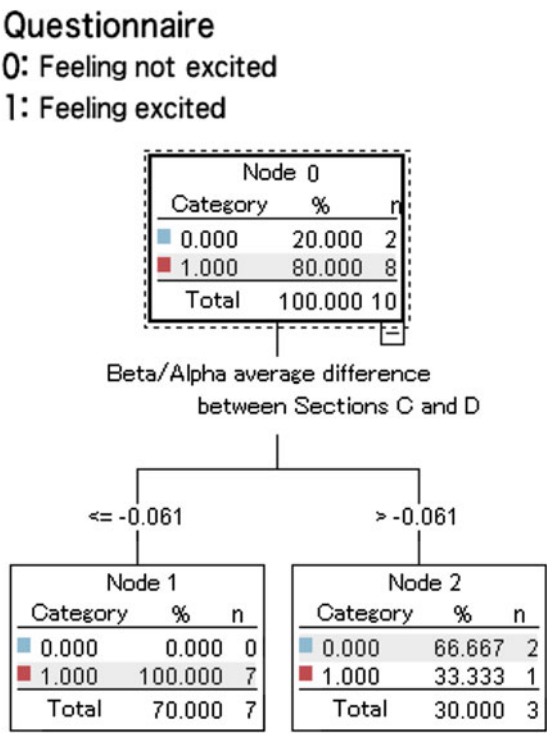


Fig. 8 Averaged beta/alpha of each participant in 1st listening to music section

Fig. 9 Decision tree created by C5.0 algorithm for averaged beta/alpha to divide excitement



- Alpha ratio average
- Beta ratio average
- Theta ratio average
- Slow alpha ratio average
- Beta/alpha average
- SDNN
- RRV

In addition, we used the differences of each element between Sections B and C and Sections C and D and clarified that the large difference of the averaged beta/alpha values between Sections C and D shows that participants felt excited while listening to music.

2.3 ECG Results

Figure 10 shows the averaged SDNNs of each participant in the 1st listening to music section. We performed an analysis of variance among all the sections (B, C, D) and found a main effect in the averages of the participants who answered "felt excited" at a 1 % level. The following are the multiple comparison results:

- Section C < Section B ($p < 0.01$)
- Section D > Section B ($p < 0.05$).

From these results, we identified that increasing the volume of the music's climax excited participants while they were driving.

Figure 11 shows the averaged RRVs of each participant in the 1st music section. We performed an analysis of variance among all the sections (B, C, D) and found a

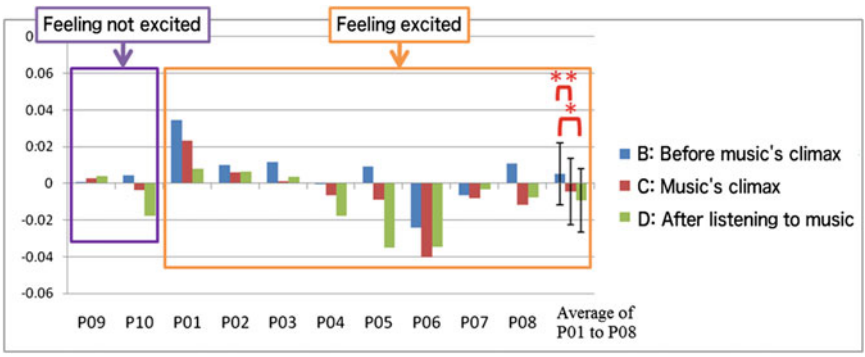


Fig. 10 Averaged SDNNs of each participant in 1st music section

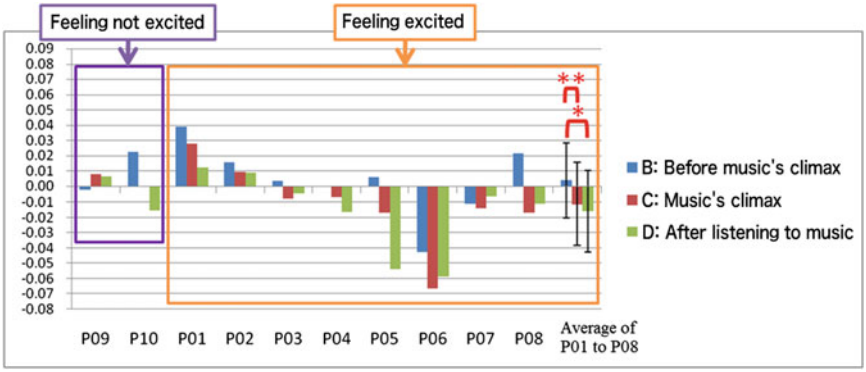


Fig. 11 Averaged RRVs of each participant in 1st music section

main effect in the averages of the participants who answered "felt excited" at the 1 % level. The following are the multiple comparison results:

- Section C < Section B ($p < 0.01$)
- Section D > Section B ($p < 0.05$).

From these results, we again identified that increasing the volume of the music's climax excited participants while they were driving.

We performed a similar analysis to create a decision tree of EEG results. However, the analysis failed to show any useful results.

3 Conclusion

Since we want to increase driving's attractiveness to young people through in-vehicle systems, we prepared a driving course that featured exciting scenes and evaluated the biological signals of the participants while they drove a driving stimulator (DS). We focused on exciting driving scenes in experiments and evaluated feelings of excitement by EEGs and ECGs. We experimentally obtained the following conclusions:

- From the questionnaire results, we clarified that participants felt excited when they drove while listening to music and found the same tendency about feeling excited between questionnaires and biosignals, such as EEGs and ECGs.
- The beta/alpha averages of EEG, SDNN, and RRV of ECGs might be indexes of feeling excited for tasks under driving conditions.

Future work will analyze a combination with indexes and clarify "feeling excited" with more reliability and reveal exciting in-vehicle systems for young people using these biological indexes.

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Effects of Impression Evaluations on Structure of Living Rooms in Narrow Site Houses

Michiko Ohkura, Wataru Morishita, Yae Aoyagi and Yoko Watanabe

Abstract Such affective impressions as the comfort and cleanliness of a residential space are crucial for its residents. Although it is sometimes difficult to maintain a good affective atmosphere in the inner-city area of a big city like Tokyo, the space's appropriate structure might increase its impressions. To clarify the effect of a living room's space structure, we designed and performed an experiment using scale models. This paper describes the experiment and its multivariate analysis results, which show that openness and comfort have a negative correlation despite employing an open structure in many narrow site houses, at least in Japan.

Keywords Impression evaluation · Space structure · Narrow site house · Multivariate analysis

1 Introduction

Since 2000, one phenomenon that represents urban housing in Japan is narrow houses. Narrow sites are often relatively inexpensive because of their topographical size disadvantage. In inner-city areas where the price of land is exorbitant, narrow site houses that are built on cramped sites are attracting much attention for obtaining houses at low cost. High-density residential environments have been created by rapid urban development that made many narrow sites and small houses.

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For planning narrow site houses, one critical feature is pursuing habitability in a narrow, complicated site condition. Such affective impressions as the comfort and cleanliness of a residential space are critical for its residents. Noguchi et al. studied the emotional effect of mirror in narrow spaces in 2013 [1] and Nakagawa et al. also studied the effect of windows in a narrow spaces in 2014 [2, 3]. The results showed that using mirror and windows could raise the openness of the space, and they might give discomfort and uneasiness of the residents at the same time. Although it is sometimes difficult to maintain healthy emotional atmosphere in inner-city areas in huge cities like Tokyo, such appropriate space structure as employing a skip floor might raise the comfort of spaces.

This study clarifies comfortable house structures for people who live in limited sites. First, we surveyed the major architectural structures of the living spaces of narrow site houses. Then we employed four typical patterns of structures and experimentally evaluated the impressions of participants to clarify the openness and comfort of the spaces.

2 Experimental Method

2.1 Scale Model

A space in a house consists of walls, a floor, and a ceiling. From our survey, we identified the following four typical patterns as the major structures of narrow site houses:

(a) standard (no open ceiling)
(b) skip floor (having split-level)
(c) open ceiling
(d) diagonal wall

We selected the Tokyo House Unagi 001, which was built in 2005, as a basic house because it is one of the famous and typical narrow site houses in Japan. It has the following features:

- Less than 50 m^2
- Built in a high-dense area in Tokyo
- Designed as a prototype of a house in the center of Tokyo.

Figure 1 shows its inside and outside [4]. Based on this house, we built four 1/20 scale models of the modified house with different structures (Figs. 2 and 3), where the living rooms are on the second floor to compare their openness and comfort. Figure 4 shows the inside views of the living rooms from the participant's

(a) outside (b) inside

Fig. 1 Outside and inside of Unagi 001 [1]

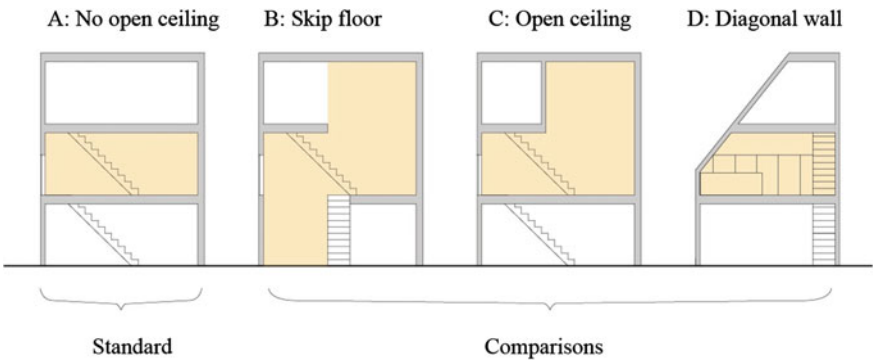


Fig. 2 Side views of four types of narrow site houses with different structures

viewpoint. Figure 5 shows the relative positions of the scale models and the participants. The viewpoint is 800 mm above the floor, and the view window is 120 mm wide × 60 mm high.

2.2 Impression Evaluation Method

To compare the openness and comfort of the above four types of space structures, we employed the semantic differential (SD) method [5] and the magnitude estimation (ME) method [6] for impression evaluations. The adjective pairs for the SD method and adjectives for the ME method are shown in Tables 1 and 2.

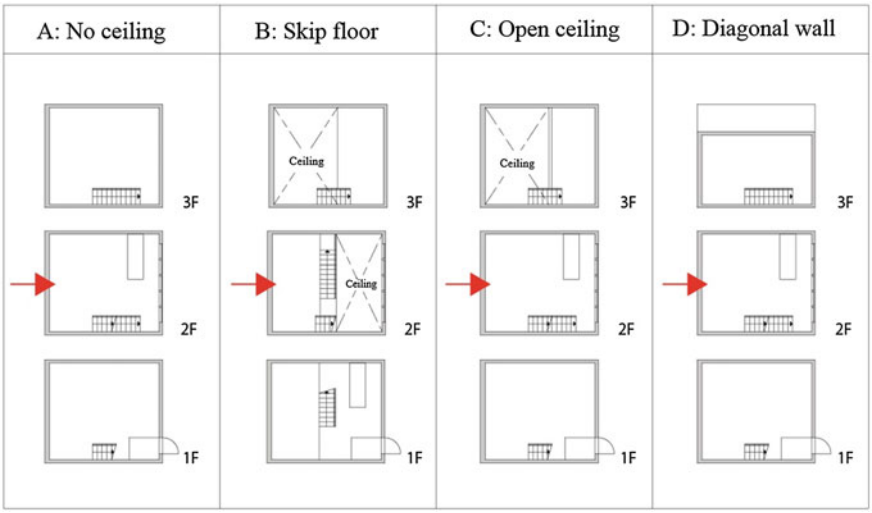


Fig. 3 Top views of four types of narrow site houses with different structures

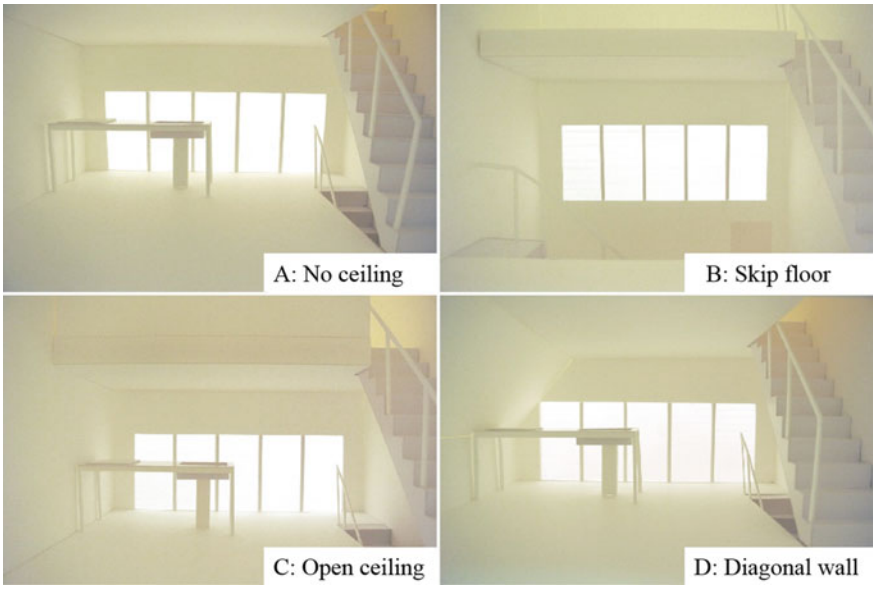
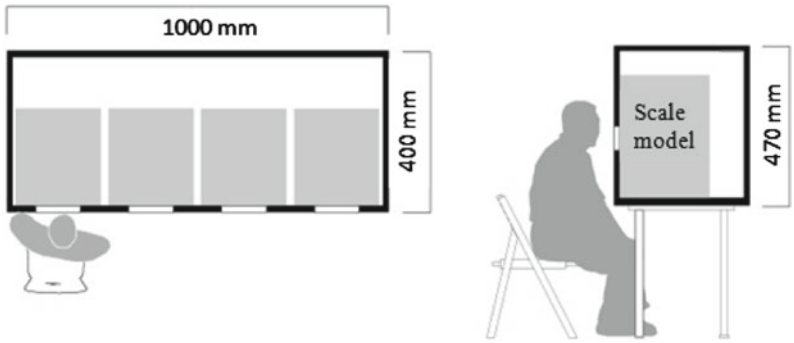


Fig. 4 Views of living room of four types of narrow site houses with different structures



(a) floor plan (b) sectional plan

Fig. 5 Relative positions of scale models and participant

Table 1 Adjective pairs employed for semantic differential method

Number	Adjective pairs	
1	Deep	Cramped
2	Beautiful	Not beautiful
3	Oppressive	Not oppressive
4	Transparent	Opaque
5	Bright	Dark
6	Stereoscopic	Planar
7	Clean	Dirty
8	Warm	Cool
9	Floating	Sinking
10	Interesting	Boring
11	Unique	Ordinary
12	Spacious	Narrow
13	Feeling easy	Feeling uneasy
14	Not feeling strange	Feeling strange
15	Varied	Monotonous
16	High	Low
17	Friendly	Unfriendly
18	Safe	Dangerous
19	Soft	Hard
20	Comfortable	Uncomfortable

Table 2 Adjectives for magnitude estimation method

Number	Adjective
1	Wide
2	Oppressed
3	Calm
4	Open

2.3 Evaluation Experimental Procedure

The following was the procedure of the evaluation experiment:

1. Participants were orally given the flow of the experimental procedure.
2. They looked inside the standard space and evaluated it by answering questionnaires about the SD method.
3. They looked inside one of the comparison target spaces, evaluated by the SD method questionnaires, and compared it with the standard space with the ME method questionnaires.
4. We repeated Procedure 3 two more times for the remainder of the comparison target spaces.

3 Experimental Results

We performed the experiment from Oct. 2 to 7 and got effective answers from 25 females in their 20's and 25 males in their 20's. Figure 6 shows an example of the experimental scene.

3.1 SD Method Evaluation Results

Figure 7 shows the averaged values for each adjective pair of the standard space and three comparison target spaces for the SD method evaluation. Table 3 shows

Fig. 6 Experimental scene

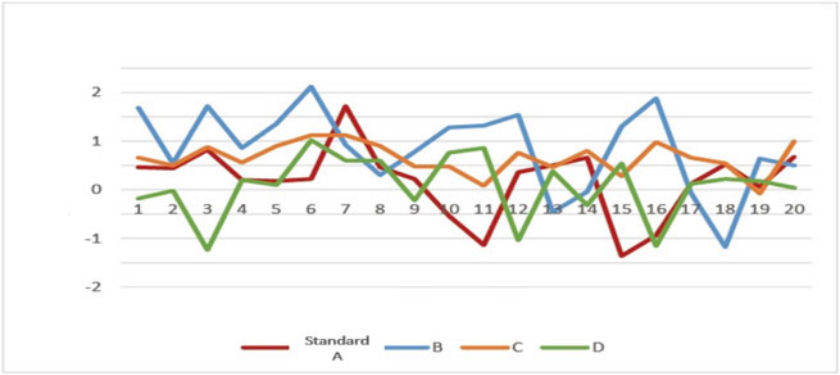


Fig. 7 Averaged values for each adjective pair of four spaces

Table 3 Factor analysis results (Three colours show main components of three factors.)

Number	Adjective pair	Factor 1	Factor 2	Factor 3
3	oppressive-not oppressive	.889	-.192	-.093
12	spacious-narrow	.886	-.105	-.041
16	high-low	.714	.237	-.093
1	deep-cramped	.626	.081	-.136
5	bright-dark	.536	.203	.027
9	floating -sinking	.444	.120	-.009
4	transparent-opaque	.418	.118	.086
11	unique-ordinary	.020	.854	.037
15	varied-monotonous	.049	.841	.019
10	interesting-boring	.111	.788	.027
6	Stereoscopic-planar	.372	.503	-.048
7	clean-dirty	.333	.368	.240
13	Feeling easy-feeling uneasy	-.258	.104	.726
17	friendly-unfriendly	.057	.143	.677
20	comfortable-uncomfortable	.535	-.021	.601
8	warm-cool	-.139	.226	.484
4	transparent-opaque	.240	-.317	.467
18	safe-dangerous	-.195	-.339	.455
19	soft-hard	.093	.039	-.352

the factor analysis results in which we employed three factors. Because the first factor has high values in *oppressive-not oppressive*, *spacious-narrow*, and *high-low*, we named it "Openness." Because the second factor has high values in *unique-ordinary*, *varied-monotonous*, and *interesting-boring*, we named it "Complexity." Because the third factor has high values in *feeling easy-feeling uneasy*, *friendly-unfriendly*, and *comfortable-uncomfortable*, we named it "Coziness." Figures 8 and 9 show the factor scores of four spaces. From these figures, we obtained the following:

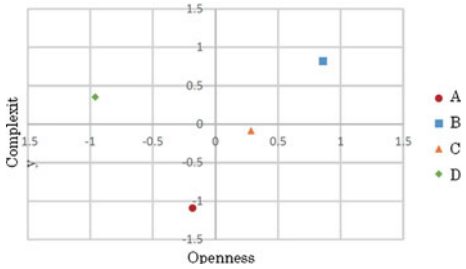


Fig. 8 Scores of spaces for first and second factors

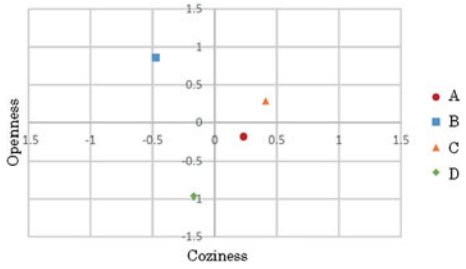


Fig. 9 Scores of spaces for third factor and first factors

- B (skip floor) and C (open ceiling) have high openness.
- B (skip floor) has the highest complexity and A (standard) has the lowest complexity.
- B (skip floor) and D (diagonal wall) have negative coziness scores.
- Increasing complexity decreases coziness.

3.2 ME Method Evaluation Results

Because of the large differences of the evaluation values in the ME method among participants, we normalized them to have 0 as the average and 1 as the standard deviation for each participant. Figure 10 shows the averaged values for four spaces of each adjective:

- C (open ceiling) has relatively similar impressions to A (standard) for all four adjectives.
- B (skip floor) has more negative impression than A (standard) for "Calm."
- B (skip floor) and D (diagonal wall) have opposite impressions for all adjectives.

Table 4 shows the correlation coefficients for all the adjectives and that "Calm" has negative correlations with both "Wide" and "Openness."

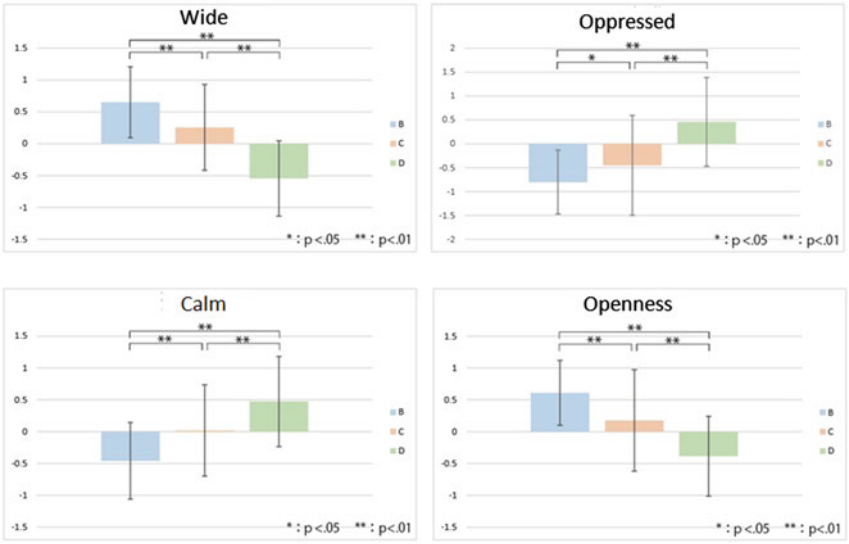


Fig. 10 Averaged values for each adjective of four spaces

Table 4 Correlation coefficients of four adjectives

	Wide	Oppressed	Calm	Open
Wide	–			
Oppressed	−0.658	–		
Calm	−0.555	0.028	–	
Open	0.426	−0.706	−0.478	–

4 Summary and Discussion

The following is our summary of the questionnaire results:

- B (skip floor) and C (open ceiling) have high openness.
- B (skip floor) has the highest complexity and A (standard) has the lowest complexity.
- B (skip floor) and D (diagonal wall) have negative coziness scores.
- Increasing complexity decreases coziness.
- C (open ceiling) has relatively similar impressions to A (standard) for all four adjectives.
- B (skip floor) has more negative impressions than A (standard) for “Calm.”
- B (skip floor) and D (diagonal wall) have opposite impressions for all adjectives.
- “Calm” has negative correlations with both “Wide” and “Openness.”

If “Calm” is prioritized for living space, B (skip floor) is considered the worst space, and D (diagonal wall) might be preferable.

5 Conclusion

Such affective impressions as the comfort and cleanliness of a residential space are crucial for its residents. Although it is sometimes difficult to maintain a good affective condition in the inner-city area of a big city like Tokyo, a space's appropriate structure might increase its impression. To clarify the effect of the space structure of a living room, we designed and performed an experiment using scale models.

We performed an evaluation experiment and got effective answers of questionnaires on both the SD method and the ME method from 50 participants. We analyzed the experimental results by multivariate analysis and found that openness and comfort have a negative correlation, even though open structures are often employed in many narrow site houses, at least in Japan.

If "Calm" is prioritized for a living space, B (skip floor) is considered the worst space, and D (diagonal wall) might be preferable. Future work will investigate how to reduce the disadvantages of D (diagonal wall).

Acknowledgments We thank all the participants in our the experiment.

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Affective Evaluation for Material Perception of Bead-Coated Resin Surfaces Using Visual and Tactile Sensations: Preparation of Adjective Pairs to Clarify the Color Effect

Wataru Morishita, Ryuji Miyazaki, Michiko Ohkura, Masato Takahashi, Hiroko Sakurai, Kiyotaka Yarimizu and Akira Nakahara

Abstract Kansei/affective values are attracting attention as a new evaluation axis of commercial value. We performed affective evaluation experiments on the tactile material perception of bead-coated resin surfaces and found that physical attributes change affective evaluations. Then, we planned to perform new affective evaluation experiment by adding hues, one of the three elements of color, as an important attribute of surfaces as the next step of our research. For the experiment, we performed two preliminary experiments: the experiment to select appropriate adjective pairs, and the experiment to select the hue candidates. This report describes the first preliminary experiment. We performed an experiment to reduce the number of adjective pairs for affective evaluations. The experimental results were analyzed by correlation analysis and hierarchical clustering analyses. From the results of those analyses, we selected 21 adjective pairs.

Keywords Affective evaluation · Hue · Material perception

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1 Introduction

Kansei/affective values continue to attract attention as a new evaluation axis of commercial value. Conventionally, the values of industrial products have been constituted by function, reliability, and cost in Japan manufacturing [1]. The Japanese Ministry of Economy, Trade and Industry (METI) is striving for new manufacturing by adding to these affective values. METI argues that it is important not only to offer new functions and competitive prices but also to create new values to strengthen Japan's industrial competitiveness.

We performed affective evaluation experiments on the tactile material perception of bead-coated resin surfaces with different surface textures generated by such different physical attributes as resin materials, bead diameters, and bead densities [2, 3]. We found that affective evaluations are changed by physical attributes. However, few studies have focused on color in surface-material perception research using visual and tactile sensations. We assumed that the hues in the three elements of color change the appearance of materials and affect their affective evaluation.

This study systematically researched the affective evaluations of surface-material perception using visual and tactile sensations. We chose the number of adjective pairs from previous research to clarify the relations among surface-material perceptions with different colors and adjectives pairs. This article introduces our experimental results to reduce the excessive number of adjective pairs for affective evaluations.

2 Experiment

2.1 Experimental Setup

We prepared four images of colored cylinders (Fig. 1). The white cylinder is the standard, and the others are comparison targets. We employed three comparison targets. As indicated in Fig. 2, we presented images to compare a standard cylinder with cylinders of the comparison target. The background is an achromatic color with a brightness of 8 based on the Munsell color system. Adjective pairs in the Japanese were displayed between the standard and the comparison target.

2.2 Experimental Conditions

The experimental conditions are shown in Fig. 3 and Table 1.

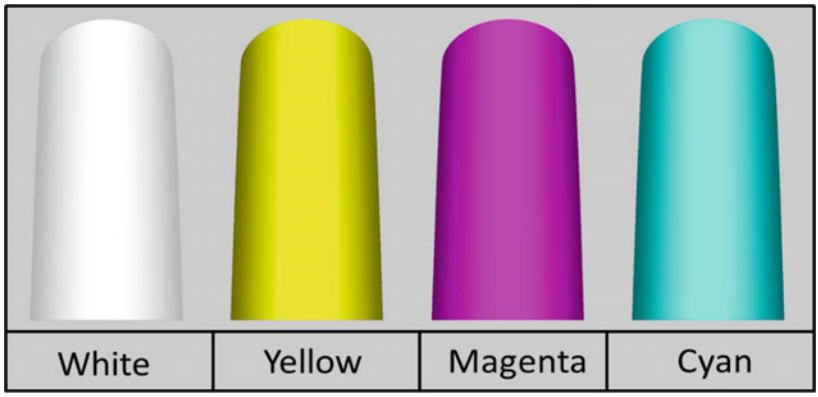

Fig. 1 Image of colored cylinders

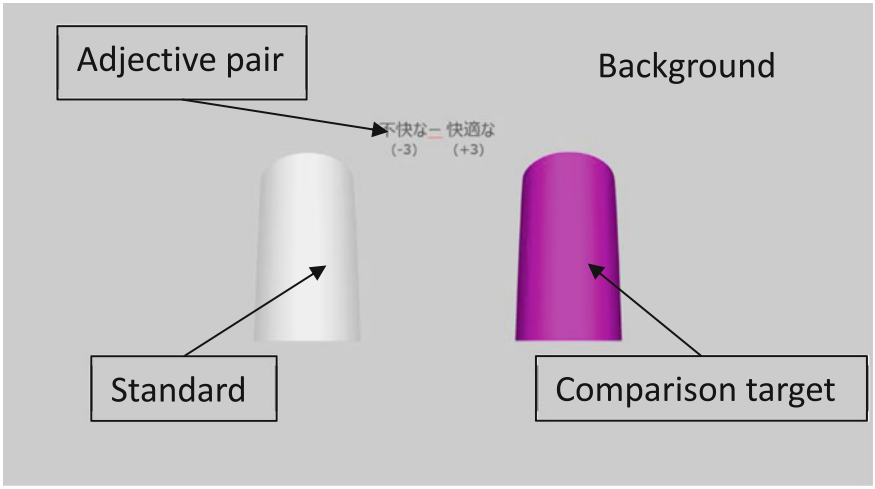

Fig. 2 Presented image

2.3 Evaluation Method

We chose 61 adjective pairs from previous research on visual and tactile sensations [2–6]. Table 2 lists the adjective pairs used for our affective evaluation experiment for which we used a 7-point Likert scale.

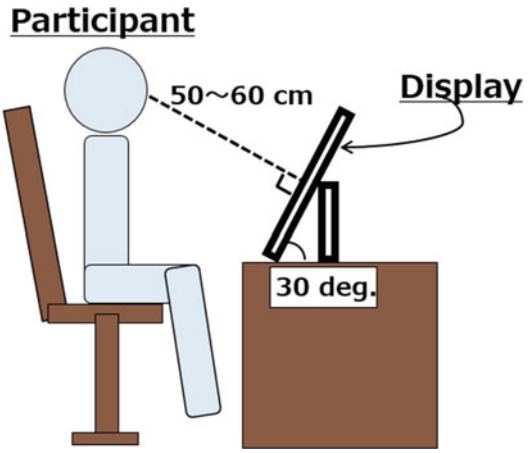

Fig. 3 Experimental set up

Table 1 Experimental conditions

Display size	22 inches wide
LCD display angle	30°
Distance between eye and LCD display	50–60 cm
Room condition	Dark

2.4 Experimental Procedure

Our experimental procedures were as follows:

1. Participants watched background images of the display for 15 s.
2. They were presented images of the standard and comparison cylinders. The standard cylinder was always on the left of the comparison cylinder.
3. They orally evaluated their comparative impressions of the two presented cylinders for adjective pairs in Japanese on a 7-point Likert scale from-3 (strongly agree) to +3 (strongly agree).
4. They were presented images of other comparison cylinder and repeated the affective evaluations. They evaluated 61 × 3 times in total. We randomly changed the order of the comparison cylinders to cancel order effects.

3 Experimental Results

We performed our experiments with six Japanese males with normal color vision in their 20 s.

Table 2 Adjective pairs

Number	Adjective pairs	Number	Adjective pairs
1	Comfortable–Uncomfortable	32	Active–Passive
2	Favorite–Hated	33	Quiet–Noisy
3	Interesting–Boring	34	Cheerful–Dismal
4	Chic–Ordinary	35	Heavy–Light
5	Artificial–Natural	36	Beautiful–Ugly
6	Masculine–Feminine	37	Lively–Sluggish
7	Hot–Cold	38	Good–Bad
8	Simple–Gaudy	39	Kind–Unkind
9	Exciting–Boring	40	Intense–Calm
10	Cute–Ugly	41	Fun–Painful
11	Dry–Sticky	42	Flashy–Sober
12	Smooth–Rough	43	Sharp–Dull
13	Relaxed–Anxious	44	Stabile–Unbalanced
14	Smooth–Prickly	45	Dynamic–Static
15	Mild–Severe	46	Rational–Irrational
16	Wild–Tame	47	Round–Square
17	Healthy–Sick	48	Clear–Obscure
18	Secure–Insecure	49	Full–Empty
19	Damp–Desiccated	50	Healing–Non-healing
20	Youthful–Aged	51	Pleasant–Unpleasant
21	Juicy–Dry	52	Gentle–Scary
22	Unique–Common	53	Clean–Unclean
23	Conspicuous–Inconspicuous	54	Refreshing–Unrefreshing
24	Cool–Old-fashioned	55	Delicious–Terrible
25	Clean–Dirty	56	Pure–Impure
26	Delicious–Disgusting	57	Powerful–Impotent
27	Resilient–Slack	58	Expensive–Cheap
28	Light–Dark	59	Fashionable–Somber
29	Moist–Dry	60	Fine in the touch–Coarse in the touch
30	Soft–Hard	61	Rare–Common
31	Warm–Cool		

3.1 Correlation Analysis

Our correction analysis results show significant correlations between all adjective pairs excluding wild pair and artificial pair. Correlations between “Warm-Cool” and some adjective pairs are shown in Table 3 and correlations between “Wild-Tame,” “Artificial-Natural” and some adjective pairs are shown in Table 4.

Table 3 Correlations between "Warm-Cool" and some adjective pairs

	Hot–Cold	Intense–Calm	Masculine–Feminine
Warm–Cool	0.974	0.899	−0.645

Table 4 Correlations between "Wild-Tame," "Artificial-Natural" and some adjective pairs

	Hot–Cold	Intense–Calm	Masculine–Feminine
Wild–Tame	−0.148	0.238	−0.174
Artificial–Natural	−0.148	−0.079	0.000

Warm pair and hot pair have a significant positive strong correlation. Warm pair and masculine pair have a significant negative correlation. On the other hand, wild pair and artificial pair have a non-significant correlation.

3.2 Hierarchical Clustering Analyses

We performed hierarchical clustering analyses with Ward's method, a complete linkage method, and a centroid method of distance metrics to confirm the robustness of the analytical results [7]. The adjectives were divided into 13 groups by Ward's method and the centroid method and 11 groups by the complete linkage method.

Based on these results of hierarchical clustering analyses, we classified the adjectives pairs into groups based on the following rules:

- The adjective pairs were categorized into identical groups regardless of metrics.
- Other adjective pairs

Table 3 shows the final grouping with 11 groups and the others. From the results of these analyses, we selected adjective pairs based on one of the following conditions:

- Strongly positively correlated with many other adjective pairs in each group
- Weakly correlated with most other adjective pairs

Finally, we selected the 21 adjective pairs shown in Table 5.

Table 5 Groups of adjective pairs (boldface shows finally selected adjective pairs)

Group1	Group2	Group3
Clean–Unclean	Healthy–Sick	Kind–Unkind
Pure–Impure	Refreshing–Unrefreshing	Round–Square
Comfortable–Uncomfortable	**Relaxed–Anxious**	Stabile–Unbalanced
Simple–Gaudy	Quiet–Noisy	Secure–Insecure
Masculine–Feminine	Rational–Irrational	**Gentle–Scary**
Resilient–Slack		**Pleasant–Unpleasant**
Beautiful–Ugly		Mild–Severe
Delicious–Disgusting		
Fine in the touch–Coarse in the touch		
Group4	Group5	Group6
Favorite–Hated	Smooth–Prickly	Full–Empty
Healing–Non-healing	Soft–Hard	**Fashionable–Somber**
Cool–Old-fashioned	Fun–Painful	Interesting–Boring
Youthful – Aged	Clean–Dirty	Chic–Ordinary
	Good–Bad	
	Smooth–Rough	
Group7	Group8	Group9
Damp–Desiccated	**Light–Dark**	Hot–Cold
Juicy–Withered		**Warm–Cool**
Moist–Dry		
Group10	Group11	The others
Cheerful–Dismal	**Conspicuous–Inconspicuous**	**Sharp–Dull**
Lively–Sluggish	Flashy–Sober	**Cute–Ugly**
Exciting–Boring	**Unique–Common**	**Expensive–Cheap**
Active–Passive	Clear–Obscure	**Delicious–Terrible**
Intense–Calm	Rare–Common	**Wild–Tame**
Powerful–Impotent		**Artificial–Natural**
Dynamic–Static		**Heavy–Light**

4 Conclusion

We continue to systematically research the affective evaluations of surface-material perception using visual and tactile sensations. We experimentally reduced the number of adjective pairs for affective evaluations for subsequent experiments to clarify color effects and selected 21 adjective pairs from our experiment results.

Future work will select colors for affective evaluations and experiment with them on the surface-material perception of colored bead-coated resin using visual and tactile sensations.

Acknowledgments We thank all the participants in our experiments.

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Three Layer Model of Aesthetics

Masaaki Kurosu and Ayako Hashizume

Abstract While authors surveyed the use of chopsticks, they found that there are different types of norms regarding the good/bad use of chopsticks. Japanese culture has created a set of rules on good manners and bad manners for using them. Good manners are DOs for the manner of using them to appear as smooth and beautiful in a similar way as the hand motion of Japanese traditional dance. When picking them up from the table, it is recommended to take three steps by the right hand first, then the left hand and finally the right hand. Then, for placing back them down on the table, the reverse movement is recommended. We can distinguish behaviors in three different layer of POSITVE manners, NON-NEGATIVE manners and NEGATIVE manners. We can say that, in a more generic sense, the cultural constraints can be classified in these layers in terms of the aesthetics. We can easily find other behavioral constraints in such cases as bowing, walking, opening the door (Fusuma), presenting the gift, etc.

Keywords Artifact evolution theory · Manner · Aesthetics · Acceptability

1 Introduction

Artifact evolution theory (AET) is an approach to survey the spatial difference and the temporal evolution among artifacts where the artifact includes hardware, software, humanware (or service) and the system. The system integrates other three wares [1]. Spatial difference is a difference that can be found between countries or

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cultures. It could sometimes be influenced by the religion. And there are different ways of achieving the specific goal depending on the country and the culture including religion. Temporal evolution occurs when the advent of new artifact conquers the old one. With regard to the eating method, there are mainly three ways including the hand eating, the use of Western tools and the use of chopsticks.

In many cases, the cultural tradition is strong and is inherited in the community from ancestors to descendants. Culture creates the constraint on the use of artifacts. Manners or etiquettes are such constraints and have the role of preventing people from the indecency. This paper deals with the manners and etiquettes in terms of the use of eating tools, especially that of chopsticks.

2 Eating Behavior

Artifacts that are related to cooking and eating are listed in Fig. 1. In this article, we focus on the hardware of eating tools and the tableware and the software of eating manners. Manners are determined in terms of the use of eating tool and the tableware. But the use of both kinds of hardware is complementary to each other.

For example, it is not allowed to take up the tableware from the table in Korea. Because of that rule, there is a spoon in Korea in addition to chopsticks. But, in Japan, it is allowed to take up the tableware to eat Miso soup, therefore there is no use of the spoon in Japan.

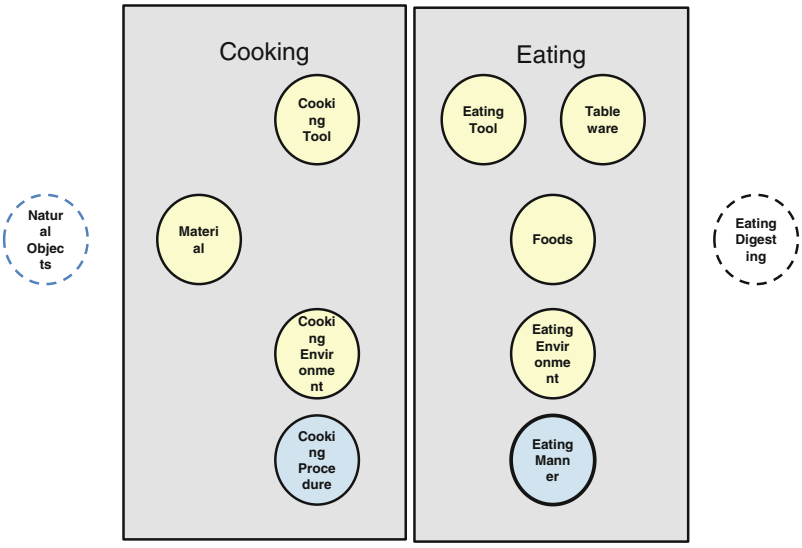

Fig. 1 Artifacts related to cooking and eating

3 Chopsticks

Chopsticks originated in China in about BC18-11th centuries. In Korea, metal chopsticks were excavated from ancient ruins of 6th century. And in Japan, wooden chopsticks were excavated from ancient ruins of 7th century.

Regarding the temporal evolution of chopsticks, hand-eating was thought to be popular before the advent of chopsticks even in China. And the early chopsticks sometimes took the form of tweezers. But, for some unknown reason, chopsticks has become to be consist of a pair of small sticks.

Interesting is the Korean chopsticks made of metal. There is an anecdote that in Ancient Korea, Kings were afraid of poison and it was decided that chopsticks are made of silver that will easily be changed in color by the poison. Anyways, metal chopsticks most of which are made of stainless or aluminum are popular today in Korea (Fig. 2).

Fig. 2 (From *left to right*) Chinese chopsticks and spoon, Korean chopsticks and spoon and Japanese chopsticks

4 Comparison of Manners for Chopsticks

4.1 Direction of Chopsticks on the Table

The direction of chopsticks on the table is different in China-Korea and Japan. In China and Korea, they are put on the table vertically as in Fig. 3 whereas they should be put horizontally in Japan. For the Kansei of Japanese people, horizontal placement looks beautiful. Furthermore it is said that the vertical placement is in the direction to pierce the person sitting in front. This manner is taught rather tightly in childhood, but when Japanese people get older, they put chopsticks vertically as shown in Fig. 4 in the casual situation.

The reason for the vertical placement is that it is easy to put on or to take up chopsticks to/from the table. As you can see in Fig. 5, the formal way takes three steps of actions while the informal (or bad) way takes only one step.

But we should be careful, why Japanese manner system adopted the three step procedure of horizontal way which is inefficient compared to the one step vertical way. Authors think it is for the sake of aesthetics. Although inefficient, the horizontal way of taking up/putting down procedure looks beauty as the hand

Fig. 3 Chopsticks on the Chinese table

Fig. 4 Chopsticks on the table in Japan (in casual situation)

movement is just like the one in Japanese traditional dance. It is quite evident that the vertical way is far too simple and is more efficient. And we cannot imagine no other explanation than the aesthetical view.

4.2 Kirai-Bashi

There a list of Kirai-bashi (literally meaning the detested chopsticks) or a bad manners. Authors counted 35 different patterns from many sources. Some examples are shown below.

- Arai-bashi—Wash chopsticks in the bowl
- Uke-bashi—Request the refill with chopsticks in hand
- Utsuri-bashi—Move chopsticks from one food to another without taking the first one
- Otoshi-bashi—Drop chopsticks on the floor (Tatami)
- Kakikomi-bashi—Gulp down the rice
- Kami-bashi—Bite the tip of chopstick

Fig. 5 Horizontal placement and vertical placement

5 Aesthetical Model

Regarding the manner on the use of chopsticks, three layers can be distinguished in terms of good manners and bad manners as in Fig. 6.

An example of taking up/putting down chopsticks (Sect. 4.1) is a manner to make the hand motion to be beautiful, i.e. it is the good manner or a DO RULE. If one follows this rule, it will be accepted as positive.

But if one doesn't follow this rule, it will be accepted as non-negative or be rejected as negative. Whether one's behavior will be judged as non-negative or negative depend on whether the person doesn't do Kirai-bashi or not because Kirai-bashi is a set of bad manners or DON'T DO rules.

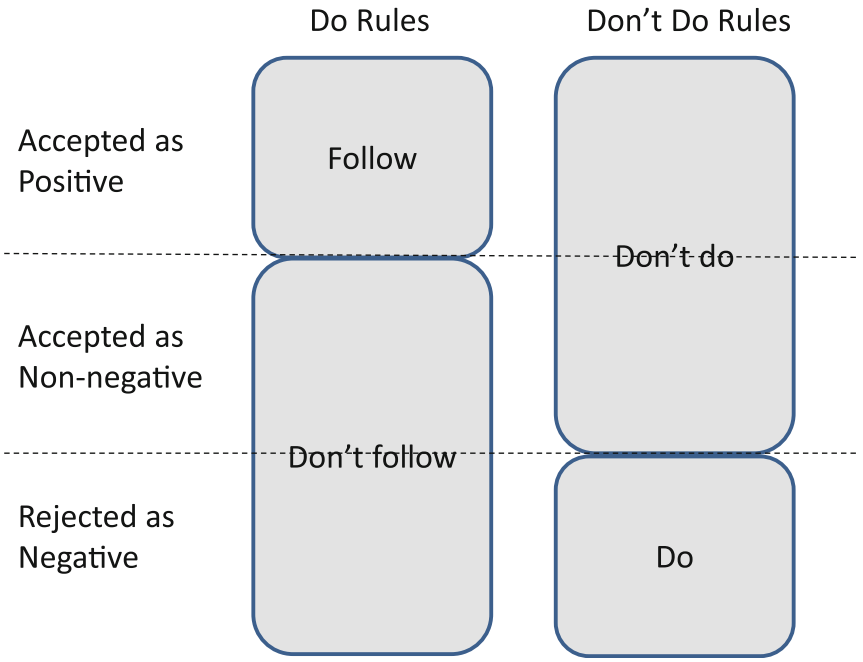

Fig. 6 Three layers of aesthetics

6 Conclusion

In terms of the use of chopsticks, DO rules and DON'T do rules were distinguished. Based on the behavioral pattern in terms of these two kinds of rules, we found three different layers of aesthetics. Similar behavioral aesthetics can be found in bowing, walking, opening the door (Fusuma), presenting the gift, etc.

The further research should be conducted if the same or similar aesthetic layers can be found in Korea and China.

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Part III
Affective/Emotion in Design Education (ADE)

Action Research of Importing Digital Service into Local Brand Marketing—The Workshop Practice

Tsen-Yao Chang

Abstract In this study, we studied the strategy for importing digital service into local brands, and four workshops were held to analyze the seven local brands in Yunlin County. The specific practices include the establishment of a basic service design concept, application of service design tools, digital service strategy, service design practice, brand strategy planning and digital marketing practice. The workshop process followed the four stages of action research. Through the cycle of planning, action, observation and reflection, 22 feedback sheets designed for the workshops and opinions on brand operation were collected; the results were analyzed based on the implementation and observation of each stage of action research, as well as encoded student comments in the feedback form. A comprehensive analysis was conducted on the import of digital service into local brand marketing in the form of workshops, and the workshop design strategy and the action research viewpoint are proposed to serve as the digital marketing strategy for local brands.

Keywords Local brand · Action research · Brand strategy · Digital marketing strategy

1 Introduction

With the development of digital media and the maturity of computer digital technology and Internet technology, digital presentations have already been deeply influencing our daily lives, become a communication media for the new generation of consumers, and formed a digital age. With the progress of broadcasting and communication technology in the life of the digital era, for brand management we must rethink how to employ the versatility, diversity and transmissibility of "digital technology" to create brand-value related business opportunities. Taiwan is

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promoting the integration of local culture and industry characteristics, and the cultural characteristics of local brands are highlighted in the borderless marketing of digital technology. However, as local brands are often limited by their industrial scales and traditional management style, they cannot be more effectively perceived by consumers and thus create a greater brand effect.

As local enterprises are rather dependent on the unique local culture, the key for them to make changes is how to utilize the local culture to create economic benefits and build local brands. If the product designs integrate the unique local flavor to make the local enterprises transform products successfully and create its own brands, it can not only produce a high value product and create an opportunity for sustainable development, but also become the major force in uniting the local residents and creating a sense of identity. Apart from the steps involved like deciding the brand's core value, building the visual identity and planning the service procedures that will shape the local brand, the designers should also take the advancing technologies and changing customers' lifestyle in the digital age into account. They should go with the trend of combining new technologies and designing a marketing strategy that meets the customers' demands while conducting brand planning. By exploring the best opportunity to integrate the culture, local feature and brand, this paper adopts the research findings to design and run four series workshops according to the process of "plan, act, observe and reflect", so as to study the potentials of digital marketing service for the seven local brands in Yunlin County. Discussions have been made based on plenty of multiple targets in the workshops to figure out the opportunities and strategies for local brands in the digital age.

2 Literature Review

2.1 The Economic Value of Culture: Localized Operation and Branding

The local culture has provided us with identifiable traits and charm; besides, it can be the key to entering the market and creating business opportunities in virtue of cultural preservation, development, promotion and application. With the innovation value of culture capitals, the industry will therefore become better in quality, more interesting and environmentally friendly, as well as more experienced, stepping into the new economic era with culture as the capital via the value-added culture [1]. Local cultural industry refers to the local industries that are rare, legal and full of local flavor and are characterized by its desire of taking action as well as its unique, creative, and independent nature [2]. The local industries have to be developed based on the product characteristics, the traditional and special features of the local place, and even the original works of the artisans or the artists. It attracts the customers by its tradition, creativity, uniqueness and charm rather than it being of

mass production. Different cultural industries shall reflect different characteristics of local culture, distinctive forms of industrial spatial structure and patterns of consumption, and should be able to arouse the common feelings, memories and values in it. With regard to the industry, the value added by culture forms the core of the product value; whereas, for the culture, the industry can promote its development [3]. It can be clearly seen that culture and industry are closed related, so we can enhance the cultural element and charm of the local industries through the added value by the culture, to further improve the industrial economic values.

2.2 *Building the Local Brand: Brand Service Experience and Digital Opportunity*

In the era of Brand 3.0, both the business owners and consumers are living in a generation full of channels and brands, so the consumers have more products to choose from and the media for them to learn products from are diversified. Consumers seek for the elements conforming to their taste and the values reflecting their sense of identity and demands. They pursue excitement and satisfaction and the responsive chord in their heart. With the aid of integrated branding strategies to enhance the overall core value and philosophy, industries and enterprises can gain the public's recognition through the establishment of brand concepts in the market.

In a consumer-centered society, brands are not selling the products only but rather, conveying the values of their services and product experience. The experience part will be the critical aspect in businesses [4]. It will be a common business activity for consumers to purchase the life experience, so the enterprises have to observe thoroughly to know clearly about their psychological needs and transform these observations into insights, so as to offer the customers with a diversified and customized experience before building a comprehensive experience that meets their demands. In the past, most of the enterprises in Taiwan believed it was unrealistic to talk about the "brand"; however, with the industrial transformation and consumers' preference changes, the concept of "brand value" has formed gradually and the companies start to acknowledge this and invest money and energy into the brand [5]. The brand-oriented enterprises started to have a positive attitude towards learning about the international market and brand marketing ability. The brand as the orientation of a company will not only exert influence on the marketing pattern and strategies, but also on the internal operations of the whole company. The cultural background of local industries has laid the foundation for the brand stories, which define the attribute values and specific character of the product or service; then the brand concept can promote its values through its design and symbols to the consumers. Faced with the digital lifestyle nowadays, if traditional and local industries fail to absorb new marketing concepts and think about design innovation possibilities, it would be rather hard to explore new markets.

2.3 Discussions on Branding Strategy: Innovative Thinking and Service Design Tools

As design education is being developed along with the development of the economy and increase in social demands, what the future will be like must be taken into consideration and it must hold its own opinion about what kinds of designers are required and the designers' core competence to adapt to the society in order to cultivate designers for the future [6]. When great importance has been attached to the cultural creative industries, the governmental and non-governmental units should invest resources in it and cultivate creative talents to work together on the basis of Taiwan's diversified cultures, so as to form a driving force to develop the industry and lay the foundation. A precise flow can make the design more dominant so that it can really work effectively rather than just take on an aesthetic function during the process of brand shaping. What's more important, with the comprehensive planning and implementation of the design flow, it can further construct an integrated framework to improve its integration capacity. Consequently, the systematic and processed service design is exactly the way to form contextual thinking and learn to utilize the tools for design.

Service designers have to think from the perspective of the observed subjects and illustrate the observed results and transform them into products or services [7]. To sum up, service design is an activity creating an overall experience, which can be tangible or intangible. With a people-oriented design philosophy, the users are treated as the center and their experience is taken into consideration, attempting to integrate the consumer's experience into the design. By using the creative tools and methods to develop the overall orientation and design the tangible products or interaction representing the combined overall experience, the service can produce co-creating values, and thus become the key to promoting the service quality.

3 Research Method

This paper introduced the concept of Workshop in its research design. Workshop refers to the act of gathering different people to solve problems together, create tangible or intangible products or to work out plans or proposals that can benefit both parties. Different forms of activities can be seen in the workshops due to the different topics or fields discussed, but the major spirit of workshops is collaborating with others to inspire new ideas and express the ideas with the existing materials quickly. Apart from simply displaying achievements, the attendees can state their own opinions and learn about others' opinions too, so that they can rapidly absorb the views of other people from different fields.

Through the four workshops we conducted, we did case studies on seven local brands in Yunlin County. As for the theoretical foundation of the workshops to introduce the research plan, the workshops are designed in line with the steps of:

Plan, Act, Observe and Reflect. All the seven brand cases discussed in the workshop differ in terms of years of experience in operating the brand and their industrial category, but their brands are closely bound to the local culture. Therefore, when investigating and studying the local brand cases, the attendees should adopt tools like SWOT analysis, consumer journey mapping, business pattern analysis, flow model analysis and service blueprinting. In the workshop, they shall discuss with other members and keep in contact with the brand owners, so as to propose the brand integrating plans, design brand APP and the finished design products are reviewed by the peers. In this paper, the achievements in the workshops are analyzed from a non-participant perspective. It also explores the strategies to introduce digital services into local brand marketing in the form of workshops, so as to provide references for the local brands to explore the various approaches to digital marketing.

3.1 Workshop Operation Process

The contents of the workshops were designed according to the 4-diamond (4D) process, a process proposed by the UK Design Council, which covers four stages, namely, Discover, Define, Develop and Deliver. Based on this, it has expanded the stage of Develop into two phases, (1) from the discussion of service design concepts to the actual application, and (2) from the exploration of context to the implementation and testing of the design. It also brings the business thinking into the process while sticking to the concepts of service design. A practical idea on digital marketing design for the seven brand cases are proposed to learn the APP design strategies and users' feedback on their experience from the perspective of APP design.

The four workshops are named as follows: (1) Workshop for Digital Service Design Strategy and Practice, (2) Workshop for Digital Marketing Integrated with Service Experience Design, (3) Workshop for Brand Integrated Marketing and Digital Strategies and (4) Workshop for Brand Digital Marketing Strategies and Application. The major strategies applied by each workshop are shown in the Fig. 1. Some guided questions are designed to arouse the attendees' interest and

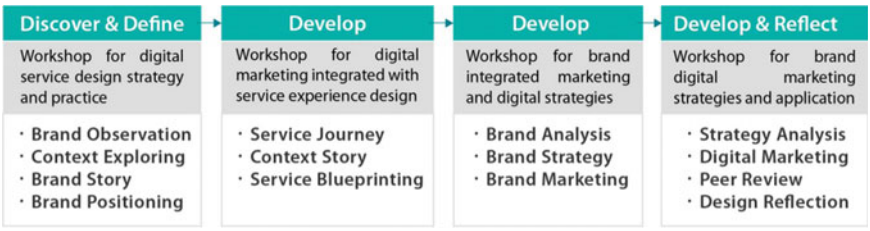

Fig. 1 Operation process and the major topics of the four workshops

sense of trust, enhance their communication and understanding of the problems, and further inspire their imagination and creativity, so that the different opinions can be integrated to achieve common views, propose ideas and figure out the schemes. In the workshop, the instructors shall have discussions with the attendees to gradually work on and establish the digital marketing strategies for local brand cases during the process of exchanging views.

3.2 Workshop Operation Process

With regard to the operation pattern of the workshops, the students have to work in groups with work divided among them, and they select the local industry that they intend to work with and communicate with the business owner. In the workshop, they would observe, interview and analyze the selected cases to provide their views and programs and figure out the opportunities and problems in the local brand business. There are three roles in the workshop, i.e., the instructor (person who teaches), attendee (person who learns and practices) and target subjects (the provider of case resources), and each role is dependent on the others and requires communication and interaction during the process.

The seven brand cases cover many industries like agriculture, handicraft, guest houses and traditional ones, and their business experience also vary from one year to a century, showing different types, conditions, business patterns and even business scopes. Some of them may even engage in the same business, but the owners' differing views about the brand concept will still result in different brand characteristics, so the experience and cases are hard to duplicate. Nevertheless, there is still something worth referring to or learning a lesson from. How to determine the effective ways of doing business in a particular industry and to avoid serious mistakes can be concluded by sorting out the process of local industry branding to serve as reference for the transformation and upgrading of related culture and creative industries.

3.3 Workshop Application Tools

Ten service design tools are adopted in the workshop to make the students get into the situation and conduct analysis, diagnosis on the target brand and provide services through the strategic and specific thinking modes. The major tools include service blueprinting, flow model and business pattern. The service blueprint can help you clearly match the various resources and manpower to work out the overall contents and standards; the flow model aids in reviewing all contacts and interactions during the process of analyzing the brand operation, and present the targets,

approach and contents when learning the brands in the radial pattern. Besides, the business pattern reflects the whole appearance of the brand and service. Therefore, after sorting out the items and contents of each brand, the business pattern can help you determine the missing aspects from the core value to the profit model, so that the final value position can be worked out.

4 Results and Discussions

4.1 Workshop Design—Extent and Difficulty Degree of the Course Contents

The course feedback sheet contains three parts. The first part focuses on the evaluation of the case studies, making the attendees do an analysis of how the brands are operated. The second part is about the course feedback which was designed with two topic categories: service design and brand strategies. In terms of the topics for reflecting, there are two major aspects according to the research purposes. The first is the feedback on the course contents, which can determine the attendees' acceptance level to the course and learn whether they can translate the knowledge into a foundation for practice and implementation. The attendees' opinions are then used as reference to determine the teaching contents in the workshop to design a course suitable for talent cultivation. The second aspect is about reflecting on the service design and brand strategy that the target brand now uses, so that the attendees can check whether the learned knowledge is helpful to the business strategy of the target brand. As for the third part, it is about enabling the attendees to share their feelings with their peers regarding the courses.

Moreover, the paper collects the attendees' views about the strengths and items for improvement in the design of the workshop, and their opinions about the working process and course arrangement from the feedback sheets, so as to provide references for the future workshops to be organized (Table 1).

For the items to be improved on that were proposed by the attendees themselves, it is mainly because the workshop was held during the semester and the courses overlapped with their own schoolwork. Consequently, some of them could not strike a balance between digesting the theoretical contents and doing the practical works. However, the paper suggests that most personnel engaged in the industry have to handle more than one case at one time, so apart from the consideration of human cost, such situations also train their ability on time management and having control of project processes. In the future, it is recommended that the content objectives are adjusted and consider the real situation in the industry, so as to make them gain something from the lessons such as time and task scheduling apart from the practical operations and knowledge learning.

Table 1 Attendees' Feedback on the Workshop

Contents	Attendees' feedback
Enhance the interaction and cooperation between the peers, inspire each other by teaching and learning	Brainstorming with others (M02). Listening to all useful opinions from others and working together with the group members (T23). Growing together during the practicing and learning (T08). The group members can discuss together to inspire new creative ideas (S10). Interaction between teachers and students and discussion between the students (C20)
Simulating the practical operation; professional instructors pass on their experience	Attendees can learn from the instructor's teaching and experience (C17). Attendees can personally run the whole process of service design, by which they can have better results compared with learning merely from books (E16). Attendees can simulate the service design in real life (E13). The instructors illustrate a lot of examples to make the attendees learn more about the processes and methods popular in the industry
Growing and adjusting one's mindset; To be in line with the thinking mode that is used to deal with issues in the industry	The design that the designer himself likes the most may not be preferred by the business owner or the customer (P05). Don't finish the design from just a student's perspective or treat it as your homework; Try to communicate to the owner with your sincerity (C25)
Operating the service design tools and learning the values of service strategy	Attendees can learn the definite results of service design and its application value, learn systematically the research methods of service design step by step and master the contents related to service design (T26). They can also know the approaches and processes used for brand planning in the industries through various actual cases and absorb different marketing strategies (P22)
Homework and exercises are heavy during the period of learning; The course schedule should be rearranged	Time left for doing exercises is not adequate and they request for have more time to do it (M12). The contents in the courses are heavy so they may not handle their own study at school (P05)
The period for practicing should be prolonged	"Time is too limited" (S06); "Time is not enough" (T09). Time for doing exercise is insufficient, so attendees hope that they can have more time to do the exercises

4.2 Application of Service Design—Reviewing and Clearing of the Multiple Dimensions of Brands

During the workshop and at the end of it, the attendees were required to review the courses to think about the application of each service tools, and their opinions were heard and sorted out. Among the ten service design tools, they agreed that four of them are the most useful during the positioning of brand strategy, namely, Consumer Journey Map, Story Versions, Service Blueprint and Business Patterns, for they can perfectly match the usage process of service tools. The Consumer Journey Map assists them in locating their target consumers. With its help, attendees can sort out and analyze the existing situation of the brand and service. Story Versions is helpful in restructuring the services to find out whether there are aspects that were missed out or are illogical. The Service Blueprint clearly matches each resource and manpower, which enables the attendees to map out the overall contents and standards. The Business Pattern reflects the whole appearance of the brand and service, so they can check the missing aspect from the core value to the profit model after sorting out the items and contents of each brand, and finally determining the final value. From the attendees' feedback, it can be learned that the service design tools can be introduced into the brands from the various stages including problem diagnosis, strategy planning, resource allocation and business patterns establishment in order to provide a complete and comprehensive view of brand building.

4.3 Planning Strategy for Workshops of Digital Culture and Creativity Empowerment

During the fourth workshop, the attendees were asked to design an APP for the target brand as the first exploration of digital marketing strategies for local brands, which inspired diversified thinking around the major topics. The designed APP was then checked via the users' experience feedback and peers' review. Differences in the opinions from users and peers were found. As the users have no idea about the design background and process, brand philosophy and value, the survey found they placed more attention on the operability and visual images of the design. On the contrary, their peers focused more on the brand core, service items provided in the program and the relevance between brands.

After summing up the digital branding strategy of the APP design and views about the brand integration and service design, the paper attempts to summarize the literature of each period and opinion feedbacks, so as to think about the value and significance of introducing digital services into local brands. Digital media has shortened the distance between the brands and the consumers. With internet, both the website presenting the brand value and the social platforms for real-time interaction are the best way to reach out to the consumers. Consumers in modern

times become more and more dependent on the digital platforms as time goes by, so the digital information transference has become a necessary strategy to reduce the costs in communication and make the brand more popular. What's more, the digital approach enables the brand owner to contact and interact with consumers directly, by which consumers loyal to the brand can be cultivated and grown to ensure the sustainable operations of the brand.

5 Conclusion and Recommendations

The paper aims to provide assistance in the branding, digitalization and strategic development of local industries, to make them think globally and act locally by combining the rich local cultures with branding, digital integration and service philosophy. Apart from the service design tools and branding strategy thinking adopted in the research, four workshops with different themes were held to analyze the seven local brand cases in Yunlin County to discover the strategy and opportunities for the digitalization of local industries. With the design practice, an APP was selected as the media for the digital development of the brands, attempting to find out the gap and serve as an approach towards the development of digital marketing of local brands. As the local business is dependent on the unique local culture, it is the responsibility of local enterprises and industries to think about how to utilize it to produce economic benefits and build unique local brands. When field surveys and planning design integration were conducted, the multiple and special local cultures exhibited high potential. If the local industry can successfully translate such potentials into a great brand, it can not only establish the core value and create the opportunity of sustainable development, but also become the major force in uniting the local residents and creating a sense of identity. The local development has to strike a balance among society, environment and economy before it develops sustainably and stably. The operation of a brand is also bound to the three factors and takes the local cultural features as the crucial part of the brand. Besides, relationships between the local residents and environment have to be maintained well to serve as the origin of sustainable development. Only by doing so can economic benefits be produced. Under this context, everyone should try to figure out the business pattern and create opportunities for branding with the help of digital tools (Fig. 2).

Because of the diversity and the variability of digital marketing, it is difficult for proprietors of local brands to effectively grasp relevant skills in this area at the initial stage. Besides, different digital means are adopted by businesses in different industries. For instance, with regard to the local brands of Yunlin as studied in this paper, they are largely varied in their business histories; some are startups, and others have already had a history of about a hundred years. Newly emerging brands are often quite unfamiliar with the use of digital marketing tools, and they sometimes don't have easy access to consumers' preference; therefore, those brands are unable to resonate with consumers. As for long-established brands, although they

Fig. 2 The digital opportunity for local brands

have a sound customer base, with their rejection and lack of understanding of digital technologies, they often fail to attract more consumers, shift their brand images, and devise new business modes. For local brands, apart from maintaining the core value of advocating the local culture, it is also essential for them to have sound interaction with consumers in order to obtain a stable revenue stream and create opportunities for sustainable development. In this respect, digitalization can be rather beneficial for the communication with consumers, but still the promotion of digital technologies depends on the cultivation and integration of talents. Therefore, it is a process with different links closely interrelated to each other including the business' core value, business strategy, integration, digital technologies and business benefits, through which a brand can find innovative ways to formulate new strategies for business operations.

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What Makes a Good UX Questionnaire? User-Centered Scorecard Development

Seunghyun "Tina" Lee and Melody Ivory

Abstract Numerous standardized questionnaires like the System Usability Scale and Net Promoter Score have been developed to provide reliable and valid measurement of subjective satisfaction. Few studies, however, examine the perceived usability and preferences of questionnaires by the raters or end users themselves. In this study, 20 participants evaluated different types of questionnaires as well as ranked and discussed their subjective preferences for them. We found that 65 % of participants chose the questionnaire with enhanced design features (e.g., color-coded ratings, user experience examples, and specific/global comments) as well as measurement of user experience beyond usability as the most preferred questionnaire, while 80 % of participants chose the questionnaire that measured user experience with semantic-differential rating scales as the least preferred. Based on participant feedback, we provide several questionnaire design recommendations.

Keywords Usability · Questionnaires · User experience · User study

1 Introduction

Existing questionnaires (e.g., System Usability Scale (SUS) [1], Net Promoter Score (NPS) [2], and Usefulness, Satisfaction, and Ease of Use (USE) [3] questionnaire) make it possible to gather subjective feedback on system quality, to use that feedback to understand how the system compares to other alternatives, and to identify areas on which to focus improvement efforts. Although these instruments assess usability, learning, and ease of use, the major challenge with these scales is that they do not assess modern-day user experience aspects like desirability, credibility, or delightfulness. Furthermore, these instruments vary with respect to

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the types of systems (e.g., web, mobile, or collaborative applications), evaluation methods (e.g., heuristic evaluations, usability tests, or rapid iterative testing and evaluations), and system fidelities (e.g., sketches, clickable prototypes, or full applications) to which they can be applied. The instruments also vary with respect to the ease with which a participant can complete them and the degree of specificity with which results can guide improvement.

We researched and developed our User Experience (UX) Scorecard to be a user-centered, flexible, and valid instrument to measure both traditional usability and modern-day user experience aspects and to present actionable results. In this study, we evaluated our scorecard against other established ones to understand its usability and to provide recommendations for questionnaire design.

2 Related Work

Numerous questionnaires have been designed to measure user’s subjective satisfaction of a product or a system. For example, studies [4, 5] have criticized existing questionnaires because of their lack of validation and low reliability. Standardized questionnaires like SUS and NPS offer a more historically reliable and valid measure of a user’s subjective satisfaction on various aspects of product quality [6]. Nonetheless, these instruments address usability and ease of use but not broader user experience considerations discussed herein.

The System Usability Scale (SUS) [1] is the most used questionnaire to measure perceived usability within the HCI community, and it includes measures of both ease of use and learning. This questionnaire comprises 10 statements with 5-point Likert scales and provides a single score, ranging from 0 to 100. Another well-known questionnaire, the Net Promoter Score (NPS) [2] measures customer loyalty with only one question and an 11-point Likert scale: “How likely is it that you would recommend this product to a friend or colleague?” The Questionnaire for User Interface Satisfaction (QUIS) [7] consists of 6 subscales and 21 statements with 10-point Likert scales. The Usefulness, Satisfaction, and Ease of Use (USE) questionnaire [3] consists of 30 statements with 7-point Likert scales. USE scales are based on 4 subscales (usefulness, ease of use, ease of learning, and satisfaction).

A recent study [6] published the results of the User Experience Percentile Rank Questionnaire (SUPR-Q), consisting of 8 items based on usability, trust, appearance, and loyalty. Although standardized questionnaires provide a more reliable and valid measure of the construct of interest, they may not be helpful at diagnosing problems to identify corrective fixes. This potential deficiency is because existing questionnaires do not capture behavioral data [4, 6, 8]. Our aim is to develop a questionnaire that can help with diagnosing problems and to close this gap.

Tullis and Stentson [5] measured the usability of two websites using five questionnaires and found that SUS provided the most reliable results across a wide range of sample sizes, however, at least 12–14 participants are needed to get reasonably reliable results. Few studies demonstrate users' perceived usability and preferences for different types of questionnaires or explore the design aspects of questionnaires. Within this paper, we report such a study.

3 UX Questionnaire Development

The goal of the UX questionnaire development was to provide our own user-centered questionnaire that can measure user experience beyond usability in an industrial setting. In order to be applicable to multiple systems, the questionnaire needed to be flexible enough and its results needed to identify corrective fixes even with small sample sizes (2–6 users). We introduce two different questionnaires that have been used for several years during assessments of various industrial systems (e.g., low-fidelity prototypes, HTML clickable prototypes, and fully deployed applications) on various devices (e.g., desktops, tablets, and wearables).

3.1 UXSC Development

A starting point for the UX Scorecard (UXSC) was the information architecture heuristics proposed for interaction designers [9]. Covert proposed ten principles consolidated from several sets of heuristics [10–12]. The ten principles include findable, accessible, clear, communicative, useful, credible, controllable, valuable, learnable, and delightful. These principles guided the initial UXSC, which comprised ten statements and an overall assessment (e.g., "How is the user experience overall?") to which the user responds on track, minor issues, serious problems, or N/A. The UXSC also includes two open-ended questions (e.g., what system element works well for you? and What system element need to be improved for you?).

The UXSC has been iterated on with feedback from users along the way. For example, users often wanted to score in-between levels, user's overall score may not have aligned with the median for the ten heuristics, and getting the user experience right did not mean being on track for every single heuristic and every single user. Thus, the revised UX Scorecard exhibited a major change of scale from (on track, minor problems, and serious problems) to a 5-point Likert scale. Finally, we used factor analysis to reduce the number of dimensions from 12 to 8. Figure 1 shows the latest version of the UXSC that describe the eight items in the UXSC and corresponding attributes for each one.

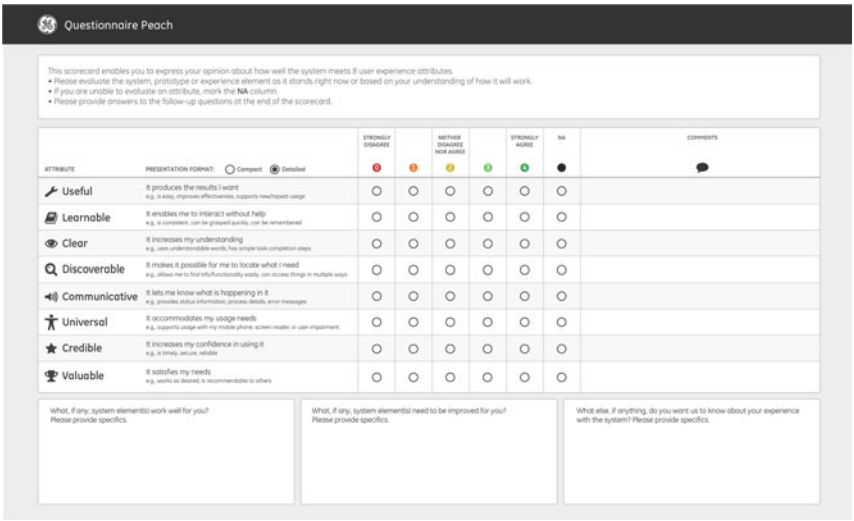


Fig. 1 UXSC questionnaire Ver. 10 used within the study

3.2 UXS Development

Another questionnaire developed at GE, the UX Scale (UXS) is composed of 12 questions designed to measure the user experience of a product with semantic differential rating scales (see Fig. 2). Semantic differential scales are bipolar with

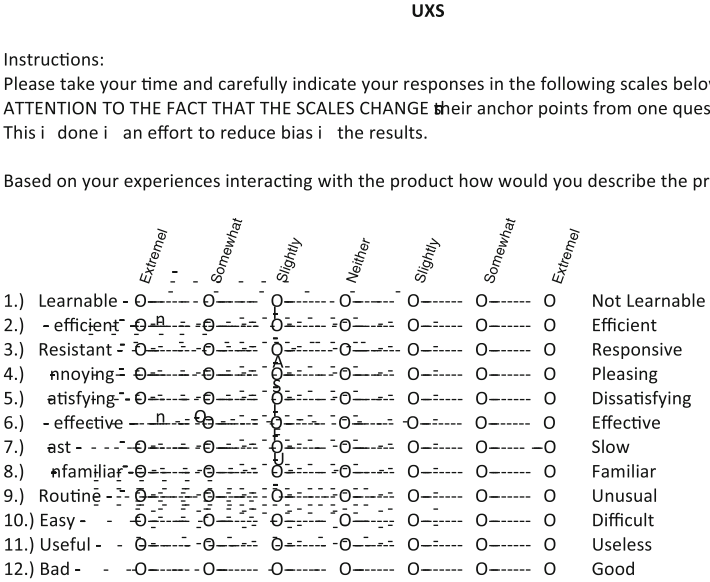


Fig. 2 UXS questionnaire

contrasting adjectives at each end (e.g., Learnable vs. Not Learnable). The respondent is asked to indicate where his or her experience falls on each scale.

4 Questionnaire Evaluation Study

The purpose of the study was to understand the perceived usability of and preferences for standardized questionnaires (i.e., SUS, NPS, and USE) that are used most frequently by HCI researchers as compared to our own industrial UX questionnaires (i.e., UXSC and UXS). Thus, within this study, participants evaluated each questionnaire as well as ranked and discussed their questionnaire preferences.

4.1 Participants

Twenty GE employees (6 females and 14 males) participated in the study. Twelve participants were expert model builders (e.g., data scientists, data analysts, and machine learning researchers) who developed data analytics daily. Eight participants were non-expert users (e.g., computer scientists or UX researchers) who had data science backgrounds but were not expert model builders. Participants' ages ranged from 25–34 years (n = 11), 35–54 years (n = 8), and one over 55 years old. Seventeen participants were non-native English speakers.

4.2 Tasks and Procedure

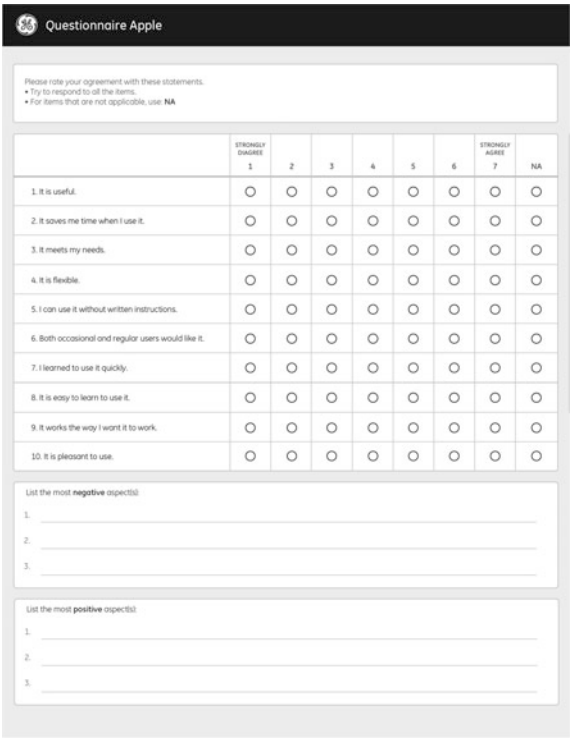
In the first half of the study session, participants were asked to complete three analytic tasks using the model-building clickable prototype. Tasks included building analytics for: (1) plant identification, (2) airplane component failure, and (3) CPU performance. For each task, they imported a data file, set model-building attributes as needed, built the model, and deployed it as code.

In the second half of the session, participants were asked to fill out four assessment questionnaires based on their experiences with the prototype. The presentation order of the questionnaires was randomized. All participants used the NPS, UXSC, and UXS. Half of the participants used SUS or USE, because we alternated them within sessions due to their similarity. For the UXSC, participants had a choice between a compact or detailed version, and we captured their questionnaire choices. In addition, participants rated the perceived usability of each questionnaire. Lastly, they listed their most and least preferred questionnaires and provided reasons for their preferences. Each session lasted about an hour.

4.3 Materials

To eliminate any technological issues that might affect usability perceptions, we used paper versions of the questionnaires. All questionnaires were printed on US letter size paper (see Fig. 3), except for the UXSC, which was printed on legal size paper due to the need for additional space to allow for comments on each statement (see Fig. 1). The names of the questionnaires were coded into fruit names (e.g., SUS: Banana, and UX Scorecard: Peach) and all design elements (e.g., font size, layout, and style) were the same except for the contents (e.g., attributes, rating scale, and comment boxes).

Except for NPS, questionnaires included 8–12 items (see Table 1). For USE, we chose 10 of the 30 items, because they were similar to the other questionnaires and addressed all four subscale dimensions. Items comprised four subscales on the USE (i.e., Usefulness, Ease of Use, Ease of Learning, and Satisfaction) and the UXS (i.e., Learnability, Efficiency, Usefulness, and Desirability) questionnaires. Items on the SUS, UXSC, and USE questionnaires included a rating on a 5- or 7-point scale of “Strongly Disagree” to “Strongly Agree.” For the SUS questionnaire, as other researchers [4, 8, 13] have suggested, the word “cumbersome” in the original statement 8 was replaced with “awkward.”


Questionnaire Apple

Please rate your agreement with these statements.
• Try to respond to all the items.
• For items that are not applicable, use: **NA**

	STRONGLY DISAGREE 1	2	3	4	5	6	STRONGLY AGREE 7	NA
1. It is useful.	○	○	○	○	○	○	○	○
2. It saves me time when I use it.	○	○	○	○	○	○	○	○
3. It meets my needs.	○	○	○	○	○	○	○	○
4. It is flexible.	○	○	○	○	○	○	○	○
5. I can use it without written instructions.	○	○	○	○	○	○	○	○
6. Both occasional and regular users would like it.	○	○	○	○	○	○	○	○
7. I learned to use it quickly.	○	○	○	○	○	○	○	○
8. It is easy to learn to use it.	○	○	○	○	○	○	○	○
9. It works the way I want it to work.	○	○	○	○	○	○	○	○
10. It is pleasant to use.	○	○	○	○	○	○	○	○

List the most **negative** aspect(s):

1. _____
2. _____
3. _____

List the most **positive** aspect(s):

1. _____
2. _____
3. _____

Fig. 3 USE questionnaire paper prototype used in the study

Table 1 Summary of the questionnaires used within the study

Questionnaire	SUS	NPS	USE	UXSC	UXS
# of items	10	1	10	8	12
# of subscales	0	0	4	0	4
Scale range	5	11	7	5	7
Instructions	No	No	Yes	Yes	Yes
NA option	No	No	Yes	Yes	No
Examples	No	No	No	Yes	No
Open-ended comments	No	No	Yes	Yes	No

All questionnaire contents followed from the original questionnaires. For example, instructions were available only on the USE, UXSC, and UXS questionnaires. Only the USE and UXSC questionnaires included a not applicable (NA) option and a space for open-ended comments. In addition, only the UXSC questionnaire provided examples for each item. The UXSC also was available in two versions: The detailed version of the UXSC included keywords with representative icons, statements, and examples, but the compact version included only statements.

4.4 Data Analysis

The SUS score for each questionnaire item was calculated from 0 to 4 with four being the most positive response. We then added up the converted scores and multiplied that total by 2.5 to convert the overall score rating to a 0 to 100 point scale. Acceptability scores range from not acceptable (0–50), marginal (50–70), and acceptable (70–100).

In order to compare mean scores of the system using each questionnaire, we converted the scores to percentages by dividing each score by the maximum score possible on that scale. For example, a rating of 3 on UXSC was converted to a percentage by dividing that score by 4 (the maximum score for UXSC), providing a percentage of 75 %.

5 Findings

5.1 Prototype Evaluation

All five questionnaires showed that expert participants rated the system itself higher than non-expert participants. SUS showed a significant mean overall score difference ($p < 0.05$) between the two groups, but it also showed the greatest variability in the responses (see Fig. 4).

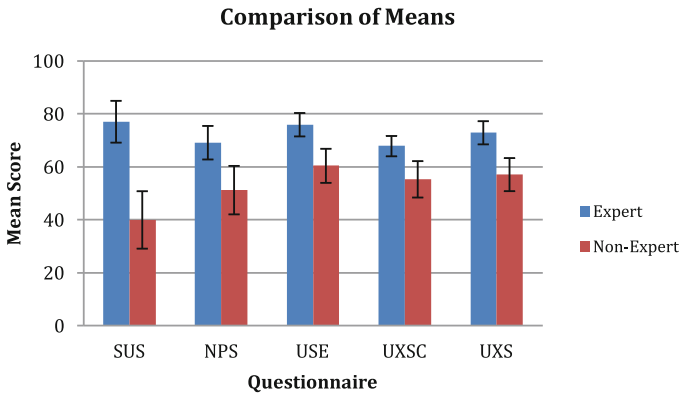


Fig. 4 Comparison of mean scores for expert and non-expert participants using each questionnaire

A Pearson correlation coefficient was computed to assess the relationship between pairs of questionnaires. Because half of participants used SUS and the other half used USE, we computed correlations among the three questionnaires (NPS, UXSC, and UXS) and the SUS as well as USE. Results showed that data from participants who used SUS were different from those who used USE. All correlations were statistically significant with strong positive correlations (see Table 2). In contrast, data from participants who used USE showed strong positive correlations (r = 0.90) only between USE and NPS.

In addition to the scores from the five questionnaires, USE and UXSC also captured users’ qualitative feedback to help identify corrective fixes for the prototype. Using the USE questionnaire, 80 % of participants provided a list of the most negative (n = 25) and most positive aspects (n = 25) of the system. Using the UXSC questionnaire, 45 % of participants left their comments (n = 35) on individual dimensions, while 85 % of them left comments about what system elements worked well (n = 15) and what system elements needed to be improved (n = 31).

Positive comments on the USE and UXSC questionnaires included: *“The overall workflow suits most data science tasks to a useful degree,” “It has the main components of the pipeline,” “Helps me to compare platforms,” “Allow data scientists to quickly explore the data,” “Step-by-step clearly laid out for non-expert users,” and “Save time for coding, applicable for people who don’t code often.”*

Table 2 Correlation matrix between questionnaires and SUS

Questionnaire	SUS	NPS	UXSC	UXS
SUS	1			
NPS	0.70	1		
UXSC	0.79	0.94	1	
UXS	0.89	0.78	0.83	1

Comments on the USE and UXSC regarding what needed to be improved included: *"Need to include results comparison visualization," "Need a lot more feedback—specific to each task," "Would like to be prompted for next logical step," "Analytic functionality is still limited," and "Font size and text was generally too small to read."*

5.2 Questionnaire Evaluation

Participants had a choice of using two versions of the UXSC questionnaire. Interestingly, although it might take a while to read all the contents, 73 % of participants (n = 14) chose to use the detailed version of the UXSC, indicating examples are helpful for them. Their comments included: "*examples are helpful to understand what the question is about*" and "*keyword is eye-catching*."

Participants rated each questionnaire on a five-point scale (1 is strongly disagree and 5 is strongly agree) based on four dimensions: (1) Understand the attributes, (2) Understand the rating scale, (3) Easy to use, and (4) Allows me to completely express my experience with the system and task (see Table 3). Repeated measures ANOVA showed that there was a significant effect of questionnaire type on three dimensions: (1) ($p < 0.0001$), (3) ($p < 0.0001$), and (4) ($p = 0.001$). There was no significant effect of questionnaire type in terms of (2) understanding the rating scale. (1) Understand the attributes: Participants rated four questionnaires (SUS, NPS, USE, and UXSC) significantly higher than UXS. No significant differences among the four questionnaires were found.

(3) Easy to use: Participants rated four questionnaires (SUS, NPS, USE, and UXSC) significantly higher than UXS. No significant differences among the four questionnaires were found.

Table 3 Questionnaire evaluation

Dimension	SUS (N = 10)	NPS (N = 20)	USE (N = 11)	UXSC (N = 20)	UXS (N = 20)
Understand the attributes*	**4.33 (0.70)**	**4.85 (0.37)**	**4.82 (0.40)**	**4.70 (0.57)**	3.65 (1.04)
Understand the rating scale	4.67 (0.52)	4.85 (0.37)	4.91 (0.30)	4.85 (0.37)	4.70 (0.47)
Easy to use*	**4.67 (0.70)**	**4.80 (0.52)**	**4.73 (0.47)**	**4.60 (0.60)**	3.30 (1.26)
Allows me to completely express my experience with the system and task**	3.83 (1.35)	3.30 (1.42)	4.27 (0.79)	**4.65 (0.49)**	3.20 (1.11)

Mean scores (standard deviation) for each questionnaire and each dimension. Bold text indicates significant differences. *$p < 0.0001$, **$p = 0.001$

(4) Allows me to completely express my experience with the system and task: Participants rated UXSC significantly higher than SUS, NPS, and UXS. No significant differences were found between UXSC and USE and among SUS, NPS, and UXS.

In terms of understanding the attributes and ease of use, participants rated the UXS significantly lower than other questionnaires even though UXS has the simplest attributes such as “good versus bad” or “fast versus slow.” Participants’ comments (e.g., “Not easy for me to interpret what the simple keyword (good vs. bad) means”) suggest that using only simple keywords may lead to misinterpretations.

5.3 Questionnaire Preferences

Participants’ most preferred questionnaire was the UXSC (65 %) followed by USE (36 %), SUS (10 %), and NPS or UXS (5 %). They commented that they liked the UXSC the most for the following reasons: ability to leave qualitative comments, descriptive statement and examples, NA options, and visual look and feel. Comments included: *“Gives me [the option] to provide my own feedback,” “Can provide detailed feedback,” “Open-ended questions are more useful than Likert scale questions for UX team,” and “Helps me to organize my comments for each attributes,” “Like descriptive statement and examples for each attribute description,” “Color-coded ranking can prevent mistakes,” and “like eye-catching bold keyword.”*

Their least preferred questionnaire was UXS (80 %) followed by SUS or NPS (10 %), and USE (9 %). No one chose UXSC as the least preferred questionnaire. They commented that they disliked UXS the most for the following reasons: confusing scale structure, not descriptive attributes, and inability to leave comments. Comments included: *“Reversing scale is confusing all the time,” “Need to change my mind frequently since attributes are reversed,” “Overlapped (fast vs. efficient) and not appropriate (effective) attributes,” “Not easy for me to interpret what the simple keyword (good vs. bad) means,” “does not capture my thoughts,” and “no room for my suggestion.”*

Several reasons why they liked the UXSC related to the visual look and feel of the questionnaire (e.g., color-coded ranking scale and bolded keywords). In fact, the UXSC (see Fig. 1) provides color-coded icons above each scale and a visual hierarchy (e.g., bold big font size keyword, medium size of statement, and smaller size of examples) that helps users to easily skim through the content. Thus, these design features could affect a user’s usability ratings on the questionnaire. The color-coded ranking icons could also be helpful to prevent unintended mistakes on ratings of different scales of questionnaires (e.g., some have Strongly Disagree to Strongly Agree and some have Strongly Agree to Strongly Disagree).

Participants were evidently confused about the reversing scale structure of UXS, likely resulting in the lowest usability rating and the least preferred questionnaire.

Participants also did not like the fact that they could not avoid particular statements that are not relevant. Except for the USE and UXSC questionnaires, users were forced to rate all attributes. Some participants left a blank when they were rating "effective" on UXS and expressed dissatisfaction about the forced rating.

5.4 *Questionnaire Recommendations*

Despite the small sample size, our own questionnaires, UX Scorecard and UX Scale, showed a strong relationship with other empirically validated questionnaires (i.e., SUS and NPS). Although we still need to keep in mind test reliability, validity, and sensitivity using psychometric evaluations, this study exhibited participants' perceived usability and preferences for questionnaires. Participants' feedback revealed several design recommendations for questionnaires.

- Provide clear and easy to understand statements with examples.
- Avoid providing only keywords that are overly simplistic and require participants to guess about the meaning of a question.
- Provide a text size hierarchy (e.g., bold bigger size keyword) with redundant visual cues (e.g., color, number, and label) to distinguish scales to reduce additional mistakes.
- Provide space for open-ended comments overall and for each dimension to allow participants to provide their thoughts and suggestions.
- Provide an NA option for use when users think a particular statement is not appropriate.

We also explored result visualizations for researchers. Figures 5 and 6 show the summary and analysis pages for UXSC results. The summary page includes an overall score with acceptability, adopted from the SUS questionnaire, and scores for

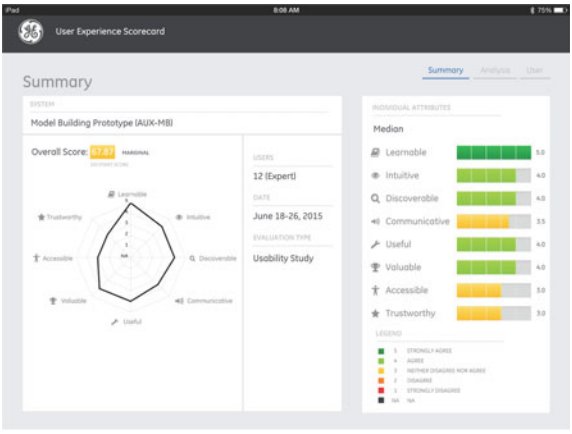


Fig. 5 UX scorecard results visualization—summary

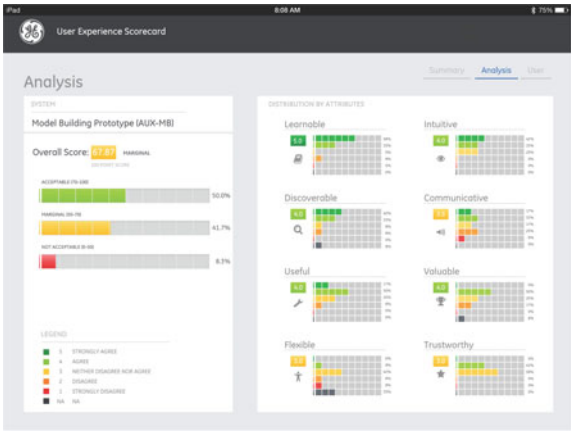


Fig. 6 UX scorecard results visualization—analysis

individual attributes. In addition, a radar chart shows the size of the gaps among the 8 attributes as well as system strengths and weaknesses.

The analysis page shows percentiles of acceptable, marginal, and not acceptable ranges as well as distributions of 8 attributes. We have found in our numerous studies that the frequencies of ratings (e.g., having a percentage of strongly disagree ratings despite a higher median rating) are important for identifying areas for improvement. The color-coded data helps researchers to get a quick glance to understand the results of subjective ratings on a particular system.

6 Conclusion

In this study, participants evaluated different types of questionnaires as well as ranked and discussed their preferences. The results show that 65 % of participants chose the questionnaire with enhanced design features (e.g., color-coded ratings, open-ended comments, and examples) and measurement of user experience beyond usability as the most preferred. Future studies require testing the reliability and validity of our own questionnaires with larger sample sizes. In addition, the visualization of the results can also be enhanced from researchers’ feedback based on their particular needs.

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A Study on the Rationality of Office Feng Shui Based on Ergonomics

Xinke Shen, Wei He, Bo Chen and Li Ding

Abstract Feng Shui is an ancient Chinese wisdom of harmonizing human beings with their surrounding environment. It is now universally applied to interior layout design for working area. But the rationality of office Feng Shui still remains doubtful with limited research on it. In this study, experimental methods in ergonomics were adopted to testify the model of office Feng Shui design developed by the Form School theory of Feng Shui. In the experiment, subjects did simulated office tasks in three different office Feng Shui designs ("best", "middle" and "worst") and indoor environmental parameters, subjects' physiological index, working efficiency, emotional states and subjective evaluation were obtained by measurement or questionnaire. The results of different designs were compared afterwards. The conclusion came that ideal office Feng Shui design can bring positive influence on office users' subjective feelings, but it does not make significant difference concerning indoor environment, uses' physiological index or efficiency.

Keywords Office · Feng Shui · Ergonomics · Subjective evaluation

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1 Introduction

Office workers comprise an increasing proportion of working population worldwide [1]. As their work performance is influenced by the environment of office workplace, to design a comfortable office environment has been a growing concern for researchers. There have been an intersection of various disciplines in interior design as well as ergonomics. One of them is office Feng Shui theory, which draws wisdom from ancient Chinese philosophy.

The Feng Shui theory is a traditional Chinese architectural concept for selecting the favorable dwelling sites and building layout designs [2]. It is regarded as being capable of bringing health, comfort and even fortune. Contemporary office Feng Shui theory derives from the ancient one and is expressed in a modern context. There has been some interdisciplinary research on office Feng Shui from the perspectives of architectural design [3, 4], environmental psychology [5] and business culture [6]. Mak and Ng [4] found that the selection of interior layout as proposed by the architects generally concurs with the ideal Feng Shui model. Furthermore, Octavia and Gunawan [3] came to a conclusion that many Feng Shui recommendations bring positive impact and some others neutral ones based on the sustainable architectural design principles. However, hardly any experimental evidence have been obtained to validate the influence of Feng Shui design. Ergonomic methods have great potential to solve this problem.

In ergonomics area, increasing workers' health and comfort has been a long-standing aim. A great amount of requirements concerning appropriate design of the workplaces have been produced (see Council Directive 90/270/EEC (1990) and the ISO 9241 (1997) standard), and systematic methods of office layout design have been introduced [1, 7]. It should be noticed that ergonomic requirements share something in common with Feng Shui design, like "orientate the workplace in such a way that there are no entrance doors behind the employee [1]", but also many other recommendations in Feng Shui design are not referred to in ergonomics. It would be an exciting exploration to apply experimental methods in ergonomics to testifying the influence of different levels of office Feng Shui design on work performance. In this study, environmental parameter, physiological index, subjects' working efficiency and subjective feelings are monitored in different Feng Shui designs, aiming to give objective evaluation of each level of Feng Shui design, examining whether it conforms to the evaluation in Feng Shui theory.

2 Feng Shui Design

The first task in this research is to develop a Feng Shui evaluation model to classify different levels of design so that it could be test by ergonomic methods. The Feng Shui model in this research is mainly based on Feng Shui theory of Form School.

Feng Shui theory has been generally divided into two main schools: Compass School and Form School. The theory of Compass School emphasizes the metaphorical meaning of direction and carefully chooses it for buildings or tombs by using Luopan, or Feng Shui compass. This school's practice has been highly dependent on the mysterious formulae. On the other hand, Form School concentrates more on the physical configuration of mountains and watercourses. It determines the best location and orientation by the land formation and terrain.

Form School has been much better recognized and widely accepted by Feng Shui researchers than Compass School, as it seems more reasonable by modern explanation and can be even applied to account for the site selection of cities beyond China, such as Canberra, Moscow and Washington DC [8]. Besides, a study by Mak and Ng [4] has suggested that architects' interior design in Hong Kong and Sydney generally concurs with the ideal model of Form School. Thus, this study chooses to focus on Form School model and testifies its application in office.

"Qi" is an essential concept of Form School Feng Shui. It represents "cosmic spirit that vitalizes and infuses all things, giving energy to human being, life to nature, movement to water and growth to plants" [9] Qi is categorized into "living Qi" and "dead Qi". The accumulation of living Qi is an essential condition for a good location [4]. The flow of living Qi is largely influenced by the geographical features around the site.

The analysis of Form School Feng Shui is conducted based on five geographical factors, respectively, termed as "dragon", "sand", "water", "cave" and "direction". They are designed to facilitate the proper flow of "living Qi".

Dragon stands for the mountain ridges. The Dragon usually begins at a high peak, and then forms a long range that displays at least three major mountains, with an end at the hill of parents, finally descending to the location of Cave [10]. Dragon provides a strong supportive back for the site and leads the flow of living Qi to Cave.

Sand means the enfolding hills and represents the surrounding environment that protects the Cave from strong wind. The ideal "cave" is described by Lee [2] as the protective "armchair" hill formation with three hills on the left, right and back respectively. A smaller hill is located in front and further from the Cave, forming an open space called "Ming–Tang" in between. Ideal sand helps to form a circulation of Qi on the site and accumulate living Qi.

Water means the flow of water through or bypassing the site. It is recommended that calm and smoothly curved water flow locates in front of the site. Water is an important factor to accumulate living Qi, for "Qi stops at where water flows" (the Book of Burial).

Cave or "Feng Shui Spot", means the niche and represents the best location. The surrounding environment of cave has been described by other factors. Cave is the location where living Qi accumulates and "Ming-Tang" provides an area for Qi to flow in and prevent it from turning into still dead Qi.

Direction of the dwelling was paramount important in ancient Chinese society, and the best direction would be due south.

The five geographical factors were initially applied to the site selection concerning the natural surrounding environment. In contemporary Feng Shui theory, they are also adapted to office layout design [4, 8]. The basis of this analogy is that

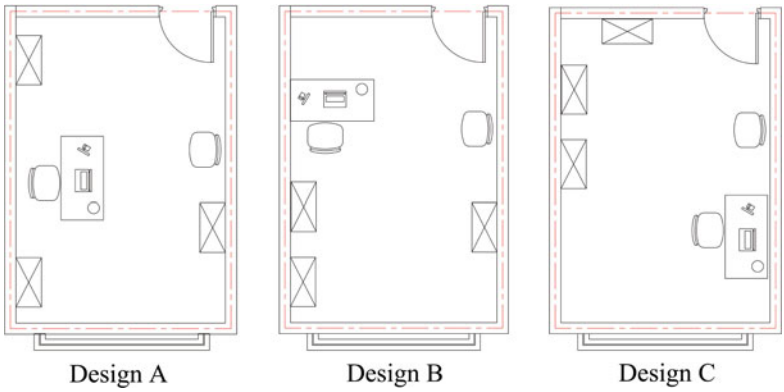

Fig. 1 Plane graphs of the three designs based on office Feng Shui model. Design A is the best design in which all the requirements for highest score are satisfied and the total score is 10. Design B is the medium design in which the first four requirements for mid score are met. It gets an overall score of 6 (The window in constantly faced south). Design C is the worst design with all lowest score for the first four items and its overall score is 2

Qi is in the dominant position to consider about, and the factors that influence the flow of Qi in office can be compared to the natural features. Thus, an office Feng Shui model was developed in this study in reference to Mak's model [4].

Three different designs (A, B, C) were applied to a sample office where the tests for the subjects took place (Fig. 1). The sample office was set to be a personal office.

3 Evaluation Methods in Ergonomics

The essential difference among the three Feng Shui designs is their work environment. Thus, to prove the rationality of office Feng Shui from ergonomic view, it is necessary to evaluate the influence of environment on the subjects' work. Nowadays, the staffs' assignment in their office is mainly based on their brainwork. So the evaluation of brainwork status is essential in the experiment.

Simulated office tasks were designed to be carried out by the subjects during the experiments. The influence of the indoor environment change on the accuracy and speed of the task were examined later. Meanwhile, emotional state test, subjective evaluation and physiological parameters measurement were combined to evaluate the subjects' brainwork status.

3.1 Simulated Office Tasks

The simulated office tasks consist of two parts: Number inspection task and typing task.

Number inspection task requires the subjects to check the randomly generated digits and mark the three consecutive numbers of which the sum is equal to 15 in a 10-min period. After a 5-min relax, subjects were asked to type the randomly generated English letters in a 10-min period. Concentration is highly required to perform well in these tasks.

During these two tasks, an experimenter entered the test site to greet the subjects at the 3rd minute and 7th minute, and 30 s of noise recorded in advance was played at the 5th minute to interfere the subjects.

3.2 Emotional State Test

Brief profile of mood states (BPOMS) is adopted in this study to evaluate the emotional state of the subjects.

Profile of mood states (POMS) is a kind of emotional state rating scale developed by American psychologist McNair et al. [11]. POMS listed a total of 65 adjectives of different emotional states. Each emotional state was rated by subjects on a 5-point scale, indicating the degree of the emotional state, namely "Not at All", "A Little", "Moderately", "Quite a Lot" or "Extremely".

The 65 kinds of emotional states were divided into six types of emotional factors, namely, tension-anxiety (T), depression-dejection (D), anger-hostility (A), vigor-activity (V), fatigue-inertia (F), confusion-bewilderment (C). The total mood disturbance (TMD) can be calculated by six kinds of affective factors. The general formula for TMD is the sum of five negative emotions (T + D + A + F + C) minus positive emotional points (V). The higher TMD score, shows a more negative emotional state, namely the mood is more disorderly, annoyed or confused. BPOMS reduced 65 items of POMS to 30, making it easier to use.

3.3 Subjective Evaluation

Indoor environment not only directly affects the staff's ability to work, but also affects their health, comfort and work motivation, and these factors will ultimately affect the efficiency of the actual work. Based on the psychology of human settlements, the subjective evaluation questionnaire was established to consider all aspects of the influence of the indoor environment on the work efficiency. The subjective questionnaire mainly contains three parts: the evaluation of environmental factors, the evaluation of the office conditions and the evaluation of the office layout. In the last part, the subjects are asked to give a score (highest score = 2, mid score = 1, lowest score = 0) to three different patterns of each geographical factor listed in Table 1.

Table 1 The office Feng Shui model considering the five geographical factors

Geographical factors	Highest score = 2	Mid score = 1	Lowest score = 0
Dragon (back)	Chair backed with wall	Chair backed with furniture	No backing behind chair
Sand (sides)	Bookcases or wall on both sides of chair (with certain distance)	Bookcases or wall on one side of chair	No enclosure for chair
Water (flow)	Curve and smooth air flow in front of chair	No air flow in front of chair	Strong air flow in front of chair
Cave (front)	Chair facing an open space	Chair facing a confined space	No space in front of chair
Direction (sunshine)	Window facing south	Window facing earth	Window facing north or west

3.4 Physiological Parameters Measurement

Three important physiological parameters were measured in the experiments: degree of blood oxygen saturation, heart rate and skin temperature.

Degree of blood oxygen saturation refers to the percentage of hemoglobin-bound oxygen compared to total capacity of the hemoglobin, which reflects the status of respiratory cycle. Research has shown that the low saturation of blood oxygen means the lack of oxygen supply, indicating that the body feels fatigue and mental decline in cognitive ability [12, 13].

Heart rate is an important parameter to measure brain fatigue and muscle fatigue. Compared with the normal situation, when the body fatigues, heart rate will change greatly in order to meet the demand of oxygen.

Skin temperature decreases or elevates with the contraction or expansion of human skin vascular. Therefore, skin temperature could reflect the degree of human body thermal stress and the heat exchange state between the body and the environment. Research has shown that that the thermal comfort of human body depends on the skin temperature to a great extent [14].

3.5 Environmental Parameter Measurement

The environmental parameters to be measured and calculated are humidity, air temperature, globe temperature, wind speed, the ratio of wind speed and PMV (Predicted Mean Vote) index.

Wind speed is measured at four points in the office: the desk, the door and two points of the window. Then the ratio of the wind speed at the desk to the average wind speed at the other three points is to be calculated to represent the influence of wind outside on the working site.

PMV index was developed to evaluate the indoor thermal comfort degree. The calculation of PMV index combines humidity, air temperature, globe temperature, wind speed, etc. It predicts the average vote of a large group of people on a seven-point thermal sensation scale: cold (−3), cool (−2), slightly cool (−1), neutral (0), slightly warm (+1), warm (+2) and hot (+3).

4 Experiment Design

4.1 Subjects

18 undergraduate students were invited as subjects in the experiment. There were 11 male and 7 female subjects, aged between 19 and 22 years old, with good health and mental condition. The subjects were asked to keep normal diet and proper rest before the experiment, and wear summer clothing during the test.

4.2 Experimental Apparatus

Black-bulb thermometer, hygrometer, illumination meter, anemometer, a laptop, button type temperature measuring device, a blood pressure and oxygen saturation monitor watch.

4.3 Experimental Procedure

1. The subject entered the office arranged in advance and rested for 5–10 min. The experimenter pasted the temperature measuring buttons on the back of both hands and put on the blood pressure and oxygen saturation monitor watch for the subject. After that, the subjects completed an emotional test questionnaire based on BPOMS, and the environmental parameters were measured and recorded by experimenters.
2. Subjects conducted the digital inspection task, and after the end of the test, the experimenters measured the environmental parameters again.
3. Subjects conducted the typing task. After that, the subjects filled in the emotional state questionnaire and subjective evaluation questionnaire, and the environmental parameters were measured.
4. The measuring buttons and watch were removed. The subjects left the experimental site.
5. Three experiments were repeated in the layouts of three different office Feng Shui designs.

The experiments were conducted from June to July in 2015, and the relative humidity in the office was kept between 50 and 70 %. The illumination was maintained appropriate. The time of three experiments for each subject were arranged in the same period of three days.

5 Experimental Results and Discussion

Each item of the results were classified into three groups according to three office designs. The mean value and standard deviation of each group were calculated and compared by analyzing the significant level of difference. If the data observe the normal distribution, Repeated Measured ANOVA and Paired-sample T test would be used to obtain the significant level. Otherwise Friedman ANOVA and Wilcoxon test would be used. The significance level was set as 0.05 in the result analysis.

The results of environmental parameters are shown in Table 2. Although humidity, wind speed, air temperature and globe temperature show some difference among the three groups, the PMV index did not see perceptual difference, indicating that the thermal comfort in the three office designs is very similar.

The physiological parameters before and after the experiment were compared among the three groups. No significant difference is shown for any parameters before or after the experiment, indicating that different office Feng Shui designs do not have perceptual influence on office workers' physiological index.

The completed quantity and accuracy of simulated office tasks for each office design group were obtained and compared. There are no significant differences as well.

For subjects' emotional states, we calculated the difference between the results obtained after and before the experiment for each emotional score and TMD, to examine the subjects' emotional change during the experiment. Then the emotional score's change in the three designs were compared. Only the change of tension-anxiety (T) shows significant difference. The score's change of Design A is higher than Design C, indicating that subjects felt more tensional or anxious in

Table 2 The results of experimental parameters measurement (*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$)

Design	A	Mean ± S.D. B	C	p
Humidity (%)	55.50 ± 10.72	56.88 ± 6.71	66.81 ± 6.62	0.001***
Wind velocity (m/s)	13.46 ± 9.05	9.22 ± 5.35	8.83 ± 5.72	0.031*
The ratio of wind velocity	0.42 ± 0.26	0.39 ± 0.15	0.50 ± 0.23	0.596
Air temperature (°C)	26.16 ± 1.24	25.85 ± 1.20	25.20 ± 1.29	0.020*
Globe temperature (°C)	26.34 ± 1.19	26.06 ± 1.07	25.44 ± 1.20	0.016*
PMV index	1.50 ± 0.18	1.46 ± 0.14	1.43 ± 0.14	0.399

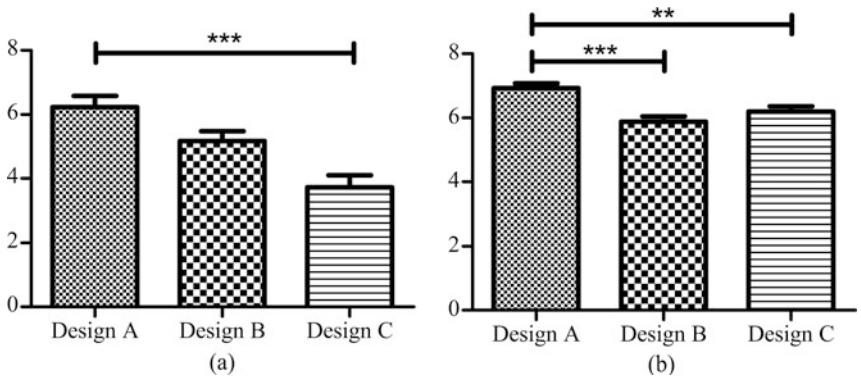

Fig. 2 **a** Total scores of layout evaluation in experiments. **b** Scores for overall evaluation of the layouts in survey (*p < 0.05; **p < 0.01; ***p < 0.001)

Design A. This could be due to random factors or the limitation of subjects' number.

For the results of subjective evaluation, the evaluation of office layout generally conforms to the evaluation according to the Feng Shui model. The five scores concerning five geographical factors the subjects gave to each design were summed up to calculate the total score for each design. Design A got the highest total score (6.22), design B follows (5.17), and design C got the worst (3.72) (Fig. 2a). This indicates that the office Feng Shui design is consistent with people's subjective expectation of an ideal office layout. The other two parts of the questionnaire, the evaluation of environmental factors and of the office conditions, did not show significant difference among different designs.

6 Questionnaire Survey

After the analysis of the experimental data, office Feng Shui design seems to show positive influence on office workers' subjective feelings about the office. In order to invalidate the conclusion, Questionnaire survey was conducted to gather more information in a larger group.

The questionnaire listed photographs of the three office designs. The subjects were asked to give an overall evaluation of the layouts in the survey.

The result of the survey showed Design A got the highest score (6.93), Design C followed (6.13) and Design B got the worst (5.87) (Fig. 2b). It is obvious that Design A got much higher than the other two designs, suggesting that the best office Feng Shui design is very likely to give office workers a positive feeling. But the difference between the middle and the worst design is not very significant.

7 Conclusion

From the experimental results and discussion, the conclusion of the study comes as follows:

1. Ideal office Feng Shui design can bring positive influence on office workers' subjective feelings.
2. Office Feng Shui layouts do not make significant difference concerning indoor environment, uses' efficiency or their physiological index in short term.

This study mainly focuses on the observation of short-term office work, further research is still needed to reveal the influence of office Feng Shui on office workers in long term.

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When Design Encounters Anthropology: Study on Approaches Where Anthropology Gets Involved in Design

Mingyue Lyu

Abstract This paper aims to study the different intervening approaches and combining ways of anthropology in different fields of design. In the field of design teaching, the anthropology often get involved into design through two ways: one is to introduce anthropological knowledge to the design curriculums; the other is to set up a major called "design anthropology". In the field of design research, there are three study themes: material culture, relationship between product-lifestyle and UCD. For the design practicing areas, anthropology usually could undertake three tasks: research tool, situational simulation, and design guidance. Briefly, this combination mode could reflect more in-depth understanding and interpretation to human nature and life. In another words, design is the materialization of human inner.

Keywords Anthropology · Design · Combining approaches · Design teaching · Design research · Design practice

1 Introduction

Why need Anthropology be involved in Design? Briefly, the reason is that anthropology focuses on "humans" while design emphasizing "design for humans" has been focusing on "humans-objects" relationship. So, there is an inextricable link between the two. Anthropological findings could provide a reliable basis for the theoretical research and practice of design, and anthropological working methods could be used in design investigation and research for reference, even its practice mode of in depth participation and observation could be directly used in the whole process of user-participatory design.

Thus, a combination of anthropology with design research and practice means a study on diverse impacts of design in modern daily life, including the shallower

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level of product issues concerning basic necessities and deeper level of mental issues referring to thinking mode. The value of such a design research is to establish a "human-centered" design science, which is distinguished from the traditional "products/objects-centered" design research. For increasing importance attaching to "analysis on the real needs of users", this combination is particularly attractive.

Are there any models to follow for the "Anthropology + Design" curriculum for students majoring in design? Where could design researchers who adhere to anthropological attitude find hot topics of their most concern? Can anthropology go beyond its traditional role as "research tool" to participate in the whole design process instead of intervening just in the pre-design stage? The three questions concern different intervening approaches and combining ways of anthropology involved into different fields of design. Analyses in this paper will focus on the three questions.

2 Anthropology Being Involved into Design Teaching

In view of international education concerned, "anthropology + design" is learnt in two approaches: one is to introduce anthropological perspectives and working methods to some design curriculums, which emphasize user-centered systematic design views, and usually focus on design practice or research of specific course projects; the other is to directly set up a professional degree of "Design Anthropology", involving not only design research and practices, but also theoretical analysis and cultural elaboration.

The first combining channel is comparatively common. I noticed that in the design curriculums of some colleges, anthropological working methods were apparently used for reference in some courses a few years ago. These courses emphasized "user-centered" system views, the contents usually were specific practical projects. In terms of the second channel, the definition of connotation of "Design Anthropology" should be defined in the first place. There is a question: which should "Design Anthropology", as an interdisciplinary research, belong to anthropology or design? In practice, there is no definite answer. Generally, however, "Design Anthropology" seems to emphasize people being engaged in designing with the anthropological attitude and methods, and aiming at "design", so some scholars even suggested it be called "Anthropological Design" [1].

Britain plays a key role in anthropological studies. University of Aberdeen even provided professional master degree, and it is clearly stated on its website that these academic education could provide the students a number of theoretical knowledge and analytical skills from leading anthropologists, and guide them to develop the ability to understand anthropology. These skills will be of relevance and applicability across a number of contexts outside academia. The related courses focus specifically on anthropological approaches, to making things, to creating and owning knowledge, to analyzing institutions in their wider context as sites of social production, and to translating concepts and understandings contained in the

anthropological corpus for non-academic audiences. Students could be strongly encouraged to practice the application of approaches and tools set out through internships or other placements towards the end of the programme. While the programme does aim to teach students to understand processes of design and making from an anthropological perspective, to understand the role that anthropologists might play in assisting or contributing to making processes, and to offer concrete exercises in utilizing these understandings. In addition to advocating wide application of anthropological knowledge or tools in the fields of design, academic pursuit becomes another important objective of this degree programme, which mostly distinguishes the second channel from the first one.

3 Anthropology Being Involved into Design Research

Design research targeted objects at the very beginning, which focused on research into "product development" and emphasized how to enable "objects" to be more popular with the market; later, it expanded to research into the relationship between humans and objects; recently, with the rise of user-centered design strategies, some design research has shifted the focus to "humans"—not only on their living habits, but also on development of these habits, and possible intervening factors as well as ideological characteristics of these habits. In the field of design research, anthropology can provide important thinking method, proofs, approaches or tools for these researches on "objects", "humans" and "human-object" relationship.

3.1 Study on Material Culture

The concept of "material culture" was previously explained on the Anthropology Website of University College London as follows: material culture believes that we are living and traveling in a world of materials, from canoes to paddy fields and from cities to jeans; we also believe that humans' habits, dietary and meeting modes and their values come partially from the physical environment where they live, daily routines in the housing space or their expected way of dressing. It is of the same importance as the development of their value views and moral beliefs. Therefore, anthropologists have been concerning about the way by which material culture could shape humans, and creation of objects by humans, including different worlds creatively built by humans, as if people have been focusing on the way by which technology and practice could shape humans [2].

Additionally, Jules David Prown also had provided the following interpretation: "Material culture is a study on believes, values, concepts, attitudes and conjectures of humans through artifacts in a specific community and society at specific time … the term of material culture refers also to the artifacts" [3]. Obviously, in eyes of

these anthropologists, material culture and design product can be connected in the research.

In fact, anthropologist Mary Douglas made the following assumption in the 1990s: humans need products to allow culture to be clearly and firmly defined [4]. The assumption led to series-related field investigations for the purpose of finding and verifying the way in which humans build social and cultural identities by consuming designed products.

Besides, Alison J. Clarke believed in his book, *Design Anthropology*: *Object Culture in the 21st Century*, that anthropology studies provide clear guidance for designers to deal with the increasingly complex and diversified material world nowadays. From design ethnography to cultural exploration, innovative designers have been searching for the inherent meanings of objects by using anthropological methods, instead of simply styling and functional design. For this reason, anthropological methods, such as ethnography and field investigation, can not only help user studies, but also facilitate designers to effectively transfer users' experience into design concepts.

3.2 Study on Relationship Between Products and Lifestyle

How do anthropologists understand the impacts of artifacts on real life? Can design activities change users' lifestyle? Masterpieces can be found among anthropological literatures on these issues and the like, and this paper intends to probe into the relationship between design activities and daily lifestyle (or ways of behavior), with the help of the viewpoint of the famous French anthropologist Marcel Mauss.

Such a design research focuses on the context of production and use of "objects" and emphasizes the interaction between "humans" and "objects". As a result, researchers need to see people's lifestyle, design activities and products as a whole. Mauss believed in his magnum opus Techniques, Technology and Civilization [5] that in a sense, the cooperation of technology,[1] objects and actions (behavior ways) was both effective and meaningful.

As he said that "a tool means nothing unless it is in one's hand(s)", a tool couldn't be understood well until the tool is placed in the whole context associated with it, and such understanding is changeable and dynamic. All actions and postures of technology are a dynamic continuous process, following which one can know how material, social and symbolic elements are constructed, coordinated and recombined during the process. The first conclusion can be drawn if efforts have been made to apply such a viewpoint to design research: it is clear that our understanding about design should be dynamic and changeable, and research on

[1]In the eyes of design researchers, technology can also be a traditional design activity, of which the concept covers the making design skill, the making process, design products and relevant cultural inheritance.

products will be significant only when the products are placed in a correlative context.

The question that "can design change humans' lifestyle or behavior ways" seems to be easy to answer in Internet Era, as "the Phubbing" that can be seen everywhere is a typical example, which proves mobile phone has changed our lifestyle. But nearly a century ago, Mauss made an in-depth analysis on this question from an anthropological perspective and believed that existing ways of act (referred by Mauss to "habitus"[2]) was one kind of behavior process guided collectively, in which technology and skill could influence and even make social "habitus". Based on this theory, we may draw the second conclusion: as a physical utility behavior, design behavior plays a role in influencing "habitus" and thus can change or build lifestyle to some extent.

Anthropologist Mauss gave his systematic thinking of "objects-humans-daily life" for design researchers, after that designer Kenya Hara also underlined in his book, Design of Design, that research on products cannot be separated from related context analyses. He believed that design could speak for "daily" life, and find problems in the life. The essence of design is to solve various problems encountered by most people (the mass) in modern society. He thought that design has been considered as "comprehensive anthropology" in Europe, and designers usually get to know the essence of life by creating objects [6].

In short, design activities are of social characteristic in both physical and ideological dimensions, so researchers should take the specific contexts into account in the understanding of these activities. Anthropology has become an essential knowledge supplement for studying people behaviors. It is applicable to studies of design history, design criticism and design principles.

3.3 Study on Users' Demands

The value of anthropology's intervention in study of user demands lies in that it is helpful to analyze users' characteristics in real context. UCD (user-centered design) is a user-centered design strategy, compared to the "object-centered" design strategy. It emphasizes designers should make design decisions based on "user experience", taking into account user demands and feelings in the entire process, carrying out design development and maintenance in a user-centered manner and advocating user priority in the design pattern, instead of adapting users to products.

Intervention of anthropology into study of USD has two advantages. The first one is that possible consequences of design can be foreseen. Ethnography is a research technique involving participatory observation and in-depth interview and underlines explain of human behaviors through a systematic and immersive study.

[2]"Habitus" is a philosophical concept derived from Mauss's viewpoints, which refers to subconscious and structural social characteristics of human behaviors.

By virtue of such studies, researchers can accurately record and analyze consumers' characteristics and help managers, marketers and designers foresee possible changes in the market [7]. The second advantage is designers can create or improve products or services in users' shoes. In anthropological viewpoints and attitude toward research, much attention is paid to mutual transformation between the subject and the object (putting oneself in others' place), so that designers could carry out a certain practical solution. Consequently, the application of anthropology in the design process can help designers "reconstruct" real living and using contexts of users, so as to define actual user demands and unique ways to use products. In this way, anthropology can provide designers with valuable advices [8].

4 Anthropology Being Involved into Design Practice

The above interpretation implies that it is feasible and effective to apply anthropology to design practice. The question designers think about most is: which stage should anthropology get involved in design process, and what role should it play?

4.1 Three Roles of Anthropology in Design Practice

Research Tool. For commercial designs, application of anthropology to the design process aims at the success of design marketing. Relevant ethnographical information should be collected in the initial stage of product development [9]. Ethnography can provide designers with broader design thinking ways and more accurate data analysis, thus increasing design efficiency. In terms of practice projects, such survey as how/when/why/who/where to use products, and the exploration into potential motives which users may have when choosing these products or services, can offer designers a basis for decision-making and facilitate the development of innovative views.

Situational Simulation. Anthropologists have been good at making intensive studies of task roles or images, who try to construct user prototype through in-depth and context-associated ethnographic studies, and each role of prototype represents a group of individuals showing similar demands, frustrations, desires, motives and behaviors. Therefore, in studies of task roles or images, ethnography can be applied to simulate the situation of a specific target in a certain context [10].

Design Guidance. The working mode similar to ethnographic is helpful for designers to understand humans' cultural transition and thus resulting effects on human behaviors. Participatory observation is an important principle in the study of behaviors of a special group of people in ethnographical research. It has become a significant symbol of ethnographical fieldwork since it was proposed by Bronislaw

Malinowski at the end of the 1960s, and is the fundamental way to collect firsthand information. It requires researchers to be involved in real daily life as specific roles, and dynamically observe and experience the ways of behavior and values of the group to be studied, instead of statically observing, recording and describing superficies of objects [11].

The interactive participatory observation can help designers have a profound understanding of the correlation between consumer demands and product design [12]. While rapid ethnographical analyses can allow designers to unearth the cultural trends and social rules under social values and then inspire the innovation of cultural attributes of design [13].

4.2 Intervention in Periodical Stage and in Whole Process

Anthropology can be involved in the pre-design stage as a design research tool; it can also be involved in the initial stage to facilitate the design guidelines; it can even be involved throughout the whole design process to help designers correct design schemes at any time. At present, design practitioners and researchers are emphasizing anthropology more and more, which begins to be fully involved in the whole design process.

Such whole process involvement is more commonly seen in participatory design strategy, where designers try to enable end users to participate in design process by actively organizing practical activities, such as organizing tool kits, using physical models and simulating prototype environments, etc. Participation of users means that ethnographical research into users is no longer just about providing design references, but about directly giving advices on the design process or evaluating solution in advance, to influence design results.

Moreover, designers usually will employ anthropological working methods throughout their participation in social innovation projects. With the currently noticeable "transformation of old communities" as an example, designers will generally have more than one direct dialogue and cooperation with former residents, organize all stakeholders to collaborate with each other, so as to bring about design proposals. In these design projects, it is very important to emphasize field investigation and lifestyle research, discover and define problems profoundly through anthropological field investigation. The problems include how to study users' lifestyle, what are any predicament or problems in such lifestyle, how should design be involved in social innovation, and what problems can design solve, etc. Finally, design proposals are generated based on problem analysis in local actual situations. Anthropological attitudes and working methods will generally be found in the whole design process of these projects.

5 Summary

With the emergence of technological innovation and network media, the concept of design has been developing in a dynamic and changeable manner from multi-discipline to cross-discipline cooperation. Design focuses no longer on creation of formal beauty alone. The creation process involves anthropology, computer science, art, philosophy, psychology and marketing, and is collectively called "design". In this period, because of change of strategy from object-centered to user-centered design, anthropology is making particularly attractive contributions to design research and practice.

This paper probes into different intervening approaches and combining ways of anthropology in different fields of design.

In the field of design teaching, anthropology often gets involved into design in two ways: anthropological viewpoints and working methods could be introduced to design curriculums; and some colleges set up professional degrees called "design anthropology".

In the field of design research, anthropology and design are combined mainly in three approaches, such as material culture studies, studies into the relationship between product and lifestyle and studies into user needs.

In the field of design practice, anthropology usually undertakes tasks such as research tool, situational simulation and design guidance. In design projects, anthropology can be not only involved in the pre-design and initial stages, but also involved in the whole process of participatory design and social innovation projects, in order to guide the generation of schemes and help timely correction of the same.

Briefly, by properly using anthropological attitude and methods, design practitioners not only could create tangible products and intangible services to meet people's needs, but also be able to improve design tools and optimize design processes or systems. More importantly, this combination mode could reflect more in-depth understanding and interpretation to human nature and life. Thus, a famous Chinese designer presented such a word: "design is the materialization of human inner".

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Part IV
Design for Smart Environments and Well Living

Relationship Between Kansei Value and Recognition on Abstract Metaphorical Beverage Packages

Yigang Huang and Namgyu Kang

Abstract D.A. Norman emphasized that a package with metaphorical expression brings emotional (*Kansei*) value. Inspired by Norman's statement, we clarify the relationship between *Kansei* value and recognition capability in beverage package design in abstract metaphorical method. To achieve this, we conducted a questionnaire with 9 packages (3 packages of soft drink, milk and water) based on a sample of 30 students from Future University Hakodate. All selected packages were new to the participants. Each feature was evaluated on a scale from 1 to 5 ("−2", "−1", "0", "1" and "2") according to the following 6 evaluation items: (1) metaphor level of packages, (2) abstract expression level of packages, (3) originality level of packages, (4) desiring level of packages, (5) recognition level of packages, and (6) interest level of packages. The scores of 9 packages were quantified as evaluated scores, and each package was visualized on the map with the x-axis, showing the evaluated scores of metaphor level and y-axis, the evaluated scores of abstract level. These 9 packages were separated into 2 groups: Group A—a group of abstract metaphor package and Group B—specific package group without metaphor, then these 2 groups were visualized on another x-axis (the evaluated scores of interest and originality level) and y-axis (recognition level). As a result, Group A has a high *Kansei* level, but its recognition level is low; Group B has a high recognition level but the *Kansei* level is low. Moreover, based on correlation coefficients, metaphor level has no relationship with recognition level. In comparison, abstract level has a negative relationship with recognition level. The principal component analysis (PCA) was conducted for an integrated survey. The following 2 principal components obtained "*Kansei* value"(with +desire level, +originality level, +interest level and +metaphor level) and "Novel"(with +abstract level, +originality level and -recognition level). And each package's scores (x-axis) for "*Kansei* value" and scores (y-axis) for "Novel" was mapped. As is it shows, if a package design gets a high score of "Novel", it will be difficult for participants to recognize what kind of beverage is. However, if a package gets a low score of "Novel", it will be easy to recognize what kind of beverage it is, but nothing original can be seen on the

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package. There will be a balanced position between “high novel” and “low novel” better for users. In conclusion, designers can attract customers in a metaphorical and abstract method, but they need to be aware that the more abstract method is overused on packages, the weaker relationship between package and beverage there will be.

Keywords *Kansei* value · Recognition · Beverage package design · Abstract metaphor

1 Introduction

With the progress and development of consumption level, people are now attaching greater importance to package design. Actually, good package can increase the attraction of a new beverage. The value of the package can also cause the users’ motivation to buy the beverage. A beverage Package design has the trademark, color, shape, materials and other components.

Therefore in this research, *Kansei* value and recognition of beverage package design are focused. The purpose of this research is to clarify the relationship between *Kansei* value and recognition in beverage package design through abstract metaphorical method.

2 Literature Review

2.1 Performance of Metaphor and Its Significance

Designers can use direct and indirect ways to express beverage package. Direct expression refers to the key expression of the contents themselves, including the appearance, functions and usage of the beverage. There are some direct ways, such as background, contrast, features, etc. These kinds of package let people directly know the beverage itself.

Indirect expression is an internal way of expressing the beverage, the beverage itself does not appear in frame, but with the aid of other relevant factors, it can finally be recognized. This method has more various performances. Some packages of beverages like perfumes, wines, washing powders cannot be directly expressed. Metaphorical method in package design is a kind of indirect expression. Metaphor is a way to express an original object with the help of the other object, proceeding from one thing to another [1]. The composition of metaphor adopted must be those specific things and images that most people are familiar with and aware of.

Thinking is the function of brain. People’s way of thinking is various. It can work from one concrete to another concrete, from the abstract to the concrete, from

the concrete to the abstract, and even from abstract to abstract [2]. When a designer creates a package of a beverage with a different thing that seems to have no connection with the beverage itself, people can find something in common, that is to say people make the package abstract in a metaphorical method. The characteristics of this method can make people have association and imagination. However, some packages look more concrete, and some packages do not look like the beverage, but pictures and symbols are used to build relationship between package of beverage and beverage itself [3]. Some package become more abstract, and the package has no connection with beverage itself. People use usual things as metaphors for unusual things. In this study, abstract metaphorical method in a drink will be focused. That means the package in this study has no connection with beverage itself, however this study reveals the relationship between package of beverage and beverage itself through imagination and association [4].

2.2 *Different Performance of Metaphor in Package Design*

Different kinds of packages in people's daily life, on beverage packages, some of them are specific and metaphorical, some are abstract and some are specific.

Firstly, on a specific and metaphorical package, designers use the physical detail in the design by turning it from one into another, but it has no relationship with the beverage itself. The advantage of this kind of beverage is to make users feel interested in it. For example, some designers make a brush package into an old man's face (As shown in Fig. 1), the designer uses the mustache as metaphor for a brush, by just painting the sense of the "mustache", then the brush looks like a face. Before looking at this face, maybe the users know that this is a brush because of the handle. The designer uses a metaphorical method but it is a concrete expression, a concrete metaphor.

Secondly, packages with specific expression is direct. users do not need to imagine and associate anything, but know what kind of beverage it is. For example (As shown in Fig. 2), the package of banana juice is designed into the banana skin, the same as the other fruit juice. The package, of course, with the pictures of beverage and specific character on it is more specific in package expression. These packages have a good identification to users.

However, some other package of beverages are abstract. These packages with special colors and lots of symbols on it have ordinary shapes. They let users know

Fig. 1 The package of brushes are made into an old man's face

Fig. 2 The package of banana juice is designed into the banana skin

Fig. 3 Two different tastes of ice-creams in the freezer

what they are. Here is another example (As shown in Fig. 3). Users get puzzled at the character on the package of ice-cream. However the package is brown in color. In that way, users will associate the color with chocolate ice-cream. Therefore, this kind of abstract package with no metaphor also needs users' association.

2.3 *Emergence of* Kansei *Value*

How to make an attractive package full of imagination and association? The purpose of package is to convey content itself correctly and to attract users. Package design is an important communicative medium between users and beverages. On the basis of promoting a beverage's quality, *Kansei* communication of beverage with users has been increasingly emphasized [5]. Abstract package sets up a bridge of communication for users, evoking association and imagination. Maslow's theory suggests that the most basic level of needs must be met before the individual will strongly desire (or focus motivation upon) the secondary or higher level needs [6] (See Fig. 4).

People's understanding of things from its appearance is the first step of *Kansei* process. People mainly perceive things with their sensory organs [7]. Perceptual knowledge refers to the users' sense or intention of a beverage. And it is a mental expectation and feeling. In today's user society, the functional performance of a beverage is not the only one of its important factors that users are concerned about. Perceptual factor, together with users' needs, makes *Kansei* value. Kano presented "Kano Model" based on the development of products and satisfaction of users.

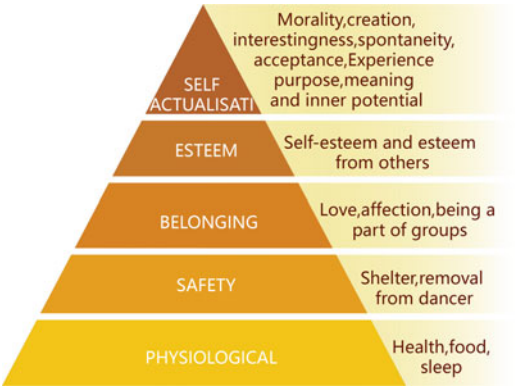

Fig. 4 To express different levels of people's needs

This theory summarizes quality control in three different levels [8]. The first and lowest level is called basic needs. At this level users can meet their least demands, "Must-be quality" is connected with this level. The second level is called performance needs. At this level designers can achieve the task of users's expectation of performance, "One-dimensional quality" is connected with this level. The third, also the highest level is called delighters. At this highest level, designers can meet users' latent demands, "*Kansei* quality is connected with this level". If a user satisfied with "Must-be quality" and "one-dimensional quality", he or her wants to be satisfied with "*Kansei* quality".

The *Kansei* value in this research is that people are based on their "feel" to identify and judge the quality of products and thus gained the hearts meet. Moreover, people in the choice of products, not necessary only to consider products "interesting", "creation", "discrimination", but by the first direct feeling to choose, and it create values therein, of the so-called "*Kansei* value".

2.4 Cognition on Recognition

Designers always try to extract concise Graphical symbols from an idea or a concept to build brand recognition for users, and users can understand what the product is. Designers can extract information which is connected to product through abstract method, and perform by using symbols. However, the more abstract the package is, the weaker the connection between package and product will be. When abstract method reaches a critical point, the connection between them will disappear. Based on this fact, designers should try every effort to make a product interesting so that consumers can understand and accept it.

3 Experiment

A questionnaire survey was used in this research to clarify the relationship between recognition and *Kansei* value in beverage package design through abstract metaphorical method. The experiment was conducted with 30 students from Future University Hakodate of Japan.

Each feature was evaluated on a scale of 1–5 ("−2", "−1", "0", "1" and "2") from the following 6 evaluation items: (1) metaphor level of packages, (2) abstract expression level of packages, (3) originality level of packages, (4) desiring level of packages, (5) recognition level of packages, and (6) interest level of packages. (Fig. 5).

In the experiment, that 3 packages of soft drink, milk and water were selected, these 9 packages were new toward participants. The nine packages used good quality images to map in questionnaires (Fig. 6).

3.1 Result of the Experiment

Separated Groups. The scores of 9 packages were quantified as evaluated scores, and each package was visualized on the map with the x-axis, showing the evaluated scores of metaphor level and y-axis, the evaluated scores of abstract level.

The relationship between abstract level and metaphorical level of each beverage package can be found from the axis (Fig. 7).

Fig. 5 Questionnaires of the experiment

Fig. 6 Images of 9 packages

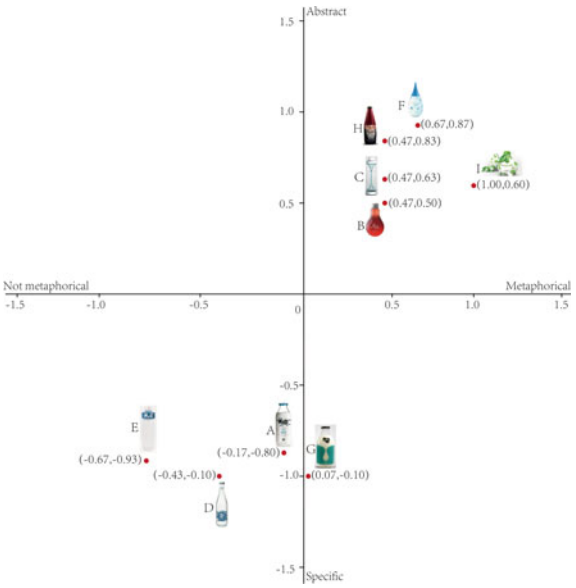

Fig. 7 Axis about evaluated scores of each two items

The metaphorical and abstract levels of beverage package A, D and E were evaluated as low. However, these levels of beverage package B, C, F, H and I were evaluated as high. From the results, the process of selecting by the people who have an experience of design education are signified.

Based on these results, the analysis was conducted by separating into 2 groups. These separated groups were shown as Fig. 8.

Relationship between Recognition and *Kansei* Value Based on Selected Beverages. The evaluated scores of recognition and originality of beverage packages were made into an axis (Fig. 9).

According to Fig. 9, participants evaluated that beverage B, F, H and I were original but difficult to recognize except beverage C. These beverages used abstract and metaphorical methods.

However, beverage D and E were evaluated as recognizable but not creative, only beverage A was original and recognizable, they were in the design methods of specific and metaphorical.

Secondly, The evaluated scores of recognition and interestingness of packages were made into another axis (Fig. 10).

Fig. 8 The separated 2 groups

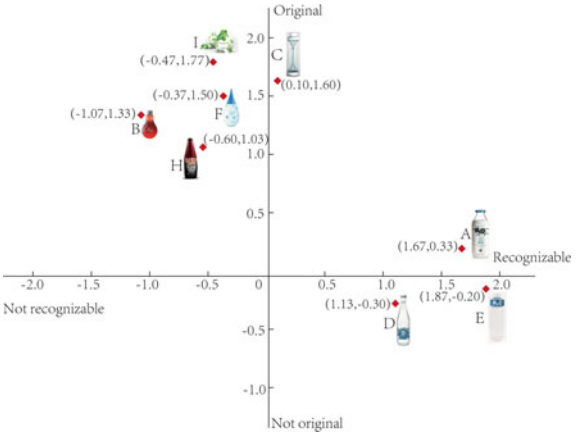

Fig. 9 Relationship between recognition and originality of packages

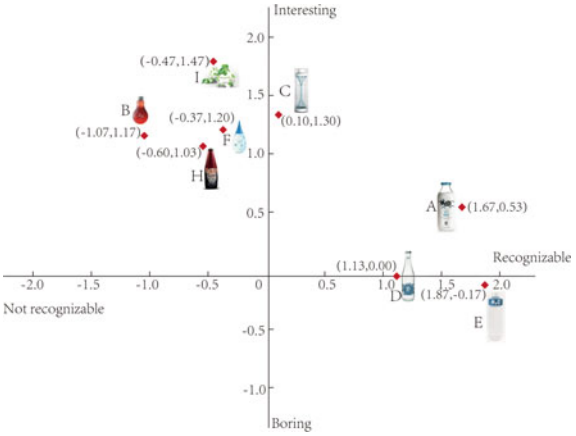

Fig. 10 Relationship between recognition and interestingness of packages

From Fig. 10, participants evaluated that beverage B, F, H, I and C were interesting, but only beverage C could be recognized, the design method of these beverage packages was abstract metaphorical. On the other hand, beverage A, D and E were easy to recognize, but only beverage A was interesting, these 3 beverages used specific metaphorical method.

At this point, the abstract metaphorical package group (B, C, F, H and I) was interesting and original but did not have a good capability of recognition. However, the specific metaphorical package group (A, D and E) was recognizable without high level of *Kansei* value (interestingness and originality).

Correlation Coefficients. Evaluated scores from questionnaires were quantified as correlation coefficients (As shown in Fig. 11).

As a result, there is no significant between "Metaphorical" and "Recognizable". There is a weak significant between "Abstract" and "Recognizable", but the coefficient is a minus correlation, it means the more abstract packages are, the more Recognizable packages won't be.

Fig. 11 The correlation coefficients of each item

Recognizable	Interesting	-0.136	n.s
	Abstract	-0.339	Weak Significant
	Metaphorical	-0.097	n.s
Interesting	Original	0.548	Medium Significant
	Abstract	0.207	n.s
Desired	Metaphorical	0.317	Weak Significant
	Interesting	0.364	Weak Significant
	Original	0.227	n.s
	Abstract	0.054	n.s
	Recognizable	0.169	n.s

The "Interesting" doesn't have any significant with "Abstract" and "Recognizable", but there is a medium degree significant between "Interesting" and "Originality". Participants evaluated that, the more original packages were the more interesting they will be.

The "Desired" has no significant between "Recognizable", "Originality" and "Abstract". However, it has weak significant between "Metaphorical" and "Interesting". Participants want more beverage packages which are interesting by using metaphorical method.

Principal Component Analysis. Scores of the questionnaires were analyzed by principal component analysis. The result of principal component analysis is that, the cumulative contribution ratio of component 1 and 2 are in excess of 61.3 % can be confirmed, these 2 components are explained below (Fig. 12).

Fig. 12 The result of principal component analysis

	Component 1	Component 2
Eigenvalue	2.309	1.371
Contribution (%)	38.476	22.847
Cumulative contribution ratio(%)	38.476	61.323

Eigenvector

	Component 1	Component 2
Metaphor	0.659	0.101
Recognizable	0.058	-0.854
Original	0.636	0.496
Desired	0.754	-0.297
Abstract	0.186	0.727
Interesting	0.752	0.257

Firstly, in the eigenvector of component 1, the stronger "Desired" is, the stronger "Interesting", "Metaphor" and "Original" will be. It can be evaluated that, if a beverage package is interesting, original and use metaphorical method, maybe participants want to buy it. Therefore, the component 1 here can be called "*Kansei* value" (Fig. 13).

Next, according to the eigenvector of component 2, the stronger "Abstract" and "Original" are, the weaker "Recognition" will be. It evaluated that, the more original a beverage package is, the more abstract it will be, participants maybe cannot discriminate what kind of beverage it is. Therefore, it can be called "Novel" at this point (Fig. 14).

Fig. 13 Eigenvector of component 1

	Component 1
Desired	0.754
Interesting	0.752
Metaphor	0.659
Original	0.636
Abstract	0.186
Recognizable	0.058

Fig. 14 Eigenvector of component 2

	Component 2
Abstract	0.727
Original	0.496
Recognizable	-0.854
Interesting	0.257
Metaphor	0.101
Desired	-0.297

Table 1 Evaluated scores of 9 beverages' principal component scores 1 and 2

	Principal component scores 1	Principal component scores 2
Beverage A	−0.093	−0.916
Beverage B	0.103	0.753
Beverage C	0.363	0.406
Beverage D	−0.66	−0.542
Beverage E	−0.85	−0.939
Beverage F	0.366	0.586
Beverage G	0.1	−0.647
Beverage H	0.029	0.641
Beverage I	0.642	0.658

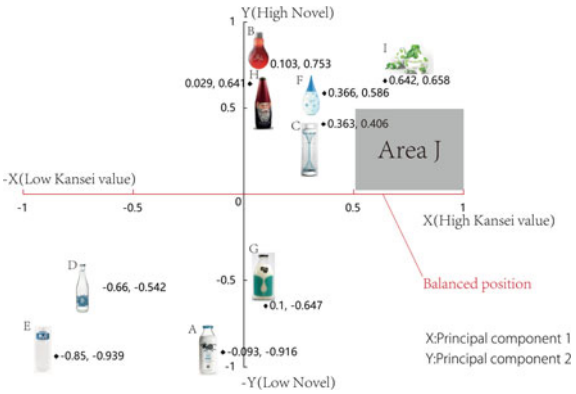

Fig. 15 Evaluated scores of 9 beverages' principal component scores 1 and 2

Otherwise, scores of principal component 1 and 2 were computed, and then these scores of 9 beverages were separately computed as evaluated scores and mapped (Table 1). These evaluated scores were made into a X, Y-axis the X-axis is the numbers of principal component 1, and the Y-axis is the numbers of principal component 2 (Fig. 15).

According to Fig. 11, if a package design gets a high score of "Novel", it will be difficult for participants to recognize what kind of beverage is. However, if a package gets a low score of "Novel", it will be easy to recognize what kind of beverage it is, but nothing original can be seen on the package. There is a balanced position (As shown in Fig. 11) between "high novel" and "low novel" better for users. On positive axis, all the beverages are "abstract metaphorical group", they get high novel but difficult to recognize. Actually, "Area J" on the figure is the best package design for users, because "Area J" means an attractive beverage is not only full of *Kansei* value but have a good recognition capability for users.

4 Conclusion

Designers can attract costumers in a metaphorical and abstract method, but they need to be aware that the more abstract method is overused on packages, the weaker relationship between package and beverage there will be. Thus, users cannot understand and recognize the beverage easily, but if a beverage is designed and packaged in an appropriately metaphorical method, it will become so interesting and original that costumers can easily understand select it.

5 Future Work

This research was only conducted by package design, in the future, we can use abstract metaphorical method to improve *Kansei* value in more design field like product design and information design.

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Research on Lift Assistance Seat for Elderly People—Focusing on Analysis of Motion Capture and EMG

Toshiki Matsuo, Kenta Yamada, Wonseok Yang and Alireza Ahrary

Abstract We observed their movement by measuring their range of motion using a motion capture to investigate behavior in sitting. In addition, we performed electromyographic analysis of joints to examine the causes of the burden in sitting down and standing up. We believe that the slower movement in sitting down and standing up in the elderly compared to those in young people was caused by loss of muscle strength and joint weakness. Therefore, we came to a conclusion that something supplementing those strengths is required. To improve the elderly's trajectory of sitting down and standing up to the level of young people, a force supporting from the bottom is needed.

Keywords Human factors · Barrier-Free · Elderly life · Lift assistance

1 Introduction

The population of elderly in Japan is increasing, and it is projected that they will comprise about 30 % of the Japanese population in 2025. The increase in the number of household with only elderly people will lead to an increase in their dependency on others for activities of daily living. Also, the number of people on

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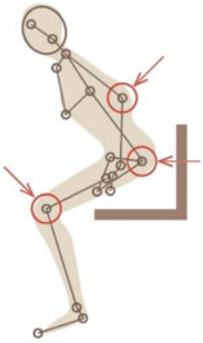

Fig. 1 The parts born sitting down and standing up

whom the elderly depend is increasing. The productive-age population and labor force population are decreasing, but it is presumed that we will need about 2120–2550 thousand care workers in 2025. Hence, the lack of people who can help an elderly person is also a serious issue. Elderly people need to be helped with eating meals, bathing, using the toilet, and so on. For performing all these activities, the chair is very important as they require it for many activities.

They have to stand up from a chair when they go to the toilet or for a bath, and once they finish that, they have to sit back on the chair. During their lifetime, elderly people who cannot stand up and sit down by themself need to be helped and supported by other people many times. We know that it is a burden on their elbows, lower back, and knees when they stand up from a chair or sit on a chair, and it is possible that this burden causes an articular disease (Fig. 1).

In order to prevent articular disease, it is imperative that we choose a chair with the ideal seat surface, seat height, size, etc. It is our thought that a better option than that would be a chair that can reduce the burden of standing up or sitting down. This needs research with regard to the most suitable height, angle, and shape of each part.

Using motion capture during the study, we tested physical burdens during standing up from a chair and sitting on a chair with regard to leg position, seat height, and armrest angle that affect the body.

2 The Research of a Chair for Elderly People

2.1 Present Life of Elderly People

There are some chairs that are thought to be barrier-free, but there are few chairs in the present market that can support the elderly people while standing up. We thought that leg position, seat height, and armrest angle influence the physical burden of standing up and sitting down.

2.2 The Way of Research

Considering the requirement of a barrier-free product, we researched 30 kinds of chairs for elderly people in June 2015.

We chose nine items that are important in a chair for elderly people and subjectively sorted them with the explanation and the expression about each product.

Analysis Items.

- Target: elderly people ⟺ all people
- important item: function ⇔ middle ⇔ looks
- size: big ⇔ middle ⇔ small
- weight: heavy ⇔ middle ⇔ light
- height control: have ⇔ not have
- inner structure: have ⇔ not have
- price: expensive ⇔ cheep
- armrest: have ⇔ not have
- seat: soft ⇔ hard
- support standing up or sitting down: have ⇔ not have

Analysis Objects (Fig. 2).

We analyzed these data with mathematical quantification theory class 3. For the result, we set careful function (high ⇔ low) for the x-axis and design quality (high ⇔ low) for the y-axis and sorted 30 kinds of chairs "Functional", "Low careful function and high design quality", and "Low careful function and low design quality". In addition, as per the views of the elderly people about chairs, determined during interviews of the elderly conducted during our research, they wanted chairs that were not only functional, but also aesthetically appealing. Hence, we decided to select a chair that has good functional value and is of a high design quality as our target (Fig. 3).

Fig. 2 Chairs for elderly people

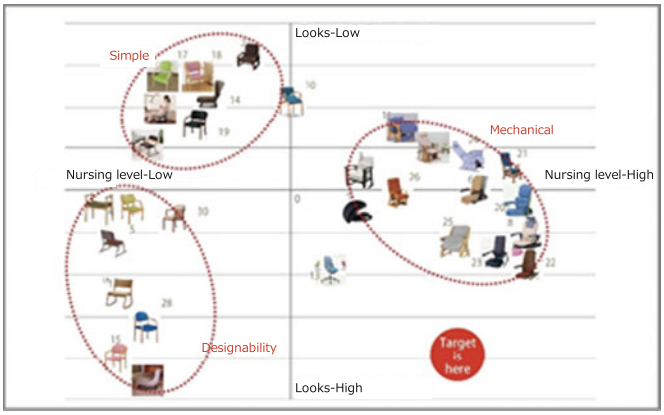

Fig. 3 The map of the market structure

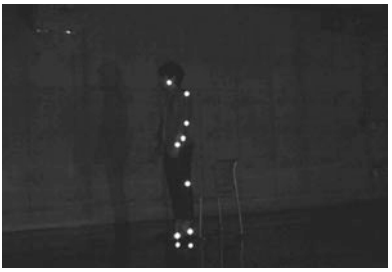

Fig. 4 The scene of this experimentation

3 Experimentation to Research the Problem When Elder People and Other People Use a Chair

3.1 The Plan of This Experimentation

Our subjects were 14 men and women, ages 22–79 years old. They were allowed to wear clothes of their choice. With our motion capture, we monitored their movement during standing up and sitting down and the time they took to stand up and sit down. In this study, we used a chair that did not have an armrest (Fig. 4).

The Condition of This Experimentation. In this study, our subjects stood up and sat down by putting their hands on their thighs because this chair did not have an armrest. Other than that, we saw them sitting down with free motion.

- The chair used in this study: W440 × D400 × H770 × SH430

The Order of This Experimentation. Subjects stand in front of the chair. After that, they sit on the chair and stand up after 2 s. They do this motion once (Fig. 5). We set the sensors of the motion capture on their head, shoulder, elbow, wrist, lower back, knee, ankle, and toe.

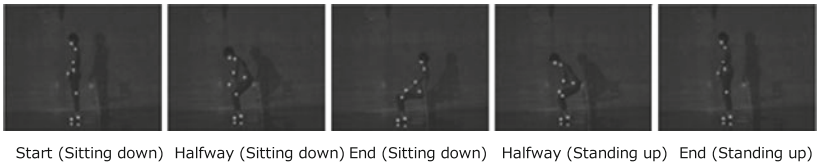

Fig. 5 The order of this experimentation

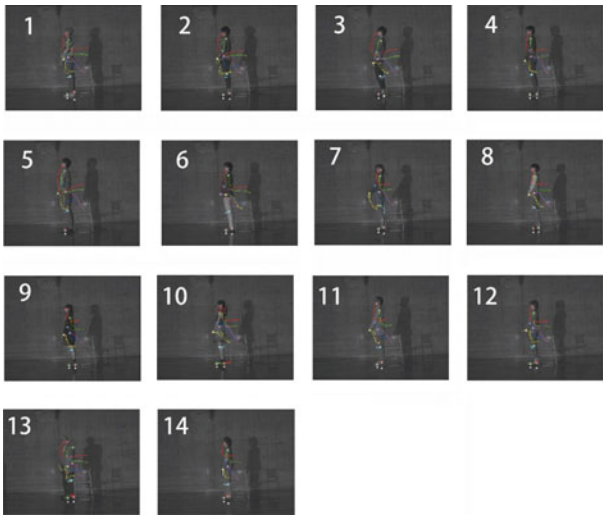

Fig. 6 The results of this experimentation

3.2 The Results of This Experimentation

The Motions of Each Part. Elderly people moved their lower half of the body more. Several other subjects sat down straight without drawing the arc. Also, they moved less because they were trying to find the best position (Fig. 6).

The Back Angles Changes when People Sit Down and Stand Up. In the cases of subjects in their 20 and 50 s, the angles of their back (Fig. 7) were greater when they stood up than when they sat down, but the results for elderly people were

Fig. 7 The angles of the back

Fig. 8 The example of subject No. 13 body motion

opposite (Fig. 8). In the cases of maximum angles, the angles of the back when elderly women sat down and stood up were too small, but that when elderly men sat down and stood up were average. Figure 9 shows this result.

The Lower Back Speed Changes when People Sit Down and Stand Up. Compared to other subjects, elderly people (especially elderly women) sat down and stood up slowly. Figure 10 shows this result.

3.3 Result

- We determined that the speed with which elderly people sit down and stand up is slower than that of young people because of the decline of the function of their muscles and joints. Hence, we understand that they need support to help them perform these activities more efficiently.
- We determined that the chair needs to provide support that can enable the motion of sitting down and standing up in the elderly becomes similar to that of young people.
- The shape of a chair which we can easily distinguish each our best positions when we sit down because of decreasing our unless motions.

4 The Experimentation of the Validity of the Present Structure

4.1 The Plan of This Experimentation

We did the experiment to determine the validity of the inner structure of the chair that we can buy from the market. Our subjects were a 76-years-old woman (Subject A) and a 79-years-old man (Subject B). They sat on the chair, kept that posture, and then stood up again. This comprises one set. We studied the difference between each result when they used the chair which had an inner structure and when they used the chair that did not have the inner structure. We set the sensors of the motion

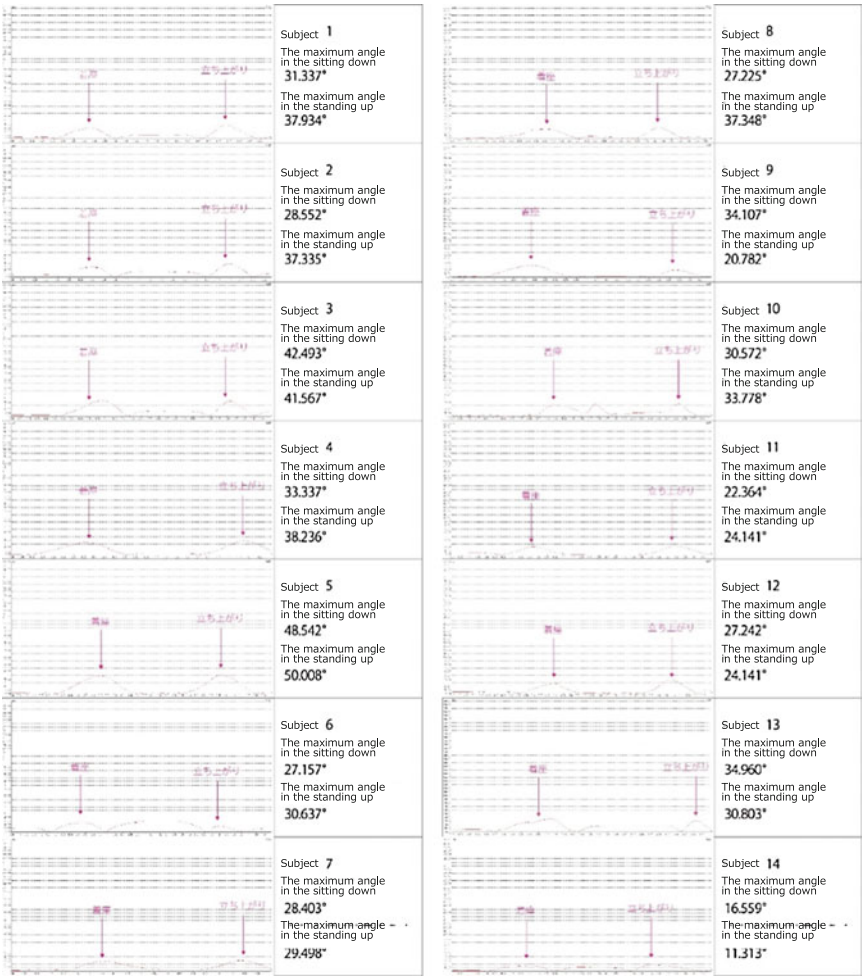

Fig. 9 The changes of the angles

capture on their head, shoulder, elbow, wrist, lower back, knee, ankle, and toe. In this study, we used an armrest made by us to make it possible to use the motion capture.

4.2 The Results of This Experimentation

We paid attention to the marker on the lower back. The straight motion is changed to a motion similar to the clothoid curve by the inner structure (Fig. 11).

Fig. 10 The changes in the speed

When subject A sat down and stood up from the chair that did not have the inner structure, the maximum speed with which she sat down was 180.692 m/s and the maximum speed with which she stood up was 180.106 m/s. When subject A sat down and stood up from the chair that had the inner structure, the maximum speed with which she sat down was 182.638 m/s and the maximum speed with which she stood up was 198.461 m/s. As per this result, both speeds were higher when the chair with the inner structure was used. When subject B sat down and stood up from the chair that did not have the inner structure, the maximum speed with which he sat down was 141.878 m/s and the maximum speed with which he stood up was 237.486 m/s. When subject B sat down and stood up from the chair which had the

Fig. 11 The markers motion results

Table 1 The results of maximum speed

	Not supported		Supported	
	The maximum speed in the sitting down	The maximum speed in the standing up	The maximum speed in the sitting down	The maximum speed in the standing up
Subject A	180.692	180.106	182.634	198.461
Subject B	141.878	237.486	280.353	282.578

inner structure, the maximum speed with which he sat down was 280.353 m/s and the maximum speed with which he stood up was 282.578 m/s. As per this result, similar to A's result, both speeds were increased when the subject used the chair with the inner structure. Hence, we proved that this inner structure assists people in sitting down and standing up from a chair and increases the speed when people sit down and stand up (Table 1).

5 Conclusion

In this study, we paid attention to the motion when elderly people stand up and sit down, and because a chair supports them for a long time in their life, we determined the typed of chair that can help them in sitting and standing up easily. We analyzed 30 kinds of chairs for elderly people with mathematical quantification theory class 3. Next, using the motion capture, we tested to identify the problem when older people and other people use a chair. From the results, we found out that elderly people sit down and stand up at a speed slower than that of young people, and we felt that the decline in the functionality of their muscles and joints caused this problem. Hence, we deduced that a chair that can supplement this functionality of the elderly people is needed. In addition, we thought that they need functional support that can help them sit down and stand up with similar speed and efficiency as that of younger people. Therefore, we assessed the validity of our sample chair that has the ability to provide functional support while sitting down and standing up. The result was that all subjects sat down and stood up faster than before, and we verified the validity of this functionality.

Lighting the Way to Independent Living: Preventative Methods for Senior Health Inspired by Daylight

Leilla Czunyi and David Craib

Abstract Rising healthcare costs and an increasing senior population, require preventative health solutions to be sought in order to mitigate the health concerns of seniors. Multiple concerns can be addressed simultaneously through appropriate daylight exposure, benefiting not only seniors but also caregivers. This paper outlines strategies for wellness that can be undertaken in a residential setting, and the supporting research for these suggestions.

Keywords Senior · Daylight · Circadian rhythm · LED · Preventative health

1 Introduction

With a rapidly increasing global senior population, many seniors are electing to live in their homes for longer, and choosing to renovate or modify their homes to accommodate their evolving needs. Renovating for seniors may address various architectural aspects of the home, including custom requirements in bedrooms, bathrooms, stairways and access routes, in order to address lighting requirements. Artificial lighting for the senior population has the potential to impact health [1], while simultaneously addressing visual and safety requirements. The ability of daylight and artificial lighting to affect human physiology has been studied extensively within the context of institutional lighting design and in healthcare settings, however these findings have not been as comprehensively examined in the residential setting. There is minimal information available regarding studies of potential uses for maintaining independent (within the home) living though daylight and artificial light. This paper seeks to outline known benefits of daylight and of stimulating seniors' biological factors through lighting design. Many of these benefits would be applicable universally—assisting the majority of the population—regardless of age. This research will be conducted through a literature review, by a researcher with 10 years'

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experience as a practicing interior designer, with several years specifically practicing lighting design. Factors that can be considered for a residential retrofit application will be identified in order to increase senior wellness through the combination of daylight and beneficial forms of artificial lighting.

2 Biological Daylight Needs—Sunlight and Circadian Rhythms

Studies have shown that simply thinking of sunlight will enhance mood, and sunlight is generally associated with health and wellness [2]. This is an association that can be both positive and negative. UV emissions from the sun can cause DNA damage and painful sunburns if the exposure is too long. However, without direct skin exposure to sunlight, our bodies struggle to synthesize vitamin D, a vital component of calcium production that directly affects the health and strength of our skeletal systems [1].

Daylight stimulates the circadian rhythm, also known as the sleep-wake cycle experienced throughout a 24-h day. Circadian rhythms are biochemical and physiological cycles that are connected to the human biological clock. The circadian rhythm in turn stimulates many other biological processes, which control digestion, immunity, hormone function, and many more aspects of health [3]. "All biological organisms depend on rhythms and oscillations to time critical activities. When timing is disrupted, systems begin to fail." [3].

Daylight is able to stimulate this system through a gradual shift towards the blue spectrum that the body uses as a trigger to suppress melatonin[1] and increase alertness [1]. With darkness, serotonin[2] is released, converted to melatonin and sleep can be triggered. Melatonin has also been shown to promote immune system efficiency, and helps the body fight infections and viruses. Without proper exposure to natural light and dark, our circadian rhythm is compromised and our overall physical and psychological wellbeing becomes severely affected [4]. The negative psychological impact of lack of daylight has also been extensively documented, most noticeably on the condition known as Seasonal Affective Disorder (SAD) [4].

3 Daylight Versus Artificial Light

Daylight differs in several ways from artificial light. Daylight consists of a full spectrum (400–760 nm) [5] that shifts gradually through the colour spectrum through the day, shifting from red through to blue and then back to red, as shown in

[1]Melatonin is a hormone that anticipates the onset of darkness, leading the body in and out of the sleep cycle.

[2]Serotonin is used by the body to regulate intestinal movements, and is linked to the production of melatonin.

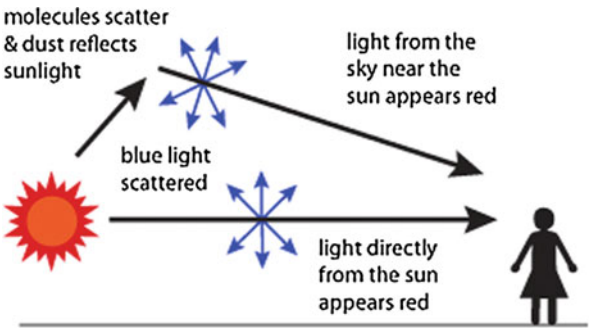

Fig. 1 Shift in light due to atmospheric distortion. Retrieved from http://www.sciencemadesimple.com/space_black_sunset_red.html on 02 Dec 2015

Fig. 1. Depending on the artificial light source, the spectrum covered can vary greatly, and will maintain a consistent output while the light is turned on. The gradual change experienced in daylight throughout the day is impossible to mimic with traditional light sources, such as incandescent,[3] or fluorescent.[4] Currently all artificial *daytime* light lamps produce a noontime light spectrum—not providing the variety that a true daylight experience would provide [3]. Artificial lighting is also typically installed with a single on/off switch, which produces an abrupt appearance of light not found in the natural environment.

Artificial lighting has always been used as a replacement for daylight, whether due to darkness or due to dim interior conditions. Historically, firelight or candlelight was minimally effective, and still enabled a biological day-night cycle. However, with the advent of technology, combined with contemporary living choices, we can minimize our time outdoors in natural daylight, and maximize our time in artificially lit environments, extending far beyond the natural daytime cycle. Contemporary lifestyles for many people include more time indoors in offices, schools, or other indoor environments, followed by time at home where we continue to interact with screens [3]. Light Emitting Diode (LED) lighting has been proposed as a potential technology that would be able to provide both the dimming and colour shift technology in a white light source, however the cost of the spectrum changing units are still prohibitive.

Ideal lighting, from a biological standpoint, is to expose the skin to a minimum of 20 min of direct UV sunlight in order to stimulate production of vitamin D [5]. Simply exposing hands for this period of time is sufficient to start this process. Maximizing exposure to daylight during the day results in a more robust circadian system [6]—however the inverse happens when more time is spent indoors, and exposure to the blue light spectrum beyond natural noon-time daylight disrupts the circadian rhythm [7].

[3]Incandescent lighting is created through heating a filament within a bulb using electricity, creating light as a by-product.

[4]Fluorescent lighting is created by sending an electric current through a mercury vapor gas producing light.

Other biological systems absorb light through the eye, however beyond the lighting requirements for vision, the functions of these systems are primarily to begin or to stop production of melatonin and serotonin for the previously described functions. These systems are specifically triggered by the light spectrum that contains blue light—which immediately prompts the body to suppress melatonin [8], and increase alertness. In natural daylight, the greatest quantity of blue light is in the morning/noon period, and as the sun begins to set the blue spectrum reduces as the reds and oranges that occur at sunrise and sunset become more predominant.

> Biological processes dictate that non-visual responses are maximally sensitive to blue light (459–488 nm) …Blue light most powerfully changes the rhythm of melatonin and cortisol secretion, acutely suppressing melatonin. [1]

Of note is the need for gradual lighting changes [3]. In order for the circadian rhythm to begin to switch from melatonin suppression to serotonin production, there has to be a gradual phasing out of blue light. If a bright light containing blue spectrum elements is switched on abruptly, the body is jolted out of this natural process into alertness and melatonin suppression. The effects of this may not be felt immediately—sleep may still be achieved, however studies over time point to a reduction in effective immunity, and other bodily functions such as digestion [3].

4 Biological Results of the Aging Eye

The natural aging of the human eye results in many changes over time. As the cornea thickens it also yellows, creating a yellow tint to everything seen [3]. Increased sensitivity to glare, and decreased contrast sensitivity are typical age-related developments, and many seniors also have to deal with macular degeneration, glaucoma, cataracts and other eye diseases [3]. These issues often lead to skewed depth perception. Typically, advanced seniors are scared of shadows because they obscure the path of travel, but also because it is difficult to tell where a shadow is and where a hole may be. Glare often contributes to falls [5], and as noted above if the body is not creating enough calcium to strengthen bones, the resulting hip and leg fractures become common.

This combination of age-related developments significantly reduce the ability of the eye to absorb light. “By the age of 65, only one-third of that light reaches the retina, by the age of 85, only one-fifth.” [9]. The changes that result from the aging eye are challenging to adjust to on their own, however it is also common for the medication used to treat many other illnesses to further increase sensitivity to light [5].

Reduced contrast sensitivity, poor night vision, and slow light-dark adaptation [10], combined with a longer response time to visual changes, makes going into public environments stressful for seniors. Sensitivity to glare leads many seniors to reduce the amount of daylight entering their homes through windows, creating dim indoor environments that can interfere with circadian rhythm. With the natural

yellowing of the aging eye, blue light in the spectrum is scattered and not absorbed as effectively [3]. This impacts the natural daytime suppression of melatonin, and can lead to fragmented sleep syndrome. Fragmented sleep syndrome is the inability to sleep through the night, resulting in increased irritability, cognitive decline, and compromised blood pressure. Further exasperation can occur due to diminishing effectiveness of the eye.

5 Light Therapy for Seniors

Many medical centers that focus on senior health are providing garden spaces that enable seniors access outside to experience direct sunlight [5]. By making the exterior of homes or condos more accessible, seniors still living at home can also gain these benefits. Sensitivity to glare can be mitigated with sunglasses, and clothing can prevent sunburn. Extra care should be taken to provide a diffuse source of light on the path of travel to the final point, to gradually allow the eye to become accustomed to the sunlight. If this path of travel is indoors, this can be provided with window treatments, or an exterior version can be provided with architectural treatments. The glazing in a typical window system does not allow sufficient UV light through to permit enough vitamin D absorption from sunlight coming through a window, and direct sunlight is still required [1]. However, in order to stimulate the circadian rhythm daylight received through glazing is sufficient if it is not reduced significantly by window treatments.

When daylight is not available due to geographic location or lack of window glazing, artificial lighting becomes an option for stimulating circadian rhythms. Short applications of true blue LED lighting, can assist in maintaining a regular sleep cycle. Experiments have shown that morning treatment is the most effective time to use blue light [7]. True blue light therapy research has mainly been conducted on healthy young adults to assist in lighting design for the international space station, however further research could be conducted on utilizing this therapy for seniors in a residential setting.

Specific care with the types of lamps used in the afternoon/evening should assist with maintaining a healthy circadian rhythm. As LED lamps become more readily available, there are more *bright white* lighting options available as retrofit lamps. Many of these light fixtures and retrofit lamps are sold as *full spectrum*. Typically this is a full spectrum of noontime light, approximately 6000 K [3]. As all LED white light is produced from a blue light source, layers of phosphor are used to create a warmer (whiter light) look. The warmer the light output required, more layers (and therefore cost) need to be added to the lamp in order to produce a warmer white light. This also reduces the efficiency of the light output, and therefore cooler, bluer light tends to be less expensive and brighter. This becomes an attractive option for homeowners looking to reduce energy costs, as the most

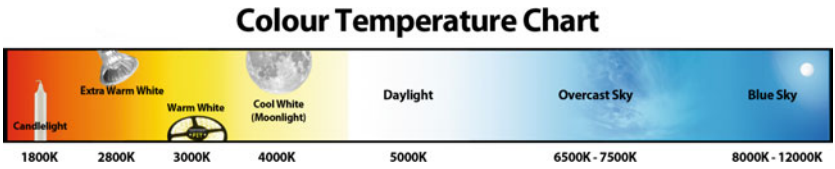

Fig. 2 Colour temperature of artificial light versus noon. Retrieved from https://www.downlights.co.uk/faq-which-colour-temperature-.html on 02 Dec 2015

efficient lamps have a greater amount of blue light available. However, as indicated in this discussion, exposure to blue light will interfere with biological systems. Minimizing the colour temperature of lamps installed to between 2700 and 3000 K in the evenings will allow the appropriate amount of light colour contrast between noontime (5000–6000 K) and evening. When daylight is not available, a 6000 K lamp should be considered for daytime use, and a warmer colour temperature used in the evening, as shown in Fig. 2.

Lighting controls are crucial for allowing the eye to adjust to lighting levels. Many light sources used in residential homes can have dimmer technology applied. Ideally, dim on and off technology should be applied directly to switches, allowing a gradual [3] adjustment to lights when turned on, as well as mitigating glare issues.

Pure darkness is required at night to permit deep sleep. "Evidence confirms that for the human brain, the absence of blue light, at least from a circadian point of view, is effectively darkness." [1]. Window blackout treatments should be used and all lights should be turned off. Night lights can be installed either in bathrooms or along the path of travel at night, which are purely amber lighting. This permits enough light to see safely, but does not cause negative biological effects—the body still reads an orange light as *night*. Any item that has a blue *standby* light, such as an entertainment system or computer screen, can be potentially disruptive.

6 Lighting Design Considerations

Many artificial lighting designs aim much of their light towards the floor, whereas the average person perceives more light in the *viewing direction* which is typically the walls. Allowing indirect light to wash over walls rather than the floor can aid visual perception and reduce direct glare. A standard North American home has a single light fixture installed in the ceiling in the center of each room, potentially creating a dark indoor environment. Newer construction has a propensity for recessed down lighting, which can create glare. An effective approach to lighting design is to address glare and contrast while still providing enough lighting for tasks by using indirect lighting as much as possible. Many indirect light fixtures require a

minimum of 9′-0″ [5] ceiling height, however if using cove and perimeter indirect lighting ceiling height can be less.

Planning for daylight is also a crucial factor, particularly the use of skylights. Skylights can dramatically increase the amount of light available indoors—but must have diffusers installed for the same reason [6]. Allowing diffuse sunlight to permeate the interior provides the dramatic contrast between daylight and night that the body needs to self-regulate. Direct sunlight through windows or skylights can create glare that becomes detrimental, and many people regulate this with heavy window curtains that cut the light out altogether. However, the use of blinds to diffuse glare while still permitting light to enter the space can allow far more control [6].

Under certain circumstances during a renovation, planning to orient the rooms most used in the morning towards the east will permit sunrise daylight in bedrooms, bathrooms and perhaps kitchens [6]. The early stimulation of the circadian rhythm as sunlight emerges is an important gradual light input in the correct spectrum. Painting rooms a light colour will help promote indirect reflection of daylight—the ideal lighting situation while daylight is available. However, it must be noted that low contrast presents difficulties to seniors, and white upon white design may cause more stress than the benefits afforded by high reflectance [5]. Light colours are a good tool, and can be contrasted against each other to delineate spaces. Important interior features such as doorway frames and changes in floor level should be clearly contrasted using colour, and preferably illuminated [10].

There are financial and independence benefits to remaining in one's home, and many retirees are currently focusing on how to modify their homes to accommodate them as long as possible. If the daylight and artificial lighting requirements have been addressed in your home, then this becomes an added incentive to remain.

Retirement homes need to maintain a high level of lighting at night for staff to operate. This combined with the low light [3] levels preferred by many residents during the day creates a situation that is too dark, and too bright at night. Studies have shown that residents who had normal sleep patterns prior to moving into a retirement home, soon experience sleep fragmentation and increased cognitive decline as a result [3].

> Artificial lighting designed to optimise the visual effect of a space does not take into account these non-visual[5]

effects, yet designing buildings that make greater use of daylight and recognize the additional benefits of natural light could have great benefits for the occupants. [7]

Prior planning for retirement can also include the changes required to make homes accessible and supportive.

[5]The non-visual effects referred to here are biological effects such as the circadian rhythm, or the production of melatonin/serotonin. Visual effects are the ability to perceive the environment, i.e. how well you can see.

7 Recommended Lighting Solutions for Wellness and Prevention

While living at home, many seniors still have the ability to impact their own environment, and make changes to lifestyle in order to improve their living conditions. Any of these changes will contribute positive effects, and the majority can be achieved without requiring extensive renovation. The following are recommendations derived from the research described in previous sections:

- Maximise daylight exposure throughout the day, starting with permitting daylight into the interior in a diffuse and controlled manner. This daylight should come from both skylights and windows if possible, to minimize contrast. Window films can be a good tool to diffuse daylight through hard to reach glazing.
- Experience at least 20 min a day of direct sunlight in an exterior environment. This can be a balcony, front yard or walk down the road [5].
- Paint interior rooms in light colours to maximise indirect daylight reflection. White has the best reflectance values but must be used with care to prevent confusion if multiple surfaces blend into each other.
- Care must be taken with both paint and other surfaces to ensure that they are matte—the glare from a reflected interior surface can be debilitating in a compromised vision situation [5].
- If a new build/renovation allows, 9′ (2743 mm) ceilings are ideal in order to install indirect lighting, light shelves and perimeter cove lighting [5].
- When installing interior lighting using dimming controls and allowing gradual light to switch on and off gently will prevent abrupt biological changes.
- Interior lighting should be indirect and layered, allowing for task lighting to take precedence where needed.
- Dementia patients require 100–250 fc (1000–2500 lx) in the vertical (viewing/gaze direction) for the majority of the day in order to have a positive effect [3].
- In interior spaces where daylight is limited, or due to mobility restrictions, providing access to a true blue (between 446 and 477 nm) light early in the morning [11], and then mitigating the afternoon evening light to a warm white spectrum can potentially help mitigate the effects of the aging eye and fragmented sleep.
- Where night lights are required for safety or navigation, installing amber coloured light will prevent circadian disruption [1].
- Paint can be used to increase contrast [10] of important milestones in a home such as door frames or changes in floor level.

8 Conclusion

Light clearly has a series of biological impacts that extend far beyond simply providing visual assistance. Our bodies have evolved to respond to the cycle of night and day [3]—and the disruption of this cycle both through artificial technology and the natural degeneration of the aging eye should be taken seriously. Everyone needs sunlight for strong bones [5]—however this becomes a particular problem for seniors, as they require more direct sunlight exposure to stimulate the biological systems of the human body. "With 15 min per day of sunlight exposure on the face and hands during clear weather (averaging 236 days per year) the individuals in the experimental group had 84 % fewer hip fractures than a control group." [5]. A revision of the architectural approach to daylight in architecture has the potential to provide therapeutic benefits in conjunction with energy savings.

Therapeutic light does not need to have an institutional feel. It can be integrated into the home in a suitable fashion. Further research should explore new ways to implement home therapeutic lighting. Unlike conventional medicine that is typically hidden away in a bathroom cabinet, daylight design and artificial supplementary light can become design features creating warm, pleasant spaces that enhance moods, create healthy sleep patterns and improve quality of life.

These are benefits that are not limited to the senior population. Many of the disruptive biological results of poor sleep patterns and negative health effects are experienced by shift workers and people who travel regularly across time zones. Additionally, improved lighting design would benefit caregivers and children who may also be living in the home, potentially boosting their biological systems as well.

A lack of light discourages movement [5], diminishing exercise, which is an important part of mental and physical health. When care is taken to regulate the quality of light and appropriate exposure to it, we can provide ourselves with the healthy interior environments we require.

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The Awareness of Human's Sedentary Behavior in the Workplace and Product Design Guidelines

Dosun Shin and Yue Huang

Abstract Americans spend a considerable amount of their waking-hours in sedentary behavior. Among the different places where sedentary behavior occurs, the workplace is one of the primary settings for prolonged sitting which is associated with poor health outcomes. This study aimed at understanding the needs and wants of office workers in relation to the products that help sedentary employees reduce their sitting time. The research was conducted using a holistic design approach, including IRB application, online survey, and data analysis methods. The primary goal of this study was to understand the barriers and motivators to sit less in the office, and explore the employees' attitudes and experiences of using products to reduce their sitting time. Based on the findings, the design guidelines of product design in the workplace were proposed to improve their sedentary behaviors that cause public health-related outcomes.

Keywords Workplace sedentary behavior · Health and promotion · Product design guideline · Public awareness

1 Introduction

Sedentary behaviors can be identified as any waking behavior characterized by an energy expenditure ≤1.5 metabolic equivalents (METs) while in a sitting or reclining posture [1]. Americans spend a considerable amount of their waking-hours in sedentary behavior, which associated with poor health outcomes (chromic conditions, notably cardiovascular disease, etc.). Most adults in developed countries spend time sitting in three domains: workplace, leisure, and transport [2]. Among these

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different places the sedentary behavior occurs, workplace is a key setting for prolonged sitting time where an average of 8 h is spent per day. Meanwhile, workers in desk-based occupations are considered a key target group for workplace sitting reduction strategies [3, 4].

To date, a large amount of research studies focus on increasing light-intensity activities (standing and walking slowly) as the primary outcome of interests, which is good for health [2]. Whereas, Healy et al. [5] proposed that prolonged sedentary time are independent of time spent exercising. Therefore, it is also important to conduct interventions with the aim of reducing sitting and breaking prolonged bouts of sedentary behaviors.

In recent years, several interventions (e.g. standing at a desk, and walking work stations in office environments) were conducted aiming at reducing sitting time. However, little research focused on the effectiveness of the interventions from a design standpoint. In this study, researcher aimed at understanding the needs and wants of office workers in relation to the products that help sedentary employees reduce sitting time. The research was conducted using a holistic design approach, including IRB application, online survey, and data analysis methods. The goal was to understand the barriers and motivators to sit less in office and explore the employees' attitudes and experiences of using products to reduce sitting time. Based on the findings, the design guidelines of products in workplace were proposed for improve office sedentary behaviors.

2 Research Design

An online questionnaire was employed in this study. By including close-ended and open-ended questions, the goal was to provide findings with a wider perspective and reduced bias.

Regarding broader, less biased findings, according to O' Leary, close-ended questions in surveys can "generate standardized, quantifiable, empirical data", while open-ended questions can provide a great diversity of responses. Open-ended questions tend to be more objective and less leading than closed-ended questions, because it allows people to fully express their opinion instead of merely having to select an answer from a predetermined set of response categories. Therefore, the survey, combined with close-ended and open-ended questions, could help research get a big picture of the target group, meanwhile, collect in-depth data to understand the needs of the target group thoroughly.

The data collection process was implemented after getting approval from the Arizona State University Institutional Review Board and all participants gave written informed consent.

2.1 IRB

Since the research focus of this study referred to human behaviors in the workplace, and involved human subjects, research protocols and related materials were required to be submitted and approved by the Arizona State University Institutional Review Board (IRB) before conducting research. Research protocol should include purpose and background of the study, criteria and recruitment methods of participants, research procedures, potential risks and benefits, privacy protection and the consent process, etc. The related material in this study included recruitment scripts and questions for survey participants. By reviewing all of these materials, the Institutional Review Board sought to protect human subjects from physical or psychological harm during the research process.

2.2 Data Sampling Strategy and Subjects

To recruit participants, two sampling strategies were adopted in this research: handpicked sampling and snowball sampling. Handpicked sampling refers to the selection of a sample with a particular purpose in mind; snowball sampling is a strategy that builds a sample through referrals. The potential participants, current full-time employees, were asked whether they want to participate in this research via emails. Once an initial respondent was identified, he or she was asked to recommend others who met the study criteria.

The selected subjects were adults who met the inclusion/exclusion criteria which included (1) full-time US employment; (2) working in desk-dependent and predominantly sedentary occupations; (3) sitting at least 4 h a day during one typical workday.

2.3 Questionnaire

An online questionnaire was administered to 50 male and female volunteers to collect quantitative data by multiple-choice questions and five Likert-scale responses. Also, the survey provided qualitative data by open-ended questions. The questionnaire was composed of 4 parts: (1) demographic information; (2) Workplace Sedentary Behaviors; (3) Attitude and experience of related products.

2.4 Data Analysis

The quantitative data collected from close-ended questions in survey was analyzed at www.qualtrics.com. Text analysis methods, including coding and context

interpretation were adopted to analyze qualitative data collected from open-ended questions. Reflecting on the development process outlined in this paper, the guidelines for product design were proposed.

3 Results

3.1 Demographic Information

A total of 50 survey participants, aged 21–65 years, were recruited, including 23 males (46 %) and 27 females (54 %). The participants, aged 21 to 30 years, were the main age group involved and made up 52 % of the (total) survey population. In terms of the 50 employees' occupations, 20 participants worked in design, 8 in the field of education, another 8 in computer science, and the remaining participants from other fields (e.g. administration, business, engineer).

3.2 Sedentary Behaviors in Workplace

Overview. Of the 50 employees surveyed, the average workday expressed was 9.5 h (including lunch break); and the average sitting time was 7.5 h. As shown in Fig. 1, the 50 employees estimated the percentage of time they spent sitting, standing and walking during working hours. On average, participants spend more than three quarters of their working time in a seated position, while standing and walking time were divided equally the rest of working hours (Table 1).

Sitting Time.

Regarding to the sitting time during work, the Fig. 1 shows that only 14 % of the respondents (N = 7) show their satisfaction with their sitting time, while half of the respondents (N = 25) are unsatisfied with their current sitting time. Corresponding to Figs. 1 and 2 shows that the majority of participants (N = 43, 86 %) would like

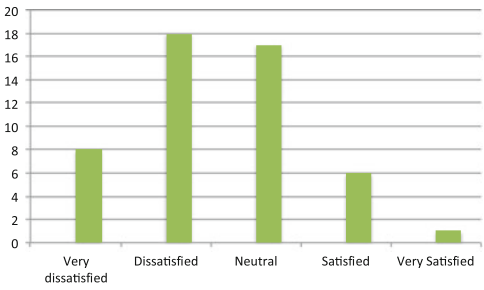
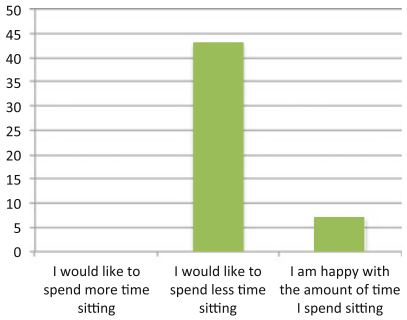


Fig. 1 Satisfaction regarding sitting time

Table 1 Percentage of time people spend sitting, standing, walking

Activities	Percentage
Sitting	76.56
Standing	12.27
Walking	11.17

Fig. 2 Willing to change the sitting time



to sit less during work, except for 7 participants who are happy with their sitting time. No one wanted to spend more time sitting.

Figure 3 demonstrates the results of a multiple choices question. It is obvious to see that two main reasons of long time sitting are both related to work. 54 % of respondents (N = 27) feel too busy to move and 42 % of respondents (N = 21) want to concentrate on work by sitting. In addition, 16 respondents provided their own reasons by selecting "others". There were 5 participants mentioned that they have to sit during work because it is job requirement to use desk, which don't allow them to stand while working. Some of the responds are shown as below: "My job requires a computer, my desk is not set up to allow me to stand while working", "Most of my work must be done at a desk, and the desk requires sitting to use", "I have everything on my desktop so it is not efficient to go anywhere else". Among the other options, "I feel tired while standing/comfortable while sitting" is also a reason of long sitting which chose by 7 participants.

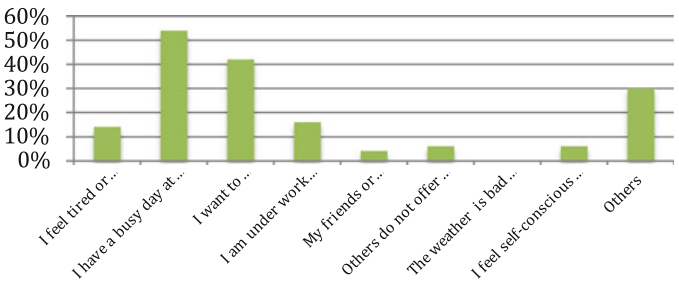


Fig. 3 Reasons of prolonged sitting

Fig. 4 Activities during sitting time

Employees were asked an open-ended question about what main activities they do while sitting at work. The frequency words appeared in their answers were counted and sorted, and the word cloud graph generated on infogr.am.com (see Fig. 4) was used to visualize the result. The bigger the texts, the higher frequency of the word were mentioned. Through the graph, it was clear to see that meetings represent one of the main activities of sitting time, which was mentioned seventeen times by respondents. Aside from meeting, writing, computer work, reading, emailing and designing composed a big part of the sitting activities. Also, researcher found that there was a relationship that was between occupations and activities. Figure 5 showed part of the answers that sorted by occupations. The designers mainly drew sketches at the desk or design using software, whereas, programming and coding were the main activities of software programmers.

Fig. 5 Example of answers of activities during sitting

Occupations	Main activities
Designer	Writing, Drawing, CAD and computer based design work
Designer	Meetings, emails, internet research, sketching, graphic work, video conferencing
Designer	Photo editing and layout design.
Software engineer	Programming
Software engineer	Coding
Professor	90% document and paper / 10% statistic
Professor	Writing by hand typing on laptop answering email reading journal
Business operation manager	Reading, super fine detail comparison of printed document,
Manager	Answer the phone/emails meeting

Non-sitting Time.

As shown in Fig. 6, the majority of people (86 %) stood up at least every 2 h, among which, 52 % of respondents stood up every 1–2 h. Figure 7 indicated that 70 % of participants stood for less than 10 min and only 6 participants (12 %) spent sitting more than 20 min.

In the Fig. 8, walking acted as a leading activity during non-sitting time. The activities with higher frequency included both work-related activities

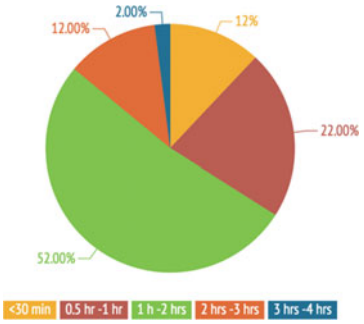


Fig. 6 Average frequency of standing

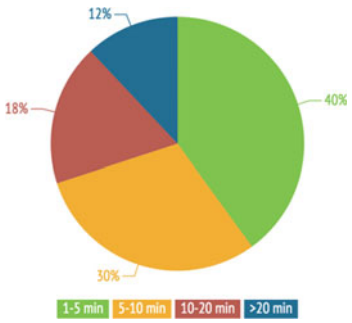


Fig. 7 Average length of each non-sitting time

Fig. 8 Activities during non-sitting time

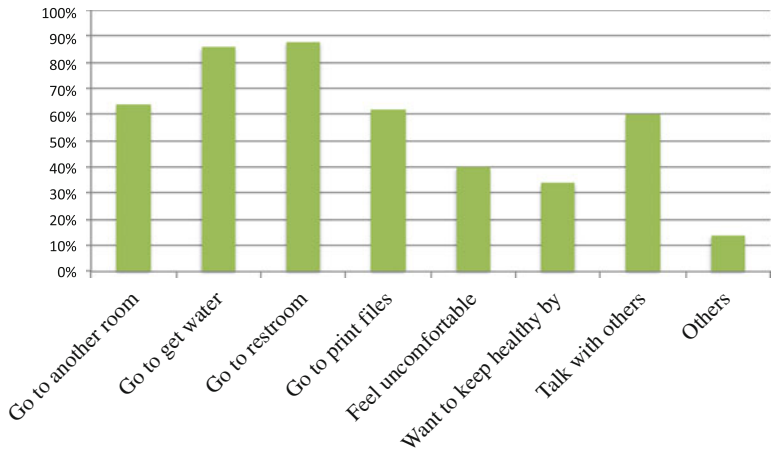


Fig. 9 Reasons of stop sitting

(e.g. printing, discussing with coworker) and relax activities (e.g. getting water, stretching body).

In regard to the reasons that stoped people from continuous sitting (Fig. 9), 86 and 88 % of the participants chose "go to get water" and "go to restroom". Besides, printing and going to another room were two secondary reasons. Aside of the extrinsic factors, two intrinsics reasons were identified: "feel uncomfortable" and "want to keep healthy".

3.3 Attitude and Experience of Product

Attitude.

In Fig. 10, 78 % of respondents showed their interests in using products to reduce sitting time, while only 44 % of respondents had knowledge of existing products. Figure 11 showed the reasons why people don't used product to sit less in workplace. More than 70 % of responsents selected "they don't know about the product". Also, a large number of participants thought "they don't have control of their office" and "the available products are too complicated to use". The reason "lacking of the knowledge of the harmfulness of sedentary behaviors" was also mentioned a lot.

When asked what kinds of product they preferred, 71 % of participants expressed their preference of physical products, and 28 % of respondents would like to use mobile apps to help them reduce sitting. Only 3 people showed their interests on using software (Fig. 12).

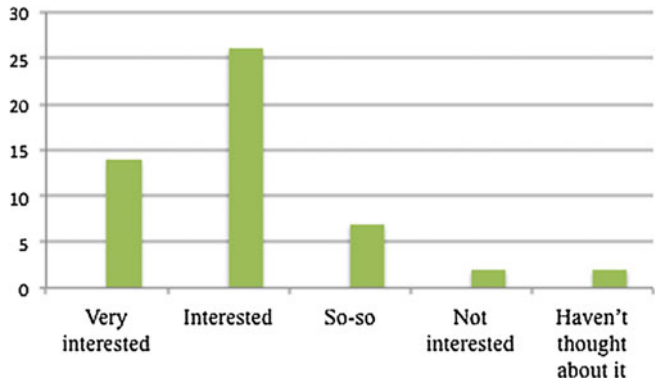


Fig. 10 Interests of product intervention

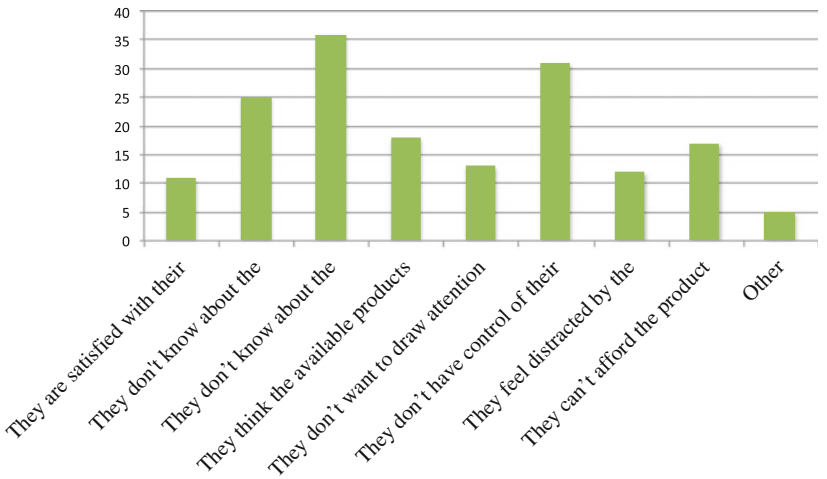


Fig. 11 Reasons of not using products in workplace

Experience.

At the end of this section, three open-ended questions were asked among the participants with knowledge of existing products: (1) Describe any features/functions you particularly like of this product; (2) Describe any features/functions you particularly dislike of this product; and (3) Describe the essential features/functions of a product that would persuade you to use to reduce sitting time. The participants without knowing any existing product only answered the third question.

By analyzing answers words by words, four categories of features were identified: cost, ergonomics, health, and work.

Experience.

Answers	Key words
timer, forced breaks	easy to use/easy to bring to work
reasonal price and stability	useful information and guide
cool, high tech; feedback	force break
Too many	timer/reminder
Have a clock, reminding people to stand up for 10 min every hour...	reasonal price/ cheap
Yes	stability
Timer	work efficiency
Easy to carry not take too much room	adjustable
accurate and some easy and helpful guide for their real life.	
don't sacrifice work efficiency	Manage pay for the product
just to make sure the products are really effective.	
Maybe a social component like doing a group activity.	more comfortable/ergonomic
making sit feel more comfortable	
alert, force me move	
comfortable /reminder/ vanessa	
The product has to be cool, it needs to motivate people and enhance there work experience. It fundamentally has to be better than conventional sitting.	
allow to work and exercise at the same time	
Must be relatively cheap and easy to use. Would probably be more likely to be implemented if came withinformation about the positive impacts on productivity and health	

Fig. 12 Screen capture of coding process

4 Conclusion

The results of the online questionnaires described the current situation of office workers' sedentary behaviors. The findings showed that the majority of participants were unsatisfied with their current sitting time experiences, and were interested in using products, especially physical products, to reduce sitting time during office working hours. Also, the survey indicated that the main barrier of standing during work was people did not want to sacrifice work efficiency, especially during demanding periods of time. However, available workstation designs often did not allow them to keep working while standing. Based on the results of the survey, extrinsic and intrinsic motivational factors to stand and worker preference findings helped the researcher develop further design guidelines to improve sedentary behavior related health outcomes.

Design guidelines were developed covering work, ergonomics, health and cost aspects as shown in Fig. 13.

In future research, different work contexts can be taken into consideration to enable a deeper understanding of the different, and/or related needs reflected across the spectrum of occupations. More specific design guidelines could be developed to help people in different occupations to be more motivated to stand more and sit less.

Work
Provide enough workspace for different types of work
Maintain work efficiency and reduce sitting at the same time

Ergonomics
Adjutable and stable at the same time
Comfortable to be used while standing
Easy to use with minimal effort and simple interface

Health
Allow to track the health status, body change
Provide more information of the benefit of sitting less and harmfulness of prolonged sitting, which could internally motivate people.
Help to keep good posture during both sitting and standing
Keep people physical active
Remind people stop sitting

Cost
Reasonable price
Provide different price level that more people can afford

Fig. 13 Design guidelines

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Phenomenology and Emotional Design: The Conceptual Synergy Between Architecture and Design for Urban Furniture

Rodrigo Balestra F. de Paiva

Abstract This article explores concepts of the senses, experiences and emotions treated by many authors and sheds light also on Phenomenology and Emotional Design, indicating how are important for the differentiation of products and services in the contemporary world. Through literature review, explores the concepts of urban furniture, explaining how such structures can transform the urban landscape of cities, people's behavior and the reframing process that is usually used by us in these structures. It is relevant to discuss the urban furniture as identity element, memory and pleasure, and how the perception of quality of users varies according to the characteristics of the projects, either through tactile and visual aspects or multisensory elements transform the experience and pave the way for new discoveries and interactions. Review both concepts will explain the pleasure and satisfaction of the people regarding to things, but also demonstrate how designers and architects choices can influence political decisions, the human behavior and at the perception of quality that people have in relation to urban facilities of cities.

Keywords Phenomenology · Emotional design · Materiality

1 Introduction

The street furniture is a recurring element of the urban landscape and, although constant presence and dispersed in the city, these structures of varying ranges and functions should go unnoticed in the cities so as not to interfere with the urban landscape or rival architectural or recognized quality buildings historical value. The development of these devices in series requires, among many approaches, a dialogue with the city, with the neighborhood and with the users as they are inserted at various levels of urban scale and social, political, technological and economic of the

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city. Guard also individual and collective memories that tell us about the social and productive conditions of the time they were executed, as the object of a given local context and temporal [1].

Based on numerous theoretical approaches, will be presented in the first part of this article the basic concepts of urban furniture, its origin, functions, and other aspects that mark their presence in the urban landscape of cities. In the second part, the concept of "place", space, memories and phenomenology will be treated from the perspective of several authors, enabling the articulation of these themes with the different approaches both in design and in architecture. The third part presents an overview of the senses in the Design and Architecture, excitement focused on the study of Emotional Design and the role of attractiveness and pleasure in the emotional interaction between products and users. Moreover, the importance of materiality in design and architecture projects will also be treated objectively to elucidate the sensory and emotional relationship that materials commonly transmitted to people. The fourth and final part will cover basically the points of convergence between the issues and how this article can contribute to the literature review on the Phenomenology and Emotional Design for other researchers and students of Design and Architecture.

2 Urban Furniture in Cities

The term street furniture has its origin in the literal translation from the french "*mobilier urbain*" or english urban furniture. According Creus [2], furniture word translates the idea of furnishing or decorating (italian "*arredo urbano*"; Arredare = decorate). The utilitarian character is also part of the concept of street furniture for Montenegro, which defines elements such as articles directed to the convenience and comfort of users, especially pedestrians. The author alleges that the urban furniture makes up the environment in which it is inserted and is part of the design of cities, interacting with its users and the socio-cultural and environmental context [3]. Guedes [4] prefers to use the term urban equipment because he believes that this concept also covers larger elements, intended for use in cities. In the author's view, street furniture is a subcategory of urban facilities.

Brazilian law, through Law Number 10.098/2000, defines the term street furniture as a "set of objects present in the streets and public spaces, superimposed or added to the elements of urbanization or building". The Brazilian Association of Technical Standards—ABNT, defines: "*All objects, elements and small members constructions of the urban landscape, utilitarian nature or not implemented by authorization of the government, public and private spaces*"—NBR 9283. According to the standard, they are examples of street furniture: bus shelters, access to subways, phone booths, poles and light wiring, trash cans, benches, among others. Kohlsdorf [5. John and Reis], in turn, uses the term "complementary elements" to designate the objects identified by ABNT as "street furniture" and reserve the term "street furniture" for mobility and smaller scale elements, such as benches,

trash cans, mailboxes etc. In order to standardize the terms used in discussions on the subject, Mourthé [6] states that in Brazil officially use the term "street furniture", and that therefore the most suitable to be used in the study.

Usually evaluates the street furniture alone in public space. However, it should be placed in the broader context of the city and not just as a decorative element. Progress demands, the complexity of the urban fabric, the emergence of new activities, the advancement of new technologies and the demand for new services have led to changes in the cities, converting them into the territory of maximum concentration of information and accessibility. "Draw" this territory from its varied structural, giving it a real urban quality and durable, should consider, particularly the presence of urban public spaces and the elements of the (urban furniture). In turn it is necessary to plan this criterion street furniture, paying attention to aspects of functionality, rationality and emotionality [2]. To Tandy [7], there are six elements that should be considered in the choice of accessories for public places: function, durability, permanence, intensity of use, cost and location feature.

The relationship between the various elements understood as street furniture present in open public spaces usually alters the perception that people have of their own cities. Disregarding the functionality or the perception of the user population in the urban furniture design could do it does not fulfill its function or not being used properly, also hindering the use of the places where these elements were implemented [6]. Relating consistent with the surrounding elements and managed to meet the functions for which it was designed, street furniture can enhance the aesthetics of the landscape and provide greater satisfaction in the use of space by the community. Studies suggest that the implementation of urban furniture could contribute to visual pollution of the landscape, influencing the environment of aesthetic evaluation [8]. For Guedes [4], the street furniture projects need to be evaluated in an attempt to improve the quality of the created elements and improve the perception of the environment in which they were deployed. For Basso and Linden [7], however, the biggest challenge of the designer when designing this type of furniture is to find harmony between the uniqueness of the objects must be in the urban space and the aesthetics of the place where they will be inserted.

Regarding the use, Bins Ely checks the expected conditions of bus users, judging, based on the comfort of the people, the quality of the shelters of this type of transport. In their study, the author took into account the ergonomic aspects of postural comfort, bioclimatic and visual [7]. Ewing, comments regarding the preference for certain bus stops and suggests that the physical comfort and formal environmental aspects could influence the preference of individuals. Among the issues raised by him, there is the fact that the existence of toppings and side closures that provide weather protection, could influence the choice of users [7].

As for the deployment location of street furniture Ribeiro, Martins and Range [7] show that the improper disposal of elements on the sidewalks can be considered a barrier to the use of public spaces. In the City of London manual—Streets for All—is a series of recommendations on the implementation and design of street furniture in order to make attractive streets, safe and pleasant to users, since the preference of the people certain spaces is affected by, among other things, by urban elements.

Some research also suggests that the furniture could significantly influence the preference of individuals for certain streets, as Kilicaslan indicate; Malkoc; Turel [7], for example, in study based on physical, visual and use, compared modern streets, traditional and renewed. According to the authors, the presence of street furniture could influence the use of such spaces is that negative ratings could be associated with the inadequacy of the elements to people's expectations. Similarly, the search results Mehta [7] indicate that the existence of appropriate street furniture on the sidewalks could make the most significant environment for individuals to stimulate the social use of open spaces and, therefore, should consider not only the functional aspects of the elements, as well as the comfort of the users [7].

3 The Concept of Place

The "landscape" is a very broad phenomenon. It can be said that some phenomena form an "environment" for others. A concrete term for speaking about environment is "place". In common parlance it is said that acts and events take place. According to Schulz, when we refer to something more than an abstract location, think of a whole composed of concrete things having material substance, shape, texture and color. Together, these things determine an "environmental quality", which is the essence of the place or the qualitative phenomenon "total", which can not reduce any of its properties without losing sight of their specific nature, preventing the seats are defined by analytical or scientific concepts. For the author, Phenomenology exists to solve this impasse, it is "a return to things" as opposed to abstractions and mental constructions. […] "There needs to be" identification "a relationship" "friendly environments". And both the guidance and the identification are aspects of an overall relationship. Thus, the environment is experienced as meaning bearer, "character is a correspondence between the external world and the internal world, body and soul" [9].

3.1 Phenomenology

Phenomenology is understood by Schulz as a "method" that requires a "return to things" as opposed to abstractions and mental constructions. Their efforts around this concept intended to highlight the study of the phenomenological point of view environment, whose potential phenomenological architecture is the ability to give meaning to the environment by creating specific places. It introduces the old Roman notion of the *genius loci*, that is the idea of the spirit of a particular place (establishing a link with the sacred), which creates an "other" or the opposite with which humanity must face in order to dwell. He interprets the concept of living as peace in a protected place. It is a metaphor that helps establish emotional sufficiently clear

parameters for new street furniture projects, which could offer a greater sense of identification, orientation, environmental image and emotional security to users.

"Anthropological place" from Augé [10] is identitary, relational and historical. That is, it brings its own identity, the result of social and cultural dynamics established there. It is also by nature relational, is constructed from the relations with other places, stimuli, contexts and to combine their own identities and relationships, makes historical place. And the relationship between users and the environment is affected by both environmental peculiarities, as the characteristics of the people involved—motivations, experiences and values [7]. Associated with this, perception processes and cognition are involved in man's relationship with the environment and influence the aesthetic evaluations and use of spaces [7]. The city, local experiences and social phenomena, individual and collective, for the spaces and places, is defined by Freitag [11] as a spatial organization of social life of a people who reveal their cultural specificity (social representations). For Jodelet [12], social representations are complex phenomena always enabled and action in social life. In his wealth as a phenomenon, we find several pieces of information, cognitive, ideological, normative, beliefs, values, attitudes, opinions, pictures etc.

Besides focusing on the site, phenomenology also covers tectonics because to Schulz, "the detail explains the environment and expresses its peculiar form [9. Nesbit; Norbert-Schulz]. Because of this invocation of the site and tectonics, phenomenology itself as influential school of thought among some contemporary architects like Ando, Holl, Clark and Menefee and Waldman. It sparked a new interest in the sensory qualities of materials, light, color and the symbolic importance and tactile joints. These aspects contribute to highlight the poetic quality that in Heidegger's view is essential to dwell [9]. To Bandeira and Rocha [13], phenomenology as dialectical synthesis emerges as the study of essences that are given through the recognition of phenomena. This recognition is dynamic and relational. Thus, the thinking being is only present at the time of their relationship with the object thought. For Dewey [14], "experience occurs continuously because the interaction of the living and environmental conditions is involved in the very process of living. Things are tried, but in order to compose in a single experiment. There is distraction and dispersion; what we see and what we think, what we want and what we get, disagree".

3.2 Memory Spaces

We have an innate ability to remember and imagine places. Perception, memory and imagination are in constant interaction; the sphere of the present merges with memory and fantasy images. There are cities that remain as mere distant visual images when recalled, and there are cities that are recalled in all its vividness. The memory brings back the pleasant city with all its sounds and smells and light and shade variations [15].

"The timeless architecture function is to create existential metaphors for the body and the life that materialize and to structure our existence in the world. The essential task of architecture is to accommodate and integrate. Articulates the experience of being part of the world and reinforces our sense of reality and personal identity; it does not make us inhabit worlds of mere artificiality and fantasy. The sense of personal identity, enhanced by art and architecture, allows us to fully get involved in the mental dimensions of dreams, imaginations and desires" [16]. In contrast, for Tschumi, the architecture reflects embodied and makes the ideas and eternal images of ideal life. The buildings and cities allow us to structure, understand and remember the amorphous flow of reality and, ultimately recognize and remember who we are. It allows us to perceive and understand the dialectics of permanence and change, insert in the world and put us on Continuum culture and time. On your way to represent and structure the action and power, cultural and social order, interaction and separation, identity and memory, architecture engages with fundamental existential questions. Any experience involves acts of remembrance, memory and comparison. In memorable experiences in architecture, space, matter and time merge into a single dimension, the basic substance of life, which penetrates our consciousness. We identify with this space, this place, this moment, and these dimensions become ingredients of our own existence. Architecture is the art of reconciling with the world, and this mediation is through the senses [15].

According to Vera Damazio, PhD in Social Sciences, designer and one of the pioneers in the field of Emotional Design in Brazil, the task of interpreting the things that make us well remember, brought together thinkers as the Scot Adam Smith (1723–1790), the French Marcel Mauss (1872–1950), as well as authors from the fields of Social Memory and Material Culture as Stallybrass and Benjamin. Its main driver was, however, the sociologist Halbwachs [17]. Developed in the first half of the twentieth century, his pioneering ideas on the collective memory has become more relevant in various areas of knowledge [18] and are of extraordinary relevance to the field of Design and Architecture. Halbwachs argued that there is no individual memory. The memories—of individuals, groups or nations—are always built in the various groups of which we are part and based on their social conventions, values and physical environment. They are the result of action to review and interpret the past in the present and reflect the tensions, norms, interests and values of the present time. Memory, therefore, encompasses the past, present and future and also remembering and forgetting. Halbwachs [17] also establishes the close relationship between memory and identity, arguing that "the usual images of the outside world are inseparable from our self." He tried also the links established with the environment, noting that "our house, our furniture and the way they are arranged, the whole arrangement of the parts in which we live, remember our family and friends that we often see in this context." In short, we live, we remember and forget in society and in a physical world. And things are a tangible part of our identity and memories.

To Damázio [18], there are prospects for the project "memorable products" that can help designers to create more relevant projects. For the author, products become memorable when: (1) the distinguished as an individual; (2) surprise and make you

laugh; (3) bring comfort and serenity; (4) encourage to do good; (5) create and strengthen emotional ties; (6) make us feel loved and important. And as a result, they were also identified the following attributes of memorability: (1) identity; (2) Humor; (3) Well-being; (4) Citizenship; (5) Sociability; (6) Self-esteem. In this regard, the street furniture, especially the bus shelter, should have some of the attributes listed by Damazio to be perceived as prominent element—memorable—in the urban landscape because its use implies acts of remembrance, memory and comparison (identity) with other experiences of the usurer, which gives him certain meanings and may or may not have "identification" with this equipment and create a "friendly" relationship with the environment in which it is inserted.

3.3 Emotion as Groundwork of the Emotional Design

Emotion is inherent in human beings. It is the feeling that moves us, helps us in making decisions, as confirmed by Antonio Damasio in his book "The Mystery of Consciousness": Without exception, men and women of all ages, cultures, education and economic levels have emotions, pay attention to the emotions of others, cultivate hobbies that manipulate their emotions and largely govern their lives seeking an emotion, happiness, and looking avoid unpleasant emotions [18].

For the author, the emotion is omnipresent in all our actions, even under the influence of reason. Possibly, this is key to the effectiveness of Emotional Design. For most neuroscientists, the human brain can be broken into three layers, on the evolution of species. The inner part (reptilian) is the place in which the primary emotions arise, mainly related to survival (search, fear, anger, etc.), the middle part, developed in mammals, related to some typical maternal emotions, and the part higher (neocortex), which is more related to logical and rational processes. And some simple perceptions are capable of promoting the emergence of some emotions. For example, many studies describe the perceptual elements dealing with aesthetic emotions [19], or the "signs" visual, able to appear different types of emotions [19]. In this understanding, Ramachandran presents the following visual principles can influence the emotions: (1) peak displacement principle: the exaggeration and emphasis on some aspects of reality; (2) Grouping and perceptual binding: ability to group signals, suggested by the principles of Gestalt; (3) Contrast: colors, tones and forms etc.; (4) Insulation: prevalence of visual modality over another.

Emotions are directly related to the meanings that the individual attributes to the stimulus offered. Consumers and users may experience a variety of potentially conflicting feelings about an object, such as admiration, disappointment, fascination, fun and disgust. Considering also that most objects and situations leads to some emotional reaction, there is thus a multitude of potential associations between objects, situations and emotions experienced. Emotion is part of being human, we know that it interacts with the rational side of each, so the emotion is part of the decision making, the choice of the evaluation to the product. There are numerous

models in the literature for understanding the role of emotions in design, being the most widespread ones proposed by Pieter Desmet, Patrick Jordan and Donald Norman. One of the most used was developed by Desmet, based on a union between a cognitive theory of emotions, Theory Appraisals, and design. From the perspective of appraisals, people value (based on fact or imagination) stimuli, according to personal meanings. Some authors argue that the excitement was absent in the design and recently gained prominence as the individual establishes personal relationships with the products that surround [20. Norman]. Norman believes the Emotional Design makes the designers start to design focused on emotion, seeking results that provide enjoyable experiences for people. In Norman's view "emotions are inseparable from cognition and are part of a trial system that is good or bad, safe or dangerous." "The author directs the emotions for three levels of processing, which are associated with each other and consequently in everything that people do. So there is a cognitive component and an emotional component, which gives meaning and cognitive affective value grants". Furthermore, Norman explains that emotions modify behavior over a relatively short period of time because they react to immediate events, and yet, the characteristic features of those defining their personality, are also mutable because change our parameters according to the situation. Thus, emotions interpreted by people regarding their experiences can be interpreted in different ways, what appeals to one may not please another [20].

For Queiroz et al. [21], if someone is attracted to a product and buys it will feel pleased to have acquired an object of your desire. However, even without purchasing the product, this person may feel pleasure to enjoy it. Thus, the interaction of the subject with the object takes on a deeper level beyond the practical and immediate interests, considering that in addition to awakening practical interest, a product can arouse aesthetic pleasure and provoke emotions [22]. This interaction occurs from several factors, both rational and emotional, which will affect the subject significantly. Rational factors are related to practical function, usability, price, among others. Emotional factors relate to the aesthetic and symbolic functions of objects [23], as evidenced by their appearance, such as shape, color, texture and also its meaning, that is, for what it represents for the individual. According to Moles [24], the relationship between man and the objects pass through several stages: start by desire, which is supplied by the acquisition, then the discovery and the affective relationship with him. After this stage, there is a decline of the relationship and the object can be maintained, replaced or discarded.

Jordan [25], in the book "Designing pleasurable products", says that the pleasure associated with the products can be a practical benefit, emotional or hedonistic. According to the author, pleasure is a relative concept, given that arises from the product interaction with the person and is an extrinsic feature to the product. Jordan divides pleasure into four types: physiological, social, psychological and ideological. For products, Jordan relates the physiological pleasure to comfort; social pleasure to status and social interaction; the psychological pleasure to usability (provided by easy to use products and reduce unpleasant sensations); ideology and pleasure, which occurs in accordance with the culture of a person and is accordingly. Norman in "Emotional Design" [20], divides pleasure into three levels:

visceral, behavioral and reflective. The author presents an analogy with the product design in which the visceral design that is geared to product appearance, the first impact is visual in nature and causes positive reactions or not. The behavioral design is linked to the functional aspects of the product, where pleasure is associated with the use and performance of the product. At this stage the initial impression of visceral nature can be confirmed or not. The reflective design is connected to the meanings which the objects to represent them. Often reflective pleasure is built on long-term, when it occurs, for example, loyalty to a particular brand.

Thus, we conclude that the meanings often go beyond the aesthetic pleasure (visceral) or use (behavioral), considering that they are associated with the symbolic dimension. The symbolic value, in turn, varies with the socio-cultural context and personal values of each subject.

3.4 Senses in the Fields of Design and Architecture

The psychologist James J. Gibson considers the senses as aggressive search engines and not as passive recipients [16]. He does not categorize the senses in the five unlinked modes, but as five sensory systems: visual, auditory, olfactory palate-from basic and tactile orientation. The philosophy of Rudolf Steiner assumes that actually use anything less than twelve senses. The senses not only mediate the information to the intellect of the trial; they are also a means to trigger the imagination and articulate the sensory thought [15]. For Pallasmaa [16], "the primacy of touch has become increasingly evident. The role of peripheral vision and afocal in the experience of the world as well as in our experience of interiority of the spaces we inhabit, also has called attention. All the senses, including vision, are extensions of touch: the senses are specializations of skin tissue, and all sensory experiences are variants of touch and therefore related to "tactility". The author also states that today the vision and hearing are the most socially privileged way, while the other three senses (taste, smell and touch) are considered archaic sensory remnants with a purely private function and usually repressed by cultural code. To René Descartes, the vision as the most universal and noble sense, having equated the vision to the touch, a sense that he considered "more certain and less vulnerable to error than the vision" [16].

3.5 Touch and Its Influence on the Choice of "Material"

Every day we perform unconsciously thousands of choices and judgments through the sense of touch [26]. We feel the softness of the linens, the moisture from the towel after the bath, the heat of the day, the texture of the fabric that is made the clothes we wear, the wind touching our face in the street, the shapes of the objects

we touch, their roughness, their weight. Touch is a sense that makes us make decisions about liking and disliking, attraction or repulsion, acceptance or rejection of any object. It is the primitive sense that awakens the other senses. There are also a formal definition of the Haptics, the science of touch. The Haptics system would then be the most extensive "organ" of the human body and house the sense of touch. It is through him that the human being comes into contact with the environment. "Our skin is what stands between us and the word," says Diane Ackerman [26], in his archaeological analysis of the sense of touch. For Erthal, "our bodies change due to new technologies and not by natural selection: to live in today's world, you need to know how to deal with the buttons of automated banking machines with electronic turnstiles on public transport, with internet for accountability on our taxes to the government, with the cell phone that ensured the ubiquity and mobility" and the proliferation of interactive arts and sensory interfaces begin to value the experience of touch and tactile ability [26].

3.6 Materiality in Design and Architecture

Currently most of the products have been developed and consumed as commodities. The products are usually similar, with structural and aesthetic features are very similar, and in this context compete for lower costs and do not have high added value. The consumer, therefore, purchase, use and discard the product, adhering to a vicious cycle that ignores their emotional relationship and life [20, 27]. During the process and design of a project, the designer is responsible for introducing significant features to objects that interfere in their conditions of consumption and use. Thus, "the designer, as a producer of visual distinctions and semantics of everyday culture, influences the emotions, behaviors and attitudes in the user" [27]. De Giorgi [28], specializing in design emphasis with materials in the project approach "centered on the human being," the role of the designer is also to shape and meet new requirements for sensory elements, pleasure and depth of experience are emerging consumers. The author states that in accordance with the latest trends in design culture, the choice of suitable materials for creation of products should be taken as early as Meta design phase, which is then expanded and loaded meaning: the materials, in fact, have a significant influence on the design; its technical functionality they support and, at the same time, create their personality. Such requirements have evolved considerably: no longer requires that products have only the traditional aspects (related to physical-technical and mechanical requirements, reliability, security, etc.), but, according to the new times, they must also have properties "soft", such as more sensory expressiveness and, while complex elements as a plane for the life cycle of the product that meets our planet.

"[…] The choice of materials for a given product represents an opportunity to be seized in order to enable technology transfer and innovation. A good designer establishes the initial stage of the project which the materials to be used, or the company does, as the scope of their work, or he develops his research to adapt

perfectly to the design objectives [29]. Due to the growth of associated industrial sector, especially the development of new products, the selection of specific and appropriate to the application materials as its conditions of use is another important criterion for consistent product design [30]. In architecture can also demonstrate the importance of materials and temporality in current projects.

According Pallasmaa, the superficiality of construction [architectural] today's standard is enhanced by a sense weakened materiality. Natural materials—stone, brick and wood—they allow our vision to penetrate their surfaces and allow convince us of the truth of the matter. Natural materials express their age and history as well and tell their origins and history of use by humans. Already the current industrial materials—without scale glass plates, enamelled metals and synthetic plastics—tend to show their inflexible surfaces in our eyes without transmitting its essence material or their age. The buildings of our technology was aimed deliberately to timeless perfection and does not incorporate the dimension of time or the inevitable and mentally important aging process. In recent decades, a new imaginary architecture employing reflections, transparency graduations, overlapping and juxtapositions to create a sense of spatial depth, in addition, subtle and dynamic feeling of movement and light. This new sensitivity promises an architecture that can turn the immateriality and weightlessness on the recent construction with high technology in a positive experience of space, place and meaning. For the author, the weakening of the experience of time in the current environment has devastating mental effects. We have a mental need to feel that we are rooted to the continuity of time, and the man-made world is for the architecture to facilitate this experience [16].

4 Final Considerations

Based on the concepts presented here in this article by renowned authors of Architecture and Design, we can say that the creation of an urban quality furniture for contemporary cities must meet, in principle, the fundamental concepts of good form (Gestalt), attractiveness and emotion (Emotional Design), the logic of materiality and the senses (Phenomenology) that integrate environmental sense, "place" and the open urban space where these structures are commonly installed. Therefore, it is clear the integration of these concepts in any projects of Architecture and Design. Moreover, it is a stimulus for new interpretations of the synergy that must exist in the projects that integrate these two disciplines. You can not lose sight also other aspects here not analyzed as accessibility, the historical context, the appropriation of space and its components, the symbolism of the urban furniture, morphology, and social and functional dynamics (the way users appropriated the city and its elements) that interconnect all of these factors to Architecture and Design. Therefore, the aim of this study provide insight to new discussions about the importance of urban furniture as an element to enhance and increase the quality of life in contemporary cities, making them more friendly and inclusive, recognized symbolic value, identity and "memorable" by its inhabitants.

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Part V
Emotional Engineering

Affective Speech Design: Emotional I/O

Logan T. Hale

Abstract Emotional states are in many cases crucial to the usability, likability, and effectiveness of an interactive system. An ideal system must be able to both efficiently analyze emotional states of its users and believably convey emotions back to its users, as well as altering its behaviors to best fit the needs of its users. Noninvasive, natural means of ascertaining emotion are essential for users to accept emotion-detection in a system. Analyzing speech patterns is one such means. Speech signals can be collected using a microphone with little to no physical contact with the user and contain a plethora of information for determining emotional baselines and temporary states. A smart, adaptive system could use this emotional information to maximize positive sentiment and affect of the user during and after its use, with system manipulation and the use of emotionally expressive agents.

Keywords Adaptive systems · Affect · Emotion · Human-system interaction · Speech spectrum analysis · Speech synthesis

1 Emotion

The study of emotions and mood (affect) has increased exponentially because of advancements in technology, namely visual, auditory, and brain-imaging technologies. While emotional states are apparently subjective, at least six emotions seem to be persistent across all subsets of humanity. These six emotions are joy, anger, fear, surprise, disgust, and sadness.

Various studies have been done on emotion in speech, or emotion's alter egos/proxies—affect, sentiment, stress, valence, arousal, and so on. An important distinction is made between emotion and affect, in that emotion is temporary and

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object-oriented whereas affect is prolonged and general [1]. The emotions usually studied are the six primary emotions; however, sometimes the distinction is only dichotomous: positive and negative emotions.

Gluck et al. [2] describe emotion as a combination of three elements: physiological responses, overt behaviors, and conscious feelings. Physiological responses of emotion correspond primarily to the sympathetic and parasympathetic divisions of the autonomic nervous system. The sympathetic nervous system is closely associated with a process known as the fight-or-flight response (or sometimes the fight-flight-or-freeze response). The sympathetic nervous system causes increases in physiological systems that aid in short term decision-making and survival while causing simultaneous decreases in physiological systems that facilitate long-term decision-making and survival. Foveal vision increases at the cost of peripheral vision. Blood pressure, flow to motor muscles, and glucose level all increase while blood flow to the digestive system and other nonessential short-term organs decreases. Notably, the sympathetic nervous system also has a pronounced effect on the organs that produce and manipulate sound through the vocal pathway.

While overt behaviors such as smiling or frowning can be utilized in the context of social interactions in order to convey emotion, humans possess the capacity and drive to manipulate their overt emotional states for social gain or compliance. The same can be said for speech, as one can overtly sound happy but be covertly sad or angry. It is, however, virtually impossible to completely disguise actual felt emotions, as unconscious conveyances such as micro-expressions, micro-utterances, and other subtle cues surface.

While there is a distinction between overt and covert emotional states, there is also a distinction between conscious and unconscious states. A person can perceive himself or herself, through self-report, as experiencing one emotion while actually experiencing an entirely different, or even opposite emotion. Studies have shown that participants exposed to sad, meaningful music report sadness but low valence happiness (blithe) [3, 4]. Alternatively, though, these findings could represent the state of experiencing sadness in terms of emotion and happiness in terms of affect.

In addition, aside from the six primary emotions discussed above, humans can express various subtle, contextual, combination, and pseudo-emotions. To name a few: sarcasm, skepticism, aloofness, snootiness, impersonation, sing-songiness, condescension, confusion, excitement, boredom, engagement, disappointment, compassion, frustration, and fun. Detection and differentiation of all these emotional states and expressions is important for the future of Human Factors, as the desire for emotionally receptive and responsive systems increases.

2 Emotion in Human-System Interaction

A person's emotion can have a profound impact on his or her interaction with a system. Specifically, on attention to, memory of, performance with, and assessment of a system [1]. Contextual emotional state temporally surrounding system

interaction affects user sentiment regarding the system. These interactions between human and system closely resemble interactions between human and human or between human and animal [5]; therefore, system responses to user emotional stimuli have the potential to greatly influence future interactions with and sentiments for the system.

In order for a system to interact effectively with humans in a socially ideal manner, it must be able to perceive human emotions and to convey emotions believably back to its users. There is still progress that needs to be made, however, on the measurement of emotional states in humans, if systems are ever to be able to read them accurately. Humans have always seen themselves as being able to recognize emotions within themselves with accuracy, but recent studies suggest that that might not be the case all the time [3, 4], so the validity of self-report measures is questionable and they should only be used for comparison between subjective and objective measures.

Physiological measures vary in their intrusiveness. One minimally intrusive study utilized a small bracelet to record skin conductance levels in call center workers as a proxy for stress level during calls [6]. Overly intrusive or self-report measures of emotion can themselves affect the emotional state of the user or detract from their interactive experience with the system by siphoning cognitive, sensational, and psychomotor attentional resources [7]. An example of a noninvasive system that incorporates speech, as well as facial and gestural, analysis is the AutoTutor [8]. This interactive tutor uses these three emotion-filled signals to adjust actions taken by an interactive school tutoring agent.

Progress must also be made on systems' ability to adequately convey emotions. Systems incorporating artificially intelligent agents are seen as more likeable and trustworthy when the agent conveys empathic emotion towards the user [9]. This could be, for example, a face that smiles at the user when he or she is happy or, a voice that encourages the user when he or she is frustrated. Agents that appear to have their own emotions, however, run the risk of entering the uncanny valley or increasing user expectations beyond what the system is capable of; therefore, non-human or humanoid agents can be employed to reduce these effects [5].

Chiefly in regards to Human Factors, the incorporation of accurate emotional modeling into speech recognition, modification, and synthesis would narrow the gap between human and artificial intelligence, facilitating communicative interaction in both directions. A system's ability to detect emotion in speech could allow it to track a user's change in emotional state for health reasons or to modify itself in order to better serve a user in a heightened emotional state. A user's ability to recognize emotion from a system's synthetic voice could increase the user's perceptual humanization of the system, removing the human element while maintaining the human-human level of social interaction.

3 Speech Spectrum Analysis

Briefly put, speech is a controlled expulsion of air from the lungs, through the glottis (the space between the vocal folds), and finally out the mouth and nose, which can be shaped by minute changes to this pathway into recognizable sounds for means of vocal communication.

Speech breathing has an aperiodic component and a periodic component [10]. The aperiodic component is the aeroacoustic noise from air being pushed through the vocal pathway, which can be increased or decreased by altering the amount of pressure on the lungs (subglottal pressure). To shape this speech breathing into specific sounds, laryngeal muscles open and close vocal folds in a complex manner to alter the shape of the glottis, while the vocal folds oscillate at desired frequencies. Additional shaping is done by placement of the tongue and the lips, and by redirecting some or all air flow through the nasal passage. All this shaping that takes place is the periodic component of speech.

The combination of periodic and aperiodic aspects of human speech, like any auditory signal, forms a complex pressure wave that can be visualized through an oscilloscope. This wave can be broken down into fundamental sine waves through a process known as Fourier analysis. Fourier transforms of a speech signal allow for detailed analyses of sound components in speech, such as pitch, tone, timbre, intonation, and prosody, which all vary in unique ways when the speaker is experiencing any sort of emotion [11]. Precise modification of speech signals is also possible, as evidenced by a karaoke system that alters only periodic speech signals to mimic a target singer's voice while maintaining the aperiodic speech signature of the karaoke singer [12].

When the sympathetic nervous system is active, the diaphragm pushes more air out of the lungs during speech and other non-speech exhalations, and muscles controlling the tongue and many laryngeal muscles exhibit quicker, more forceful movements. These changes lead to a pronounced speech pattern indicative of "high valence" emotions—joy, anger, fear, surprise, and others [13]. Speech during high valence emotional states is louder, faster, and more enunciated as well as having a higher average pitch, more energy in the high-frequency range, and a broader general range of pitch [14]. These patterns in speech have been used as a proxy for sympathetic nervous system activation in many studies, while some researchers refer to it as "stress" or "arousal," depending on the study. Speech is additionally altered depending on the specific high valence emotion. In observing only one high valence emotion such as stress, joy, or anger, overall sympathetic nervous system activation can been used as a proxy for the observed emotion; however, when differentiating between various high valence emotions, additional semantic and prosodic evidence must be acquired.

On the other side of the coin, low valence emotions—primarily sadness, but also contentment (or blithe), romantic love, and other less studied emotions—are associated with activation of the parasympathetic nervous system and its subsequent effects on the vocal pathway. These effects are a mirror image of those found

with sympathetic nervous system activation: lower average pitch, less energy in the high-frequency range, and a narrower range of pitch.

Humans use these auditory spectral cues during social interactions in order to make guesses as to the emotional or affective state of others. Consequently, humans have developed the ability to mimic the spectral signature of emotional speech in order to feign emotion for survival or social status. A fascinating byproduct of this is our unique ability to create music that also mimics emotional speech, causing, in theory, a transference of that emotional state onto the listener. If conveyance of complex emotion states is possible through a completely nonverbal stimulus such as music, then it is also possible to convey emotion through modifications of sounds and artificial speech utilized in systems.

4 Emotionally Adaptive Systems

As system automation becomes more and more prominent in our society, the need for these systems to adapt to the psychological state of the user becomes more and more important. In order for a system to perform at maximum efficiency, it must recognize its users' norms on a variety of psychophysical and assumed psychological measures. Psychologists recognize the similarities among humans in regards to these measures as the environment changes, but should also recognize that every individual is affected differently. An ideal automated system should detect certain states of the user and adapt in order to maximize its usability, performance, and likeability.

With automated cars, spaceships, workstations, and so on, that users interact with every day, it is possible to establish a baseline of affective states of particular users. If the system, then, can assess the emotional state of the user at a particular point and tell that that user is experiencing a high level of stress or anger or other state relative to their norm which could impair effective use of the system, the system could then shut down or adapt to that state in order to ensure maximum safety or usage. Airplane autopilots could engage if a pilot is experiencing a panic attack or other debilitating condition. Healthcare or diet systems could adjust a user's regimen based on their emotion. Artificial intelligences could adjust their techniques of human interaction, say in computerized social communication, based on what the user would most benefit from hearing or seeing given their psychological state.

Speech is an ideal candidate for system assessment and conveyance of emotion. Recording speech from users requires only a microphone placed within their vicinity, as noise can be reduced or eradicated from the sound signal [15]. Speech signals can be analyzed almost instantaneously to assess emotional state by comparing current state to baseline rates and known specific emotional changes on the speech spectrum. Conveyance of emotional or emotionally corrective/responsive auditory information can occur instantaneously as well, only requiring the user be in the vicinity of a speaker.

Abuse of emotionally adaptive systems, however, is inevitable. Company systems could potentially coerce users into unhealthy personal choices while in negative emotional states or target happy individuals for profit. Emotion-capable artificial intelligences could manipulate users into acting outside of their comfort zone. In other words, emotionally intelligent systems could become as coercive and subversive as humans themselves currently are.

5 Conclusion

In order for emotionally adaptive systems to become relevant in human factors, much research has to be done on the development of systems for calculating baselines and variations in emotional and affective states. Research on emotional facial expressiveness is currently popular, but extensive research must be done on other non-intrusive indicators of state such as speech.

Each human's speech spectrum is unique to that individual, both in terms of his or her static voice "fingerprint" as well as the contextual changes their voice undergoes in response to variance in long-term affective and short-term emotional states. A process must be developed to extract all these signatures in speech from individuals if speech is to be utilized effectively as a means of relaying important emotional data between users and systems.

For a system to interact efficiently with human users in a socially ideal manner, it must be able to accurately determine human emotions and to express emotions convincingly back to its users. Just as a human builds a dynamic image of another human's affective equilibrium, states, and variations over time while adjusting responses and actions accordingly, systems should be created to build a mathematical model of their users' affective equilibrium, states, and variations to give their users the best possible experience with the system.

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Aesthetic Intelligence for Effective and Pleasurable Design

Daniela Alina Plewe and Carsten Röcker

Abstract This paper discusses the relevance of beauty and aesthetic values for an aesthetically pleasing design of technology-enhanced spaces in the context of ergonomics, usability, and technology acceptance. Under the concept of Aesthetic Intelligence we subsume various aspects, including conceptual scoping, formal design skills and creative methodologies. Our goal is to provide a concept for the exchange of ideas, initiation of collaborations and the development of methodological practices for facilitating effective and pleasurable designs.

Keywords Aesthetic intelligence · Aesthetics · Design methodologies · Ambient intelligent systems

1 Introduction

Smart technical devices are present in our daily life and it is foreseeable that they will be increasingly used within various environments, from homes [1–3] to commercial spaces [4–6]. Besides ergonomical criteria, practicality and usability, the aesthetics of the devices play a crucial role. To develop these devices, there is a need to understand the relevance of beauty and aesthetic values as well as the meaning of aesthetically pleasing design for usability, technology acceptance, and

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well-being in technology-enhanced spaces, where these aspects are likely to gain additional importance in the future [7]. A variety of authors, including Hassenzahl [8], Ziefle et al. [9] or Kasugai et al. [10] showed that users wish for more than the pure technical functionality and prefer devices with a high social and hedonic value. Previous work [11–13] explored the various factors constituting those hedonic, social and economic values. In this work, we briefly reflect upon the concept of *Aesthetic Intelligence*, discuss creative methodologies facilitating it and illustrate research into methodologies fostering aesthetically pleasing system design.

2 Aesthetic Intelligence

Emphasizing aesthetics, design, and the elegance of technology is often credited to Steve Jobs as the visionary behind a whole new generation of "beautifully designed" technology products. Enthusiastically embraced by the markets it became a widely accepted truism, that design adds value to consumer products, facilitates their acceptance as well as promotes commercial successes. Norman's *Emotional Design* focuses [14] on emotions as the key to successful designs, which need to combine usability, practicality and aesthetics. While methodologies exist to develop and evaluate products with respect to usability and practicality, there seems to be a lack of well-researched methodologies on how to consider aesthetic aspects. If we subsume the Apple innovation as an example of *Aesthetic Intelligence*, we may ask: what actually constitutes aesthetic intelligence, how can it be methodologically facilitated and what is its relevance for technology in general and smart systems in particular?

We would like to introduce a core distinction between "reception aesthetics" perceiving artifacts and leading to aesthetic judgments and "production aesthetics" dealing with the creation of artifacts. We argue, how both, yet production aesthetics probably to a higher degree, could inform and inspire potentially designers of technological systems: theoretical aesthetics foster mental rigor and conceptual stringency, "elegance" (as a form of efficiency and effectiveness) and "meaningfulness" of artifacts; whereas production aesthetics lead to an awareness and competence in creative methodologies besides craftsmanship and technical domain knowledge.

2.1 From Reception to Production Aesthetics

In its original meaning aesthetics defined the field of philosophical enquiry dealing with beauty, art, taste. Baumgarten [15] is credited for establishing the notion of aesthetics its modern usage in the 18th century. The word *aesthetics* had merely meant "sensibility" or "responsiveness to stimulation of the senses" in its use by ancient writers. Baumgarten developed aesthetics to mean the study of good and

bad "taste", thus good and bad art, linking good taste with beauty. By trying to develop an idea of good and bad taste, in other words define aesthetic judgments as the core of so-called "reception aesthetics". Baumgarten generated a philosophical debate around the meaning of aesthetics by focusing on "sensory input" and the pleasures derived from those. So the expression of "pleasurable designs" non-surprisingly suggests somewhat positive user experiences and therefore fosters acceptance and in an economic sense s marketability.

With Kant [16] and Hegel [17] the discourse of aesthetics integrated a strong non-hedonic statement: for example, "the beautiful" had to engage the intellect and could not just provide "joy" which appeals to the senses only. "The sublime" even introduced a strong self-reflective dimension pointing the viewer to the limitedness of his existence as a human within the vastness of the universe. These categories were mostly discussed in the context of nature and artifacts such as fine art. Aesthetics was a descriptive discipline (so-called "reception aesthetics") mostly aiming at epistemological insights. With a few exceptions like Hogarth [18], classic aesthetics did not provide heuristics for the creation of beautiful or sublime artifacts, which was mainly due to the epistemological focus of the discipline at that time.

Interesting is the inherent role of "elegance" often referred to as "necessity" (Hegel) or "simplicity" in the aesthetic discourse introducing a criterion of what we may call today efficiency. Negotiating the contrasting principles of "variety" and "simplicity", yet creating "greatness" were criteria for judging art-pieces and the challenge for creating art according to Hogarth. These aesthetic principles may be translated to technical criteria of "efficiency" of in sight of the aesthetic goals as "effectiveness".

Today, in the context of designing artifacts such as technological systems meant to interact with humans, the notion of aesthetics resurfaces as a rather *normative* discipline, i.e., providing heuristics and methodologies. Taught at art and design institutions reception aesthetics are still present and meant to inspire the creatives and expose them to the intellectual rigors of philosophical thinking thereby fostering conceptual skills.

"Production aesthetics" referring to the actual creation of things consist of various components: the body of knowledge of more or less formalized *design practices and principles* regarding the arrangement of visual elements such as colors, forms, structures etc. It also includes analytical and interpretative insights gained from the reception aesthetics. Crucial for any creation is the question of the "why", the *conceptual scoping* and an "agenda setting" component, meaning reflection of the overall functionality, "meaningfulness" and entrenchment into society with its issues and trends etc. Commercial viable strategic goals would fall also into this category.

And, as a kind of meta-knowledge *creative methodologies* (e.g., ideation techniques) making use of the other domains may help to steer the creative process towards the desired outcomes. Being able to command in combination over all these skills we consider a form of intelligence, hence the combination of terms.

Therefore, *aesthetic intelligence* informed by production aesthetics includes *conceptual, visual and methodological competences* and could be considered as an (ideally) internalized ability of the producers of artifacts.

2.2 Implications for Ambient Intelligence

What does this imply for the design of technology systems, especially ambient intelligent systems? The actual formal knowledge on visual knowledge and principles might be achieved in interdisciplinary teams with trained designers. Awareness about conceptual, strategic and methodological aspects of the creative process—does it facilitate the aesthetically intelligent design of systems?

The field of ambient intelligence based on the idea of the "disappearing computers" requires perhaps even more aesthetic intelligence than the design of user interfaces [19]. The embeddedness of ambient intelligence into the world automatically requires a conceptual and cultural entrenchment into its surroundings. We assume that the agenda-setting and meaningfulness aspects beyond mere product and market related strategies become more challenging and that aesthetic intelligence can help to address these issues.

Recent work investigates experience types of users with designed products and tries to analyze their relevance with respect to socio-demographic factors. For instance [20] reports on the relevance of acting and sensing as significant predictors for effective aesthetic experience activities. Stimulating consumer's curiosity first by an attractive product needs to be complemented with sensual pleasure, to which the ability to relate the product to a story in the consumer's life seems to be a further significant factor. Considering the importance of the relate-ability of products, what are the implications for ambient intelligence systems? Are the findings different depending to the role of ambient intelligent systems, e.g. for a lifestyle ambient intelligence systems on one side and ambient assistance systems, trying to compensate lost or declined abilities? More studies are required in order to gain insights about which aspects matter for the specific target users of ambient intelligence systems.

3 Conclusion

We claim that bridging both kinds of aesthetics has surprisingly not been well established, partly because of the institutional divides between universities specialized on technological disciplines and humanities on the one side and art schools on the other. We believe that the communities around aesthetics and technology development could both benefit from an exchange of ideas, theories and practices. *Aesthetic Intelligence* could perhaps become a term for the skillsets informed by aesthetics supporting the creation of effective and pleasurable systems.

In this context, we believe that it is crucial to bridge the institutional gap between systems engineers and designers and to further explore if and how awareness for creative methodologies can contribute to the developer's work individually and within the team due to the shared terminology and explicated processes during the conceptual phase. Complementary to the creative methodologies, the goal of future work should involve the presentation and discussion of the various aspects that constitute significant factors of intelligent systems, such as stimulating curiosity, ensuring sensual pleasure, and meaningfulness.

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Perceived Quality and Craftsmanship—Common Terminology Proposal for Automotive World with Guidance of Kansei Engineering

Emel Ünlükal İlhan and Hafize Çelik

Abstract Globalized world and heavy competition conditions require customer-oriented product designs. Especially, the manufacturers are forced to do their designs for their customers in the automotive sector by the increased competition. Understanding and upgrading the customer's perception about the quality of vehicle will allow automotive manufacturers to proceed in the competition environmental. Generally perceived quality can be defined as consumer's opinion of a product's (or a brand's) ability to fulfill his or her expectations. Kansei Engineering is a method for translating feelings and impressions into new design solutions and precise technical parameters. This study aimed to propose a common terminology for automotive world with guidance of KE.

Keywords Perceived quality · Craftsmanship · Kansei · Automotive

1 Motivation

The automotive industry is fully global, consisting of a set of linked, specialized clusters and challenging competitive, especially after recent economic crisis. Globalized world forces automotive manufacturers to be more customer focused. Main features of the global automotive industry, identifies several important trends for customers. In recent years, «perceived quality and craftsmanship» is included to global value chains. The actual quality of a vehicle is not enough to be competitive, the main point is perception of customers about the vehicle. Besides, customers really know what they want in a certain way, but their ideas of a vehicle can be verbalized as basic words, such as "I like it", "this really nice" or "no, it is not what I want" even they cannot explain in technical way. The main point is customers

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always verbalize their feelings about a product, but engineers can only methodically improve, what we can measure in a robust and reliable manner. The goal is translating perception into measurements.

There are several technical researches for perception of customers in areas of marketing, customer searches and physiologic sides. Perceived quality is subjective and it is not easy to analyze by all aspects in a methodological way. Craftsmanship takes a subjective topic and makes it objective. Moreover, for automotive customers, «product» is not only automotive itself, showrooms, services, cost to repair, after sales are directly other aspects of perceived quality from customer point of view. Besides, common terminology consisting all aspects is not created yet.

Value based perceived quality and technical perceived quality definitions are done especially for automotive. The VPQ embodies the total customer experience of the product attributes and external factors (e.g. brand heritage) through the senses. The TPQ represents the engineering approach, based on the level of individual technical aspects of the product. TPQ is defined as a subset of VPQ [1].

In this paper, authors present extended terminology for automotive industry with the base on Kansei Engineering. This paper presents as follows: Sect. 2 is a literature review regarding existing definitions of quality, PQ & C and Sect. 3 presents meaning of KE, Kansei quality and the case of an automotive company. Consequently, Sect. 4 describes a framework that the authors propose regarding PQ&C in the automotive industry. Section 5 concludes and summarizes the most important findings and future work needs.

2 Perceived Quality and Craftsmanship in Literature

2.1 Meaning of Quality

The word «quality» is originated from a Latin word «qualis» and it has main meaning as «of what kind» and other meanings are character, nature and essential. Generally, it means the property or the nature of things [2]. ISO 9000 standard defines quality as "the totality of those properties and characteristics of a product or an activity that relate to its suitability to fulfil stated requirements". Generally quality is defined by strict and certain standards, it could be measured in methodological ways and critters that achieve uniformity of a product in order to satisfy specific customer or user requirements [3]. Crosby defined quality as 'conformance to customer requirement', according to Juran 'fitness for purpose or use'. Beside, Deming defined Quality as 'a predictable degree of uniformity and dependability at low cost suited to market' [2].

Garvin proposed eight basic dimensions, as follows:

- Performance (primary product characteristics)
- Features ("bells and whistles"/secondary attributes that improve product performance and quality)

- Reliability (frequency of failure)
- Conformance (match with specifications)
- Durability (product life)
- Serviceability (speed of repair)
- Aesthetics ("fits and finishes")
- Perceived quality (reputation and intangibles) [1, 2].

2.2 *Factors Affecting the Perceived Quality of Product*

Cue utilization in product perception is a terminology taken from consumer physiologic studies and it means that product perception of a consumer is affected by specific factors at the sale point. These specific elements are price of the product, appearance, shape, production, use of the properties and salespersons speech etc. Customers, evaluate all these cues and perceptions before buying a product [4]. Product's cues, awake customer quality perceptions and these are very affective that directly connected to buying tendency. With cue utilization theory a framework for assessing consumer perceptions of quality is created [5] (Fig. 1).

3 Kansei and Kansei Quality

3.1 *Meaning of Kansei*

Kansei has a dictionary meaning as sensitivity of a sensory organ where sensation or perception takes place in answer to stimuli from the external world. Kansei, generally translated as "sensibility" to English from Japanese. On the other hand, Kansei has a deep meaning as it depends on Japan philosophy that connects to human being, life or living [6].

Fig. 1 Intrinsic and extrinsic quality cues

3.2 Kansei Engineering

Kansei Engineering is a method for translating feelings and impressions into new design solutions and precise technical parameters. The base of method depends on establishing new methods for accurately grasping consumer needs, integrating these needs (practical and emotional, declared and undeclared) into the product in early phases and by providing designer with quantitative and objective results [6].

There are six types of KE methods;

- Category classification; means from zero- to nth-category.
- KE system; uses a computer-aided system.
- KE modeling; utilizes a mathematical framework to reason the appropriate ergonomic design.
- Hybrid KE; refers to KE system constructed by the forward and backward reasoning
- Virtual KE; combines KE technology with Virtual Reality.
- Collaborative kansei designing system; is a new system in which the designers apart from each other collaborate to make a new design through an intellectual internet using the kansei databases [7].

3.3 Kansei Quality

"Kansei quality" means "quality that can appeal to Kansei" or "quality that can be evaluated by Kansei." [6]. Aim of kansei quality is to attract customer's senses, feelings and emotions. For realistic approach, kansei quality always set a quantitative criteria to evaluate such a quality. In this way, designer can has a clear goal to achieve.

3.4 Kansei Engineering Examples at Automotive Industry

One of the best example of how affective Kansei methodology is "Mazda Miata" that certainly we can say "The Best Two-seat Sports Car Ever Built" and more than ten years after its first launch the Miata is the best sold sports coupe in the world (The Guinness book of records). 178 major automotive awards around the world has been given. Their aim was to make low cost sport car and their focus idea was "feel faster than it is, but it doesn't have to be fast in absolute terms". Type I Category Classification is the most suitable method for automotive. Their first step was recording drivers all manures such as opening door, driving, changing gear, adjustment of mirrors etc. by video and taking photos. Second step was analyzing

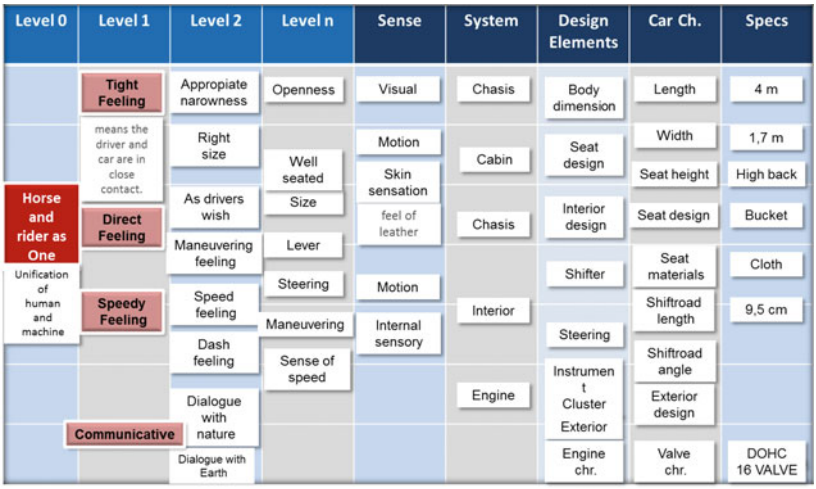

Fig. 2 Use of Kansei

them by "Creation of K cards" by examine all pictures & videos. When they got a point they noted a keyword on each small card (K-cards). Next step was creation of tree structure and groups were rearranged from the top level to concept to sublevels. Top level is defined as "One-human Machine" which implies unification of human and machine, inspired by horse and jokey as one. After that, they divided to sub levels and Nth level become the real data and technical design parameter [8] (Fig. 2).

4 Common Terminology Proposal

Literature review shows that, common terminology for automotive perceived quality is needed to grasp all customer requirements. To cover all aspects of automotive industry the author propose to create comprehensive conceptual terminology for automotive industry. At this point, Kansei is guiding methodology to create a common terminology as it helps to grasp customer feelings and convert them from subjective to objective.

Generally perceived quality can be defined as consumer's opinion of a product's (or a brand's) ability to fulfill his or her expectations, first impressions of customer when he see the product or after basically usage of product and it gives perception of customer without any measurement of real quality. As a result, perceived quality cannot always have relevance with actual quality.

4.1 Practical Implementation

As practical implementation of this study and to achieve right information an interview is done to «Fiat Turkey, customer relationship department». To grasp customer needs, results of below activities are discussed mainly in order to define the product and analyze customer satisfaction;

- Market researches (including market shares, production and sales numbers etc.),
- Content comparisons (such as interior material qualities, version differences etc.),
- Technical comparisons (Engine, transmission etc.)
- Customer expectation evaluations (Car Park Survey, NCBS etc.),
- Tear-down activities by R&D, and Quality Departments,
- International/National Auto shows,
- Dealer network feedbacks,
- Call Center & Web feedbacks,
- Competitor dealer visits

For automotive customers, «product» is not only automotive itself, showrooms, services, cost to repair, after sales are directly other aspects of perceived quality from customer point of view.

To grasp customer's Kansei, the authors have analyzed quality surveys as QT (Quality Tracking) and NCBs (New Car Buyers Survey). The NCBs, for instance, is conducted for auto manufacturers by survey agencies in each geographical market. It is arguably the most thorough ranking on the continent, measuring quality as well as general customer. NCBs is doing this survey to collect feedback from new car buyers. QT is another survey, especially for Fiat vehicles and it is done after 3 months usage with well-defined questions.

Surveys of 2012–2015 are analyzed and try to understand mainly customer requirements. In this paper, authors do not present the survey results to not to digress from our main subject. Customer feedbacks are grouped mainly to see their areas for common terminology of customer satisfaction as Fig. 3.

There are four main groups as style, dynamic performance, static performance and perceived quality. Although, style is independent from quality, customers consider the style as one of main satisfaction subject. Dynamic performance of the vehicle contains handling, dynamic control, climate, fuel economy, NVH, ride, braking, steering, drivability and performance. All these topics summarize reliability performance of the vehicle and driving satisfaction of the customer. Besides, physical roominess, storage, visibility, ingress/egress, ergonomic comfort and serviceability are sub titles of static performance. Apart from dynamic & static performance, perceived quality is key point for customer satisfaction; because other subtitles could be improved by engineering activities. On the other hand, pleasantness, visual, tactile, hearing and odor are more difficult to measure in a reliable manner, so their improvement is more difficult in an engineering approach. In fact, that's why guidance of Kansei engineering is chosen.

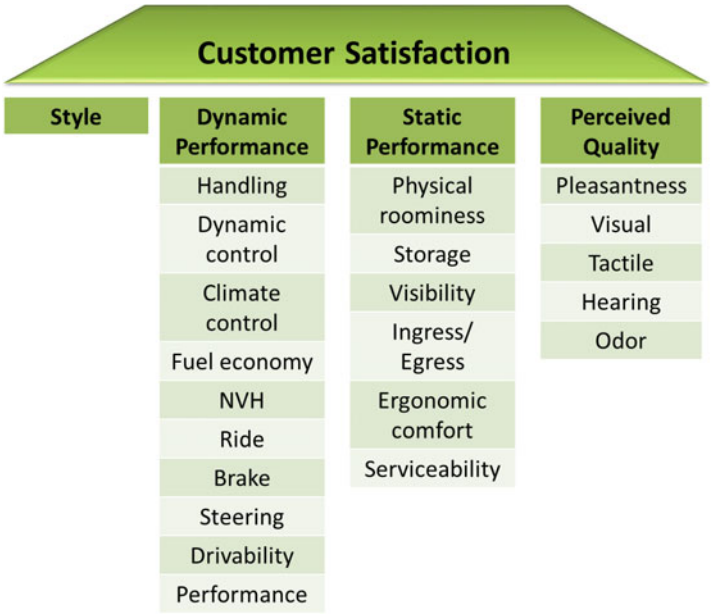

Fig. 3 This figure shows main subjects of customer satisfaction for automotive

4.2 Common Terminology Proposal

Depending on all survey analyses, the authors can say that the first touch of customer begins with «awareness» of a product by commercials. The customer goes to dealers (showroom) to see if the car fulfil his expectations. KE advices to observe/record dialogues between customers and marketing staff at the shops/showrooms. Buying decision is a complicated action depending on customers conscious and unconscious demands, customer not only evaluates the cost, specifications of the vehicle he also thinks about service quality, cost to repair and second hand opportunities. KE wants to clarify each step and understand customers' expectations deeply and it is not easy to collect them under one title. Perceptions of the customer gets more importance at this point, because there are some unconscious or unmanageable factors for customer. For analyzing deeply customer's Kansei, the authors propose to divide vehicle to five areas and sub titles are first quality perception, interior, exterior, cargo area and under hood (area motor).

To attract customers' attention, first quality perception is critical and it has subtitles as competitive design, brand value, affective commercials and showrooms. Depending on practical implementation and what customer feels, touch and sense on vehicles main areas such as interior, exterior, cargo and under hood significant subjects are defined in Fig. 4. These subtitles are proposed as main PQ&C terminology for view of customer.

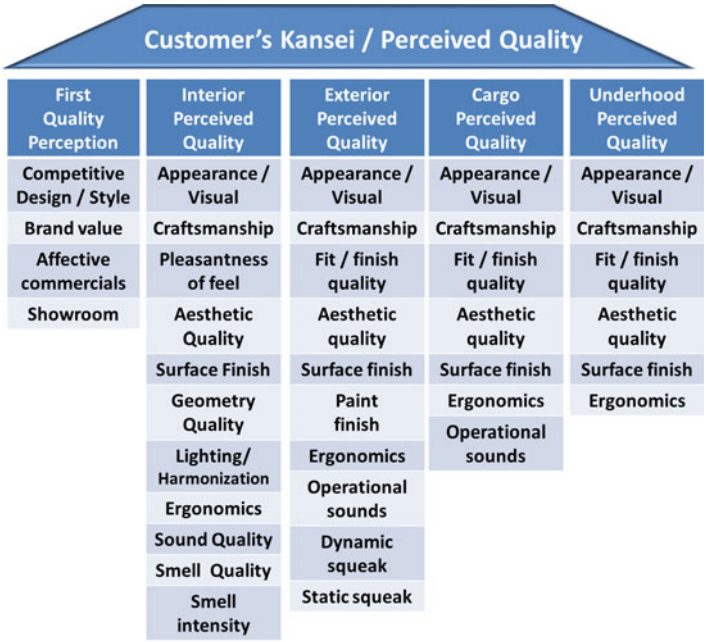

Fig. 4 This figure shows customer's Kansei and terminology for automotive

To attract customers' attention, first quality perception is critical and it has subtitles as competitive design, brand value, affective commercials and showrooms. Depending on practical implementation and what customer feels, touch and sense on vehicles main areas such as interior, exterior, cargo and under hood significant subjects are defined in Fig. 4. These subtitles are proposed as main PQ&C terminology for view of customer.

5 Conclusions

Perceived Quality is a customer's initial emotional response to the overall look and feel of a product irrespective of its functionality. Besides, not only must our products have higher levels of PQ&C, they must be brought to market in less time and for less investment than the products they replace. PQ&C is helping to ensure that the finished product is right first time and without costly delays. Kansei Engineering try to translate impressions, feelings and demands regarding established products or concepts into a new design solutions and precise technical parameters.

Kansei engineering, can provide design team with quantitative and analytical tools to correctly improve projects and to analyze the results in a reliable and efficient way. This paper presents proposal terminology for automotive world

PQ&C activities. Beside, this study should be carried to more detailed works to understand customers all senses and improve them by methods of Kansei Engineering.

Acknowledgments The authors would like to thank Tofas R&D Body and customer relationship teams, for theoretical and applied studies for this project.

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Accessing the Function of Emotion in Appreciated User Experience Design

Amic G. Ho

Abstract During recent years research in new design development (included product design, services design, etc.) has tried to understand how humans experience the artificial world. The research field which investigating human lived experiences of design is known as user experience. It focused on the interactions between people and the design that occur in a particular place and time, and how the interactions provide living qualities associated with the emotional and affective levels of a person such as pleasant, fears, joy, etc. The literature on user experience has constantly investigated new theories. However, these theories were piecemeal and they failed to provide a clear and comprehensive overview of the most influential aspects of user experience. This caused the situation that some concepts may be overlooked and relevant features may be absent from a general perspective. This study investigated how the experiences resulted from the human-design interaction, which is the foundation to explore the methods to optimise the design process and tools to support designers. The literatures of user experience were reviewed to understand the process of how user using and experiencing outstanding designs. The pragmatic characters of the design and the corresponding significant experiences in the human-design interaction were identified. Empirical studies then were adopted to find out how the experience provided by awarded designs and how the role of emotion in these experience. Based on the understanding of experience obtained from the studies above, the study then presented an evaluative research. Eight-category emotion system from psychologist studies was adopted as the measurement for users and designs to rank. This resulted the understanding on what emotions they prefer to experience and how their emotion were elicited through the designs. Thus, a design tool to support designers in the elicitation of experiences was proposed. The tools encourage create experience through emotions under the prediction of designers. This study is the preliminary study to connect existed knowledge and provide the overview of user experience. It provides a general

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understanding on the role of emotion in user experience for design research field. This study also suggested an optimised design tool for designer from the perspective of user experience.

Keywords Emotion · User experience design · Design process

1 Introduction

Some researches were conducted for investigating the methodologies to connect design outcomes with consumers. Several connections were found and actually, they are the attributes those influenced design consumption, included instrumental, aesthetic and symbolic functions [1–5]. These attributes mostly refer to the functions of design and play the main role in design from the typical industrial perspectives. Generally, designers start their design process from this functional perspective and solely concerned how these functions contribute to users. However, this general approach is limited to provide the function of the design outcomes only. It neglects the aspects like the consumer experience which also influence the user. Based on the prior research, it was found that consumers are interested by the overall experience of the design rather than functions. This direction inspires scholars to develop more knowledge of user experience and related strategies for designing desired products. In order to investigate how the design outcomes provide the desired experience. This study investigated how the experiences resulted from the human-design interaction, which is the foundation to explore the methods to optimise the design process and tools to support designers. The pervious literatures of user experience were reviewed to understand the development of human-design interaction. Following the studies of the human-design interaction in user experience, the actual role of emotion in experience was examined in the empirical study. Some users were invited to rank the emotions they prefer to experience. The research team also investigated how their emotions are elicited through the designs. Based on the result, a design tool to support designers in the elicitation of experiences were proposed and evaluated. The tool helped designer to create experience through emotions as they intended. It was expected that this study can provided a guideline tools for enhancing user experience with emotion for design research fields.

2 Development of User Experience

In order to understand the exact definition and development of user experience, theories and models from varies research fields included design, psychologies, etc. was reviewed [2, 6]. Compared to the prior studies, Desmet and Hekkert [6]'s concept on the experience provided by product would be regarded as a relatively completed comprehensive explanation for the user experience [6]. They argued that

experience provided by design outcomes is a set of effects which is elicited from the interaction between a user and a design outcome. It included aesthetic experience, the experience meaning, the feeling and the emotional experience. They also pointed out that designers have to understand the concerns of users in their interactions with the design out-come in order to understand how emotion responds to human-product interactions.

3 Emotions Involved in Interactive Experience Design

Prior studies investigated how the experiences resulted from the human-design inter-action, which is the foundation to explore the methods to optimise the design process and tools to support designers. Chapman [7] conducted a research for user experience from the product design perspective. He pointed out that user have various feeling and sensations included relatedness, status, popularity and freedom during the design consumption. These sensations, appearance, utility and usefulness influenced the user's evaluation of the design. In order words, the users' appreciation on design qualities related to their interactions with the design. The pragmatic characters of the design and the corresponding significant experiences in the human-design interaction were identified. User attitudes, such as needs, values, personality trails, motivation and expectation were the subjective and intentional elements those affected this interaction [8]. When the users consumed the design outcomes, these user attitudes interacted with the functions (i.e. aesthetic function, instrumental function, symbolic functions) of the design. Such interaction sharped the user experience. The process of how user using and experiencing out-standing designs were investigated and developed a set of perspectives, such as user-centered design, co-design and inclusive design [5, 8, 9].

4 Empirical Studies Then Were Adopted to Find Out How the Experience Provided by Awarded Designs and How the Role of Emotion in These Experience

Based on the understanding of experience obtained from the studies above, the study then presented an evaluative research. Eight-category emotion system from psychologist studies was adopted as the measurement for users and designs to rank. This resulted the understanding on what emotions they prefer to experience and how their emotion were elicited through the designs.

To explore the relationships between the participants' emotions and the samples, the participants were asked to rate the preference of the emotion they desired to experience, from 1 to 10. It was expected that the participants would describe their emotions by differentiating them on the basis of the "underlying dimensions".

Desmet [10] also adopted this method to describe emotions in his product emotion research, whereby emotions were differentiated on the basis of their manifestations, preceding appraisals and underlying dimensions [10]. As emotions are interrelated, and some emotions are more similar (e.g. anger and irritation) than others (e.g. boredom versus inspiration), they are best described and differentiated by using the underlying dimensions. The dimensions are generally labelled as "pleasantness" and "activation". The pleasantness dimension ranges from unpleasant (e.g. unhappy) to pleasant (e.g. happy). The activation dimension is defined as physiological arousal [11], and ranges from calm (e.g. content) to excited (e.g. euphoric). On the basis of these two dimensions, emotions can be classified into eight types:

- neutral excited (e.g. aroused, astonished, stimulated, surprised, active)
- pleasant excited (e.g. enthusiastic, elated, excited, euphoric, lively, peppy)
- pleasant average (e.g. happy, delighted, glad, cheerful, warmhearted, pleased)
- pleasant calm (e.g. relaxed, content, at rest, clam, serene, at ease)
- neutral calm (e.g. quiet, tranquil, still, idle, passive)
- unpleasant calm (e.g. dull, tired, drowsy, sluggish, bored, droopy)
- unpleasant average (e.g. unhappy, miserable, sad, grouchy, gloomy, blue)
- unpleasant excited (e.g. distressed, annoyed, fearful, nervous, jittery, anxious)

The concept of 'underlying dimensions' has been used in psychology and cross-disciplinary studies to differentiate emotions in various ways, such as through emotion words [12], facial expressions [13] and self-reporting [14]. The underlying dimensions help participants describe their emotions and identify their emotional responses in a more effective way. In this study, the participants were asked to describe the emotional changes they had experienced in relation to decision making and the design process according to the above categories (i.e. underlying dimensions). In all, the research findings collected in the focus group provide insights to confirm the criteria 'emotion typography/types' would include 'emotion typography/types' elicits an emotional responses from users.

5 Proposed Tool to Support Designers in the Elicitation of Experiences: Designing for Desired Emotion: Desired Emotion Guide

Desired emotion guide was proposed to support designers in the elicitation of experiences were proposed and evaluated. A sample page refers to Fig. 1. This was a tool that provided the detail description of the proposed desired emotions from the recent empirical studies. The desired emotions guide included the followings:

- The investigated expressions and reasons of this emotion
- The structure of that particular emotion under the appraisal theories
- The experiencing path in design

Fig. 1 A sample page of the design for surprised

The desired emotion guide provided a comprehensive knowledge of emotion. It helped designers to understand those emotions through the investigated knowledge from design and emotion theories. In other words, desired emotion guide was a tool to enhance the design experience through the interactions between the users and design outcomes.

6 Application of the Desired Emotion Guide to Evoke Positive Emotions

To evaluate the effectiveness of the desired emotion guide to evoke positive emotions, one design workshop was conducted as a test. Fifteen designers were invited to attend the workshop. Half of them adopted the desired emotion guide in the design process for eliciting the investigated desired emotions. Another half group of designer was the control group and they manipulated their design process as usual. In the last phrase of the workshop, one hundred users were invited to consume the design and evaluated how the design experience evoked their emotions. It was expected that the workshop organised would provide the appropriate circumstances to teach and apply the design process with emotional concerns.

6.1 Participants

Fifteen designers participated in the workshop. All of them were graduated designers with average of 3 years of working experience. They are ideal participant of this application as they have plenty design knowledge and experience on manipulating design process. It avoided the influence of the differentiate design knowledge and experience on generalisation of the result.

In the evaluation phrase, one hundred users were randomly invited from the working class and business class. 30 % of them are university graduated, 70 % of them are graduated from secondary school. This proportion of the educational background was same as the ratio of education background in Hong Kong actually.

6.2 Process

Three phases were organised in this workshop and each of them was assigned the specific activities. They are structured as follows (Table 1)

Before starting the design process, introduction on the concept of designing for emotion and desired emotion guide were provided to the group A designers. Five participants worked on one emotion among the four emotions (astonished, and

Table 1 The research phrases to examine the effectiveness of the desired emotion guide

Phases	Design tasks		Evaluated activities
	Group A • 2 teams for two different emotions, i.e. exited and relaxed; • 5 designers in each team	Group B 5 designers	
Introduction	Provide briefing section of the design tasks; Introduce the concept of designing for emotion and desired emotion guide	Provide briefing section of the design tasks	Introduction
Design	Designing with desired emotion guide	Designing with normal design process	Design
Evaluation	Presentation of design outcomes		Evaluation of the design process with the designers Evaluation of the design experience by the 100 users

relaxed) and design one webpage for a theme park to present that emotion. Group B designers just follow the design objectives to design one webpage for a theme park and manipulated their design process with their professionals.

After the design phase, participants in both two groups presented the design outcomes. After the presentation, one hundred invited users were assigned to consume the design outcomes and evaluated the design experience. They rated their experience to browse the webpages. At the same time, the two groups of designers rated their experience to design with emotion for this experience design project.

6.3 Result

In this study, the research team first found that some of the emotions are relatively easier to be perceived by the users. Designers therefore, have to understand those emotions in order to trigger users' emotional changes and experience. The desired emotion guide was developed based on the identification of the various emotions. Based on the ranking of the emotions by the users, it was found that mostly, positive emotion is more workable to elicit users' interaction with the design outcomes. This investigation enhanced the knowledge of emotion in the user experience. The high ranking emotions were investigated and developed as the desired emotion guide.

In the next phrase, the effectiveness of the desired emotion guide was examined. Fifteen designers and one hundred users were invited to participate in the study. The desired emotion guide was adopted by Group A designers as a part of design tools to contextualise their design. Group B designers adopted their own general design process and rational design tools as the control sample. The 100 users rated their design experience on the theme park webpage for different groups (Table 2). The average statistic of Group A got over $[(8.5 - 6.3)/6] = 36\ \%$ higher than the Group B. It reflected that the design adopted the desired emotion guide can enhanced users' experience of design. The research team also evaluated the desired emotion guide from designer's shoes; they asked the point of view from designers towards the designed emotion guide. The average scores of the feedback is high, $\hat{y} = 7.5$ (Table 3).

Table 2 The statistic provided by users for their experience on using the theme park webpage

Participants	Assigned emotion	The average scores provided by users for using the theme park webpage
Group A (1)	Exited	8.5
Group A (2)	Relaxed	8
Group B	N/A	6.3

Table 3 The statistic provided by designers for evaluating the desired emotion guide from various perspectives

The point of view from designers towards the designed emotion guide	The average scores provided by designers for evaluating the desired emotion guide
1. The desired emotion guide provide me the information which is useful for design	8
2. The desired emotion guide is helpful to develop a design outcome	7
3. The desired emotion guide is helpful to enhance my design skills	6
4. The desired emotion guide is easy to be understood	7
5. The desired emotion guide is helpful to provide an organised overview of those emotions	8
6. The desired emotion guide is applicable to the future projects	8

7 Conclusion

Based on the perspective of design and emotion studies, most of design is possible to elicit emotional changes of users, as emotion is one of the factors that influence human's decision-making, judgement and action taking. Therefore, designer scholars investigated methods of evoking the users' emotions by providing a design outcomes in the recently decades. It was found that the knowledge of emotion would help designer to understand the users' emotional changes. As a result, the desired emotion guide can inform designer about the emotional experience and suggest the implement ideas in the design process. This study was the preliminary study to connect existed knowledge and provide the overview of user experience. It provided a general understanding on the role of emotion in user experience for design research field. This study also suggested an optimised design process and tools for designer from the perspective of user experience.

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Affective and Pleasurable Values that Ergonomics Provides to the Product Design Inspired and Produced from Natural Amazon Resources

Susana Paixão-Barradas, Karla Mazarelo and Mirella de Sousa

Abstract For centuries, people have created and refined products. Nowadays the consumers are looking for emotional benefits rather than utilitarian performance. The challenge today is to switch from material product dimensions to a holistic view of consumer experience. The design products inspired by natural elements and produced by raw natural materials may contribute to this satisfaction. Through ergonomic inputs about the human factors on multisensory perception of a product, we conducted a study to identify the affective and pleasure values, and to estimate their pertinence, in a product conception inspired and produced with natural Amazon resources. A quantitative technique, based on a questionnaire during a product exhibition, was employed. People appreciate the use of natural raw materials in the creation of new products, preferring mainly to natural product finishes preferring mainly to natural product finishes, its unique character, the textures and the historical and cultural values. The implications and limitations of the approach are discussed and further research steps indicated.

Keywords Product design · Natural resources · Effective and pleasurable values

1 Introduction

For centuries, people have created and refined products. A common understanding of Gestalt laws or color harmonies has developed within and beyond cultural boarders. Designers have long been occupied with form-giving of material products,

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asked to work on form, color and semantic; while engineers dealt with functions, components and performance [1]; and the ergonomists were occupied with the comfort, the safety and the adaptability of the product. Nowadays the consumption experience as a phenomenon is directed to-ward the pursuit of fantasies, feelings and fun [2]; consumers are looking for emotional benefits rather than utilitarian performance [3]. The challenge for products developers is to switch their focus from material product dimensions to a holistic view of consumer experience [4].

We believe that the design products inspired by natural elements and produced by raw natural materials as an Amazonia may contribute to this satisfaction. Through ergonomic inputs about the human factors on multisensory perception of a product, we conducted a study to identify the affective and pleasure values, and to estimate their pertinence, in a product conception inspired and produced with natural Amazon resources.

Through a brief introduction about the importance of the design values that come from the raw natural resources in use for create empathy, affectivity and pleasure; this article proposes, through a questionnaire about the exhibition of 13 products inspired and produced in Amazonas, answer to these two questions:

- *What are the design values that people most appreciate in our products?*
- *What are the values of the design most appreciated by the people who highlighted ergonomics in our products?*

2 The Context

Design research literature refers to pleasure as a product benefit that exceeds just proper functioning; pleasure is an emotional benefit that supplements product functionality [5]. All human interactions involve emotions, including interaction with our material world; and for the designers it is important to design products that 'fit' the emotions of the users [6].

The perception involves two closely related mechanisms: cognition and affect. Cognition enables the human to understand his environment, affect allows him to judge what he perceives [7]; cognition is the analytical, rational part of information treatment, affect is intuitive and experiential [8]. And we know that an interaction impacts on the affective experience Human-Objects [9].

We can design objects for the desired cognitive and affective response; to understand cognitive and affective mechanisms of human perception is important the User Experience. This experience results from the interplay of a wide range of concrete (form, color, semantic, function) and abstract (affective and sensorial quality, semantic quality, aesthetic quality) product dimensions; and, through

analysis of relations between concrete and abstract dimensions, indicated by the participants that classical product design characteristics like form, color, material and style were often linked among each other; however, links with emotions and sensations were very few [10].

The humans experience emotional episodes induced by an object but also independently of any stimulus [11]. Krugman's [12] early definition of involvement emphasized the tendency to make personal connections between one's own life and the stimulus, explicitly excluding components such as attention, interest, or excitement.

Some research, started in the 1980s, related and evaluated internal patients' welfare with creating and designing spaces in residential and hospital treatment. It was shown that when these spaces were attached to nature through images, materials, textures, sounds, lights, ornaments, etc., calm appeared in a patient's condition, leading to decreased blood pressure and reduced medication load [13–16]. Moreover, current consumer-related market trends analyzed by research centers (within the habitat area) have reflected consumer need to establish contact and closeness with nature [17].

Product design inspired and produced from Natural Amazonian Resources will justify a different project, focused on specific products oriented towards the user's needs and desires regarding the human perception and knowing the characteristics of the raw materials that are local and unique.

2.1 Natural Amazon Resources

In this context, the aim is to give special attention to the Natural Fiber and Woods from the Brazilian Amazon, especially those used for craft work, because they have a variety of native species and be employed by the popular knowledge, suggesting the possibility of its transformation and integration with other raw material widely studied and well positioned in the market, also of natural origin—*Pedra Mármore Branco de Portugal com veios*-, for product development, with sociocultural, technological and eco-sustainable expression, contributing to the improvement of producing communities, the market and its potential consumers across borders.

Natural fibers and woods from Amazons, have been the focus of many researchers in recent years in search for new materials that present themselves as a unique opportunity to find alternative and innovative solutions. This means moving toward success, winning dominant and promising positions [18]. The interest for these types of raw materials is a function of being less abrasive to processing equipment when compared with other features—they are renewable, biodegradable

and recyclable, allowing them to compete with other fossil fuels and industrial materials [19].

Fiber: Tucumã-i. The fiber used comes from *tucum* originated by *Astrocaryum* genre of *acaule* species, known as *tucumã-i*, which is a palm-class located in the *Alto do Rio Negro* region (Amazonas state) where it is produced, grown and handled sustainable and handcrafted by indigenous and mestizo communities [20], being singled as a major supplier of natural fibers for these activities [21].

This species has a predominantly underground stem upland or lowland, measuring between 6–15 m high, having large foliage and coloring in dark green. According to Miranda et al. [22] their economic capabilities are centered on the leaves, with the extraction of high-strength fibers. Its production method seeks to comply with the rules of the World Commission on the environment, created by the UN, trying to make her a natural resource capable of generating employment and better living conditions for their producing communities [23]. Moreover, the fiber excels in its region for its resistance, absence of toxic components, possibility of textile applications and the ability to generate a wide variety of products [24]. About its commercialization, this is done through the purchase and sale of fiber in your state in nature, or already turned into handmade product, the main markets to Amazonas state capital (Manaus), some Brazilian states and some countries of America North, South America and Europe [25].

Wood: Cedrinho, Maçaranduba e Itauba. The woods from rainforests are commonly appreciated for their quality and exotic colors present in most species, besides the fact that there are plenty of possibilities to do a significant quantity of products from your trees [26].

The *Scleronema micranthum* species, commonly referred as "*Cedrinho*" [27], is classified as heavy wood, and is depicted with little resistance to fungi and termites, has density of 0.75 g/m^3 and is suitable for construction, interior carpentry, roof structures, and other products. Its color is among the most appreciated shade of tropical wood, with brown colored sapwood/brown and reddish brown heartwood.

The second selected species, "*Maçaranduba*" presents the core of dark brown-red color, and excellent machining qualities. Endowed with the scientific name of *Manilkara huberi*, this wood is very coveted by the ease of working, as well as get a good finish, is durable and resistant (density 1,10 g/m^3). Silva [27] also lists numerous possibilities for the use of this species, which ranges from more rustic objects such as poles and beams, to more sophisticated objects such as musical instruments.

The third species selected for the products of this research is scientifically termed as *Mezilaurus Itauba* with yellow-olive to brown heartwood dark wood, this species gets a good finish and can be considered a heavy wood (0.85 g/m^3), aimed mainly shipbuilding and construction.

Fig. 1 Production of some pieces with marble (on CEVALOR—Portugal), Tucumã and wood (at UFAM, in Manaus—Brazil). Source(s): From project archives

2.2 Product Design

The greater impact of product design research it's on the initial stages of the creative process [28] in this case, focusing on how to achieve the requirements of the user perception and emotions transmitted by the uniqueness of the raw materials.

The developed products were the result of a cultural exchange between two universities—*Universidade Federal do Amazonias* (UFAM, Manaus—Brazil) and *Universitat Politécnica de Valencia* (UPV, Valencia—Spain) and a technological transfer between two centers—*Instituto Nacional de Pesquisa do Amazonas* (INPA, Manaus—Brazil) and the *Centro Tecnológico da Pedra Portuguesa* (CEVALOR, Borba—Portugal)—involving two European countries and Brazil [29].

The idealization of the proposals was carried out by the students of UPV and UFAM, taking as inspiration the Amazonian Fauna and Flora [30]. The prototypes were produced firstly in Portugal, CEVALOR, all pieces of marble; and after in Manaus, at UFAM and INPA, all the pieces of fiber and wood—pictures above, Fig. 1. All products have been handled by the students, and the final results were 13 products that combine different materials—next figure show some of these products, Fig. 2.

Fig. 2 Some of the products. Source(s): From project archives

3 Method

Participants. In total 185 individuals participated in the study, interviewed in Brazil (57 %) and in Spain (43 %). They were majority women (62 %), students (85 %), between 17 and 30 years old (85 %).

Stimuli. The interviews were conducted during the presentation of prototypes made in design schools of each of the universities integrated on the project: UFAM

in October and the UPV in November 2015; and only the students, teachers and technicians of each design school are invited to participate.

Design. To measure the variables of the study we create a questionnaire demanding some aspects about the materials, focus on the design aspects. Two types of questions were used, closed-ended and Likert-scale questions (from 1 meaning 'not important' to 4 'very important').

Procedure. All interviews followed a similar procedure. Firstly, the researcher, or a student instructed, comes into contact with the visitor to explain him the objectives of the project and obtain his consent to do the interview; after this, the researcher makes a guided tour with the interviewee, to present to him the products, talking about the materials, the finishes and doing some description about the processes of prototypes production; finally, the data are registered in a form on paper, with a pen. Data analysis was carried out after the exhibitions, using as a support the SPSS software to do frequency analysis and average reckoning.

4 Results

The results show that the users appreciate 'a lot' the majority of Design Values linked to characteristics of the materials questioned, consult (Fig. 3).

The Design Values more appreciate as 'a lof' was the Finishes, the Uniqueness, the Texture, the Resistance, and the Friendly aspect; however, the aspect Impermeability was the least appreciated.

When we asked to identify the most outstanding Design Attributes in the products exhibited, the big majority signalized the Formal Attributes, as you can see on Fig. 4.

Of the 185 people interviewed, only 10 respondents (5 %) classifies the Ergonomy as the Design Attributes most prominent in our products. In this study, we identify this little group of people and highlight the Design Values that they most appreciate on these products.

Group ID. They are all young students, eight of them are between 17 to 20 years old and two are between 21 to 30 years old. The half part of this group are women and the another part are men; and, seven of them was interviewed in Spain and three in Brazil.

Design Values. As we can see on the next figure (Fig. 5), the Design Values that this group of people appreciate as 'a lot' in this products are substantially the same, that the global of the sample.

These values include the Uniqueness, the Friendly and the Finishes of the product, and, as well as the global sample, the Impermeability as the value fewer appreciated.

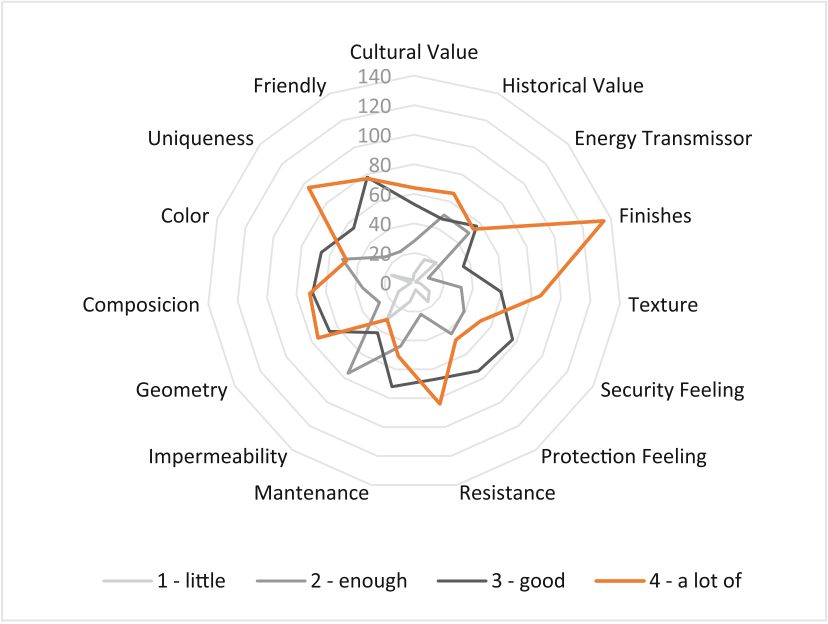

Fig. 3 Design values. Source(s): Created by the authors

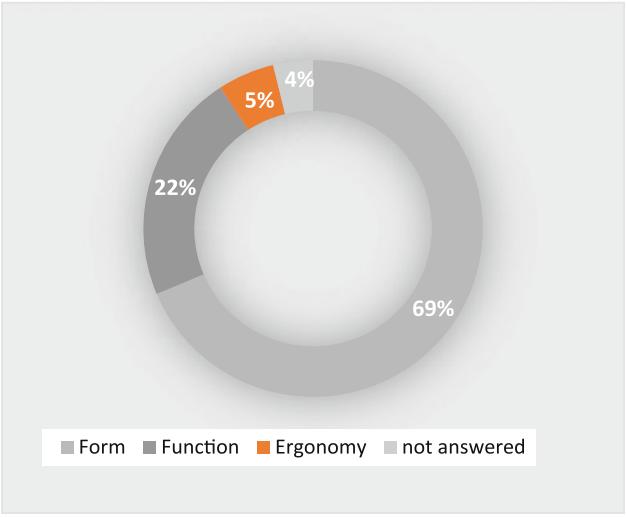

Fig. 4 Design attributes. Source(s): Created by the authors

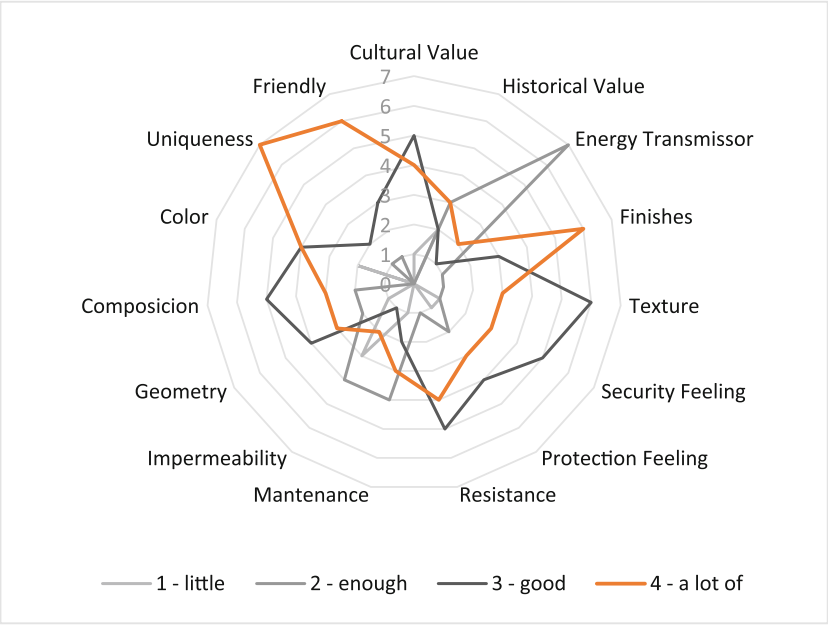

Fig. 5 Design attributes. Source(s): Created by the authors

5 Conclusions

The presented study broadened the affective and pleasurable values that ergonomics provides to the product design inspired and produced from natural Amazon resources, through analysis of a wide range of concrete (texture, color, resistance, geometry) and abstract (friendly, protection and security feelings, cultural and historical values) product dimensions. We introduced the prototypes to the participants and then we assigned the task to evaluate the Design Values linked to the characteristics of the material most appreciated on the products exposed. Various concrete dimensions, associated to the functionality of the product, among them Finishes, Texture and Resistance appeared as the most appreciate Design Values. Nevertheless, the participants appreciate also the some abstract dimensions closer to the affective mechanisms of human perception, like the Friendly and Uniqueness aspects.

The association of abstract values with the ergonomics of a product are not obvious to the majority of participants, although appreciated, Ergonomics is highlighted only for a minority of contestants. This minority are coherent, and appreciate above all the abstract dimensions of the product.

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Method to Handle Haptics Optimization of Products Based on Simulation Models

Peter Gust and Frank Mersch

Abstract The perceived quality of a product is—in case of a large number of product alternatives—a key purchasing criterion. The designers challenge is to create (often very complex) products that can be perceived by the customer as high quality. The objective of the work is the creation of a method, which allows the designer to detect influencing factors and enables them to analyze the haptical characteristics of a product, already in the early design stage. Based on the CAD model, this method allows it to create the haptics of a product by defined design targets, or to perform improvements on existing products. The result of this optimization is a design model with a defined parameter setup, containing the desired haptical characteristics and ready to be used for the further embodiment-process.

Keywords Haptics optimization · Perceived quality · Product development · Man-machine interaction · Simulation

1 Introduction

The general field of this work is about the human machine interaction. The focus is on the quality of products, as it is perceived by customers and users. With an increasing number of product alternatives, the perceived quality of a product becomes a crucial factor influencing the purchase decision [1, 2]. Studies demonstrate, for example, that a high perceived quality is one of the most important factors influencing the return on investment (ROI) [3].

The customer builds his quality judgment based on an emotional comparison process. In this process the user compares his conscious and unconscious sensory

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impressions with his expectations and experiences, while he is in interaction with the product [4]. These sensory impressions are caused by so-called quality cues resp. quality descriptors, consisting of one or more parameters [5].

According to the state of research, hierarchy models are developed and applied for a systematic analysis of the perceived quality, based on the system structure of a product [2, 5]. In his gradual model of quality perception, Falk et al. describes the abstraction of the overall product, through the individual components, their properties (descriptors) to the technical parameters, which can be described by physical quantities [5]. On these foundations it was possible to detect (with the use of empirical studies and metrological analysis) a significant correlation between the perceived quality of a product and quality cues resp. individual parameters [6–8]. Due to these correlation studies it is possible to derive specific recommendations for the product development. Especially in the field of haptical perception of control elements, there is a strong correlation between the perceived quality and the force—displacement—curve (quality cue). This curve characterizes the haptical behavior of the control element. Excerpts from this research studies are shown in Fig. 1.

Similar approaches were chosen by Dylla and Davis et al. Besides metrological experimental setups, they are using multi-body simulation (MBS) to analyze and optimize the shift comfort and the shift quality of car transmissions [8, 9]. With the use of MBS it is possible to produce knowledge for the haptical characteristic of the final product, already in the early design process. However, there is still no basic method that describes the use of simulation technology to analyze and optimize the haptical behavior of random products. In addition, it should be possible to use other

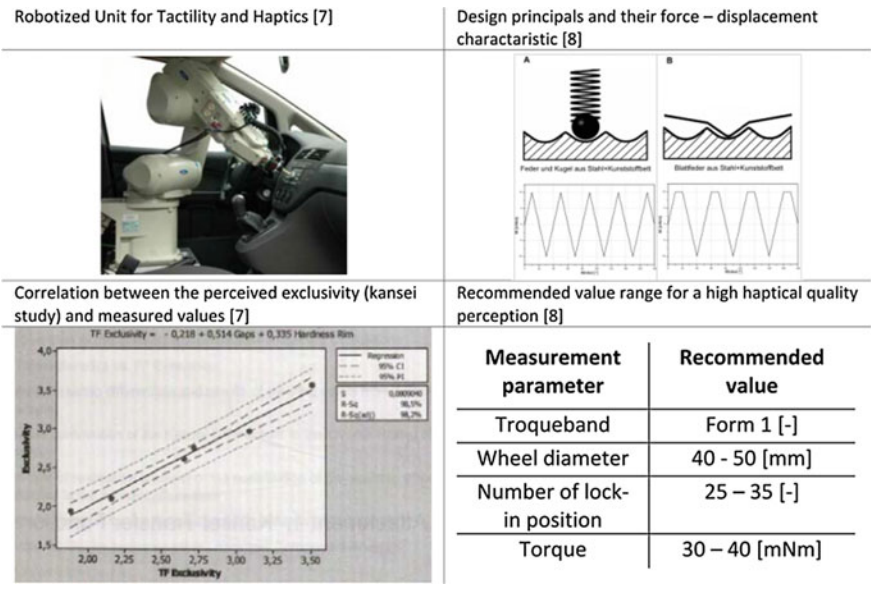

Fig. 1 Recent studies for the identification of attributes influencing the haptical perceived quality

simulation techniques. Thus, the central objective of this work is to deliver a contribution to the increase of perceived quality by the strategic use of simulation technology.

2 Method

The hereinafter presented method serves as a guideline for the analysis and optimization of the haptical behavior of various products (e.g. tools, electrical appliances, etc.). In order to ensure universal applicability, the method is divided into three basic parts, which are based on the current state of art (Fig. 2). The method is designed so that all steps for modeling by Davis et al. [10] are considered. Further, possible connecting factors for methods and processes of product development are worked out. In this way, the practical applicability is especially being ensured. The method starts at the stage of concept formation with the question of how the product concept behaves in the interaction with the customer, and which design characteristics (technical parameters) must be chosen by the designer, so that the customer perceives this behavior as a superior quality.

2.1 Product Handling Setting

The first process step (Fig. 3) is used to create the product handling setting. Objectives are the definition of the point of a component, on which the customer is interacting with the product (P_i), and the force vector (F_v), resulting from the interaction between human and this component of the product. For the analysis and definition of P_i, it is necessary to access the data of the product concept. These are, in terms of product development by Pahl Beitz, the requirement list, the functional structure, the system structure and—if applicable—the process structure [11]. Possible *Pi* are e.g. gripping elements, actuator elements or control-elements. According to their relevance for the customer, the identified P_i should be prioritized. These information e.g. can be obtained from requirement-list, user observation, eye tracking or quality function deployment. Hereby the focus is directed to the main contact points.

From the assessment of ergonomics (for example, the type of hand position and type of coupling), the force vectors are derived. To avoid false estimations during

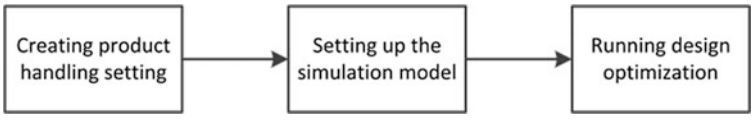

Fig. 2 The three basic parts of the method

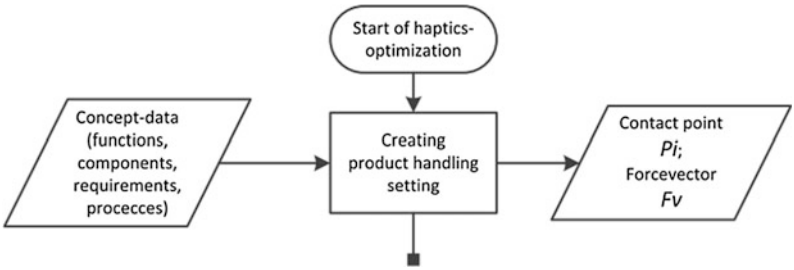

Fig. 3 Creating the product handling setting

the definition of the force vector, a hierarchical analysis method, referring to Bullinger, is used. In the first step the control task has to be described. In the second step posture, movement-abilities of the hand-arm system and the motion-attribution of the operating unit, in relation to the hand-arm system, are analyzed. Step three defines the type of gripping and handling, so that in the fourth step the analysis of power transmission, by the type of coupling, can take place [12].

Especially at the point of sale (POS) customers are comparing products e.g. by rattling to obtain conclusions about the products quality [13]. For that reason it is advisable to check all possible degrees of freedom of the previously defined type of coupling, by the simulation. Finally, the force vector/the force vectors, in accordance to the relevant percentile, can be defined by a minimum-, par-, maximum-force or a force function.

2.2 Simulation Model

At the beginning of this process step, the suitable simulation model (in dependence of the previously defined type of force transmission), the function of the selected component and the quality cue to be analyzed, must be selected (Fig. 4). Table 1

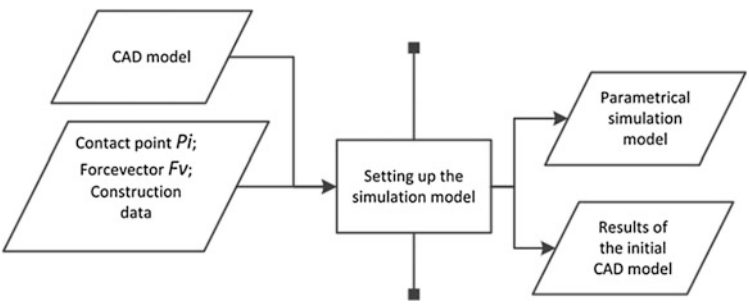

Fig. 4 Setting up the simulation model

Table 1 CAE techniques and their investigatable quality cues, referring to [18]

CAE technique	Investigatable quality cue	Design variables	Mode of perception
MBS	Force-distance-behavior, force-time behavior	Topology, material property, vibration, tolerances	Haptic visual
FEM	Tension, deformation, thermal conduction	Topology, material property, vibration	Haptic
NVH	Sound pressure, noise emission, force-distance behavior (vibration)	Topology, material property, vibrations	Haptic acoustic

gives an overview of common computer aided engineering (CAE) techniques and associated ascertainable, potential descriptors resp. quality cues.

According to the—in the first process step determined—contact points and the force vectors, components must be intended, which have an impact on the haptical characteristic. Here for, it is helpful to consider the flux of force, using the system structure. If necessary, additional components (not belonging to the actual product) have to be mapped in the simulation model, in cause of their impact on the process of perception. For that reason all physical relationships of the entire system should always be analyzed. After the selection of the relevant components the respective CAD data is transferred and described in the corresponding CAE system. Further input for the development of the simulation model is a list of design data (e.g. material characteristics, spring stiffness or damping constants). To use the model not only to analyze the haptics, but also to optimize it, individual parameters of the model are created as variables (e.g. length dimensions, location dimensions, Young's modulus). After the creation of the product model, the human-machine interface is generated. For this purpose the human body part, which acts on the contact point, has to be added to the simulation model (as an additional component) and linked to the associated force vector. Thereby the degree of model discretization, according to the analyzed type of coupling, has to be chosen. Finally the calculation is ready to be started. Outputs are thus a parameterized simulation model as well as a first analysis of the quality cue for the haptics of the product.

2.3 Design Optimization

As a part of this process step (Fig. 5) optimization objectives (e.g. threshold values, functions etc.) are defined and variables determined, which can be changed in the design process. The objectives of the optimization have to be chosen based on realized customer- or expert assessments, Kansei Engineering, etcetera. This ensures that the design parameters are optimized in so far as the quality cues are in

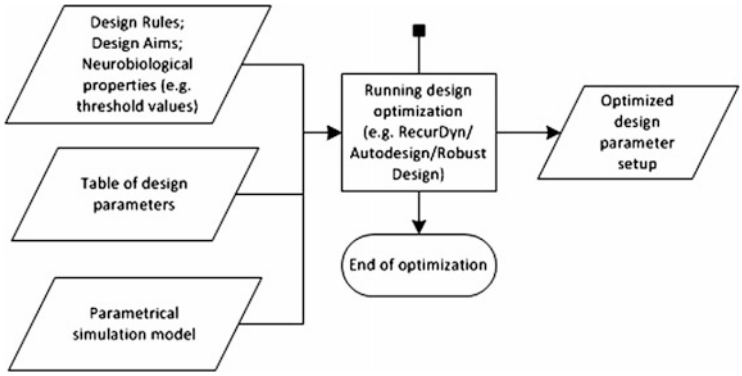

Fig. 5 Running design optimization

accordance to the customer expectations. Other objectives may be defined by human perception threshold as described for example by Eigner and Roubanov [14].

The design parameters have to be chosen in accordance to the undefined resp. unrestricted design parameters of the design process. Options for that are, inter alia, the type and number of bearing points, the typology of the components or the material. This simultaneously supports decision making in product development, as thus the optimum product solution is determined in regard to the haptics of the product. Further it is determined by the sensitivity analysis (the basis of the design optimization), which parameters have the greatest impact on the haptics of the product and which are less influential.

Depending on the type and the subsequent use of the product being optimized, the design optimization should be replaced by a robustness analysis. Herewith, production related changes of design variables are also taken into account.

The process ends with the optimized design parameter setup, which can be introduced as a specific guidance for engineering and design, in the further product development.

3 Application

The applicability of the method is to be tested by the example of a walker.

The market for walkers is heavily occupied with 500 000 sold walkers annually and various competitors [15]. To be successful in this market, the concept of the walker includes new functionalities. Moreover, the design shall be created in a kind of way, so that the customer perceives the haptics as high quality. Figure 6 shows individual excerpts from the application of the method.

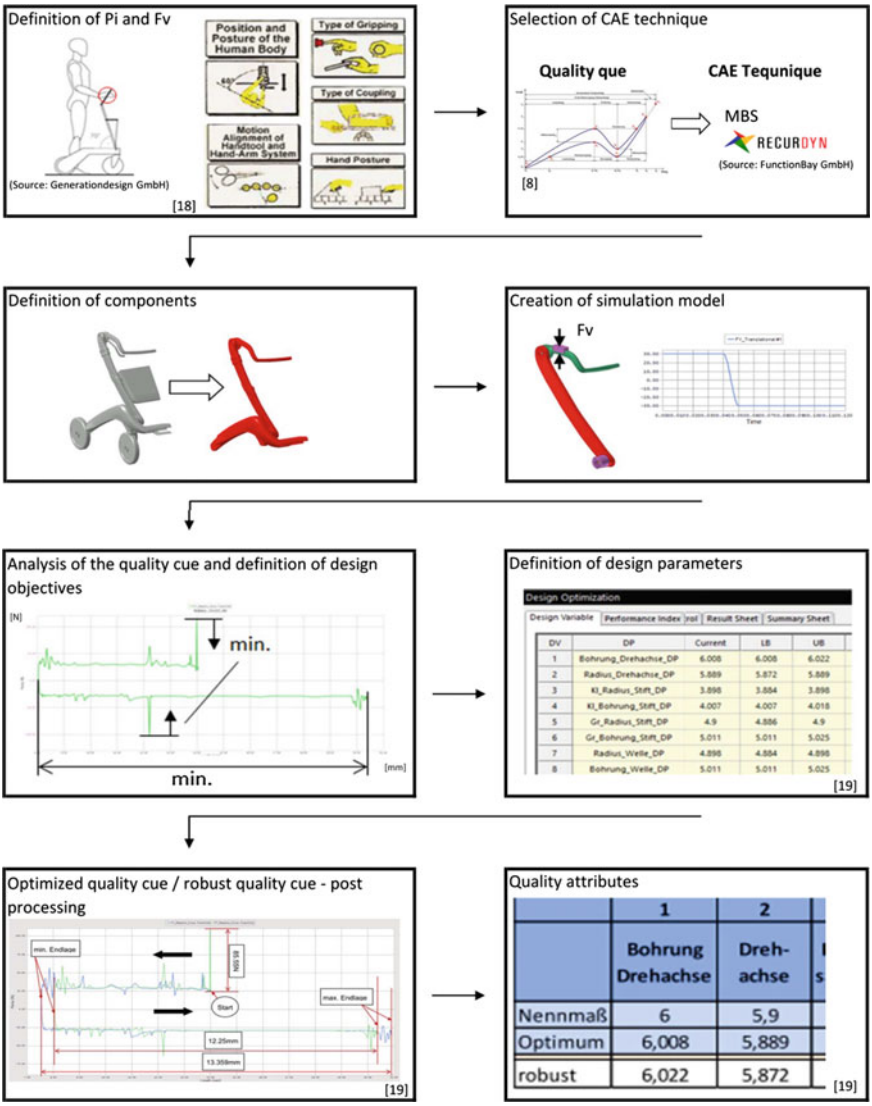

Fig. 6 The application of the method for the optimization of a walker

3.1 Product Handling Setting

The main function of a walker is to enable the user to support oneself when walking or standing. This function is realized through the handle of the walker. So the handle is defined as the contact point. By ergonomics analysis a clasp of hand is identified as the type of connection. Furthermore it is observed by user case analyzes, that customers

rattle at the handle to achieve conclusions about the stability of the product. The force which the customer—in this case—is introducing into the product is determined to +30 N resp. −30 N according to [16, 17]. In this process the customer will perceive, due design or production-related influences (elasticity, type of bearing, clearance, tolerances, etc.), a displacement (distance) and a reaction force in cause of his applied force. On that base the customer is drawing conclusions about the products quality.

3.2 Simulation Model

To analyze this type of quality cue a MBS has to be selected. The selection of the relevant components is carried out—according to the system structure—along the force flux. To set up the simulation model the CAD data of the walker has to be imported, linked (with the current constraints) and parameterized.

The defined force vector is also introduced into the simulation model and is getting linked with the interaction interface. The result of the simulation shows the force-displacement curve as the basis for the targeted optimization.

3.3 Design Optimization

In absence of accurate studies of this optimization case, which could provide specific guidelines for the definition of objectives, the optimization objective is set at the lowest possible reaction force associated with the lowest possible displacement (in coordination with the product designer). As design parameters only the fits of the bearings are being used.

The results of the optimization are showing a significant reduction of the reaction force to 53 % with an increase in total displacement of approximately 9 %, compared to the initial setup. The result of the robustness optimization[1] is a reduction of the reaction force to about 50 % with an increase in total displacement of approximately 25 % compared to the initial setup. In addition to the graphical output of the optimized quality cue, its relating attributes of the design parameter are also given out and can be implemented to further design process of the product.

4 Conclusions and Discussion

Based on the discussed prior research, the need for a method was worked out, which enables the use of simulation technique for analysis, optimization and robust design of the product haptic. Requirements for the method are i.a. to ensure the

[1]A standard deviation of 0.01 mm and a sigma level of 1σ are assumed.

connection to the design process and the implementation of collected findings about the aspired haptical characteristics of a product.

Special advantages—offered by the simulation technology—are the time savings (compared to prototype testing) and the comfortable implementation of the design of experiments (DOE)—schemes. These schemes are enabling the identification of factors, influencing quality cues and to weight them (according to the influence degree on the optimization objective). Thereby it is possible, for example, to reduce the subjective influences in the determination process of the quality perception quotient by Steinberg [2].

The application example of the walker demonstrates the capabilities of the method. With the use of modern simulation technology it is possible to consider and analyze a wide array of factors in a mathematical model. The interface between simulation and design resp. the product concept is realized by CAD software, so that even complex assemblies can be analyzed in a short period of time. The fact that the walker has only been analyzed regarding the optimum determination of his fits, shows the high sensitivity of the quality cue of a complex product. So especially the haptical characteristic of series products should be designed robust, to reduce these tolerance-induced effects.

In order to force research in the field of perceived quality, the University of Wuppertal is working on a procedure—in addition to the proposed method—whereby perceptual relevant knowledge (e.g. technical parameters, quality cues, optimization objectives and design rules) will be provided for the development of new products, in an efficient and applicable way.

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Gamification of Production? A Study on the Acceptance of Gamified Work Processes in the Automotive Industry

Oliver Korn, Peter Muschick and Albrecht Schmidt

Abstract In this work, we investigate how gamification can be integrated into work processes in the automotive industry. The contribution contains five parts: (1) An introduction showing how gamification has become increasingly common, especially in education, health and the service industry. (2) An analysis on the state of the art of gamified applications, discussing several best practices. (3) An analysis of the special requirements for gamification in production, regarding both external norms and the mindset of workers in this domain. (4) An overview of first approaches towards a gamification of production, focusing on solutions for impaired workers in sheltered work organizations. (5) A study with a focus group of instructors at two large car manufacturers. Based on the presentation of three potential designs for the gamification of production, the study investigates the general acceptance of gamification in modern production and determines which design is best suited for future implementations.

Keywords Gamification · Assistive technology · Computer-Assisted instruction · Augmented reality · Human machine interaction

1 Introduction

Gamification refers to the use of "video game elements to improve user experience and user engagement in non-game services and applications" [1]. However, the pervasion of different domains by gamification differs strongly. As explained in a recent meta-analysis on the success of gamification based on the Gartner hype cycle

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diagrams [2], this method may be well on its way to what Gartner calls the "plateau of productivity" in the area of education and health. However, at the same time in the production domain, gamification is still at an early stage of the "slope of enlightenment". Why are there differences in the application of this method? Are they due to domain-specific requirements or rather due to domain-specific traditions and mindsets, i.e. various degrees of affinity towards playful approaches and innovation in general? We will address these questions in the following sections.

Firstly, we take a quick look back at the history of gamification. We should acknowledge that this method originates from education. In pedagogy, play has always been an important means to motivate children to learn. In the nineties, when researchers and practitioners coined terms like "edutainment" or "serious games", most of the corresponding applications were designed and developed for the educational domain. More recently, the term "applied games" is used increasingly for games addressing real-world problems outside of the educational domain. However, currently the most widely used term to describe this method is "gamification".

Given this history, it is not surprising that the first gamification solutions described in research originated from education. The next area where gamification was used productively was health. Clearly, learning and health share common challenges: for example, a certain amount of repetition when it comes to "exercises" is essential. Gamification can well be able to overcome or at least reduce the boredom and lack of motivation when doing such repetitive processes. This might be the anchor point for the success of gamification in the service industry. Especially in low-skilled areas like call-centers, work is essentially repetitive, too—so gamification can help to reduce boredom and increase motivation and focus. We will describe best practices from these established domains in Sect. 2.

However, repetitive processes also are a familiar problem in manufacturing. In spite of increasing levels of automation, especially the production of small lot sizes (i.e. a relatively low number of parts to be produced, which may well mean several hundreds or even thousands) cannot be economically automatized as setting up an automated solution is far more expensive than "classic" manual production [3]. In fact this area even grows, as the individualization of products results in smaller lot sizes [4]. Therefore, clearly a great potential for applying gamification in production exists. In Chaps. 3, 4 and 5 we will describe the special requirements in this domain (which may have previously prevented the use of gamification), discuss first design approaches to gamify production and finally present a study with instructors at car manufacturers to learn more about the acceptance of potential solutions.

2 Gamification Best Practices

Since gamification is still most common in the domain of education, it is not hard to find examples. A good general overview on educational games is provided in [5]. Also the use of gamification in the educational domain is already well researched: a

Fig. 1 A screenshot from the company simulation "learn2work"—one of the first serious games, first published in 2004. It provides a bird's-eye view on a small production company. Copyright granted by KORION GmbH

meta-analysis on the effectiveness of game-based learning [6] provides strong empirical evidence for their usefulness: 29 out of 40 selected studies showed positive results, seven showed neutral results and only two showed negative results.

Two books described and shaped this successful development: Firstly *Serious Games: Games That Educate, Train, and Inform* 2005 by Michael and Chen [7], secondly *Digital Game-based Learning* 2007 by Prensky [8]. Both books made a huge impact in the learning community and set the field for the success of serious games or "gamified learning applications".

An early but still relatively complex example of a serious game is the company simulation *learn2work* [9]. This interactive simulation was developed from 2004 to 2007 in a cooperation between the Fraunhofer Institute for Industrial Engineering (IAO) and its spin-off KORION GmbH. It provides an interactive environment where learners become the manager of a small industrial company (Fig. 1). This simulation is used as a hands-on tool in the professional education at companies like Stihl or Siemens and at some business schools and universities.

As lined out in the introduction, the step from the education domain to the health domain was small and natural. In both cases, repetitive and thus potentially boring processes are required to succeed.

One of the first examples of a "serious game for health" was *Re-Mission* developed 2007 by HopeLab. It is essentially a simple shooter game—but the users were children with cancer and the game boosted their imagination of actively fighting against tumor cells. An advantage of this game was its instant scientific evaluation. The result that playing the game led to a significantly higher reliability in the children's medicine intake [10] fueled the success of this new domain.

Health-related serious games gained even more momentum with the 2007 release of the Nintendo Wii and the 2010 release of the Microsoft Kinect. Their sensors can track 3D movements and use them for natural interaction. This allowed the gamification of typical rehabilitation exercises, as they are common for illnesses or accidents with movement impairments like strokes or Parkinson. Accordingly,

such physically oriented serious games are also called “exergames”, combining the words exercise and game. Unsurprisingly, an analysis of efficacy between traditional and video game based balance programs showed positive evidence for the latter [11]. Well-documented examples are the game *VI-Bowling* which helps visually impaired users to increase their throwing skills [12] and *motivotion60* + which combines several gamified balance and strength exercises preventing senior citizens from falls [13].

The next step of gamification was to spread to the business domain. However, depending on how broadly the concept is understood, it has been a part of business processes for decades: the frequent flyer program (created in 1972 by Western Direct Marketing for United Airlines) already awarded members with special bonuses; in 1979 mileage tracking was added to give “rewards” to passengers. This example illustrates how ubiquitous gamification mechanics have been even before the term was coined. Still its systematic computer-based integration into the business world took its time. In 2009, when serious games reached the peak in interest, a small book already described what “ingredients” would help to gamify work in order to increase engagement [14]. It maps existing game elements like avatars, leaderboards, leveling and reputation to general business processes. However, most applications concentrate on only a few of these game design elements: as a 2013 blog post on gamification puts it, “employers use gamification to incentivize employees by establishing clear goals and rewarding those employees that achieve those goals” [15].

This method is especially useful if the goals are more abstract than in the industrial domain. Thus a typical example comes from the service domain: gamification has been used in call centers to help agents and supervisors managing their performance [16]. This performance is typically measured through key performance indicators like the average handle time, which represents the average time an agent spends on a call with a customer. As each call center has to keep this value within a certain threshold—agents are in turn expected to manage their calls accordingly. The *Agentville* widget visualizes this in near real-time information for both agents and supervisors.

Another example is *Freshdesk*, a helpdesk software for customer support centers that aims to improve both employee productivity and customer satisfaction [17]. The solution involves transforming customer inquiries (e.g. telephone questions or comments posted on Twitter and Facebook) into virtual tickets, which are randomly assigned to players (i.e. customer service employees). In this way, the application inspires a real-time, competitive environment via which players potentially compete to improve their performance.

In spite of their playful features, both systems easily allow to detect underperforming agents. This illustrates the potential for ethical dilemmas when using gamification in work environments: in opposition to the domains education and health, it can be used against the users’ interests. This is important to keep in mind when looking at the special requirements in the production domain in the following chapter.

3 Special Requirements in the Production Domain

When we think about work, most of us envision the knowledge worker—a person focusing on processing information or knowledge, usually with some form of digital support. However, in a production environment the focus of a worker's interaction is not the interface of a software but the current work component. While human machine interaction plays an important role when steering advanced machines by computerized numerical control (CNC), many production processes are much less digitalized, especially when working with small lot sizes (see Introduction). According to the authoritative guideline VDI 2860 Technology for Assembly and Handling [18], the central work activities in production are joining, handling, fitting, controlling and auxiliary functions like labeling. Interacting with computers systems is not yet one of them, although it might be considered an auxiliary function.

Although screens or projectors can show visual elements like instructions or even technical details in close proximity to the working area, the user's focus will be distracted if these elements become too prominent. The same is true for gamification elements. In order to be acceptable in production environments, gamification has to be discrete and "stay in the back" in critical situations. This results in the following set of requirements.

3.1 R1: Implicit Interaction

Implicit or natural interaction (NI) allows the user's regular work activities to become the predominant input for the gamification component. The motion recognition technologies required to achieve this have been described in previous work [19–21]. Implementing NI also addresses several general design requirements for interactive systems which the gamification of production should address: self-descriptiveness (ISO 9241 part 110), informative feedback (Golden Rule [22]) and "recognition rather than recall" (Usability Heuristic).

3.2 R2: Error Prevention

Another special requirement originating from the production domain is the goal of reaching 100 % product quality or "total quality". If gamification does not somehow support this paradigm, it will simply not be implemented in production environments. A trade-off between increased worker motivation and a slightly increased error rate due to gamification is inacceptable in this domain. Thus, gamification should automatically "blend out" if a worker's stress level indicates

that he or she is in a situation of high cognitive or physical workload. This results in a derived requirement.

3.3 R2': Stress Detection

Detecting stress is comparatively easy if body-attached sensors can measure the heartrate or the galvanic skin conductance. However, in production environments movement is inevitable so other solutions for measurement are required. We experimented with a system for facial recognition of emotions [23] and found that it still was strongly influenced by pose and lighting conditions. Clearly, this is a vast area for future research.

3.4 R3: Addressing Employment Rights

The final point is linked to the ethical issues raised at the end of the previous chapter. Unlike call center agents and many other knowledge workers using computer based systems, workers in production environments are not used to a real-time monitoring of work tasks. Typically products are tested at defined quality gates in the production workflow, but in-between the workers' activities like sequence of actions, pauses etc. are comparatively free. However, real-time monitoring is a direct result of R1, so additional sensors have to be integrated to allow the gamification of production workplaces.

At the same time, there is a very strong tradition of employment rights in the industrial sector. Not integrating the workers' council when implementing the gamification or trying to use gamification mechanics against the workers' interests (as in the examples from the service sector) will probably prevent a successful gamification of production at least in Europe, Japan and the USA.

4 First Design Approaches to Gamify Production

From 2012 to 2015 three designs for gamification in production have been proposed (Fig. 2): the Tetris design [24], the circle design [25] and the pyramid design [26]. All three designs are based on the assumption that the continuous real-time visualization of work progress can incite a state of flow [27] where concentration and engagement rise. All three designs have been evaluated in sheltered work organizations. The studies showed a common tendency towards increased work speed and also towards a heightened motivation of impaired workers—however, the product quality slightly decreased if no counter measures were taken (see previous chapter, requirement R2).

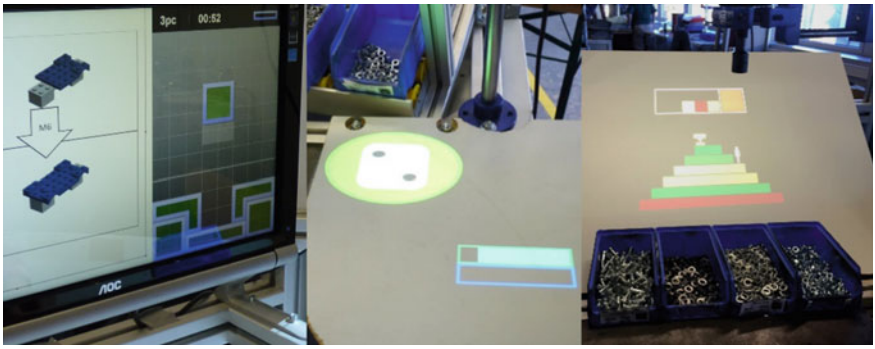

Fig. 2 The Tetris design (2012, *left*) was the first attempt to gamify production. The Circle design (2014, *middle*) uses projection and simplifies the visualization by showing just the active work step and two progress bars. The Pyramid design (2014–2015, *right*) shows each work step on a virtual climb to the *top*

To visualize progress within the gamification component, all three designs use color-coding: work processes completed faster than usual are rendered green while processes completed slower than usual are colored yellow, orange or red. Errors always result in red process visualizations and may have additional consequences—e.g. the removal of the cup at the top of the pyramid. The most recent study [26] showed that impaired workers strongly prefer the pyramid design to the two alternatives ($p < 0.01$).

The study we present in the following chapter does not only intend to evaluate general attitudes towards gamification in production but also aims to determine, if the design solution preferred by impaired workers is also acceptable for workers without impairments.

5 Gamification Study with Instructors at Car Manufacturers

Back in 2012 a study with 134 production companies [28] showed that there is a general interest in gamification. Without knowing any specifics about the system, about 63 % of the decision makers would consider a system attractive that contains motivating elements. We suppose that with the ongoing increase of burnout rates the interest in gamification has rather grown than diminished.

For this reason, we decided to conduct a study with two large German car manufacturers. The test population was 10 instructors who teach technical skills and create design requirements for future assistive systems in production. In this function, they are very close to the workers' needs and know their mindset, so they can potentially act as multipliers.

The setup was very simple: after asking a few questions about gamification in general, we confronted the instructors with the three design solutions. The aim was to determine if there is a clear preference for one of them and if this preference is the same as with the impaired persons.

To determine the positive and the negative features of the design solutions we evaluated different aspects: the graphical attractiveness, the potential to motivate, the complexity, the transparency of the reward mechanism and the level of potential distraction from work. To measure the instructors' level of agreement to the corresponding assertions we used a standard Likert scale with 5 steps: do not agree at all (1), do not agree (2), neutral (3), agree (4), strongly agree (5). We assume that this scale is continuous rather than ordinal or discrete. In the following, we will present and discuss the findings.

When asked about the attractiveness of the graphical visualization (Fig. 3, left), the instructors appreciated the simplistic Circle&Bars design least with a mean approval rate of 2.9 (standard deviation SD = 0.7), followed by the Tetris design with 3.7 (SD = 0.5). The instructors appreciated the Pyramid design most with 4.0 (SD = 0.8). The analysis of variance (ANOVA) shows that these differences are highly significant ($p < 0.01$). Clearly, the visual attractiveness of the pyramid design is high. Still the relatively high SD as well as qualitative findings show that design remains an issue: while some instructors prefer a simplistic or "schematic" design, others argue in favor of a more appealing design that corresponds to the high quality the instructors attribute to the cars their companies produce.

Games and thus gamification are mainly judged by the game design—in this case the set of rules, which visualize the progress and reward the worker. We asked the instructors about the transparency of these rules (Fig. 3, right), e.g. if a red step really is an easily understandable indicator of suboptimal work. Compared to the graphical attractiveness, all three designs receive higher scores: Circle&Bars a mean approval rate of 3.9 (SD = 0.7), followed by the Tetris design with 4.2 (SD = 0.8) and the Pyramid design with 4.3 (SD = 0.8). Since the rules are similar

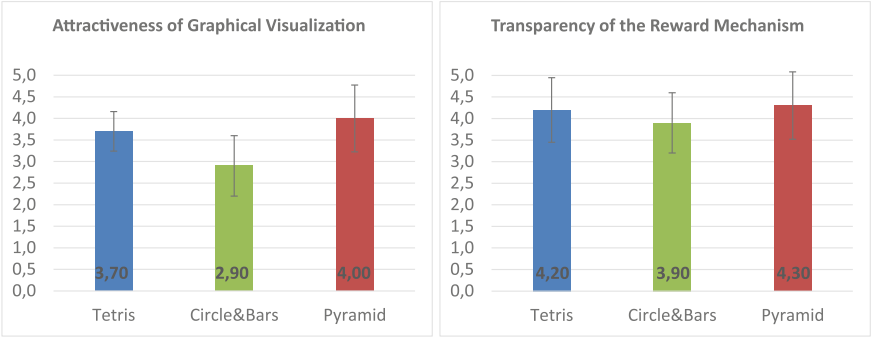

Fig. 3 The attractiveness of the graphical visualization of the three gamification designs (*left*) and the transparency of the reward mechanism (*right*). *The error* indicators show the standard deviation

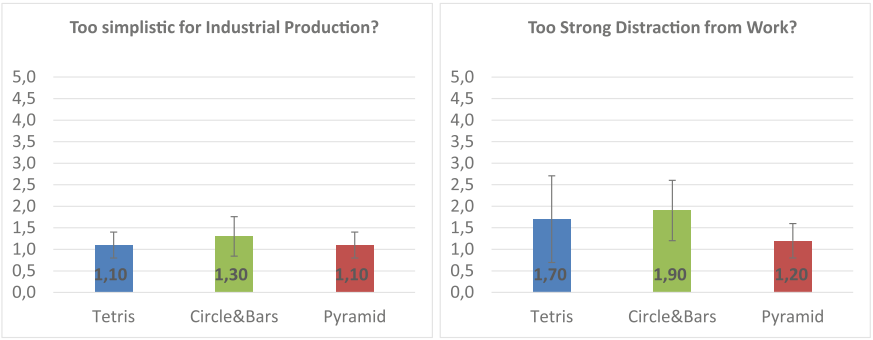

Fig. 4 We asked if the design is "too simplistic" for industrial work (*left*). On the other side of the scale, minding the high standards in production, we wanted to check if the designs would be perceived as too distracting from work (*right*)

for all three designs, these differences are not significant. However, the general approach (color-coding) is highly appreciated. Again, there is a tendency towards the Pyramid design. The qualitative findings show that the cup on its top is controversial: while some instructors perceived it as an additional factor of motivation, others feared that its removal after an error might me demotivating. Another instructor even proposed a solution: instead of taking it away, the cup's "level" should be reduced, e.g. from gold to silver.

The next two questions (Fig. 4) were testing two ends of the complexity scale: either the gamification designs—which have been developed for persons with cognitive impairments—might be perceived as too simplistic for un-impaired persons in industrial production. Alternatively, the instructors might still feel that even the simple gamification design draws too much attention away from the product, so we asked about the designs' potential distraction from work. The results are obvious for both questions: the instructors considered none of the designs as too simplistic or too complex and distracting.

There are no significant differences in the designs' acceptance regarding simplicity (Fig. 4, left). However, the Circle&Bars approach received a slightly higher score, so it was at least perceived as more simplistic than the alternatives. With assertions like "the design cannot be too simplistic" or the "complexity is just right for something next to work" the qualitative findings strongly support the data.

When asked about the potential distraction from work (Fig. 4, right), the instructors were slightly more critical: Tetris was rated 1.7 (SD = 1.0), Circle&Bars 1.3 (SD = 0.7) and Pyramid 1.1 (SD = 0.4). Although the ANOVA shows no significant differences (p slightly above 0.1) the Pyramid design clearly is the favorite. The qualitative analysis shows that the instructors attributed this preference to the fact that "the pyramid does not move": although the small avatar moves up the pyramid's steps, this movement is very contained in comparison to the movement of blocks in the Tetris design or the movement of the circle towards the bar in the Circle&Bar design (Fig. 5).

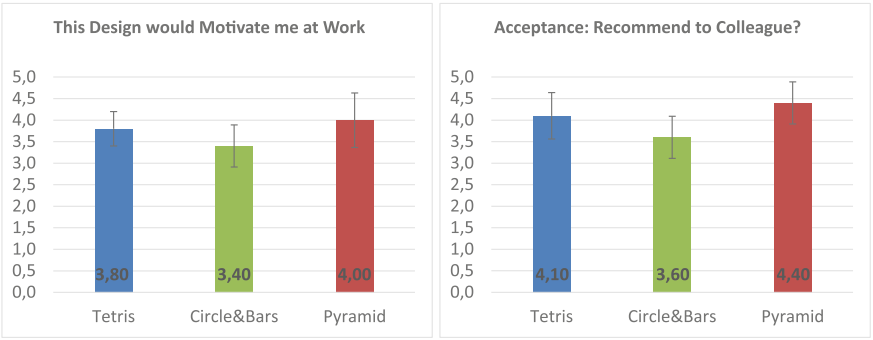

Fig. 5 The designs' potential to motivate at production work (*left*) and the results of the ultimate acceptance question: "Would you recommend it to a colleague?" (*right*)

To make sure that the approval of the designs was not speculative but linked to the concrete automotive work context we also asked the instructors to what extent the designs would motivate them at work and if they would recommend them to a colleague. Like in the two questions on simplicity versus distraction, the results are obvious: All designs are well appreciated. Still there are some differences.

When asked if the design would be motivating for the instructor when he or she was still in active production work, Tetris was rated 3.8 (SD = 0.4), Circle&Bars 3.4 (SD = 0.5) and Pyramid 4.0 (SD = 0.6). With $p < 0.06$ these difference are marginally significant. Again, the most striking difference is the preference for the pyramid design.

A classical way to test the acceptance of a new design is the question: "Would you recommend it to a colleague?" Here Tetris was rated 4.1 (SD = 0.5), Circle&Bars 3.6 (SD = 0.5) and Pyramid 4.4 (SD = 0.5). In this case with $p < 0.01$, the differences in preference are highly significant. Once again, the Pyramid design is clearly preferred.

6 Conclusion

In this work, we investigated how gamification can be integrated in work processes in the automotive industry. We first showed that gamification has already become popular in various domains. Originating from education ("serious games") the method spread to the health domain ("exergames") and now starts to become more common in the service sector. The best practices exemplify this development but also point to ethical challenges as soon as designers start to apply gamification to work contexts.

Even within work contexts, we argue that there are strong structural differences separating production from other domains, which result in a set of special requirements. The fact that the product is the center of attention led to the

requirement of implicit interaction. The total quality paradigm led to the requirement of error detection and, subsequently, stress detection—to avoid that gamification adds cognitive workload to a worker already challenged by high cognitive or physical demands. Finally, we saw that employment rights are traditionally handled with special care in this domain, so changes have to be made carefully. While work activity at computers (service and knowledge domain) can easily be tracked, tracking activities in a production environment requires additional sensors. If workers are feeling they will become "observed" or "controlled", gamification might not succeed in this domain, even if the other requirements are met.

In spite of these special requirements, the study showed that the instructors from the automotive industry are not rejecting the gamification of production work—instead there is a very strong interest and fascination for the potential. It is an interesting finding that the current simplistic gamification designs, which have been developed for persons with impairments, were considered adequate for un-impaired production workers. The naïve hypothesis that premium technology also requires more complex gamification could not be supported. Statements like "the design cannot be too simple" show that the simplicity of the core gamification mechanisms is a key for success in this domain.

From the three designs we presented to the instructors, the Pyramid design was clearly preferred. While the instructors found the Tetris design visually attractive, they also perceived it as relatively complex. The Circle&Bars design received lowest scores in several areas.

In the last part of the study, we investigated the acceptance of gamification within the concrete automotive context. With respect to the favored Pyramid design, the instructors agreed that it would motivate them at work and that they would recommend it to colleagues. To conclude, the general acceptance of gamification in modern automotive production currently is be very high, if the special requirements are met.

7 Future Work

In Chap. 3, we listed the requirements, which, in our understanding, have to be met for gamification to be successful in the production domain. While implicit interaction is a requirement already "solved", the infinite struggle for "total quality" in production will definitely not be solved by a gamification component. Even if some form of error detection is implemented, e.g. by using object recognition algorithms, there will always be errors which are hard to detect.

To avoid situations where the gamification draws attention away from the product when it is highly needed there, a set of sensors could detect the worker's stress level. Thus, gamification could be activated during dull and repetitive tasks, and automatically deactivated if the worker has to cope with high cognitive and/or physical workloads. However, developing a reliable stress detection working in the

field without a body-attached sensor currently still requires considerable future work.

In spite of these shortcomings, additional fieldwork can already be started: the next step is implementing the preferred pyramid gamification design in an automotive production environment with a "guaranteed" low stress level, to test if the workers' acceptance rate of gamification matches that of the instructors.

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Japanese Packaging Design: An Approach Through Ideogram Language

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Abstract This article aims to demonstrate the relationship between language and thought in the eastern culture. Given this relationship, it should examine how ideogrammatic writing influences the visual identity of Japanese packaging. The objective of this research is to identify the relationship between ideographic writing and the visual identity of Japanese packaging. It also try to determine at which level and aspect, the ideogrammatic language affects favorably or prejudice the design and the visual identity of the packaging of a product. This characteristic includes concepts of emotional and affective design and the messages they can transfer to the users. Established this association, it should consider how the diagrammatic writing influences the visual identity of the Japanese packaging.

Keywords Ideogram · Packaging · Semiotics · Visual language

1 Introduction

Languages such as Japanese and Chinese are written by ideograms. Dictionary defines ideogram as a sign that expresses the idea and not the word sound that represents the idea: the Egyptian characters were ideograms.

According to Taniguchi, in [1], the first ideograms were thought by similarity, since the original form of writing used by the Paleolithic man was pictorial. Thus, the Japanese ideogram for river is represented by similarity throught the sign "川", which, according to Campos [1], visually refers to water threads that functions as a visual metonymy for the few laconic lines; or the character for tree "木", which refers to a tree format.

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The growing interest in ideogrammatic written in a multicultural world without frontiers in which we were inserted in since the beginning of globalization, raises a more complex relationship than we imagine between language and thought. Therefore, in its cultural and social developments they are highly differentiated between the west and the east. The aesthetic, philosophical and pictorial approach of ideograms added to the poetic and emotional character of oriental languages, instigate us to verify the different way of elaboration and communication of its product identity, particularly here, through the analysis of consumer packaging in general, seen from the perspective of cognition, thought and language. Serralvo [2] in his studies on packaging states that there are symbolic and cultural differences between the Western and Eastern societies. Both have different meanings and sometimes opposite aspects, for example, the white color represents unity or purity in Western society, while in the eastern is mourning. There are several other cultural, religious and social aspects such as this example, which can be determined, according to some authors, by the relationship between language and thought, and between language structure and behavior. Various authors as Korzybski and Hayakawa conducted studies that analyze these issues in 1933, as in [1] (229–230), citing Whorf[1]:

> We dissect Nature following guidelines established by our native languages. The categories and types that we isolate in the world of phenomena are not find there because they look us in the face; on the contrary, the universe is presented to us in a kaleidoscopic flux of impressions that must be arranged by our intelligence—which means: the linguistic systems in our minds. We scalp nature, organize it into concepts, and assign meanings to it, largely because we participated in an agreement to organize it this way—agreement that impose itself throughout the community speech and is codified in language patterns. This is obviously an implicit and unformulated agreement, but its terms are absolutely required; we could not speak unless by submitting ourselves to the organization and classification data enacted by the agreement. [1, pp. 229, 230].

As we shall see, the monosyllabic and not deflectable ideographic characters provide a fascinating tool for relational reflection. According to Fields, in [1], by virtue of Oriental language structure, attention turns to the relationship between words, rather than for individual words itself. This relational thinking is reflected, for example, in Oriental cuisine. The food preparation consist in cut and cook the ingredients in the proper proportions. By the understanding of [1], 'cooking only one dish or prepare a menu', it is a matter of building a configurative model. Moreover, a Western meal gives the impression that it is the product of an analytical mind, like: eating flesh because of protein, potato and bread because of carbohydrates, butter by its fat and vegetables for the fibers. What we will argue is that a signal-based language (ideograms), may eventually facilitate the interpretation and elucidation of a product for immediate identification (pictorial/iconic) of the signs resulting from the language structure and ideographic thought, and can interfere

[1]Benjamin Lee Whorf, "Science and Linguistics", Language in Actio—Hayakawa, pp. 311–313, New York (1941).

with or provide a different cognitive performance on the reading and presentation of a product.

2 Objective

The study aims to identify the relationship between the ideographic writing and the Japanese visual packaging identity and determine at what level and aspect ideogrammatic language favors and/or interfere with the visual packaging identity design of a product. Established this association, it should consider how the diagrammatic writing influences the visual identity of the Japanese packaging.

3 From Chinese to Japanese's Ideogram

Zhang Jian in [1] states that "According to this cognitive model the ancient Chinese linguists have made their observations and knowledge of the universe to dissolve into the classificatory system of radicals" [1] (p. 15). He exemplifies that during the Song dynasty, a linguist performed the division of the world of beings and objects to create signs, setting in ten classes: astronomical things, rivers and mountains, land, plants, humanity, animals and birds, fish and insects, ghosts, implements and official business.

Largura in his M.Sc. research [3] reported that the Japanese ideogrammic system originated from Chinese writing. He explains that Japan did not have its own writing and it was only an oral culture until about 5 million years ago. As well as Chinese written, Japanese writing is comprised of signs, a pictograms system in which each sign corresponds to an idea and this idea results in the phonetic and semantic junction called "kanji" (ideogram). Iwakami [4] in his studies "Routes of the ideogram: the process of language" makes it clear that the formation process of Japanese ideograms, Kanji, must be analyzed from three aspects: graphic, sound and meaning. "In fact, Kanji is a hieroglyph, if we consider it in its formal and figurative aspect" [4].

3.1 Ideograms and Pictograms: Icon, Index and Symbol Systems

The Chinese semiotician Yu-Kuang Chu in the chapter Interaction between language and thinking in Chinese, on the Ideogram book: Logic, Poetry and Language, by Haroldo de Campos (org.), in 1994, explains that language and culture are closely related. Chinese is an uninflected language where words do not suffer

changes according to the number, gender, case, time, voice or mood. Chu notes that in bilingual environment, the Chinese language, predominates on issues that deal with indirect ways of understanding and feeling, while the English language prevails in the objective and direct matters [1, pp. 203–204]. However, to what extent the structure of a language can influence the thought process of any culture?

According to [3], the Chinese created their writing in order to be used throughout China and its merits would be more practical, not intellectual. Leibniz in [1] believed that the highlight of the Chinese language was purely institutional and arbitrary; invented to facilitate communication for diversity people who lived in the great empire of China. Though, for Leibniz, the ideographic writing was seen as an idealized conception of its nature, a philosophical language and compares the Egyptian hieroglyphics to Chinese writing. He defined hieroglyphics as "sensitive" and "allegorical" while the Chinese ideograms sounds to him "more philosophical", built on intellectual configurations [1, p. 45].

The term "ideogram" comes from "Deograma", the Greek word idea (idea) and gramma (something drawn or painted). Ideogram is the representation of an idea. Unlike the pictogram, the ideogram represents the idea of the object, not the object itself. For example, a prehistoric drawing of a flying bird, which conveys the idea of freedom, and not the bird itself, is considered an ideogram.

Eisenstein, in his essay, "The cinematographic principle and the ideogram," portrays the combination of two hieroglyphs (pictograms) from the figural Japanese writing,

> It should not be considered as the sum of them, but as their product, that is, as a value of another dimension of another level; each separately corresponding to an object, a fact, but their combination corresponds to a concept. The combination of two sensitive elements being painted allows the representation of something that cannot be graphically portrayed [1].

For a better explanation, in Japanese the ideogram of water drawing with the drawing of an eye means "cry"; drawing a knife over a heart mean, "sadness"; the ear close to the drawing of a door means "hear".

According to Aurelio Portuguese language dictionary (and many other dictionaries), unlike ideogram, pictogram is a primitive system of writing in which ideas and objects were represented by drawings. The term "pictograph" originates from the Latin word pictus (pictured) and the Greek word grafos (write). The pictograms are 'graphisms', graphic signs that represent an object, an idea, a sound or a being, as well as in the prehistoric period when man drew a bird, he was referring to, the drawing represented by its meaning. "The animals painted in the caves are pictographs.—pictures or sketches that represent things" (says Graphic Design History). Explains that throughout the world, from Africa to North America and the islands of New Zealand, the prehistoric people left numerous petroglyphs, which are signs or simple figures carved or scratched into the rock. Many petroglyphs are pictographs, and others, perhaps ideographs—symbols to represent ideas or concepts, in [5, p. 19, 6] visions.

In order to better understanding this comparison it is important to read Peirce thoughts. For Charles Peirce the ideogrammic system is necessary to define some semiotics terms as sign, icon, index and symbol. Farias in [7, 8] defines sign in her, as "A sign is a 'first' establishing some kind of genuine relationship with a 'second' (it is an object) in order to determine a 'third' (it is an interpretant)" [6, p. 14]. This means that any signic process implies the presence of these three elements, firstness, secondness and thirdness. According to Peirce [9–11], there are three categories, as shown in his studies entitled Collected Papers (CP 1.532-33, 3.422, 6202 and 8330) [11]:

- Firstness: chance, spontaneity, randomness, feeling.
- Secondness: existence, dependence, crude reaction, action.
- Thirdness: mentality, mediation, continuity, reason.

Thus, we can infer that the sign is everything that is, it seems or indicates something. It is polysemous, and has several interpretations. These three categories are present in the definition of the three ways in which the sign can relate to itself subject (as an icon, as an index, or as a symbol). Peirce, the founder of semiotics defines three types of signs, from the relation they have with their objects.

Always according to his doctrine categories, he calls: the first, whose relation is based on simple qualities that both have in common "icon"; the second, whose relation is a factual correspondence, "index"; and third, those whose relation is allocated based on some characteristic attributed, "symbol". Therefore, the drawing of a house made by a child can be considered an icon; a footprint in the sand, or smoke in a chimney can be considered an index; and finally, a chart or cross can be considered a symbol.

Also according to Peirce [8–10], the division proposed by the founder of semiotics, part of an analysis of the sign, can be translated into the following groups of questions and answers:

1. What is the sign itself?

   A mere quality, a qualisign
   A current existing, a sinsign
   A general law, a legisign

2. How do it relates to its object?

   It is related by virtue of its own characteristics, it is an icon
   It relates in an existential way, it is an index
   It relates through conventions, it is a symbol

3. How, through the interpretant, it presents its object to a possible interpreter?

   As a sign of possibility.
   As a fact sign, existing.
   As a sign a law, it is an argument

'Images' should be understood as instanced icons immediate qualities, apparent or superficial;

'Diagrams' in turn, can be defined as hypo icons whose resemblance to its object is based, first, in a structural similarity;

'Metaphors' ultimately correspond to instantiated icons habits, conventions or laws.

3.2 The Basics of Language and Eastern Thought

Initially thought is nonverbal and language is not intellectual. Their development paths, however, are not parallel; they cross. The language penetrates the sub consciousness to be in the thought structure in childhood, since the age of two. According to writings [9–11], the thought of the individual is not determined by congenital factors, but from a result of activities performed in accordance with the social habits of the culture in which the individual develops himself. Just like in the animal kingdom, the human thought and language have different origins as described in [9, 10].

In "The empire of signs", Roland Barthes analyzes "Why Japan?" Because is the country of writing: from all countries Barthes might know, Japan is the one where he found the nearest sign of his convictions and his fantasies. Another avid oriental writing researcher was the historian Ernest Fenollosa in the essay "The Chinese written character as a medium for poetry". He did pioneering scientific study of the nature of Chinese writing as reports [1, p. 23]. It was Fenollosa who first saw in the graphic quality, the kanji sense carrier, compared with western writing systems as the energy of the original language (hypo icon). "And he adds that while Western languages would tend to 'anemia', the Kanji, in contrast, continues today able to absorb the poetic essence of nature", radiating exuberant glow-sense, as the thoughts of Vygotsky [12, pp. 18–19].

By Campos, other reference reinforces the main aspect of oriental language: the M. Ito dances in 'Noh Theater', which reflect the concrete illustrations, essence that is expressed by kanji, where everything lies in the concentration. All the elements that make up the eastern visual and oral language congregate itself in a clear, simple and unique expression. The goal is always to express a relation and a primal human emotion. "The emotion is always up on the idea and not on the personality" [1, p. 21] reminding the Irish poet W.B. Yeats.

Fenollosa analyzed the ideographic characters, such as the pleasure of aesthetics contained in the Sino-Japanese poetry, and was quoted as saying that "this pictorial method, whether the Chinese exemplifying it or not, would have been the ideal language of the world" [1, p. 42]. Campos added that this would be a mythopoetic thesis of an original language, which uses metaphors, in which fantastic characters of animated substances have designed the ideas of things [1, p. 42]. Fenollosa exalts that "The metaphor of nature, revealing the nature is the same substance of poetry" [1, p. 43] and faces the Chinese as the mirror of nature, in "picturality" near the

active world of things [1, p. 45]. Also in Campos a clarification: Ezra Pound, the poet-inventor, received Fenollosa's texts directly from the historian's widow, and, as the author says, he was the cultural legatee and executor of Fenollosa, translator-inventor of Chinese poetry [1, p. 41].

Ezra Pound was one of the biggest names of the modernist movement of the early twentieth century, which influenced by the renovation project of poetic language names like Joyce, Yeats and TS Eliot. Pound reaffirmed the graphic nature of poetic highlighting the importance and significance of Fenollosa aesthetics, coming from clear Eastern influences. Campos cites the designer and poet Shutaro Mukai, for whom the Chinese characters are a "model consisting of a schematic system that originates from iconicity, but for the richness of its explanatory power, evolves towards symbolicity" [1, pp. 15–18–19]. In the writings "Characters That Represent, Reflect and translate Culture—in the Context of The Revolution in Modern Art", Shitaro Mukai notes that the Kanji emphasizes the sense of touch. It evokes the act muscles movements memory to write, and argues that the sense of touch is what integrates all, and is the most fundamental, which creates a tendency to see it as a predominantly visual system. Mukai reconsiders a possible reassessment of "rhythmic forms of life, including gestures and visual perception." [1, p. 19].

The kanji graphic quality allows us to imagine, from time to time, which it means even if we are not able to make its reading. "[…] At the same time, the Kanji are associated with the sense of touch or physical feeling." [1, p. 18].

By North [13], Diderot, in 1749 and 1751, concluded that the gestures language is more expressive and logical than verbal language. It is three-dimensional and corresponds to the reality of the world, more than other one-dimensional representations. For Diderot language distorts reality, explains [13, pp. 49–50]. The argument at the time was that the iconic signs and natural signs are semiotic representation means aesthetically superior to arbitrary signs being the most iconic and natural of signs also the most beautiful [13, p. 50]. This non-verbal superiority argument goes against the aesthetics of eighteenth century, with its theory of mimesis, the representation of iconic signs discussed by Niemayer [14] in design applications, which includes the packaging design.

3.3 The Ideogram and Package Visual Identity

In general, the Japanese packaging use hypo icons work establishing existing signical relations due to some kind of similarity they have with their objects. As defined above this relationship can be directly through a drawing or may be through the diagram or metaphor.

In this sense, we do not even need to understand the ideograms to know what the product is. The use of images is evident and is defined in the following examples.

The example of juice packages that are instantiated icons of immediate and apparent qualities belong to the first class defined by Peirce, the firstness. The

Fig. 1 Juice packaging—created by award-winning Designer Naoto Fukasawa, examples of Firstness icons, www.jeffhandesign.info/2012/06/08/naoto-fukasawa. 2012

Japanese industrial designer Naoto Fukasawa has created a series of creative fruit juices packing which have the appearance of the fruit it contain. A juice-packing box is supposed to be more appealing to the eye, imitating the real fruit it contain. How Naoto puts it: I figured that if the surface of the package mimicked the color and texture of the fruit peel, then the object would replicate the feeling of the peel, the real "skin", as shows Fig. 1.

We can understand the use of a hypo icon in a class diagram, as this packaging establishes a structural link between the hair and the cookie curly texture, Fig. 2; the sign relates to its object through secondness.

In the case of Ajinomoto (food seasoning trademark), which makes use of a representative convention, using the agreed representation of the face of a panda (with eyes changed to the panda's eye shape). The 'Panda' seasoning glass is shown next to the Japanese Geisha image of delivery food, totally formed by triangles, with the "hashi" used as a hair clip. These are signs related to the object through the thirdness. The food packaging was designed by Swedish design student Helen Maria Bäckström, with the Geishas inspiration (Fig. 3).

One more detail, this project comes into focus joining the traditional chopsticks, complementing the Geisha look—they are made to hold the geisha hair. Fun and luxurious design allows easy and comfortable transportation of the food.

Another kind of packaging focused on well-being, nature and lightness presents a clear and clean aesthetic; or elements that integrate the visual transparency and product vision conceived in interaction with the packaging.

In this case, in Fig. 4, Japanese Design Studio: Rise Office Design created a minimalist and fresh packaging for the brand of "Forest Milk" that sends the message of a natural product that seems handmade, "ecofriendly engaged" and

Fig. 2 Biscuit with structural relationship to the hair curly. In: blog.naver.com, 2011. www.designer-daily.com/afro-cookie-17601

Fig. 3 "Anthropomorphic Packaging Mascots"—spice "Panda" Ajinomoto (Monosodium glutamate) and, NOO-DEL: Asian meal type takeaway that imitates a Japanese "Geisha with Hashi"; Ajinomoto "Panda" in: www.beachpackagingdesign.com, 2008; "Japanese with Hashi"—www.huaban.com/boards/14458472/ and photoweibo.com (2013)

fresh. It looks like 'produced by cows' that inhabit the forest freely according to the rule: happy cow, better milk!

Sometimes are applied other details, as face, eyes and smiles on products to make it more simple ones and "cute". Alternatively, it is applied the emotional effect of "cute" = the "Kawaii" product, which means graceful, dainty, cute.

About the conception of image and design, the poetry, the clean look without excesses, a characteristic of Japanese culture and art, are present in these simple packages projects presented. The visual purity, symbology, iconicity and index undergo a language thought even in the way to close the bottle, simple and devoid of technology. These packaging in its design have presented 'hypo icon' languages, in various stages of firstness, secondness and thirdness, through its "visual cleaning."

Fig. 4 "Forest Milk" package created by Japanese design studio Rise Office Design. www.1stwebdesigner.com/inspiration/japanese-product-packaging-design.ImagebyVizeer (2011)

4 Conclusions

The Japanese Packaging is created not only to contain the product; it contains a single soul, a representative iconic identity. The Products enchants through a differentiated and value-added language since there is an idea that relates to the user, in his memory, emotion and poetry.

There is a significant comparative difference between a Western and an Eastern product packaging design. Independent from writing and text, the visual identity and product understanding of Japanese packaging is done without the need to speak the language, or read what is written. This aspect resumes the issue already mentioned of Chinese writing system. The Japanese mentor system, created thousands of years ago, for a complete understanding of all peoples, where the hypo icon, either in first, second or third level, reveals the meaning automatically. We can see then that the Japanese design uses much of hypo icon in all its ratings, thus having an amount of energy and "life" conveyed by the product design, which is perceived by the receiver. Western packaging in general looks more limited, "contained" in the presentation or labeling, and, with a somewhat tiresome text amount that often do not communicate the qualities of the product displayed. It is also relevant the aspect of the Japanese design may seem "animated" when it comes to a focused product for the children's market and even when you can convey emotion and satisfaction in the sense of joy, fun or mood.

The impact is immediate by either the aesthetics, the humor, or the "Kawii" (cuteness). The packaging color and its shape and the interrelation of both the content and all the nature of iconic references, makes the Japanese packaging, a singular form of expression. Apart from all the features mentioned, another part of

the Japanese packaging design prize for harmony, subtlety, poetry and elegance and has relationships with nature, aesthetics and beauty, and, in line with the architecture of Peirce's thought provides the basis for three normative sciences: Aesthetics (ideal), ethics (conduct) and critical logic or semiotics (the truth).

It is a fact and it is a conclusion that there are differences of language and effects between the transmitted message from the Japanese packaging (Eastern) and messages of packaging from Western countries. However, all the different forms of world culture understand messages of Oriental products, in a very positive way.

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Affective Response to Photographs of Natural Landscapes Based on OCEAN Model

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Abstract The Attention Restoration Theory (Kaplan in J Environ Psychol 15:169–182, 1995 [2]) and the psychological stress reduction theory (Ulrich et al. in J Environ Psychol 11:201–230, 1991 [3]) show that natural landscapes generally stimulate positive emotions. However, Gray's biopsychological theory of personality suggested different personalities process environmental stimuli differently, leading to varying levels of or completely different emotions. Thus, current emotion tags to landscapes are likely inaccurate, as they lack the consideration of personality type. This study investigates the relationship between the emotions experienced and personality types. 50 participants aged 10–80 years were invited to watch a slideshow of landscapes. Subsequently, they were recorded reading a short passage. To assess participants' emotions, the voice recordings were processed using PRAAT, a scientific software for analysis of phonetics in speech, and a modified version of the Profile of Mood States (POMS). The results provided the foundation to more accurate tagging programmes linking photographs of natural landscapes with emotions evoked in different personalities.

Keywords Emotions · Mood · Natural landscapes · Personality · Five factor model · OCEAN · PRAAT

1 Introduction

Hartmann and Apaolaza [1] found that visual representations of natural scenery stimulate emotions, similar to the effect of direct exposure to natural landscapes. The stimulation of emotions is further supported by the Attention Restoration Theory (ART) [2] and the psychological stress reduction theory [3] which explains that exposure to natural landscapes enhances positive emotions, as compared to

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urban landscapes which lack natural elements, and instead, hyper-stimulate the mind.

However, Gray's [4] biopsychological theory of personality suggests that different personality types are stimulated differently when exposed to the same stimuli which inducts either positive or negative emotions. Hence, this study focuses on how photographs of different natural landscapes can evoke different levels of emotions in people with different personalities. Results indicated that natural landscapes change the level of emotions, with a consistent increase in positive emotions in all participants regardless of personality. Further analysis of the results showed that the degree of the five factors of OCEAN have a positive correlation with the extent of positive emotions felt. Using the primary data gathered, a simple sketch of the application was created.

1.1 Five Factor/OCEAN Model

The five factors in this model refer to openness, conscientiousness, extraversion, agreeableness and neuroticism. Under each broad factor is a number of correlated and more specific primary factors. For example, extraversion is associated with qualities such as gregariousness, assertiveness, excitement seeking, warmth, activity and positive emotions [5]. The five factors are as follows:

1. Openness to experience (inventive/curious vs. consistent/cautious): This factor describes the extent to which a person is imaginative or independent.
2. Conscientiousness (efficient/organised vs easy-going/careless): This factor describes the extent of organisation and self-discipline.
3. Extraversion (outgoing/energetic vs solitary/reserved): This factor describes the extent of energy and sociability.
4. Agreeableness (friendly/compassionate vs analytical/detached): This factor describes the tendency to be cooperative rather than being cynical.
5. Neuroticism (sensitive/nervous vs secure/confident): This factor describes the tendency to experience unpleasant emotions or the extent of emotional stability.

The results of this study may change the setting of stressful environments such as schools and offices into a less stressful one.

1.2 Hypotheses

Our research study investigates the relationship between personality traits and the emotions evoked by different landscapes. The aim is to find an answer to the research question: "*Do the emotions evoked from visual representations of landscapes vary according to personality traits?*"

The participants who undertook this study were aged from between 10 and 80 years. Measurement of mood was assessed using PRAAT, a scientific software for the analysis of phonetics in speech, and a modified version of the Profile of Mood States (POMS). To answer the research question, the following hypotheses will be tested:

Null hypothesis: Natural landscapes do not cause a change in the level of emotions in all participants of all personality traits.

Alternative hypothesis: Natural landscapes cause a change in the level of emotions in all participants regardless of personality traits.

If the Alternative hypothesis is proven true, we will proceed to test the following hypotheses:

- (H_1): Natural landscapes increase the level of *positive* emotions in all participants regardless of personality traits.
- (H_2): Different personality traits affect the types of emotions evoked.

1. Those who show high openness to experience feel positive emotions on higher scale compared to those who show low openness to experience.
2. Those who show low conscientiousness experience positive emotions on higher scale compared to those who show high conscientiousness.
3. Extroverts experience positive emotions on higher scale while introverts experience them on a lower scale.
4. Those who show high agreeability experience positive emotions on higher scale compared to those who show low agreeability.
5. Those who show low neuroticism to experience feel positive emotions on higher scale compared to those who show high neuroticism.

We predicted that natural landscapes will evoke positive emotions such as happiness, relaxation and contentment in all participants, regardless of their personality type. We also hypothesize that different personality types will experience varying degrees of different emotions.

2 Methodology and Materials

50 participants were invited to participate in the study. The 35 participants who responded comprised of 11 males and 24 females aged 10–80 years. The occupations of the participants are: students, domestic help or retirees.

Participants were informed of the details of the study and experiment beforehand. Consent by participants and parents (for minors) were obtained, for both real-time and online participants. Before exposure to photos of natural landscapes, participants completed the personality test and the first POMS section. After exposure to different slideshows of landscapes containing five photos each, participants completed the subsequent POMS sections. Upon the completion of the experiment, participants were debriefed and thanked for their time. Institution

Review Board approval was obtained before conducting this experiment. The experimental condition included two independent variables: different combinations of personality traits and photographs of different natural landscapes (Creeks and Lakes, Beaches and Coasts, Forests, City, Savannah and Rocky Desert, Snowy Landscapes, War and Military Zone). The dependent variable, change in emotions, was measured quantitatively and qualitatively. Quantitative analysis was done by processing a voice recording into PRAAT, a scientific software for the analysis of phonetics in speech, which determined the prosodic features of a voice recording such as pitch and intensity. Combination of personality factors was determined using a modified version of Goldberg's IPIP Big-Five factor markers.

Statistical tests were employed to determine if there was a correlation between personality and emotional responses from landscapes.

3 Results and Discussion

3.1 Effect of Landscapes on Emotions

The results of POMS showed that there is a statistically significant difference ($p < 0.01$) between the level of emotions before and after exposure to each natural landscapes. From Fig. 1, the level of emotions was highest for the control at 35.0, while it was lowest for Savannah and Rocky Deserts at 30.1 arbitrary units, followed by Snowy Landscapes (30.8), Forests (30.9), City (31.7), War and Military zones (32.1), Beaches and Coasts (32.3), and Creeks and Lakes (32.5).

It has been shown that green and blue spaces, such as landscapes which were tested, generally increase relaxation [6–10], due to the ART theory which explains that exposure to nature restores directed attention and leads to recovery from mental fatigue, hence resulting in overall emotions of lower intensity. The level of

Fig. 1 Level of emotions against each landscape. Landscapes tested were: *Creeks and Lakes*, *Beaches and Coasts*, *Forests*, *City*, *Savannah*, *Snowy*, and *War and Military*

emotions was the highest for control as the participants were accustomed to the urban setting which has less green space, leading to less of a restorative effect as compared to natural landscapes as hyper-stimulation of the mind increases stress levels, causing the overall emotions to increase in intensity [11].

From Fig. 2, the level of positive emotions was 54.2 arbitrary units for the control, and subsequently increased to a maximum of 57.1 arbitrary units for Creeks and Lakes. There is also a statistically significant difference ($p < 0.05$) between the level of positive emotions before and after exposure to each landscape, which shows the effect on the level of positive emotions from the exposure to natural landscapes. However, level of positive emotions dropped to 54.1 for the Savannah and Rocky Deserts instead of increasing as hypothesized.

The increase in positive emotions is suggested to be due to four therapeutic experience dimensions within participants' green and blue space narratives—symbolic, immersive, achieving and social [12]. Participants have certain qualities they associate with the landscape due to stereotypes and personal experience. For example, Creeks and Lakes depict calm waters which induct peaceful emotions in contrast to the high stress levels in urban environments. Similarly, Snowy Landscapes are associated with holiday activities such as skiing and this has a restorative effect on participants, leading to higher levels of positive emotions such as cheerfulness and contentment [1]. The stimulation of positive emotions in Snowy and Creeks and Lakes is further supported by the proportion of participants who chose these landscapes as their favourite: 60 and 52 % before and after the experiment respectively. For Savannah and Rocky Desert, the decrease in positive emotions could be because these landscapes are perceived as threatening and unpleasant [1], and participants were least familiar with them, as compared to the other more pleasant and more commonly seen landscapes. Hence negative emotions such as anxiety and fatigue increased, resulting in a fall in the positive emotions.

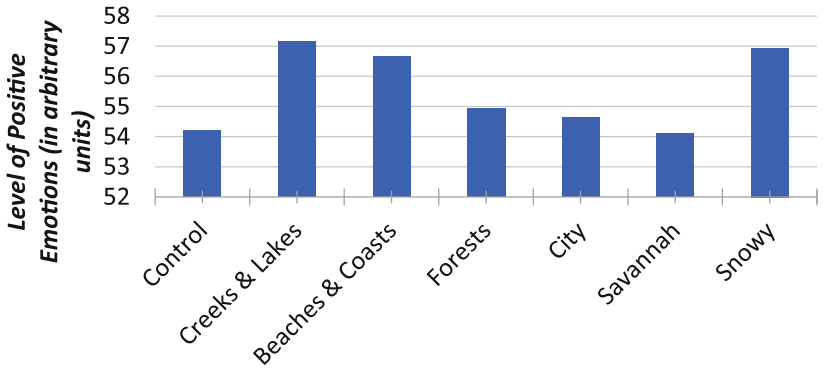

Fig. 2 Level of positive emotions against each landscape. Positive emotions include Excited, Cheerful and Relaxed

3.2 *Effect of Personality Type on Positive Emotions*

Openness to Experience. Goldberg's IPIP Big-Five Factor Markers was used to determine the participants' openness to experience. The scores ranged from 11 to 29, out of a possible maximum of 50. 24.2 % scored below 20 while a majority of 75.8 % scored between 20 and 29. No one scored above 30.

Using POMS and the Big-Five Factor Markers, a very strong and positive relationship was observed between the degree of openness to experience and the level of positive emotions, as further shown by a Pearson Correlation Coefficient value of 0.998. From Fig. 3, the level of emotions was lowest at 52.7 for the group with the lowest openness scores ranging from 15 to 19, followed by 56.4 for the other group with openness scores ranging from 20 to 29. This is in accordance with previous research, which suggests those scoring higher on openness experience greater degrees of positive emotions like interest, satisfaction and love [13]. Hence, the higher the openness score, the higher level of positive emotions, as shown below.

Conscientiousness. Goldberg's IPIP Big-Five Factor Markers was used to determine the conscientiousness of participants. The scores ranged from 12 to 37, out of a possible maximum of 50. 22.9 % scored below 20 while a majority of 57.1 % scored between 20 and 29, followed by 20.0 % scoring between 30 and 39.

Using POMS and the Big-Five Factor Markers, a very strong and positive relationship was observed between the degree of conscientiousness and the level of positive emotions, as further shown by a Pearson Correlation Coefficient value of 0.980. From Fig. 4, the level of emotions was lowest at 53.6 for the group with the lowest conscientiousness scores ranging from 12 to 19, followed by 55.1 for the intermediate group with openness scores ranging from 20 to 29, and the highest level of positive emotions of 59.9 for the group with openness scores higher than

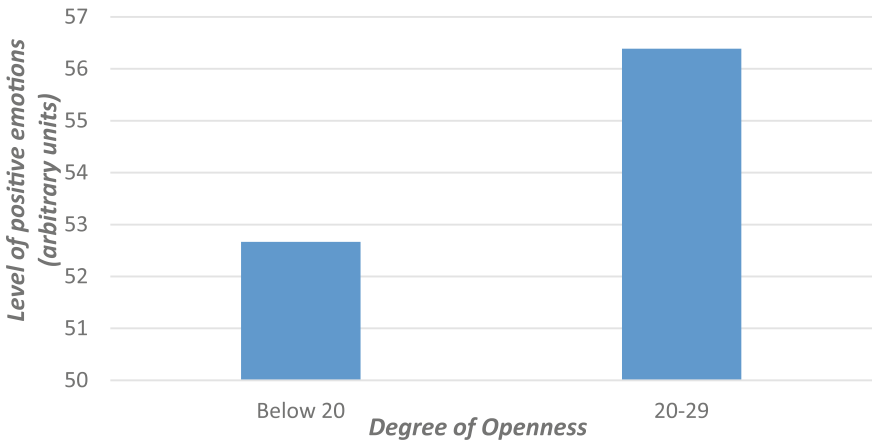

Fig. 3 Level of positive emotions against openness to experience score

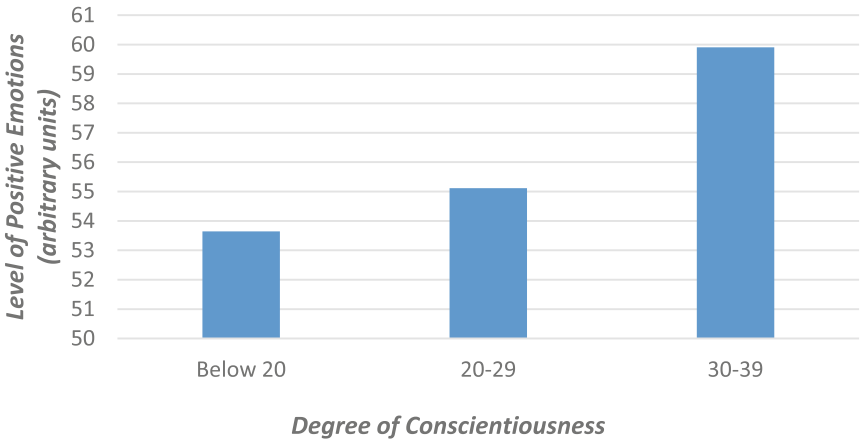

Fig. 4 Level of positive emotions against conscientiousness score

30. These results are consistent with previous research [14] which found that individuals with higher conscientiousness scores have less tendency to experience negative emotions because of their self-disciplined and goal-orientated behaviour [15] could have allowed for suppression of negative emotions, resulting in higher levels of positive emotions as seen in Fig. 4.

Extraversion. Goldberg's IPIP Big-Five Factor Markers was used to determine the degree of extraversion in participants. The scores ranged from 14 to 45, out of a possible maximum of 50. 14.3 % scored below 20 while a majority of 34.3 % scored between 20 and 29, followed by 28.6 % scoring between 30 and 39 and 22.9 % with a score above 40.

Using POMS and the Big-Five Factor Markers, a very strong and positive relationship was observed between the degree of extraversion and the level of emotions, as further shown by a Pearson Correlation Coefficient value of 0.889. As seen in Fig. 5, the level of emotions was 54.1 for the most introverted group with extraversion scores ranging from 14 to 19, followed by the lowest level of positive emotions of 52.7 for the second group with extraversion scores ranging from 20 to 29, and then 56.2 for the third group with scores ranging from 30 to 39, and the highest level of positive emotions of 60.8 for the most extroverted group with extraversion scores higher than 40. Previous studies [16, 17] have shown that extraversion influences the intensity of positive emotions. This is because the extraversion trait is associated with qualities such as gregariousness, warmth and positive affectivity. Hence, participants with higher extraversion scores have greater sensitivity to reward signals, which in this case is the induction of positive emotion, and this increases their response to the reward signal through a biochemical pathway, resulting in heightened levels of positive emotions such as cheerfulness and relaxed [18].

Agreeableness. Goldberg's IPIP Big-Five Factor Markers was used to determine the agreeableness of participants. The scores ranged from 15 to 33, out of a possible

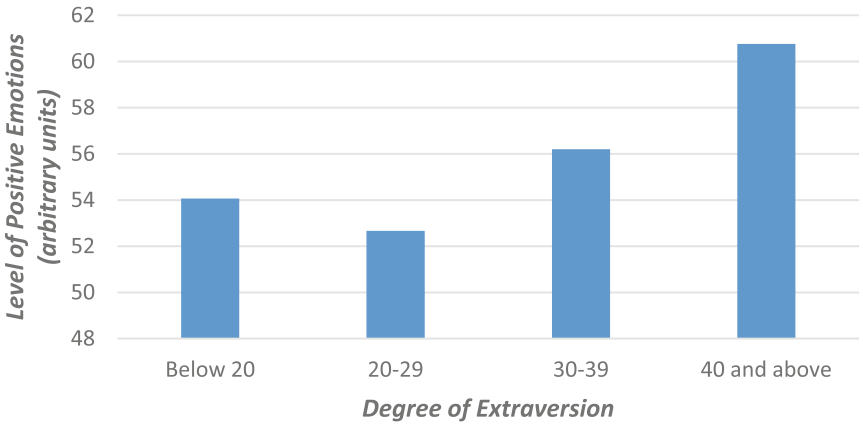

Fig. 5 Level of positive emotions against extraversion score

maximum of 50. 8.6 % scored below 20 while a majority of 74.3 % scored between 20 and 29, followed by 17.1 % scoring between 30 and 39.

Using POMS and the Big-Five Factor Markers, a very strong and positive relationship was observed between the degree of agreeableness and the level of positive emotions, as further shown by a Pearson Correlation Coefficient value of 0.929. As shown in Fig. 6, the level of emotions was lowest at 53.6 for the group with the lowest openness scores ranging from 15 to 19, followed by 55.2 for the intermediate group with openness scores ranging from 20 to 29, and the highest level of positive emotions of 60.3 for the group with openness scores higher than 30. These results are supported by a previous study, whereby higher agreeableness scores are associated with people who depend on emotion-focused coping, and hence are generally happier and more optimistic. Hence, the higher the agreeableness score, the less negative emotions experienced, resulting in a higher level of positive emotions as shown in Fig. 6.

Neuroticism. Goldberg's IPIP Big-Five Factor Markers was used to determine the neuroticism of participants. The scores ranged from 12 to 34, out of a possible maximum of 50. 42.4 % scored below 20 while a majority of 54.5 % scored between 20 and 29, followed by 3.1 % scoring between 30 and 39.

Using POMS and the Big-Five Factor Markers, a very strong and positive relationship was observed between the degree of neuroticism and the level of positive emotions, as further shown by a Pearson Correlation Coefficient value of 0.935. In Fig. 7, the level of emotions was lowest at 54.4 for the group with the lowest neuroticism scores ranging from 12 to 19, followed by 55.7 for the intermediate group with openness scores ranging from 20 to 29, and the highest level of positive emotions of 66.3 for the group with openness scores higher than 30. These results do not correspond with our hypothesis. This can be explained—though those with high neuroticism experience more positive emotions, these positive emotions are more prone to fluctuations. This is supported by a previous study which found

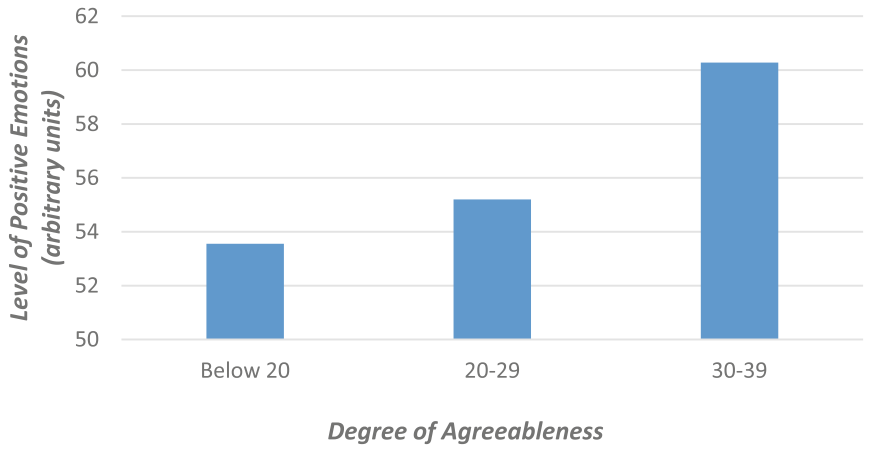

Fig. 6 Level of positive emotions against agreeableness score

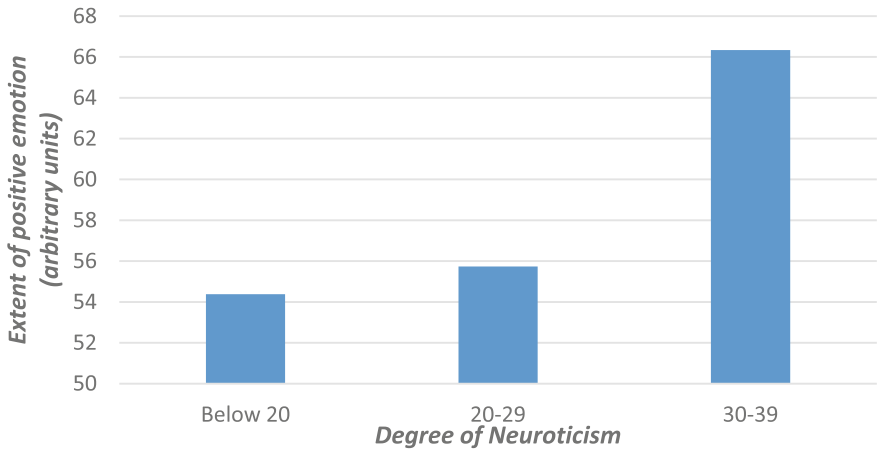

Fig. 7 Level of positive emotions against neuroticism score

people who are more psychologically healthy and stable have less variability in their positive emotions [19]. Hence, our results show that the higher the neuroticism, the more positive emotions experienced, but does not provide an indication of emotional variability.

3.3 Voice Recordings

Out of the 35 participants, only 12 participants' recordings could be processed with Praat. For mean intensity, as seen in Fig. 8, it was highest for the control

(69.23 dB), followed by Snowy landscapes (69.07 dB), Savannah (68.72 dB), City (68.69 dB), War and Military (68.21 dB), Beaches and Coasts (68.16 dB), Creeks and Lakes (67.72 dB) and lastly, Forests (67.66 dB). There was a statistically significant difference ($p < 0.01$) between the mean intensity before and after exposure to landscapes, which shows that contact with landscapes can stimulate changes in degree of emotions, as hypothesized in H_0. For mean pitch, as seen in Fig. 9, it was highest for Snowy landscapes (180.72 Hz), followed by City (180.21 Hz), Creeks and Lakes (178.07 Hz), Savannah (176.87 Hz), War and Military (176.63 Hz), Control (176.73 Hz), Beaches and Coasts (176.22 Hz) and lastly, Forests (176.01 Hz). However, there was no significant difference ($p > 0.05$) between mean intensity before and after exposure to landscapes, which contradicts the previous findings for the survey and the mean intensity. Therefore, for the voice recordings, the results are not conclusive, and more data is required.

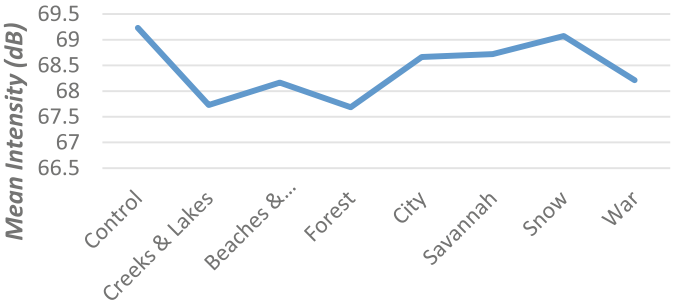

Fig. 8 Mean intensity (dB)

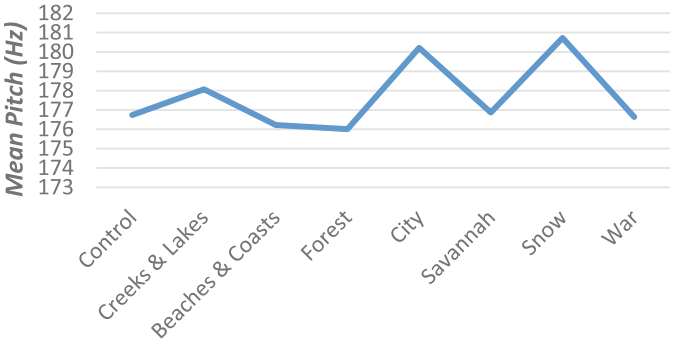

Fig. 9 Mean pitch (Hz)

4 Conclusion and Future Research

We determined that natural landscapes except for savannah stimulate positive emotions in all participants. According to our results, those who have high scores for all 5 factors experience positive emotions on a greater scale as compared to those with lower scores. This is supported by previously conducted research, in which the OCEAN factors have been linked with positive emotion [20]. Further research would be to decipher the relationship between the Big Five factors to specific positive emotions such as satisfaction, peacefulness and love. In addition, the variability and duration with which general positive emotions last can also be investigated.

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Using Biometric Data to Assess Affective Response to Media Experiences

Charlotte Thodberg Jensen, Anne Mette Karnøe Jessen, Lotte Ishøy Jørgensen, Jeanette Kølbæk Laursen, Lars Bo Larsen and Jacob Lyng Wieland

Abstract The purpose of this work is to investigate a method of measuring emotional experience by interrupting video content every three minutes to self-report. We let 16 test participants watch the short-film Helium divided into a control group and an intervention group. The subjective experiences from nine subjects (the intervention group) were captured by self-reporting via the widely used SAM pictogram scale. The intervention group was interrupted every three minutes for this. We found that interruptions induced by the self-reporting approach have negative effects on the subjects' experience. This is observed in the biometric GSR data, which shows a clear correlation between GSR measures and the interruptions, showing an average of 30 s to return to "normal" after interruptions. The intervention group's experience evaluation of the video content also support this effect, showing statistical evidence of a reduced experience when using the method of interruptions.

Keywords Emotions · Core affect · Arousal · Valence · Biometrics · Skin conductance · Galvanic skin response (GSR) · Self-reporting · SAM · Media research

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1 Introduction

The audience's emotional experience is of high priority for video content production, since the audience base their evaluation of entertainment on their emotions [1]. Research present the assumption that the audience desire a pleasant feeling when watching video content and even negative emotions can create a positive emotional experience [1, 2]. Furthermore, empathy and identification with the contributory characters add to the emotional experience [3, 4]. Identification happens when the audience gets a direct simulation of the characters state [3] and empathy occurs when the audience take on the character's emotional states; psychological perspective; and cognitive sense of reality [4]. Thus, video content should stimulate the creation of emotions, identification, and empathy in order to provide a good experience.

The purpose of this study is to investigate methods for measuring emotional experience in video content.

It can be difficult to clarify if the video content actually creates the desired emotional experience among the audience. Researchers still argue the origin of emotions [5], as it is possible to characterize emotions as a top-down or button-up process [6]. Early researchers such as James and Lange define emotions as a button-up process where we experience emotions by detecting and interpreting our physiological activity [6]. More recent theories view this as a more complex and mixed cognitive-physiological interplay [6]. Despite the complexity of defining emotions, various methods for measuring emotions are available [6–9].

Facial expressions or EEG patterns can detect emotions [6, 8]. However, facial expressions can be suppressed [10] and other factors than emotions can influence EEG measurements (e.g. minor body movements, eye movements, and sweating) [7]. Other biometrics measures such as skin conductance (GSR), heart rate, respiratory changes or pupil dilation only capture the physiological dimension of emotions [6] and they should be integrated with other measurements in order to measure all processes of emotions. Moreover, they can be hard to interpret, since other factors such as cognitive load can cause similar reactions [11].

As an alternative to biometric measurements, researchers, such as Russell argues that emotions can be recorded using self-reporting techniques, since the term people use to describe emotions is characterized by the dimensions: arousal (degree of physiological activity) and valence (pleasure/displeasure) [9, 12, 13].

Various models such as the Circumplex Model [12]; PANAS-X [14]; and the Self Assessment Manikin (SAM) [15–17] can be used to self-report emotions. However, self-report methods are often retrospective which may cause problems regarding the intensity of emotions; memory; and the time delay between the measurement and the experienced emotion. Firstly, most intense emotions are self-reported more often than less intense emotions [18]. Secondly, the more intense the emotions are, the more likely it is to be remembered when self-reporting retrospectively [19]. Thirdly, there is a risk that the most recent emotions experienced are remembered as the most intense emotions even when it is not the case [18]. Fourthly, the longer the delay between experienced emotion and self-reporting is, the more stereotype the

self-reporting will be [20]. Finally, the retrospective self-report may only contain an average assessment of all experienced emotions [18].

Based on the problems concerning retrospective self-reporting methods, [18] suggest to use cued-review to measure emotions that occur during video, which is a stimulated recall method [17]. With this method, the respondents use cues from re-experiencing the video content to recall their emotions during the video content [18]. However, this method is still retrospective, and the emotions occurring during the recall may not fully reflect the emotions experienced during the video in the first place. In addition, the method is time consuming since it requires the video content to be viewed twice.

To overcome these problems, we suggest another way of measuring emotional experience of video content. By focusing on valence and arousal as dimensions describing emotions [9, 12, 13], we apply a method where arousal is measured using GSR and valence is measured using self-report. GSR is a method for measuring arousal objectively [21] and we find GSR relatively easy to obtain and analyse. In addition, the GSR primary changes in relation to emotional arousal [21]. For self-reporting valence, we suggest that the self-reporting should be performed frequently, or even continuously during the video content, as proposed by e.g. [22]. Therefore, we apply a method of interruptions, were a short break of the video content every three minutes makes time to self-report the valence of the experience. We use the SAM for the self-reporting task [15, 16]. The method is still retrospective, but based on experience we expect that only a few emotional events will occur within in a period of 3 min, which makes this a reasonable compromise.

However, interrupting the video frequently might influence the overall experience of the video content. Thus, the purpose of this study is to investigate audience's emotional experience when implementing the method of interruptions. We will investigate this through an experiment comparing a group of respondents exposed to the method of interruptions with a control group.

In the following, we present methods used for the experiment as well as the setup. Afterwards, we analyze and present our findings from the experiment. To support these findings, we introduce a supplementary experiment. Lastly, we discuss and conclude upon the results and the method in general.

2 Methods

To investigate the method of interruptions, we set up a laboratory experiment.

2.1 Design

We use a between-subject design with a control group and an intervention group. Each participant in the control group watched a video stimulus without any

interruptions and each participant in the intervention group watched the same video stimulus with interruptions. We measured GSR on both groups using the Shimmer3 + GSR measuring device [23] at a sampling rate of 104 Hz. We used Attention Tool 5.0 by iMotions to display the video content; record the GSR data; and in general control the experiment [24].

In addition, we carried out a post test experience evaluation based on previously developed scales. The evaluation contained two parts: Part 1 measured the overall subjective experience of a video stimulus [25] and Part 2 measured the level of empathy felt for the characters [26] as well as the level of identification with the characters [27]. For both parts, we used 5-point Likert scales going from "Strongly Disagree" to "Strongly Agree".

As video stimulus, we chose the Academy Award winning short-film Helium [28]. Helium is about a friendship between a boy that is hospitalized with a terminal decease and the cleaner at the hospital. This short-film had a duration of 20 min and we judged that it had the ability to stimulate the audience emotions and create empathy and identification with the characters.

2.2 Participants

16 volunteers were recruited at Aalborg University, Denmark, using opportunity sampling. The control group consisted of 3 female and 4 male participants (M = 25.6, SD = 5.3) and the intervention group consisted of 2 female and 7 male participants (M = 22.4, SD = 2.0). None of the participants had seen the short-film Helium before. The duration of one trial was approximately 1 h.

2.3 Procedure

The participants watched the short-film *Helium* individually through a computer monitor. For the intervention group, we interrupted the short-film every three minutes, so that the participants could report their emotional valence via a paper version of the SAM scale [15, 16]. The participants controlled the duration of the interruptions, which were typically less than 10 s. The facilitator was present throughout the trial, but sat behind a room divider to reduce potential stress on the participants during the video and self-reporting phases. The participants filled out the experience evaluation questionnaire immediately after the video session.

3 Results

In the following, we present results from the experiment. As we focus on the effects of the method of interruptions, we are not concerned with the participants' actual experience of watching the Helium short film. Instead, we focus on a statistical analysis of the experience evaluation as well as the GSR data.

3.1 Results from the Experience Evaluation

We analyzed the answers from the experience evaluation by averaging the scores for each part. The scales used to measure the subjective experience of the video content (Part 1) and the level of felt identification and empathy (Part 2) have been individually validated [29–31], but not in combination and not in the present context. Therefore, we carried out a Cronbach's Alpha (CA) test to verify the internal reliability. Lounsbury et al. [32] recommends a CA value not lower than 0.75 and preferably above 0.80. After a few adjustments, the CA test resulted in a CA value of 0.94 for Part 1 and CA value of 0.80 for Part 2. The corrected item-total correlation (r-value) describes the correlation between individual statements and the mean of all other statements combined [32]. Thus, the r-value is a representation of the reliability of the individual questions and should be 0.4 or higher [32], which was also the case here for all items in Part 1 and Part 2.

We carried out a two-tailed unpaired t-test (equal variances) for each category comparing the control group with the intervention group (N = 16). This showed a difference between the two groups for both categories. For Part 1 we found a strong tendency ($t = -2.09$, $p = 0.055$) and for Part 2 we found a significant difference ($t = -2.21$, $p = 0.043$) at a significance level of 0.05.

3.2 Results of the GSR Data Analysis

The GSR data is split into two parts: a tonic and a phasic driver. To examine the level of arousal, we only focused on the phasic driver, since this changes instantly when exposed to a stimulus (an emotional event), whereas the tonic driver varies slowly over time. In general, the phasic activity can be characterized as peaks [33] and a high arousal is characterized by a high peak amplitude and high peak frequency [21]. To identify the high arousal peaks, we used the Ledalab Matlab Toolbox to extract the phasic driver from the GSR signal [33, 34].

First, we analyzed the GSR peaks from the control group. Participant 6 from the control group was not included in the analysis due to technical errors. Based on the analysis, we extracted the 15 highest peaks from each of the remaining participants in the control group. We compared these peaks and were able to identify seven

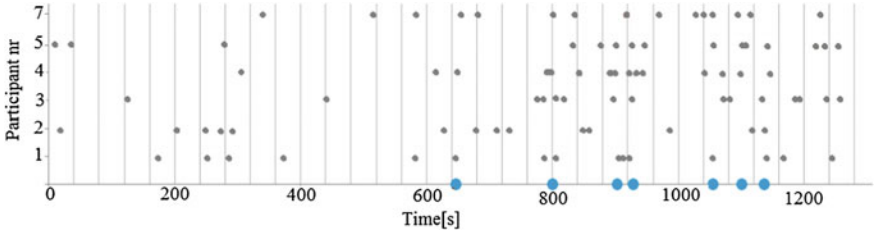

Fig. 1 Arousal peaks for the control group. A *grey dots* denotes an individual peak and the *blue dots* indicates where 3–5 participants peaked in the same 10 s interval

common high-arousal events during the video content (see Fig. 1). We defined a high arousal event as when at least half of the participants peaked within the same 10 s interval. These peaks match narrative events in Helium, where we would expect a high emotional engagement. The events are found in the second half of the movie and are grouped towards the end as shown in Fig. 1.

Secondly, we analyzed the data from the intervention group. This showed that peaks caused by the interruptions were the most dominating (see Fig. 2). This suggest that the interruptions had an effect on the intervention group. Moreover, this effect was still present in a prolonged period after the interruptions, when the video content was resumed.

To investigate this effect, we estimated the recovery time defined as the time it takes for the GSR level to return to the level it was before the interruption. Figure 3 shows the recovery time for the interruption peaks. The median was 30 s and the quartiles (24.5 and 35.6 s) were quite close indicating a high agreement between participants. This indicates that the interruptions influence the arousal in approximately 30 s after each interruption.

As the interruptions caused the highest peaks, we removed these and identified the 15 highest peaks. We found only a limited agreement between the two groups, when compared with the intervention group. At the 10 s interval described above, we identified only one co-occurring event. Increasing the interval to 15 s, we found only four of seven events co-occurring with the control group.

Summing up, the method of interruptions has clear and dramatic effects on the GSR data. It is, however, still unclear exactly how the interruptions cause this disturbance.

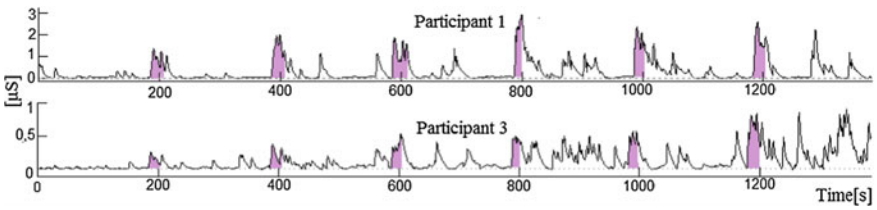

Fig. 2 Phasic driver for participant 1 and 3 from the intervention group. The *marked peaks* indicate peaks caused by the interruptions

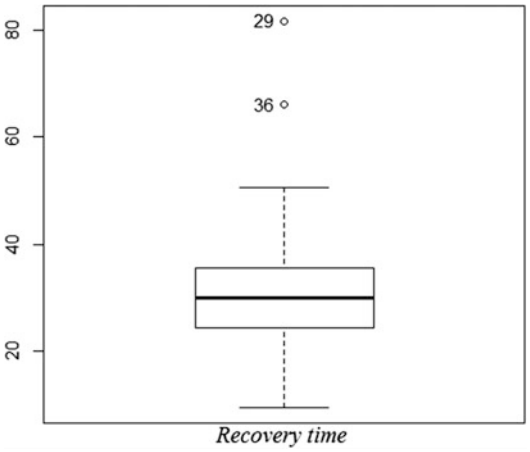

Fig. 3 Boxplot for the intervention group's recovery time after interruptions

3.3 Supplementary Experiment

We repeated the intervention experiment with the purpose of investigating whether it was the interruption of the video content or the *act* of physical and cognitive self-re porting that caused the peaks at interruptions. We recruited a new group of 1 female and 4 male participants (M = 40.4, SD = 10.7). The only adjustment in the experimental setup was the interruptions, which were fixed to 10 s and contained no self-reporting task. Instead, the participant remained physically inactive and only watched a black screen. The video stimulus was the initial 540 s of Helium with interruptions every 3 min.

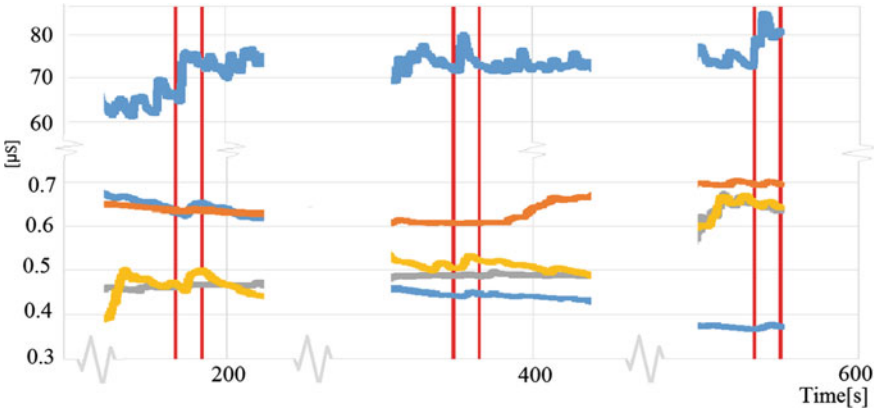

Fig. 4 GSR data showing peaks when being interrupted. Interruptions are between the vertical *red lines* spaced 10 s apart. The *five lines* represents GSR data from each participant

The results showed that the GSR data had a similar pattern as the intervention group during the interruptions (see Figs. 4 and 2). All participants peak, when an interruption occur, even though they were completely inactive physically and had no cognitive tasks to perform. This result indicates that the interruption itself causes GSR peaks.

4 Discussion

This section discusses the implications of the findings presented in the previous section. The discussion focuses on the practicability of the method of interruptions and the influence of the experimental setup.

As illustrated on Figs. 2 and 4, the GSR intensity and number of peaks varied considerably among the participants. Likewise, it has been found that the emotional experience can vary considerable for different persons experiencing the same media [13]. This could be a problem when comparing peoples measurements and call for a within-subject experimental design. However, we judge the present design was able to show the effects of the interruptions reliably, since we saw a high agreement between participants *recovery time* shown in Fig. 3, and since we were able to identify common high-arousal events for the control group. Overall, we accept the GSR data as a reliable indicator for detecting high arousal events in settings similar to the one used here.

Even though we accepted the GSR measurements as a reliable method, interrupting the participants during the video content affects the experience. The supplementary experiment showed a peaking pattern similar to the intervention group, even though they were completely inactive physically and had no cognitive tasks to perform. This indicates that the interruption itself can cause a high arousal event regardless of the self-reporting method. Furthermore, results from the experience evaluation showed that the intervention group expressed a less positive experience of the video content and a lower level of identification and empathy with the characters. These results, together with the GSR data results, indicates that the method of interruptions is not a valid method for measuring emotional experience. Consequently, the measurements will not fully reflect the audience's emotional experience, when using the method of interruptions. Indeed, our findings show the emotional experience will be reduced; the phasic peaks will be unreliable; and the arousal measurements will be affected the following 30 s after an interruption (i.e. 20 s after the interruption ended). It is therefore still unclear how to measure arousal and valence continuously during video content without affecting the experience.

A solution to reduce the self-reporting effects could be to only place interruptions at predetermined points, where no significant emotional events are expected to occur within the following 30 s. These points could be extracted from a narrative analysis of the video content and ideally be placed right after expected high emotional events. This strategy will work as long as high-emotional events do not occur too frequently, i.e. within more than 30 s between each event.

5 Conclusion

Based on our findings, we conclude that interruptions induced by the self-reporting approach have a clear effect on the participants, thereby influencing the emotional experience negatively. Several factors have evidence for this. GSR data supports it, since only a few peak events from the intervention group occurred at the same time as events from the control group. Moreover, the experience evaluation showed statistical evidence for a less positive emotional experience and reduced identification and empathy with the characters. In addition, we found reliable evidence of a 30 s recovery time after interruptions, showing the disruptive effects are persistent over a prolonged period of time. We conclude that interrupting the video content frequently at fixed intervals is inappropriate for subjective self-reporting. Instead, we recommend that interruptions should be carefully placed according to a prior narrative analysis and that the method will be unreliable for video content containing clusters of high-emotional events spaced less than 30 s apart.

Furthermore, we were able to identify common events with high emotional response from the GSR data across the control group, indicating GSR indeed is a reliable measure for automated detection of emotional arousal to video media.

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Attribution of Meanings to Eco-materials Through the Expressive-Sensory Experience

Stefania Camplone

Abstract In recent years we are witnessing the spread of plastic materials with ecological characteristics derived from food waste that, if on the one hand, they solve some problems related to the environmental impact, on the other hand are often considered poor, unreliable and unsightly, and so little regarded. The possibility of giving them a specific "personality" and thus to define and enhance the aesthetic character may contribute to their widespread use. The paper presents the results of a research experience as part of a Design Course held in the Department of Architecture of Pescara. The research focuses mainly on one aspect: to explore how eco-friendly materials are used for the creation of meanings and how they get different meanings in different user products. The research objective was to verify whether it is possible to attribute, through the expressive-sensory experience, specific "meanings" to ecological materials, thus starting the definition of their own specific "personalities".

Keywords Eco-materials · Expressive-Sensory features · Personality of materials

1 Introduction

The European Bioplastics Association has defined a specific class of polymers, with approved biodegradability according to EN 13432, by including both polymers derived from renewable sources, such as corn, sugar cane, potato starch or castor oil, both those of fossil origin. These are the first eco-friendly solutions appeared on the market. For example by extracting the starch from corn, it is possible to use it directly in order to obtain a thermoplastic polymer, or it is possible to ferment it to obtain lactic acid and, subsequently, polylactic acid (PLA).

In particular, the latter found its first applications in disposable products, and it is the biopolymer that is still most commonly used for most common uses. Yet,

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Advances in Intelligent Systems and Computing 483,
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despite the numerous application possibilities and respectable performance, acceptability and therefore the affirmation of these new materials on the plastics market are still not entirely satisfactory.

Still today, in fact, too often there is a widespread feeling that "green plastics" are low-performance materials, not very durable and resistant, unreliable and unsightly. It is important to understand the reasons why, in order to attribute a dignity and a central role to biopolymers in the world, in itself complex, of over one hundred thousand plastic materials available today.

2 Objective

This contribution presents the results of an experiment carried out as part of a Design Course held in the Department of Architecture of Pescara, whose intent was to define a methodology to analyze the issues of "identity" of biopolymers, also called "eco-materials", and in particular of the PLA, identifying its sensory properties and giving them a specific communicative "meaning".

Parallel to a scientific objective, that experience made it possible to also pursue an "educational" goal, which is to introduce students to research activities, through a concrete experience carried out with all the attention and rigor necessary to obtain objective results and comparable.

3 Method

The research presented in these pages dealt with the complex issue of sensory expressiveness of materials. In fact, the universe of products around us is related substantially with our senses: sight, touch, smell, hearing and taste.

In particular, the surfaces of objects, interacting with our sensory system, also stimulate our intellectual and emotional reactivity. it is therefore legitimate to ask what role the materials (and associated production technology) can play in arousing emotions through the transmission of sensory information, and even if one can speak of a specific "language" of materials. This is a particularly useful information, also in view of the fact that the "emotional" component is one of the major factors in the purchasing preferences of a product compared to another, and therefore of its market success.

On that basis, the research begins with some studies referred to the "meaning" of materials conducted by a research team at Delft University of Technology.

In particular, research has used the same research protocol developed by professor Elvin Karana [1, 2], which is based on a system with icons useful to assess the sensory characteristics of materials from a sample of users, divided into groups.

A structured system of questions has collected "sensorial" information from touching (tactile, visual, olfactory) the samples of materials used for the test, as well as information related to their expressive "meaning", referring to their symbolic qualities. In both cases, these are subjective information which, revised with statistical methods, may regain a level of objectivity helpful to understand the current level of appreciation by the users.

In any case, the studies of the Delft research group studies are based on two main principles.

The first is that often, even in ordinary language, to describe the expressive characteristics of the materials, are used words similar to those used to describe a person, rather than strictly observe their physical qualities. So we have such words as: ATTRACTIVE, ELEGANT, FUTURISTIC, ROMANTIC, CRAFTS, KITSCH, SURROGATE, SOBER, SEXY, NOSTALGIC, CHARISMATIC, VULGAR, LIVELY, ARTIFICIAL, RETRO', PRIMITIVE, PROFESSIONAL, SOPHISTICATED, POOR, RICH, SHOWY, HISTORICAL, FEMALE, MALE, DULL, RELIABLE, SURPRISING, NATURAL.

The second principle is that the identity of a material derives from its consideration, or rather from its reputation, so as it has been defined in the minds of users. And it is just through this process that you can define the "personality" of materials.

Based on these principles, the research was divided into four phases.

3.1 Identifying the Sample of Users

Three samples of PLA material were used for the research.

Starting from the human ability to perceive through the senses and make judgments of intensity and satisfaction, it has been carried out a so-called "sensory" analysis with respect to each material sample. In particular, we have referred to a definition of the American Society for Testing and Materials Institute of Food Technologists, which describes the sensory analysis as «a scientific method used to awaken, measure, analyze and interpret those responses to products that are the outcome perception through the senses of sight, smell, touch, taste and hearing» [3].

For this purpose, the research was conducted on a sample of users divided into four groups, each composed of six members, defined as follows:

- GROUP 1: students of Architecture, 3 males, 3 females, mean age 28 years.
- GROUP 2: College Students of Engineering, 3 males, 3 females, mean age 22 years.
- GROUP 3: unrelated to the academic or professional world (non-experts), 3 males, 3 females, aged 25–75 years.
- GROUP 4: experts or professionals in the materials sector (engineers, designers, materials dealers, etc.), 3 males, 3 females, aged between 25 and 75 years.

This articulation of the sample of users was dictated by the will to consider different cultural backgrounds, life experiences and interests, on the assumption that they translate into different sensory experiences.

3.2 The Materials Evaluated

A specific focus has been reserved for the identification of the natural plastic material most suitable for carrying out the test. three PLA elements were selected: they are actually three production "scraps", each with its own surface finish and the appearance of which, deliberately, is not well defined and linked to a specific form.

3.3 The Test Development

The sensory analysis was conducted by subjecting to the users the same list of sensory properties in reference to the three samples of PLA materials: these properties actually has formed the so-called "vocabulary" of the sensory descriptors. The entire course of the test, however, is designed in reference to a specific technique of descriptive assessment used to define the sensory profile of a product (QDA, Quantitative Descriptive Analysis) [4], widely spread in the literature, both for the simplicity of experimental procedure and for the speed of collection of the information.

The analysis was intended to collect all the sensations felt during the evaluation of each sample of material. In particular, the survey protocol is divided into four phases:

1. definition of the dictionary of the sensorial descriptors of the materials;
2. development of reference standards for each descriptor, corresponding to the maximum intensity value on the used rating scale;
3. evaluation of the intensity of each descriptor of the product concerned;
4. Statistical analysis and interpretation of results.

Specifically, the time of the assessment involves a period when each user becomes familiar with the three samples of material object of study and describes them using a specific list of previously selected sensorial descriptors uniquely identified by the research team. therefore, each user is required to use these words only to express their perceptions. Moreover, during the evaluation each user must also express its own quantitative judgment on the intensity of each descriptor referred to each analyzed sample, indicating a value on a scale from −2 to 2. The final profile is obtained by reporting the values for each descriptor on the axes which defines the main sensory profile of the product, offering a immediate quantitative-descriptive perception of the material (Fig. 1).

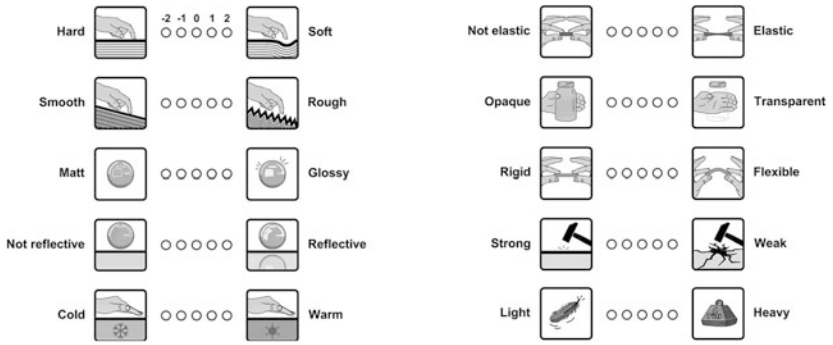

Fig. 1 Sensorial properties more commonly used for attributing meanings to materials

3.4 The Survey

The second part of the test consists of twelve questions, in open and closed response, of various kinds. In particular, during the test it is never revealed to the user who submits the questionnaire the nature of the three samples of material that he is seeing and touching, not to affect his judgment and leaving him free to express any emotion or mental association. In this way it was possible to obtain a particularly rich framework of judgments with respect to three samples of observed materials.

In particular, the questions try to understand if the user acknowledges the material and if he associates it with something known, as well as to collect opinions regarding the possible applications and the reliability of the material. Other questions, however, more evocative, urge the user to associate the material to something else than the sensorial characteristics. The last questions, finally, want to collect opinions and judgments of a general nature in respect of eco-plastics: This to acquire how the prejudice was significant in considering these materials of low economic and aesthetic/performance value.

4 Results

The test allowed to define a clearer framework of what are the expectations of people with respect a new plastic material with decidedly "green" features. The following figures show the values assigned to the three samples with respect to the perceptions and sensations of the four groups of people who participated in the test.

4.1 Group 1

Students of Architecture, 3 males, 3 females, mean age 28 years (Fig. 2).

From the chart it follows that the second sample is perceived more soft and elastic, while the third is perceived more smooth than the other two, although presenting characteristics similar to the first.

The questionnaire also provided a specific identity to each material sample as described below (Fig. 3).

In reference to the "identity" of the three analyzed materials, the first is considered "reliable", the second "surprising", while the third "attractive." From the responses to the questionnaire however result considerations contradictory to each other, resulting from lack of knowledge of the material, however, considered of little value.

4.2 Group 2

College Students of Engineering, 3 males, 3 females, mean age 22 years (Fig. 4).

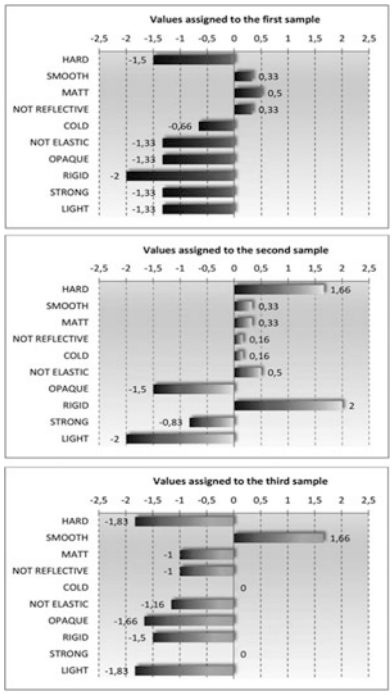

Fig. 2 Group 1: graphics of the "perceptions" of the three materials

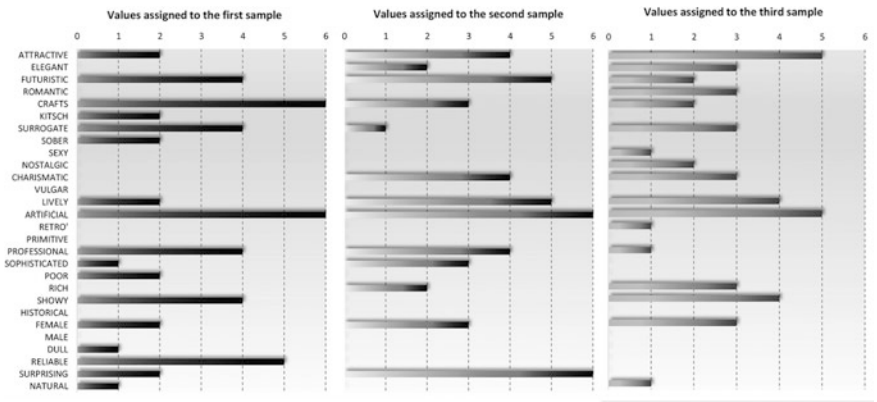

Fig. 3 Group 1: graphics of the "identity" of the three materials

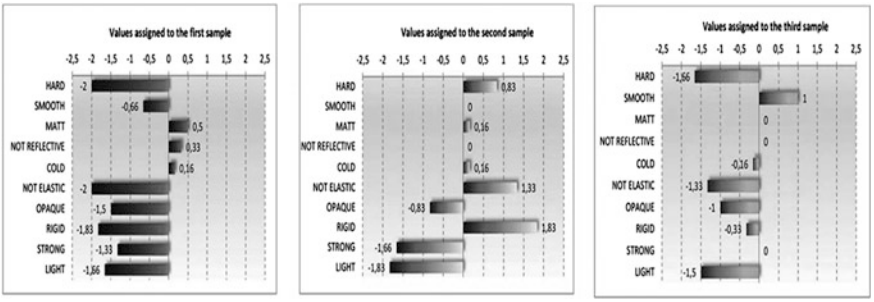

Fig. 4 Group 2: graphics of the "perceptions" of the three materials

In this case the elements highlighted are the "reflectance" factor, which is perceived only moderately in the first sample while in the other two don't appear, and the "smoothness" factor, that is attributed only to the third sample (Fig. 5).

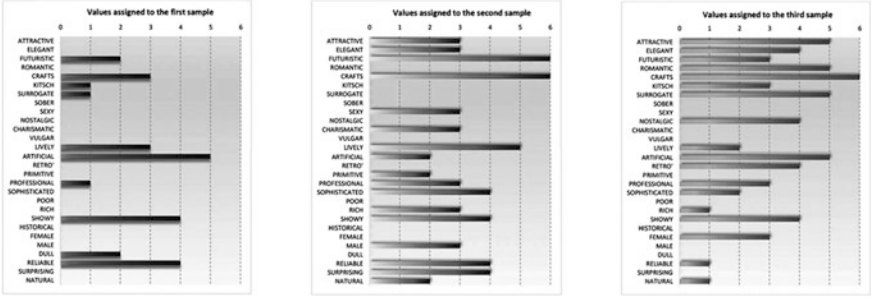

Fig. 5 Group 2: graphics of the "identity" of the three materials

Among the answers to the questionnaire the concept of durability prevails, while reliability seems to be more important for the first two samples compared to the third. Among their possible applications suggested by the users, mostly referred to the first group, those in the sectors of interior design, building components and coatings in the automotive sector prevail.

4.3 Group 3

Unrelated to the academic or professional world (non-experts), 3 males, 3 females, aged 25–75 years (Fig. 6).

People who never had direct design experience recourse to a vocabulary derived directly from their own experience. As their perception of materials is independent from known forms, their comment was particularly complex, and as a result they have resorted to words particularly interesting because unusual. For example, the first sample was attributed to the term "plasticaccia" (bad plastic), despite having perceived it harder and smoother than the other two, and thus appreciating it as less "extravagant" and therefore more reliable (Fig. 7).

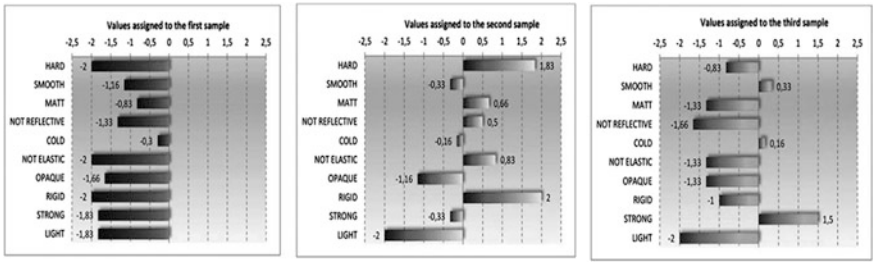

Fig. 6 Group 3: graphics of the "perceptions" of the three materials

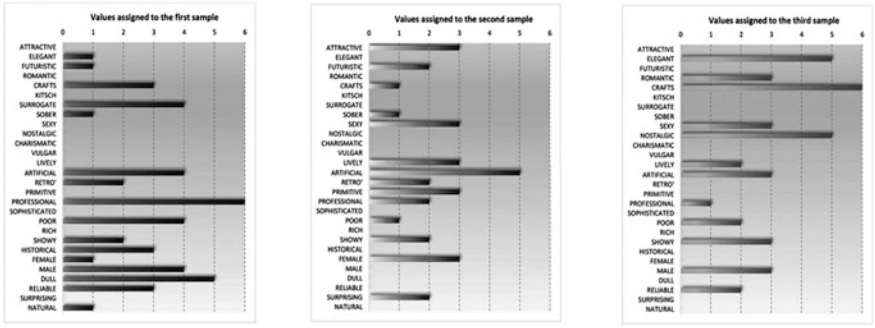

Fig. 7 Group 3: graphics of the "identity" of the three materials

The surface finish of the samples was not appreciated: in the first sample it was criticized the white color (easier to get dirty and therefore unhygienic). Regarded as low value and therefore not very durable, it evokes the materials used for pipes, water conduits for plumbing and outdoor furniture objects.

4.4 Group 4

Experts or professionals in the materials sector (engineers, designers, materials dealers, etc.), 3 males, 3 females, aged between 25 and 75 years (Fig. 8).

The vision expressed by the experts generally appears much more clear of the previous cases.

Also the answers to the questionnaires were very thorough and comprehensive. The possible applications, in fact, range from street furniture to valuables high sensory profile as furniture, electronics, automotive components, structural elements (Fig. 9).

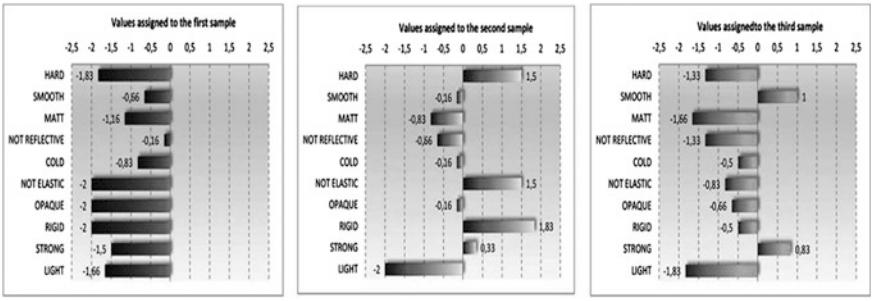

Fig. 8 Group 4: graphics of the "perceptions" of the three materials

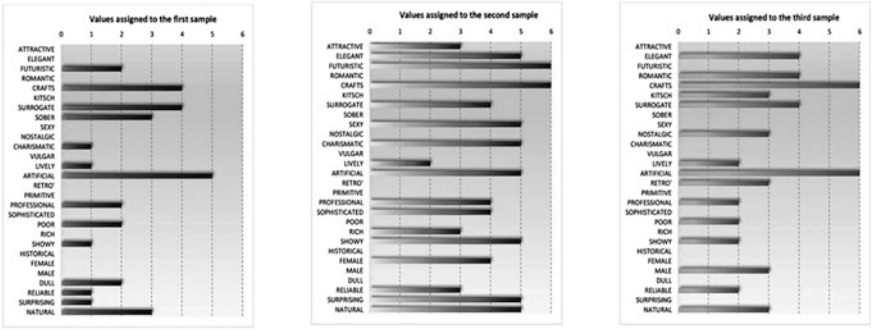

Fig. 9 Group 4: graphics of the "identity"of the three materials

In this case the surface finish is less appreciated, although this group recognized that this factor is determined by the processing that these samples have not undergone because of their being production waste. Many consider the analyzed samples precious for their characteristics of versatility in coloring and conformability, that make them comparable to polymers.

5 Conclusions

The research has shown that it is possible for biopolymers to identify the sensory properties in a sufficiently objective, giving them a specific communicative "meaning", until get to define a specific "identity".

This allows to anticipate scenarios and new contexts in which applications could be developed, consistent with the characteristics of the new materials. These, however, until now have been considered only as simple surrogates of more "noble" plastic materials.

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Tackling Design Fixation of Cultural Product Designers Through Homeomorphism

Edward C.K. Hung

Abstract Design fixation affects the emotion of a designer and so the quality of his design. This paper is to explore how an understanding of cultural product design through homeomorphism—a mathematical concept—can assist in tackling design fixation of cultural product designers. In particular, homeomorphism offers a scientific viewpoint toward a cultural product, dissecting it into structures and features that are all bounded by cultural rules and influenced by biases, the functions of rules, that shape their manifestations. The features define the variants of a cultural product, while the structures define its invariants. This paper concludes that homeomorphism in cultural products tells cultural product designers what to change and what to reserve, providing a means for them to tackle their design fixations.

Keywords Cultural product · Design fixation · Homeomorphism

1 Introduction

Design fixation is a designer's blind adherence to a set of ideas [1]. Sapp [2] names this point in time during a human creative process as the point of creative frustration, referring to "a sense of stagnation or frustration" of a designer, dampening his emotion. This point of creative frustration can bring out "crucial and conscious decisions" affecting the manifestation of a creative work. Sapp claims that "[i]t is at this point that the individual chooses how to proceed; he or she makes choices which will determine whether or not the problem will be solved and whether or not the product will acquire creative significance" [2].

This paper specially investigates the application of homeomorphism in cultural product design to the design fixations of cultural product designers. It aims at exposing the nature of cultural product scientifically and therefore, defining a new

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way to tackle the relevant design fixation, revealing the possible creative solutions. Herein, cultural products are nonmaterial goods embodying lives, aesthetic and utilitarian purposes, one-of-a-kind performances and/or unique sets of ideas [3]. These cultural products include clothing fashion, furniture, narrative, and popular music—all under the strong influence of the mainstream of a culture. This paper adopts a prescriptive model of design to describe cultural product design through homeomorphism and suggest a new way tackling the relevant design fixations.

In the following sections, this paper will first review design fixation and cultural product in details. It also discusses the current methods of tackling design fixation. Then, it refers to homeomorphism—a mathematical concept—to describe the nature of cultural product, ontologically; and suggests a new way for cultural product designers to tackle their design fixations.

2 Literature Review

2.1 Design Fixation

Youmans [4] summarizes different definitions of design fixation and states that it happens when a designer has unconsciously forged a new design that owns the features of another design. The designer is trapped in a fixation. Smith et al. [5] emphasize that design fixation, a conformity effect, happens to both novice and professional designers. Vasconcelos and Crilly [6] add onto theirs and highlight that design fixation can reduce a designer's "propensity to move effectively between the conceptual space (of abstract ideas) and the configuration space (of potential solutions)."

A possible way to tackle design fixation is to use a morphological chart to list down a matrix of possibilities that might stimulate the thinking of a designer. However, this may create another paradox about where to gather the possibilities, how to rank them and present them in a creative way. Furthermore, Sio et al. [7] claim that design fixation can be tackled by the common-ness (typical knowledge and approach), richness, and modality (timeliness) of examples—the properties of examples. In addition, Atilola et al. [8] stress that an exploration of the representations in idea generation, such as the use of a function tree, can help tackle design fixation. Nevertheless, all these methods remain ad hoc, and are, therefore, difficult for a designer to prepare and learn in advance.

2.2 Cultural Product

As described in the introduction, cultural products have both aesthetic and utilitarian purposes. A pair of scissors that only carries utilities but not beauties

(representing the trend of a culture in a specific period of time) as well as a brooch that only has beauties but no utilities does not fall into our discussions. Then, what enables them to hold beauties and utilities? We refer to the studies about societal and institutional views on cultural products as well as the typology of cultural products for the answers.

Peterson and Anand [9] claim that there are societal and institutional views on cultural products. The former concerns the values of cultural products and their retardation over time. The latter focuses on their production aspects and rapid changes in expression. In other words, there are changing expressions in the retardation of cultural products. It is possible to further interpret the retardation as having stable structures in cultural products. These structures support different expressions, as institutionalization is part of a society that allows tautology in cultural products such as the co-existence of retardation and rapid changes in expression. Note that the different expressions are like features running on structures.

In the typology of cultural products by Deinema [10], cultural products can be universal, culturally inclusive, or culturally exclusive. A universal cultural product is "widely used, recognized and understood around the world." The use of English in a cultural product is an example. A culturally inclusive cultural product requires "culturally-specific heritages, knowledge and tastes," but not limited to a particular culture. It encourages cultural hybridity. World music is a culturally inclusive product. Lastly, a culturally exclusive product is produced, understood, and appreciated by a specific culture. It involves "intricate and refined expressions of traditions" developed through a long period of time. In the production of such a culturally exclusive product, the intricate and refined expressions are similar to biases that shape the product to fit the relevant culture. Cantopop (popular music in Cantonese) is an example of a culturally exclusive product.

According to the analyses by Deinema [10], Peterson and Anand [9], cultural products do consist of structures, features, and biases. They are all bounded by rules, a more general term for Zeigeist. Hung and Choy [11] also claim that a creative work in the form of a cultural product is consisting of these four components—rules, structures, features, and biases. They further characterize features as "attributes of a creative work that a user can easily detect through his five senses," structures as hidden parts that need our analyses to identify them, and biases as "functions of rules preferred by a culture in a specific period of time affecting the manifestation of a creative work." An example of cultural products that own these four components is clothing fashion with fashion theory as the rules; fabric combination and cutting as the structures; color, weight, and texture as the features; age group, social class, and occupation of a target market as the biases.

Hung and Choy [11] further develop a creative work ontology specially catered for cultural products with their four components as the ontological properties. The creative work ontology also focuses on mereology and topology of cultural products, referring to the connected-to and part-of relations between different parts of a cultural product as well as their connections, respectively. This paper is based on the availability of topology in the creative work ontology concerning cultural

products and therefore homeomorphism as regards the connections between the different parts of a cultural product to shed a new light on tackling design fixation in cultural product design.

3 Methodology

This paper refers to prescriptive model of design to define a new way to tackle design fixation in cultural product design. The prescriptive model is about how a design process should happen and what attributes a design artifact should embrace [12]. In this paper we also try to describe cultural product design based on our observations and analyses and suggest using homeomorphism to do so and further define a new way to tackle the relevant design fixation.

4 Homeomorphism in Cultural Products

In this paper we do not delve into mathematical jargons to explain homeomorphism. Readers can refer to Hung and Choy [11] for a technical discussion of it regarding a creative work in the form of a cultural product. Instead, we provide an intuitive explanation of it highlighting its transformation. Figure 1 shows the most famous example of it stretching a donut (torus) into a teacup.

Homeomorphism allows two entities or parts to share the same set of topological properties though they have different appearances. As shown in Fig. 1 the donut and teacup look completely different but they are topologically the same. Is this phenomenon available in cultural products?

Referring to the discussions by Deinema [10], Peterson and Anand [9], cultural products have stable structures and changing features. Hung and Choy [11] even coin these characteristics of cultural products as the axiom of the creative work ontology, namely, the balance between novelty and appropriateness. The novelty happens through features that are affected by biases representing a trend, while the appropriateness is offered by the stable structures. A new cultural product can be derived from an old one provided that they belong to the same category in a specific period of time and therefore running on the same set of stable structures. As discussed by Hung and Choy [11], a part of a cultural product can also be deduced from another part of it. In other words, cultural products are topologically stable

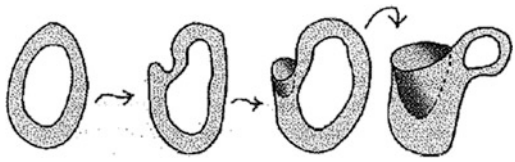

Fig. 1 The transformation of a donut (torus) into a teacup due to homeomorphism [13]

despite of their different exteriors. This nature of them is in response to the axiom of the creative work ontology as well as the concepts of homeomorphism.

Examples of cultural products that incorporate homeomorphism include (i) popular music that always run on the same harmonic structures while offering different catchy tunes; (ii) T-shirt design that keeps the same cutting but often varies in collars and colors.

In fact, several scholars have already applied topology to describe creative works [14–16]. Yoshikawa [17] specially highlights the importance of topology in design in his general design theory (GDT). Reich [18] has a good summary of it in his critical review of GDT:

> A *transformation* that conserves the continuity or convergence properties is useful in design because it allows creating different viewpoints of the desired functionality and the partial design description that may simplify or direct future design steps. In topology, such a transformation is called *homeomorphism*.

GDT states that a mapping between function space and attribute space is continuous. It does support the use of topology and homeomorphism in the design of cultural products.

When cultural product design can be described by homeomorphism emphasizing the preservation of structures and novelty in features that are influenced by biases, it is possible for a cultural product designer to identify the scope of changes in a cultural product to tackle design fixation. Homeomorphism in cultural product design hints the following two steps to tackle design fixation:

1. *Define the Structures, Features, Cultural Rules, and Biases of a Cultural Product.* Referring to Sio et al. [7], it is possible for a cultural product designer to gather a certain amount of examples to tackle design fixation. Instead of analyzing their different properties including commonness, richness, and modality, we suggest generalizing them into structures, features, cultural rules, and biases. The cultural rules control the combinations of structures and features. The structures provide a robust foundation for changes to happen in features leading to novelty. The biases define the current trend affecting the selections of features to form a new cultural product.
2. *Create New Rules or Allow Rule Changes to Have New Features.* Since the existing cultural rules are already controlling the combinations of structures and features, there is a need to break an existing cultural rule or even make a new one to facilitate a new combination of structures and features to happen. Homeomorphism implies the limitations of a cultural product and urges for a breakthrough.

We use a simple case study about the Fitbit Flex accessory band to illustrate the application of homeomorphism in cultural product design to tackling a Fitbit Flex accessory band designer's design fixation regarding the need of a stylish wrap cover. Figure 2 shows three images about the existing Fitbit Flex accessory bands.

In this simple case study, the possible structures include the use of a lightweight plastic material with a length about 6 3/8 inches to support the features that can be

Fig. 2 A Fitbit flex with its tracker taken out and its accessory bands [19]

itemized as color, pattern, wrap cover, fastener, and clasp. One of the rules states that a non-studded brushed metal concealed pouch cannot be attached to a Fitbit Flex accessory band due to unstable connection. A possible design fixation is that a Fitbit Flex accessory band designer has no clue about designing a stylish wrap cover. Referring to our previous discussion on homeomorphism, the designer can first define the structures, features, rules, and biases of certain number of Fitbit Flex accessory bands. Then, he can identify certain rules that can be changed or even implement new rules to allow new features to happen, forming a new stylish wrap cover for a Fitbit Flex accessory band. A possible solution to the design fixation could be a fake jewelry wrap cover.

5 Discussion

Using homeomorphism in cultural product design to tackle the above design fixation implies two points. Firstly, new cultural products happen with reference to the topological properties, especially rules and structures, of previous cultural products. This defines the scope of changes in cultural products—features, guiding cultural product designers to tackle their design fixations. Secondly, homeomorphism implies the limitations caused by previous cultural products. If a cultural product designer is aiming at having a brand new feature that is not supported by any existing structures, a new rule or rule change is needed. These two points reveal the practicality of homeomorphism, describing the nature of cultural products and defining a generalization for the solutions to design fixation in cultural product design.

Mumford et al. [20–22] suggest a cognitive approach in their discussions of the process-based measures of creative problem-solving skills. They claim that problem construction on an ill-defined problem based on certain categorical structures can help us derive a creative solution. In this research study, a design fixation can also be an ill-defined problem to its cultural product designer, giving him/her the point of creative frustration. Then, problem construction is followed by information encoding, category search, specification of best fitting categories, and combination and reorganization of category information in the process-based measures of creative problem-solving skills [23], leading to our future work for this research study.

6 Future Work

With this research study as the foundation work, we will work out a comprehensive case study about applying homeomorphism of cultural product design to tackling a specific design fixation in the future. We will also invite a number of practitioners to participate in the experiments to verify the practicality of homeomorphism in overcoming design fixation.

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A Trial on Systematic Terminology Approach to Aid for Delight Design

François Charles Rovere, Tamotsu Murakami and Hideyoshi Yanagisawa

Abstract To design a delightful product, kansei of customers as well as technical requirements should be considered. Kansei engineering has been developed and implemented with different approaches, depending on the prospects and goals. It has been evolving and separated in important categories and this research aims at providing a new way, more systematic, to consider kansei engineering and to implement it in product development tools. In order to do so, data mining and population studies are important factors to cope with. The main prospect of this research is to provide this new kansei engineering methodology taking two inputs, a defined population and a defined product, and delivering one output, design advices that would enhance chosen emotions and the delight of customers. Such a methodology is thought to be implemented in a software.

Keywords Delight · Kansei engineering · Systematic terminology · Wordnet · Polarity · Co-occurrence · Product development · Ergonomic · Representativeness

1 Introduction

Design is and has always been a major concern for industrials in the development process of a new product in order to meet the satisfaction and maximize the delight of the customers. Nevertheless, as aesthetics is highly and mostly a personal and

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private evaluation made by humans, the difficulty to design a product that could reach the requirements of a population of individuals increases with the number of individuals in this specific population. The latter can be divided in subgroups with individuals sharing the same characteristics and traits but the difficult dwells in the fact that it is extremely common for a company to target populations larger than those subgroups. In other words, there is no easy way to maximize the delight of all the individuals targeted with a specific design.

Nevertheless, systematic approaches have been developed in order to assess the emotions and the feelings of individuals while in contact with a product. The one this paper will treat is the kansei approach. The goal of the research is to provide a tool that could take as input a product and a targeted market, and deliver a design assistant tool based on the kansei methodology as output.

2 Kansei Engineering

Created in 1988 by Mitsuo Nagamachi in Hiroshima, the kansei engineering is defined as "translating technology of a consumer's feeling and image for a product into design elements". Different from the chisei, as it only deals with emotions, the main goal of the kansei approach is to link people's feelings to specific traits and characteristics of the product in order to understand to which extend a trait interferes with a feeling.

In 1997, in order to provide a harmonized definition of the state of the art concerning the kansei engineering, Mitsuo Nagamachi divided into six different categories his invention [1, 2]:

- Type I—Category Classification
- Type II—Kansei Engineering System
- Type III—Hybrid Kansei Engineering System
- Type IV—Kansei Engineering Modelling
- Type V—Virtual Kansei Engineering
- Type VI—Collaborative Kansei Engineering Designing

2.1 Ambitions

As mentioned in the introduction, the goal of the research is to provide a design assistant tool that is ergonomic and systematic enough to a very general input and a detailed output. More specifically, the tool is aiming at integrating the six different categories of the kansei engineering in a comprehensive software.

Indeed, in the same way Mitsuo Nagamachi defined them, this research aims to implement in a single tool the following process:

- For a chosen product, different populations are defined according to their particularities and similarities.
- Mathematical and statistical tools are used to connect the kansei of those populations to the product properties.
- Based on a database, suitable suggestions can be advised for the design of the product in order to reach specific purposes.
- Connected on the internet so engineers can share the same information and design accordingly.

3 Integration of Kansei Methodology

3.1 Domain

The scope of the kansei engineering is extremely broad and the different ways to carry kansei analysis are numerous. With the improvement of technologies, sophisticated methods have been engineered to quantify people's emotions and feelings but some difficulties remain in creating a systematic process able to determine precisely which emotions are linked to which product's properties and which words should be used to describe them. Indeed, the most general way is to select a bunch of words and to use it as a mean for the individuals when they are asked to evaluate the products. This set of words is hard to define in a sense that it is highly dependent to the population studied and the product selected.

3.2 Limitations

In this research, in order to create a systematic method to determine this set of words, the decision has been made to focus only on adjectives to describe products.

3.3 WordNet

The database of adjectives used in the research is the one given by WordNet [3]. The benefit is plural. It gives the complete list of adjectives used in English but also provides a link between them via the principle of synsets. Synsets are different possible uses of a same word in different contexts. It will be used in order to determine with precision what is the meaning an individual is giving to a product when he or she uses the word.

4 Analysis of Populations

For a chosen product *X*, *Y* different populations can be created according to similar characteristics. The higher is the number *Y*, the smaller are the populations and the more specific the kansei evaluation is getting. As the goal is to be as specific and precise as possible, the first objective is to understand the *Y* populations and to determine for each which adjectives would describe the best the chosen product *X*.

For this purpose, data mining is essential for understanding those populations. In the specific case of the automotive market, *X* is a car and the *Y* populations are *Y* different markets car makers intend to target.

The process to determine the set of adjectives to describe a product is found by analyzing the activities of the *Y* populations. For instance, by surveying and auditing a population (a subdomain of the larger *Y*), it is possible to acquire the supports this population would mainly use if they were to buy the product *X*. In this particular case, the supports can be websites, magazines or newspapers. Going through all those supports can give a list of adjectives that can potentially be used for the kansei analysis.

4.1 Zipf's Law and Pareto Distribution

Many researches have been carried out in order to determine the representativeness of words in a text. The Zipf's law [4], which is deeply linked to a Pareto distribution, is a good first step to rank words according to specific criteria. In this case, Zipf proved that the number of occurrences of a word in a corpus is linear to the multiplicative inverse of its rank. The rank is defined as follow, the most occurring word has the first rank and the less occurring the last rank. A representation is given in the Fig. 1.

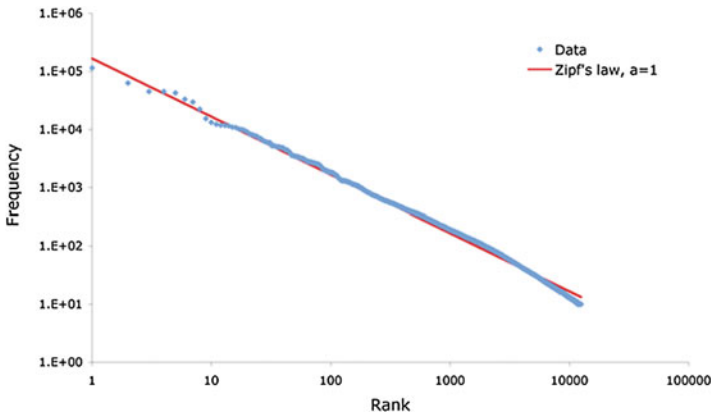

Fig. 1 The Zipf's law shows that the frequency of a word in a corpus is log-linear with the multiplicative inverse of its rank

According to the Zipf, any corpuses of text follow the law. Therefore, it becomes extremely easy to filter the adjectives from the whole and to determine the number of occurrences (even without actually counting them) thanks to the law. As occurrences is a good mean to determine the representativeness of a word in a corpus, a set of adjectives can be derived for the kansei analysis.

Nevertheless, there is an important shortcoming using this method for the current purpose of the research. Indeed, the adjectives found by this method are extremely general. They are neither linked to the product nor to the population [5].

4.2 Adjectives Extraction

In order to build a set of adjectives that is more specific to the product and the population studied, the supports, as defined previously, used by the individuals to get information on the product *X*, are relevant [6].

In fact, as those supports refer to the product X and are read by the population Y, the likelihood the adjectives written in those supports would be more representative than the set obtained through the Zipf's law is high.

4.3 Adjective Selection

Obviously, the larger is the corpus the larger is the set of adjectives obtained [7]. In practical cases, the list extracted at the previous step is composed of thousands of adjectives and it is not rational to conduct a kansei analysis using this amount of adjectives. Technics are required in order to reduce this set to a reasonable number.

TF-IDF. In terms of word representativeness of a word in a corpus, the TF-IDF (term frequency, inverse document frequency) [8] measure is a possible candidate. The expression of this measure for an adjective n in a corpus D, relatively to the first article, can be given as follow:

$$TF-IDF = \frac{n_{1,1}}{\sum_k n_{k,1}} \log\left(\frac{|D|}{\left|\{d_j : t_i \in d_j\}\right|}\right). \quad (1)$$

By computing all the TF-IDF measures for each articles and each adjective, it is possible to extract a global index of representativeness of the adjective in the whole corpus. Nevertheless, this measure by itself is not sufficient to select the final set of words. Indeed, if a word is extremely rare in the corpus, its index would be very high but there is no way the "rareness" itself.

Forgetting Curve. The mathematical law of Zipf has a lot to do with the human way of communicating. Based on the principle of least effort and preferential attachment, smaller words tend to occur more in a text while longer words are less

frequent [9]. In other words, words' length is optimized for efficient communication between human beings [10]. The memorization follows the same trend. A Pareto distribution can be found between the rate at which we forget and the length of a word [11].

Consequently, a longer word is easier to forget, but on the opposite, brings more meaning to the context if understood. As said previously, the rareness was not well informed in the TF-IDF measure but it is shown that a rare word is more representative than a short and omnipresent word.

Therefore, it is relevant to find a way to determine if a word is rare enough to be meaningful but at the same time understood by the population [12].

In this domain, researches use the forgetting curve as an important way to calculate the human's tendency to forget what has been read [13] (Fig. 2).

The probability to remember a word on the term if reviewed many times in a short period of time is lower than if reviewed on, for instance, a weekly basis.

The formula of the forgetting curve can be given as follows:

$$FC = e^{-\frac{t}{R}} \tag{2}$$

Given the length of an adjective and the population's memorization abilities, it is possible to calculate the proportional coefficient R inside the exponential of the forgetting curve.

As adjectives got remembered in the time, the coefficient R tends to grow [14]. It is known as the spacing effect.

This said, depending on the population studied and its memorization capabilities, it is possible to determine the threshold between a word too rare and a word too common.

Forgetting Limit. In the meanwhile, thanks to the data collected on the population, it is also possible to determine how often a word would be read thanks to the following formula:

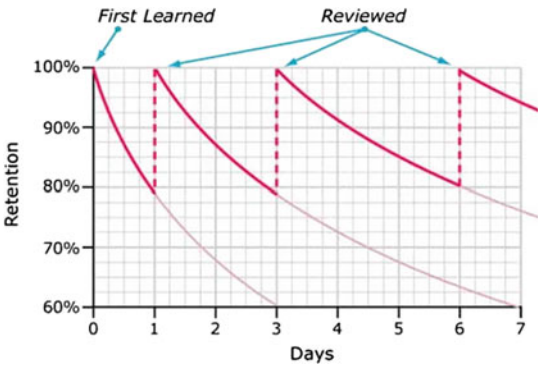

Fig. 2 The forgetting curve links the retention rate of a word to the time axis

$$T_g = \frac{1}{f_c}\left[1 - \frac{\binom{|D| - \left|\{d_j : t_i \in d_j\}\right|}{A.R_{\%}}}{\binom{|D|}{A.R_{\%}}}\right]. \quad (3)$$

The parameters are the same than in the TF-IDF measure, with A the number of articles in total on the support (it differs from D which is the number of articles actually read), R the retention rate from the forgetting curve, fc the frequency of reading the support and dj the articles where the adjective is present.

Compared to the threshold found previously, Tg is a good mean to determine if a word will be remembered by the population.

5 Results

5.1 Comparing TF-IDF and Tg

By comparing TF-IDF and Tg, it possible to obtain the following plot where each dot is an adjective found in the support read by the population.

As an example, if we consider a product, such as automobile, and a sample population of 15 individuals, it is possible to parse the corpus of texts they would mainly refer if they were to buy an automobile. In this fictive situation and for the purpose of calculation, it was considered the population browsed five different websites to inform themselves on automobile. With a periodicity of reading defined at 14 days and an alleged 10 % reading of all the new articles published, we reach on a period of one year a total amount of articles read of 500.

From those 500 articles, adjectives are parsed and saved in a database with their number of occurrences. All the parameters are known to compute the forgetting limit and Tg and the term frequency, inverse document frequency TF-IDF. The results can be shown on the following plot, each dot representing an adjective. In this example, the number of adjectives found is around 600 (Fig. 3).

No matter the sample population and the corpus studied, the plot always follow the same pattern. By analyzing the results on this plot, five different zones can be extracted, each of them bringing a different meaning to our purpose.

- Low TF-IDF—Low Tg: an adjective in this zone appears in all articles read. When it appears, the number of occurrences is very low. In other words, those adjectives are highly dependent to the support and not representative of the product (e.g., “like”, “fine”).
- Low TF-IDF—Medium Tg: an adjective in this zone appears in few articles with a low number of occurrences. It can be seen as a common adjective to describe the product (e.g., “huge”, “powerful”).

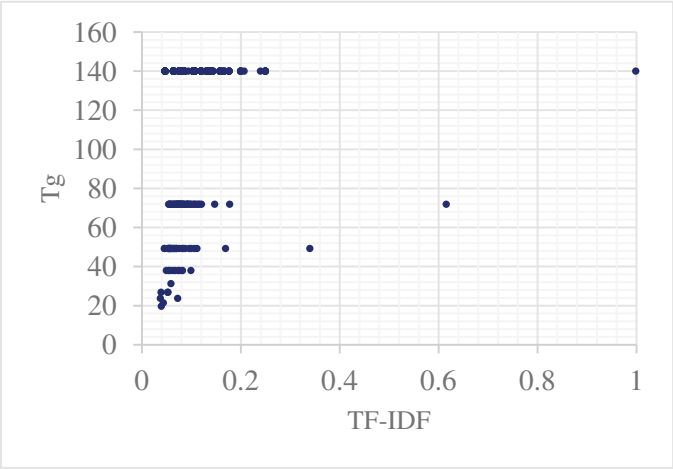

Fig. 3 Comparing TF-IDF and Tg brings to light different zones with different meaning

- Low TF-IDF—High Tg: an adjective in this zone appears in very few articles with few occurrences. Therefore, the word can be seen as highly dependent to the manufacturer of the product (e.g., "economical", "expensive").
- Medium TF-IDF—Medium Tg: an adjective in this zone appears in few articles but quite often. It can be seen as a transition zone between useless and useful words.
- High TF-IDF—High Tg: an adjective in this zone appears in very few articles but many times. It can been seen as highly dependent to the product itself (e.g., "white", "transparent").

Depending on the zones, the value and the representativeness of an adjective can change from highly valuable to useless.

Apparently, the most fitting zones would be medium TF-IDF and Tg, high TF-IDF and Tg. The choice of the former or the latter is highly dependent on the study carried, particularly if it is meant to be product-centered or maker-centered.

The best way to separate those zones is an oncoming topic of research.

5.2 *Hapax Legomenon*

In the set of adjectives found, some of them can have be seen as hapax legomenon. That is to say, they appear only once in the whole corpus [15]. In the light of the previous statements, those words are extremely specific and ranks as the most representative adjectives possible for the product considered. Nevertheless, they are too rare and, based on the forgetting rate and Tg, are not satisfying for further research.

As a matter of consequence, those words are not taken into account in the set of adjectives.

5.3 Co-occurrences

Once a zone, based on the designer goal, has been chosen for further computation, the number of adjectives has been drastically reduced but it remains too numerous (varying from 50 to 150). Based on this observation, some adjectives must be discarded to reduce the amount of possibilities. A possible way is to make use of co-occurrences.

Indeed, some of the adjectives found in the set are not dependent one another and, therefore, can be removed from the set. This process is well documented as "co-occurrences" [16]. By measuring the probabilities bigrams or trigrams can be found together in the same text, part of the whole corpus, a systematic process can be implemented [17] to discard dependencies.

6 Conclusions

From the diversity of kansei methodologies, this research aimed at providing a first attempt to a more general and comprehensive process in other to help designers with a more systematic feedback of customers' kansei.

One of the first prerequisite of this research was to find adjectives so that the individuals can evaluate a given product appropriately. The purpose of this paper was to give a systematic way to collect and provide a set of adjectives that is efficiently describing the product, understood by the population considered, representative and independent one another.

A first batch of results of such an attempt has been given and paves the way for a relevant kansei analysis. Nevertheless, some shortcomings, particularly on providing precise decision criteria, remain to be solved in further research.

7 Further Research

7.1 Appropriate Delimitation of Zones

One important topic for further research is to determine a precise criterion to delimitate the zones as presented in Sect. 5.1. Indeed, it was possible to give a general meaning to each of them according to the value of TF-IDF and Tg, but the precise limit separating them is still unknown. As the density of adjectives is the highest near the frontiers, it is crucial to come up with a relevant delimitation.

7.2 Distance

As explained in Sect. 5.3, the use of co-occurrences to dismiss the dependences between adjectives was an interesting try. Nevertheless, it can be improved and enhanced by using a distance measure between adjectives. In this case, the distance is the difference between the positions of the two words in a text. Researches have shown that the association of co-occurrences and a distance measure was efficient to determine dependencies between two adjectives [18].

7.3 Polarity Between Adjectives

Once all the possible dependencies have been dismissed, the set of adjectives is reduced but still too numerous (around 20–50). To sum up, the words remaining in the set have been chosen in order to be representative of the product and its characteristics, understood by the population studied and independent one another.

A last possible method to discriminate adjectives so the set can reach the amount of 10–20 words is to calculate the similarities in meaning. The concept of polarity is extremely relevant in this case [19]. Calculating the polarities give the relative similarities of adjectives between them. By optimizing the polarities in the working universe, the set of adjectives is expected to be reduced. Such an implementation is a topic for further research.

7.4 Kansei Database and Validation of Model

Collecting information from individuals is extremely important as it is the base of all the computation made downstream. Therefore, building the kansei database regrouping all the information and kansei analysis is an essential step. Furthermore, the results obtained and the design advices provided in order to improve customers' delight will grow in accuracy with the size of the kansei database.

Consequently, creating such a database will be an important phase in the research.

Eventually, the results obtained from the newly developed methodology will be used to design product samples with new specifications. Confronting individuals' kansei toward the samples with the expected kansei will hopefully validate the model.

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A Kansei Database Framework for the Delight Design Platform

Hideyoshi Yanagisawa, Sohya Nakano and Tamotsu Murakami

Abstract The delight design platform (DDP) is a vision of a new integrated design environment that would enable design engineers to consistently design delightful products. Such delightful products satisfy an attractive quality as well as the performance and must-have qualities of the Kano model. The attractive quality depends on a customer's subjective evaluation involving emotion. To implement DDP, we aim to develop a model-based design (MBD) environment that can simulate a customer's affective responses toward digital design models. With this environment, a designer can test their ideas in the early-design phase. In this article, we propose a Kansei database framework as an essential component of the DDP. The Kansei database stores functions that estimate the customer's emotional responses to the design model. We propose a Kansei database structure including two indexes, perception and delight, with a delight map as a visualization scheme. Furthermore, we propose a methodology to create the indexes.

Keywords Kansei · Delight design · Database · Model based design

1 Motivation

Products that satisfy the users' positive emotions, in addition to providing the desired functionality, succeed in the recent matured market. The Kano model classified product qualities into three types: must-have, one-dimensional, and attractive (Fig. 1, left) [1]. The must-have quality is a quality that the product must

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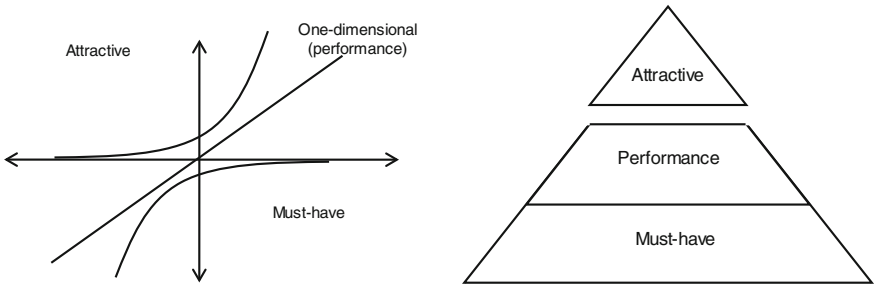

Fig. 1 Three qualities and a delight design pyramid

have, such as safety and basic functionality. A one-dimensional quality, e.g., performance, linearly correlates to the customer's satisfaction. The attractive quality provides satisfaction when achieved fully, but does not cause dissatisfaction when it is not achieved, e.g., aesthetics and perceived quality. Here, we define a *delight design* as a design with all three qualities together (Fig. 1, right). Our objective is to develop a delight-design platform that helps design engineers to integrate all three qualities.

In recent engineering designs, tools for model-based design (MBD) and related design environments, such as Modelica [2], are being developed for concept design. Such a design environment enables a design engineer to build an essential physical model of the entire product on a computer. Simulation using such a model provides feedback to the designers in the early-design phases so that they can test their ideas before making physical prototypes. Such essential physical models and simulations in the early-design stage help design engineers make a global strategy before entering the detailed-design stage.

To create a delight design, the designer must solve psychological problems involving customer perception and emotion as well as the physical problems of a product because the attractive quality depends highly on the customer's subjective evaluation. Product perception and emotion have been studied in Kansei and emotion research [3–10].

Kansei is a Japanese word that refers to a series of cognitive functions for experiencing psychological phenomena, such as feeling, aesthetics, affective meaning, and emotion [8]. In a product-development context, Kansei is often interpreted as a mapping function from physical stimuli to such psychological phenomena. Researchers and practitioners have developed several methodologies and tools to link product attributes and psychological phenomena with industrial applications (e.g., [3, 4, 8]). However, they can still be specifically applied to common engineering-design processes. To create a delight design platform, we aim to integrate these Kansei methodologies into an engineering-design platform such as MBD so that general design engineers, such as a mechanical designer, can evaluate the attractive quality based on a customer's Kansei.

A key technical issue is to formalize the mapping between the engineering physical world and the customer's psychological world. Such a mapping can be used as a simulation component in MBD to estimate a customer's psychological responses to a design model before building a physical prototype. Such an estimation provides the designer with a clear direction and quantitative feedback during the early-design stage.

In this article, we propose a Kansei database framework that stores such Kansei mappings as a core component of the delight design platform. We discuss the concept of a Kansei database, including its role, structure, and output.

2 Role of a Kansei Database in the Delight Design Platform

Products produce physical phenomena, such as light, sound, vibration, heat, flow, pressure, movement, etc. These physical phenomena work as sensory stimuli to product users. Users perceive the sensory stimuli and demonstrate their appraisals using emotions, such as comfort or annoyance. Certain positive appraisals of sensory stimuli provide the users with a delightful experience.

The design engineer composes a product structure to achieve the desired physical phenomena, i.e., sensory stimuli. A recent advanced concept design environment based on MBD [2] enables designers to model the entire product on a computer and simulate the physical phenomena of the digital model before making physical prototypes.

However, such an engineering simulator does not estimate the user's responses regarding his appraisal of the physical phenomena. In the delight design platform, the Kansei database aims to provide a set of mapping functions that estimate the user's cognitive and affective responses from physical phenomena as sensory stimuli. Such mapping functions work as components in the MBD environment that estimate the user's responses to the physical phenomena simulated with the digital model of a product (Fig. 2).

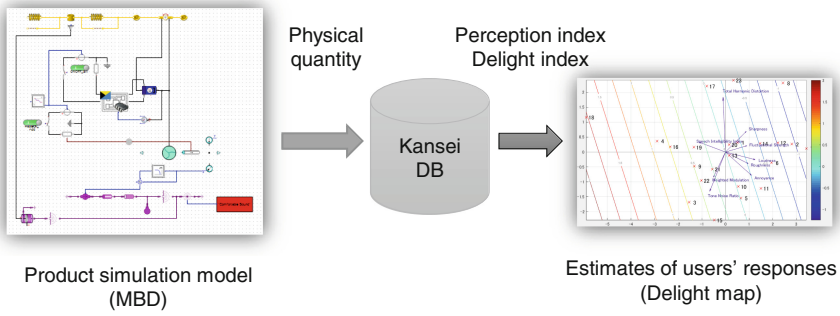

Fig. 2 Role of a Kansei database in the delight design platform

3 Kansei Database Structure

Between the sensory stimuli and the delightful experience, we assume two cognitive layers: the *perceived feature* and *delight factor*, as shown in Fig. 3. Perceived features are sensory-stimulus features perceived by the user about a product. For example, the loudness or sharpness of a machine sound are examples of perceived features. Delight factors are elements that the user finds in a combination of the perceived features that provide a delightful experience.

We define two indexes corresponding to the two layers, the *perception index* and the *delight index,* as components of the Kansei database. The perception index is a function that estimates the user's responses to a perceived feature from the physical quantity of sensory stimuli. Candidates for perception indexes have been studied, some of them have been standardized, for each sensory modality, e.g., vision, hearing, and touch. For example, the psychoacoustics research field provides sound-quality metrics (SQM) that estimate the acoustic perceptions of sound qualities, such as loudness, sharpness, roughness, and fluctuation strength [11]. CIE (the International Commission on Illumination) provides a model for color appearance [12].

The delight index, a scale of the delight factor, is a function of perception-index combinations. For example, certain conditions of sound-quality metrics provide a comfortable sound. The definition of a delight index may differ depending on the conditions, e.g., target product, individual, and situation. Thus, we need a methodology to create delight indexes for each design target. To do this, we can apply several methods developed in the Kansei research field (e.g., [8]). We propose an integrated methodology for creating delight indexes in the next chapter.

Figure 3 summarizes the essential structure of a Kansei database. Such hierarchical models are typical in Kansei research and different layers have been developed for certain contexts. For example, Bouchard et al. proposed three layers of Kansei information: high, middle, and low [13]. The high level includes values, semantic adjectives, emotions, analogies, and style. The middle level consists of

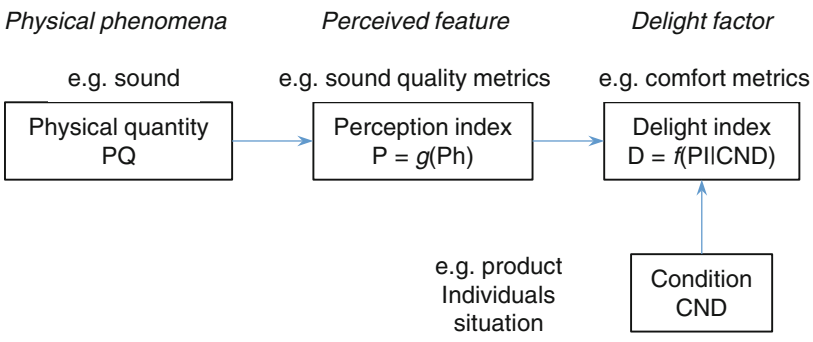

Fig. 3 Kansei database structure

sector names (e.g., product type), context, and function. The low level includes product attributes such as color, shape, and texture. The high, middle, and low levels roughly correspond to the delight factor, condition, and perceived factor, respectively.

The key idea of our structure is to discriminate the perception index from the delight index depending on certain conditions. With this structure, we can consolidate perception-science knowledge for each sensory modality as perception indexes and reuse them in different situations. The reusability of the indexes is an important element of the database structure.

4 Delight Map

To visualize the output of the Kansei database, we developed a *delight map,* which shows estimates of the user's responses to sensory stimuli and the desired direction for improving the design. Figure 4 shows an example of a delight map for product sound qualities. Each plot denotes the machine sound of different products. The coordinate system represents an SQM space as perception indexes. In this example, four SQMs for each sound sample were calculated. We applied principal component analysis (PCA) to map four-dimensional indexes into two-dimensional principal components (PC). PCA composes an orthogonal space involving fewer PCs so that information on the data is kept as much as possible. The vertical and horizontal axes denote the first and second PCs, respectively. Each PC consists of a

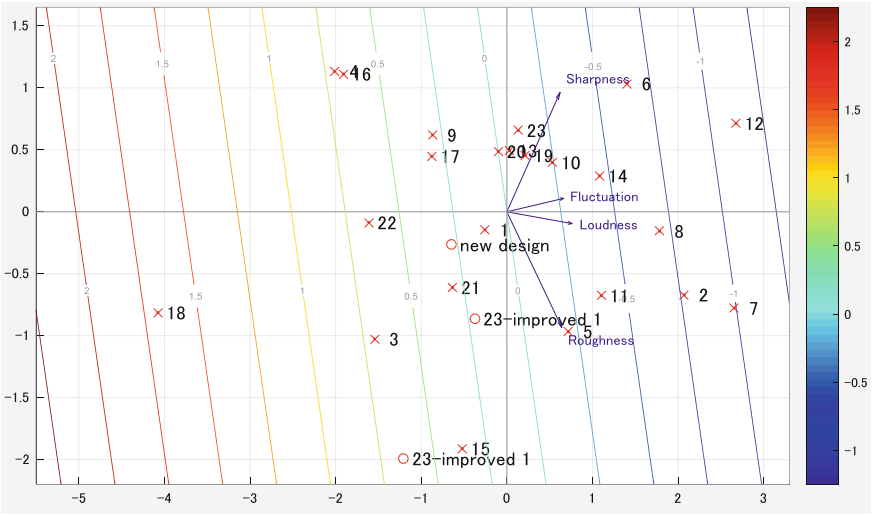

Fig. 4 Example of a delight map for product sound quality

weighted sum of the original data (SQMs as perception indexes in this example). The weights are called PC loadings.

$$PC_i = \sum_j a_{ij} P_j, \tag{1}$$

where P_j is the jth perception index and a_{ij} is the ith PC loading. The arrows in Fig. 4 represent PC loadings as vectors in PC space. With the plots, design engineers can understand the positions of their own products by comparing them with competing products in the perception space.

The depth denotes the user's response to a delight index. The contour lines represent the estimates. Figure 4 shows an example of "comfort" as a delight factor, where a positive value represents "comfortable" and a negative value represents "annoying." In this example, we used five levels of semantic-differential (SD) scales, such as "comfortable-annoying" for scoring the extent of the sound comfort. To make a delight index here, we applied multiple regression analysis (MRA) with the SD scores of a delight factor as the objective variable and the PCs of SQMs as the explanatory variables.

$$\hat{D} = f(P) = \sum_i b_i PC_i = \sum_i \sum_j a_{ij} b_i P_j, \tag{2}$$

where $\hat{D}$ is an estimate of the delight index and b_i is the regression coefficient of the i^{th} PC. Such a linear MRA is the simplest way to create a delight index (the function f). Several sophisticated regression models, including non-linear models, can be applied in a detailed analysis [8]. However, the simple linear regression has an advantage in a practical design. For design engineers who are not statistical-analysis professionals, it is easy to interpret the results of such a linear regression.

The linear regression provides rough directions to improve the design for a delight index. In Fig. 4 example, the lower left is the direction for improving the sound comfort. The cross plots with numbers denote products (hairdryers) in the current market. To increase the sound comfort, a designer improved the product No. 23 sound, which was evaluated as a little annoying, by decreasing the sharpness and loudness. The circle plots named "23-improved" in Fig. 4 represent the improved sound of product No. 23. We can confirm that the estimated comfort of the design has improved.

On the other hand, the circle plot named "Novel design" in Fig. 4 denotes the sound quality of a new design involving a novel structure that achieved a powerful wind with low fan revolutions based on an ejector-pump structure. Low fan revolutions provide low sharpness. As a result, we can see that the comfort estimate shows a positive value.

5 Conclusion

We proposed a Kansei database framework for a delight design platform. The Kansei database provides functions to estimate the perceptual and emotional responses to the sensory stimuli of a product. These functions, embedded in an MBD as simulation components, enable design engineers to test their ideas with respect to the customers' perception and emotion in the early-design phase. Rapid feedback in the early-design stage affects both the efficiency and creativity of the design activity.

Kansei may differ from person to person. With the Kansei database, designers can grasp the Kansei of target customers that may differ from their own. Furthermore, the Kansei database provides directions to improve the design object with respect to delight factors.

The key feature of the proposed Kansei database structure is that the perception index is separate from the delight index. Perception indexes are common among different conditions. Different manufacturers in different sectors in different fields can share those indexes collected from the distributed research field of perception science for each modality.

On the other hand, delight indexes depend on set conditions, such as product sector, target user, and context. Each manufacturer creates an original delight index with the methodology. Therefore, the independence of the perception index and the delight index provides both reusability and originality for the Kansei database.

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A Walking Promotion Method Using the Tuning of a Beat Sound Based on a Two-Dimensional Emotion Map

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Abstract We proposed a method that promotes walking which uses a two-dimensional emotion map. In this method, a subject listened to a beat sound while walking. The beat was adjusted according to the condition of the subject, based on his/her comfortable walking frequency. Simultaneously, the walking velocity, the stride length, and the heart beat of the subject while walking was measured, and LF/HF was calculated from the result of measured heart beat. Furthermore, we asked them to give information on the condition of their feelings, from pleasant or not by 5 levels in each case of the beat sound. By using these data, a two-dimensional walking condition map and two-dimensional emotion map were made and we found the relation between these two maps. Therefore, according to the emotional condition of the targeted person while walking, this method can promote or restrain walking adequately, only adjusting the beat sound.

Keywords Walking assistance · Beat sound · Emotion map

1 Introduction

Japan has so large elderly population, and this is one of the serious problems in Japan. To address this problem, many devices to promote the exercise of walking were developed [1, 2]. Most of these devices assist the hip or/and knee joint. However, most fatigable muscle while walking is TA (tibialis anterior) muscle. Therefore, we have developed various walking assistance apparatuses which assist the ankle joint of the equipped person. By only assisting the ankle joint, the

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equipped person's leg can be raised. From previous study, the effectiveness of improving on the gait of the user was confirmed by using our developed apparatus [3, 4]. However, it is important to reduce the weight, downsize, and improve the usability of this apparatus. We developed a new small and simple type walking assistance apparatus [5]. It is low cost, because we used a micro computer and servo motors for hobby.

Furthermore, to keep motivation of walking, it is important to assist by using not only these physical methods but also a mental method. In this paper, as a pilot study of the hybrid (physical and mental) assistance method, a method that promotes walking which uses a two-dimensional emotion map and the results of the experiment are shown.

2 Two-Dimensional Emotion Map While Walking

We proposed a method that promotes walking by using a two-dimensional emotion map. The two-dimensional map is made with two axes, the horizontal axis is pleasant or un-pleasant, with the vertical axis being arousal or not, same as the circumplex model of affect [6]. Figure 1 shows our assumed emotional shift while walking on the two-dimensional emotion map. When people walk for gait training as a rehabilitation, their emotion might be un-pleasant and their emotion vectors exist in the second and third quadrants. When the emotion vector exists in the first

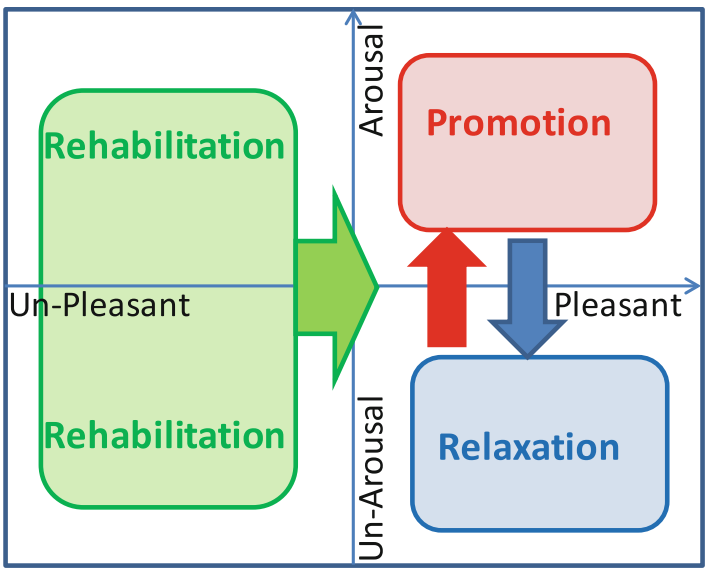

Fig. 1 Assumption of the emotional shift while walking on the two-dimensional emotion map

quadrant, a walking person will be promoted by his/her emotion and walking velocity will be accelerated. However, if the heart beat is too high, the emotion vector will be shifted toward the second or third quadrant. On the other hand, when the emotion vector exists in the fourth quadrant, a walking person will be relaxed by his/her emotion and walking velocity will be decelerated. However, if the heart beat is too low, he/she might stop walking. Therefore, to keep motivation and walking for a long time, it is important to control the walking person's emotion.

3 Two-Dimensional Walking Condition Map While Walking

We also proposed a method that promotes walking by using a two-dimensional walking condition map. The two-dimensional map is made with two axes, the horizontal axis is the cadence (walking frequency) [step/min] which is the inverse number of the walking cycle, with the vertical axis being the stride length [m/step], same as the reference [7]. Figure 2 shows our assumed walking condition shift on the two-dimensional map. From this reference, when the walking ratio which is the gradient value in this map, is 0.006, it is better for an able bodied person's walk. Then in this paper, this line is defined as an ideal walk line. When a rehabilitation person try to improve his/her gait, the point of the present location will be shifted toward the ideal walk line on the two-dimensional walking condition map. When

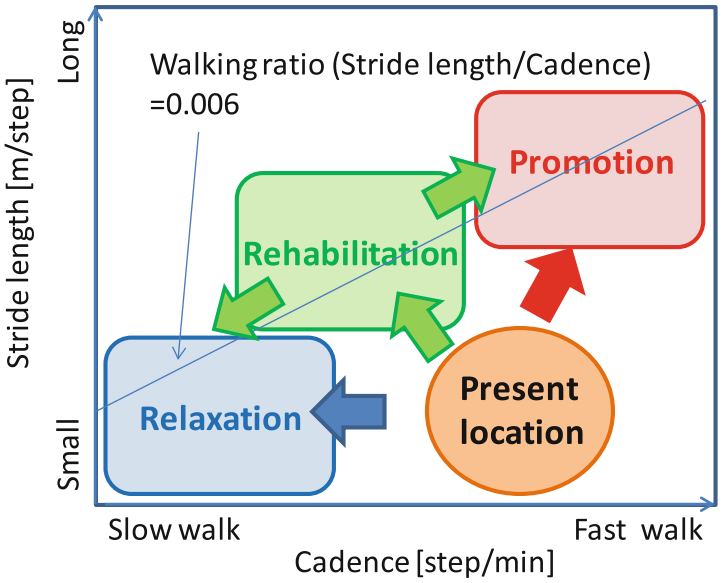

Fig. 2 Assumption of the walking condition shift on the two-dimensional walking condition map

the walking person walks more slowly with a smaller stride length than the present walk, the point will shift lower left along the ideal walk line in the two dimensional walking condition map, and he/she will feel relax. On the other hand, when the walk person walks more fast with a longer stride length than the present walk, the point will shift upper right along the ideal walk line in the two dimensional walking condition map, and he/she will feel active. If some parameters of walking are able to adjust, and if the tendency of the point shift has some relations between the two-dimensional walking condition map and emotion map, the emotion while walking will be change to keep motivation and walking for a long time. Therefore, our purpose of this study is to confirm the relation of the tendency of the shift between the emotion vector on the emotion map and the point on the walking condition map.

4 Walking Experiment and Making Two-Dimensional Emotion Map and Walking Condition Map

As a pilot test before using our developed walking assistance devices, we carried out the experiment where four subjects (able bodied men, Age: 21–22) walked on the treadmill while listening to a beat sound as shown in Fig. 3.

It was adjusted from 50 to 200 % beats gradually by 10 % based on the walking cycle with a tablet computer. We asked them to give information on the condition of their feelings, from pleasant or not by 5 levels in each case of the beat sound. We

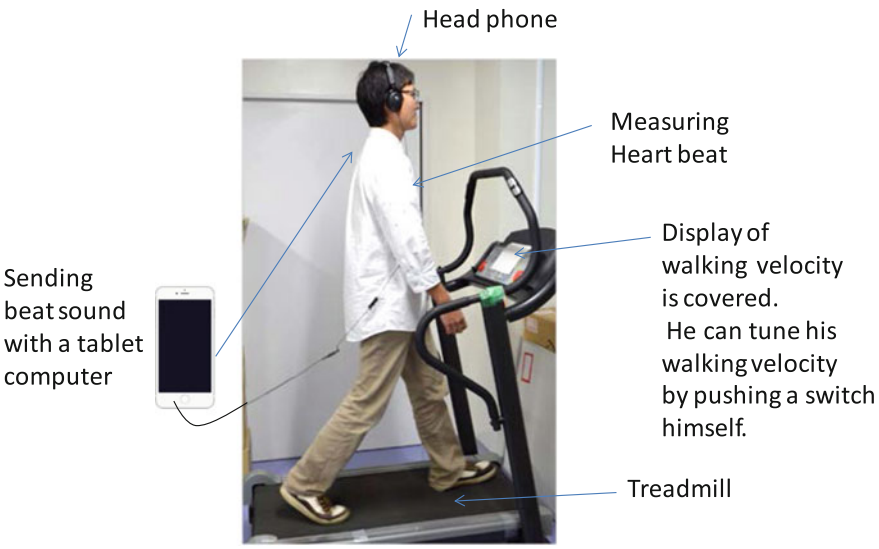

Fig. 3 Photo of the walking experiment

defined the result of this questionnaire as the horizontal axis of the two-dimensional emotion map.

We also measured their heartbeat. We translated the LF/HF (LF: low frequency, HF: High frequency) to the vertical axis of arousal, and the value of LF/HF when the subject walked while listening to the 100 % beat of the walking cycle was defined as an original point. We assumed each result of these calculated values were on the vertical axis. By using these two parameters, we could define the two-dimensional emotion vector on the map.

Figure 4 shows the results of the emotion vector shift on the two-dimensional emotion map of this experiment. As a result, when the sound was at 60, 110, 160 % beats, the vectors of most of the subjects were in the first quadrant (arousal and pleasant). At 140, 180 %, the vectors were in the second quadrant (arousal and un-pleasant). At 90 %, the vectors were in the fourth quadrant (un-arousal and pleasant). Therefore, according to the beat sound, the emotion has a tendency in the two-dimensional map.

We also made a two-dimensional walking condition map as shown in Fig. 5. The horizontal axis was the cadence [step/min], and the vertical axis was the stride length [m]. When the line is drawn on the walking condition map whose slope (walking ratio) is 0.006, it is the ideal walk line of an able bodied person as mentioned above. The cadence and the stride length which were measured while walking and listening to the beats mentioned above, were plotted on the two-dimensional walking condition map. From these results, the similar tendency to the shift of the plotted point on the emotional map could be confirmed. When the listening beat sound was at 100 %, the plotted point on the walking condition map was close to the normal line. When the beat sound was at 60, 110, 160 %, the plot points were in the higher area than the line. When the beat sound was at 140 and 180 %, the plotted points were lower than the line. On the other hand, when the

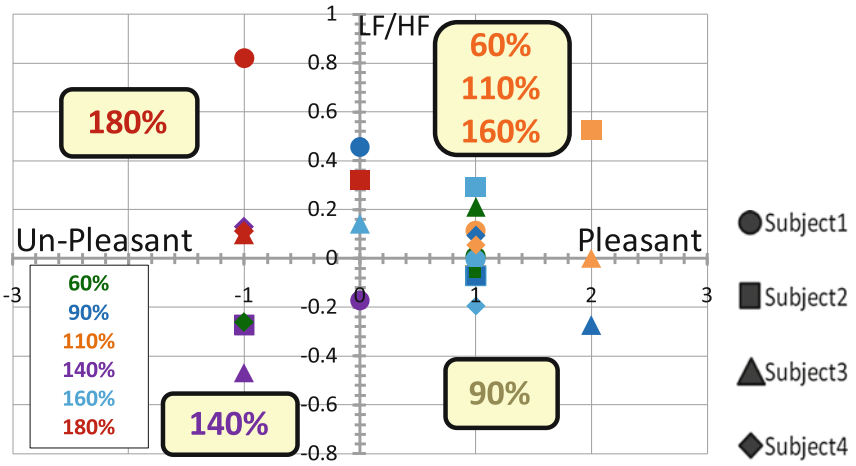

Fig. 4 Results of emotion vector shift on the two-dimensional emotion map

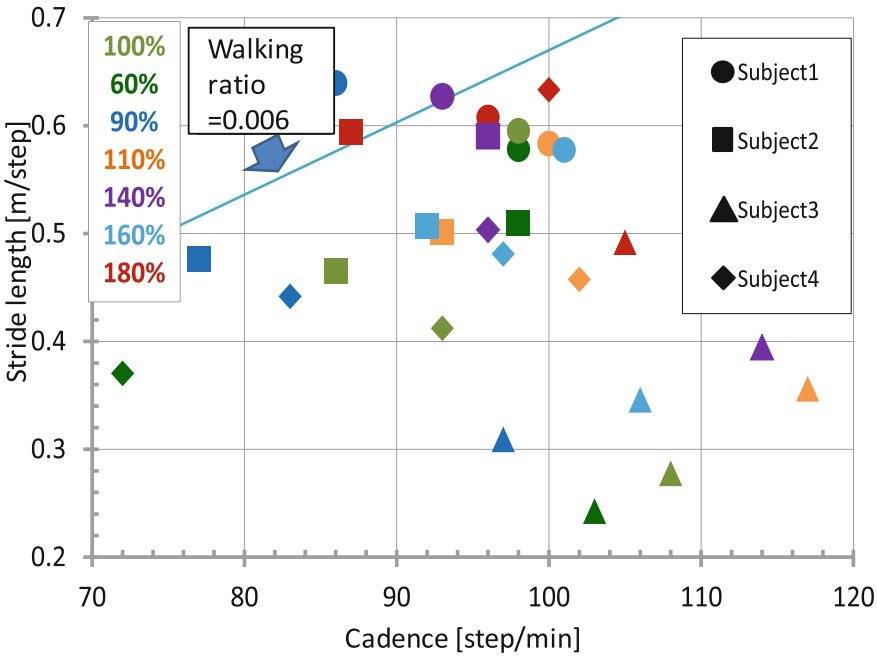

Fig. 5 Results of point shift on the two-dimensional walking condition map

beat was at 90 %, the plotted point was close to the line, however, it was closer to the origin than the plotted point at 100 %. Therefore, we confirmed the relation between emotion map and walking condition map.

5 Conclusions

We proposed a method that promotes walking by using not only a two-dimensional emotion map but also a two-dimension walking condition map. We confirmed the relation between the emotion and the condition of walking and by tuning the beat sound, these are able to shift according to the beat. By looking at this relation, we can suggest the method to keep motivation for gait training of neuro-rehabilitation and promotion to exercise walking. As a future work, we will carry out the experiment by using both this method and our developed walking assistance apparatus.

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Haptic Feedback System Using Informative Resisting Torque for Lever Joystick Operation

Kazunori Kaede and Keiichi Watanuki

Abstract Elderly adults show an aging-related decrease in hand dexterity. Hence, there is a need to develop techniques to address this impairment in manual dexterity, especially when the elderly operate equipment such as powered wheelchairs. In this research, we built and tested a prototype of a manual controlled input lever with two degrees of freedom. The system uses magnetic particle brakes in each rotational joint. The drag torque was implemented by actuation of the magnetic particle brake. In order to help control the input to a control system, the lever generates a resisting torque against the user's actions at a suitable angle. The purpose of the proposed system is to reduce the burden of operation on the user while respecting their intentions. We confirm that this system is able to allow lever manipulation while avoiding inappropriate operation. The results of this study enable control input devices to adapt to the ability and preferences of the user.

Keywords Human-machine interface · Resisting torque · Joystick

1 Introduction

The human perception of motion is affected by not only information from sense organs, but also processed information from motor commands. It has been found that the accuracy of weight perception increases during deceleration, and the differential threshold decreases when a weight is changed suddenly during a lifting action [1]. Research regarding the effect of feedback force delay and visual

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information on the perception of elastic force has also found that the point of subjective equality of elasticity linearity decreases as the delay of feedback force increases [2]. In addition, the characteristics of impedance perception in humans who are operating a mechanical system have been investigated [3].

These studies show that the ability of perception and motion have a deep connection to the operation of devices. Perception includes the vision, acoustic, and haptic senses. Motion is exerted by arms, fingers, and feet. We have investigated the effect of generating a resisting torque on a two-linked lever mechanism and a hand wheel and evaluated the sensations of a user when he/she operates the device [4, 5].

Many studies have investigated the sense of manual operations in the workspace to improve the efficiency of workers in the manufacturing industry [6–8]. The work situation comes to need examination from the viewpoint of gerontology now. Several robot arms have been put into practical use for the assembly of large, heavy goods. They have an air cylinder or a servomotor for each joint, and the majority of these robot arms are controlled by feedback based on position, reaction force, and other sensor information. Therefore, it may be said that the control of these robot arms is active.

In addition, apparatus that use robotics technology have been developed in the service field, including nursing care, transportation, and movement support [9–11]. Nursing care robots are required to have high safety performance and dependability for their particular usage. However, the interest in these robots is increasing. In addition, low noise and energy expenditure are expected from support equipment that is to be used in a facility or home. Therefore, passive working equipment technology has been used for rehabilitation devices [12] because it is safe and quiet. For example, Sekine et al. developed a parallel linkage using a magnetic powder clutch [13]. Haraguchi et al. implemented a two-dimensional passive force display system with a low voltage Electro-Rheological (ER) fluid brake [14]. In addition, Kikuchi et al. developed isokinetic exercise and evaluation systems using the ER brake [15].

In this study, a resisting torque against a lever control is displayed to an operator as an aid to correct operation. The aim of this research is to develop an adaptive control input device that can reflect the intention of the operator and hence reduce their burden when operating equipment such as a powered wheelchair. In addition, an equipment control device that can adapt to the motor ability and preferences of the user is examined. Therefore, an experimental device was built in which a user controls a device such as a mobility scooter using the joystick lever. The operability of the control input lever with two degrees of freedom is examined when the resisting torque was generated by a connected magnetic powder brake. The added function of a magnetic powder brake enables passive control input so that the desired characteristics of safety, low acoustic noise, and low energy consumption are achieved.

2 Mechanism of Resisting Torque Generation

With control input units such as joysticks, the operational feeling of the lever affects its precise control. Therefore, the torque resistance generation mechanism for an input lever (shown in Fig. 1) was developed. The experimental apparatus is made from a joystick type control input unit with a tilting system of two degrees of freedom. The lever stick is attached to the body by a gimbal system, and a rotary encoder and a torque meter are installed along each axis of tilt perpendicular to the center of rotation. The magnetic powder brakes are located so that they generate resisting torque for each axis of tilt at a reduction ratio of 3/1 through a timing belt. The resisting torque of the magnetic powder brake is controlled by the current from the controller circuit. In addition, the output of the rotary encoder is counted and the posture of the lever stick is calculated by a microcontroller. Furthermore, the resisting torque that the brake applies to the lever is measured by the torque meter. The perpendicular posture of the lever stick is designed to be the neutral posture. A so-called spring return function, which returns the lever to neutral posture is implemented in the device. It produces a force in the return direction according to the adjustment of the spring's preload.

The control input unit that controls the equipment based on the rotation angle of a lever stick is simulated by this device. An information display function can be implemented by both the position of the lever and the sense of force generated by the appropriate resisting torque of a magnetic powder brake. This approach assumes that it is used as a control support technique that provides information about a variable (such as the target speed of the wheelchair) by sense of force to the operator of the equipment. The sensation of a click may be generated by adopting a mechanism such as a selector switch, and this sensation could also be used for control support. We note that that this approach is an effective control input method when the most suitable control input can be determined during the design stage. However, a mechanism that can change the position where the click is felt is necessary for the operation of a mobility scooter, which requires changing the candidate of the most suitable control input according to the environment. This mechanism can adapt its position and amount of the resisting torque by controlling the exciting current of the magnetic powder brake. Using this approach, we aim to

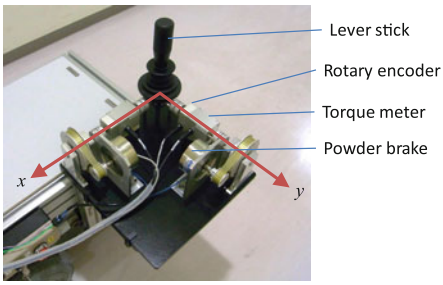

Fig. 1 Prototype of joy stick unit with a resisting torque display. Rotary encoders, torque meters, and magnetic powder brakes are implemented on each rocker-shaft of the lever stick

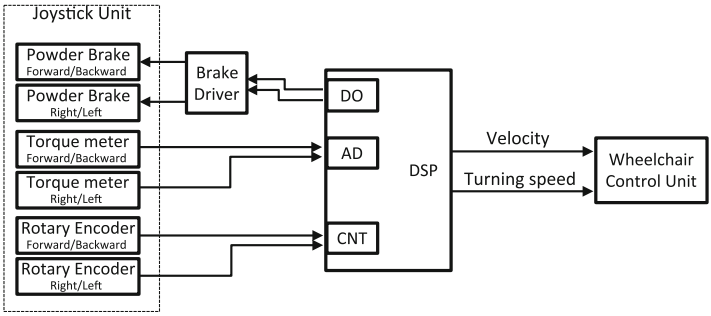

Fig. 2 Signal processing of the prototype. The magnetic powder brakes, torque meters, and rotary encoders are included in the joy stick unit. The output of the resisting torque is calculated by a DSP, and the resisting torque is controlled using a driving circuit. The target velocity and turning speed, which depend on the angle of the lever stick, are output to the control unit of a powered wheelchair

develop a sense-of-force-based control support technique in the service field that has not been used until now. The control system of the powered wheelchair is shown in Fig. 2.

3 Control Support of Powered Wheelchair

The acceleration, braking, and travelling direction of a joystick-powered wheelchair are controlled by a single apparatus. In contrast, the gas pedal, brake pedal, and steering wheel separately control these functions in an ordinary automobile. The forward and backward angle of the lever stick controls the speed of the wheelchair, and the angle in the right and left directions turns the wheelchair to various degrees. The maximum speed is often set by a dial installed in the control panel. It is sometimes necessary to tune the controller settings or train the user in order to operate the wheelchair. Joystick lever control extends control adaptability to a person with a disability because the two commands of travelling direction and speed can be performed at the same time.

3.1 Speed Control of Powered Wheelchair

After the maximum forward velocity is set by a dial, the powered wheelchair lever stick is often tilted fully in practice. In this situation, control correction is necessary to avoid causing the wheelchair to tilt. In addition, there is a danger of sudden acceleration in confined spaces because the maximum speed setting can only be confirmed visually when the wheelchair is stopped.

3.2 Generating the Feeling of Braking by Resisting Torque

We investigated the ability of a two-linked lever to generate the feeling of equipment braking to overcome problems in powered wheelchair operation. In addition, we evaluated a generation method of the braking force and its effect. This allows a constant speed to be maintained and the wheelchair to turn safely by giving information to the operator through a tactile sense.

4 Support of Speed Control by Resisting Torque

In this study, resisting torque is generated to modify the speed control of the powered wheelchair. The viability of the proposed technique is evaluated through a real driving experiment.

4.1 Experimental Conditions

The value of the resisting torque depends on the difference between the target and actual velocity of a wheelchair (controlled by the angle of the lever stick), as shown in Fig. 3. The lever stick has a range of motion of 0.42 rad in either direction mechanically, and the difference between the actual and target velocity can be up to 5.0 m/s. The resisting torque is set to 1.0 Nm when the target velocity is exceeded by 1.0 m/s and to 2.0 Nm when it is exceeded by 3.0 m/s. In addition, the resisting torque is not activated when the lever stick returns to the neutral position.

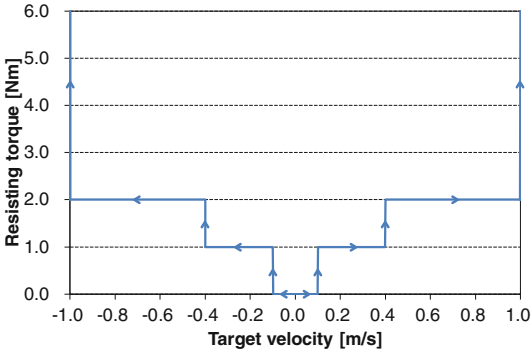

Fig. 3 Level of resisting torque generated according to the target velocity of the wheelchair as controlled by the angle of the lever stick. The *arrow* indicates that the resisting torque is generated only when the absolute value of the target velocity increases

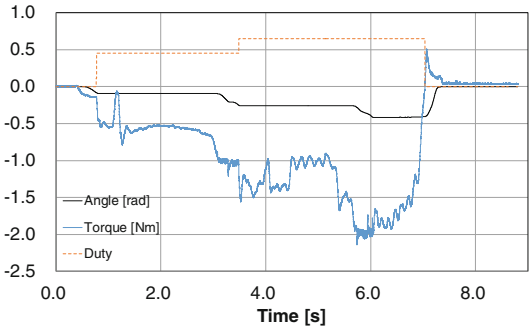

Fig. 4 Example of speed control. The angle of the lever stick is indicated by a *black line*. The generated resisting torque is shown as a *blue line*. The driving duty ratio sent to the magnetic powder brake by the control system is shown as an *orange dashed line*

4.2 Experimental Results

An example of a straight line travel log for a powered wheelchair with the proposed speed control system an indoor straight line is shown in Fig. 4. In this figure, the resisting torque changes at 3.5 and 0.8 s. The change of the angle of the lever stick is restrained by the change in the resisting torque. The angle of the lever stick reached the mechanical limit of the joystick mechanism at approximately 6.0 s. The tiny variation of the manipulation torque which is on a lever stick does not have an influence on the change of the angle due to by the proposed operation support method by the resisting torque. Here, the operating force of the operator measured by the torque meter vibrates. This is caused by the fact that the hand and arm gripping the lever stick shakes because the body of the operator was shaken by the acceleration and deceleration of the powered wheelchair and uneven road surface. However, the angle of the lever stick maintains a constant value. Because the user can maintain an angle as if pushing a lever stick in the region where resisting torque is exhibited, it is thought that this stops the vibration of the body and does not allow it to reach the lever stick. When the operation support was enabled, the system was set to maintain the angle of the lever corresponding to each target velocity at 1.0, 3.0, and 5.0 m/s. It was difficult to maintain a constant angle of the lever because the velocity was changed by the swing of the lever stick when the operation support was disabled. When operation support is enabled, the system could maintain each target velocity. Hence, the resisting torque-based operation support is effective because travelling at a constant velocity helps improve ride comfort and reduce fatigue.

5 Conclusions

In this study, a resisting torque generation function was implemented on an operation input device that consists of a rocking mechanism of two degrees of freedom. In addition, its viability was examined. An experiment was performed in which the

target speed of the powered wheelchair was set by rocking the lever stick forward or backward. The results showed that minute fluctuations of the lever stick angle were restrained by the resisting torque in the operation support system. Furthermore, it was confirmed that maintaining a constant operation input was easy in this case. The sensation of a click may be generated by adopting a mechanism such as a selector switch using the sense of force, but this mechanism is not the most suitable control input candidate for a mobile environment. The position and amount of resisting torque can be freely changed by controlling the exciting current of the magnetic powder brake, and an operation support technique based on the sense of force can hence be developed.

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Preliminary Study of Ontological Descriptions of Emotions Using Motion Assistance Apparatus

Keiichi Muramatsu, Eiichirou Tanaka and Keiichi Watanuki

Abstract In the current study, we formulated ontological descriptions for emotional states of users using motion assistance apparatus. In our previous studies, we developed apparatus that assists the ankle joints of patients in neuro-rehabilitation. Although we have confirmed the apparatus can improve the gait of the patient while walking, we have to capture and manage patients' emotions as feedback of the usage. The ontological descriptions provide a feasible framework for common understanding while sharing and using this knowledge. In future work, we will develop a subset of this framework for more practical usage, in addition to expanding the descriptions of emotional states. After that, we will assess the validity and utility for design and implementation of software and hardware applications using this subset.

Keywords Ontology · Emotional states · Motion assistance apparatus

1 Introduction

Recently, the viewpoint of service has broadened. For example, service-dominant logic [1] and service logic [2] have received considerable attention in the field of marketing in the last decade. These studies discussed value creation by consumers in the usage process. Although the concept of value is difficult to define and measure, Grönroos [3] used the following simple working definition: "Value for customers means that after they have been assisted by a self-service process

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(cooking a meal or withdrawing cash from an ATM) or a full-service process (eating out at a restaurant or withdrawing cash over the counter in a bank), they are or feel better off than before." That is, value emerges through the physical or mental use of resources. Therefore, value is realized through possession, usage, or mental states [4].

For enhancement of value in usage of manufactures, providers have been required to adopt the concept of value co-creation in the service viewpoint, and to provide values co-created through the manufacture. Production, including design, is the generation of potential value, whereas usage is the generation of real value [5]. According to Grönroos and Voima [6], value co-creation occurs in a joint sphere where providers and customers interact with one another. That is, a consumer creates value independent of the value generated by a provider. Therefore, providers of the manufactures have to attempt to understand consumers' experiences and emotions in using manufactures and to obtain feedbacks effectively from consumers. We have developed a conceptual framework, namely an information and computer science ontology, to share the knowledge of consumers' emotions. In concrete terms, in this study, we formulate ontological descriptions for emotional states of users in using motion assistance apparatus.

2 Emotions in Walking Assistance

In our previous studies, we developed the apparatus that assists the ankle joints of patients for neuro-rehabilitation [7, 8]. Although we have confirmed the apparatus can improve the gait of the patient while walking, we have to capture and manage users' emotional states as feedback of the usage for co-created values of users. In the research area of psychology, emotional states are often captured and represented in a two-dimensional model. Tanaka et al. [8] developed a method to promote walking by using a two-dimensional emotional model known as a circumplex model of affect [9].

They carried out an experiment where four subjects walked on a treadmill while listening to a beat sound. The beat was gradually increased from 50 to 190 %, in increments of 10 %, based on the walking cycle. Participants were asked to give information on the condition of their feelings, from pleasant or not, by five levels in each case of the beat sound. This questionnaire became the basis of the horizontal axis of the two-dimensional emotion map. Their heartbeat was also measured and the LF/HF (LF: low frequency, HF: high frequency) was translated into the vertical axis of arousal, while the value of LF/HF when the participant walked while listening to the 100 % beat of the walking cycle was defined as an original point. Each result of these calculated values was assumed to be on the vertical axis. The two-dimensional emotion vectors on the map were defined using these values. As a result, when the sound was at 60, 110, 160 % beats, the vectors of most of the participants were in the first quadrant (arousal and pleasant). At 140, 180 %, the

vectors were in the second quadrant (arousal and un-pleasant). At 90 %, the vectors were in the fourth quadrant (un-arousal and pleasant).

These results indicate the method that listening to the beat sound, which was adjusted according to the walking cycle, is useful for keeping the user's motivation of the exercise while using this apparatus. Therefore, this kind of knowledge must be described and shared with providers as feedback. Development of ontology is one of the methodologies to describe knowledge systematically on the basis of defining concepts. That is, ontological descriptions can help appropriate interpretation of emotional states of users for readers (providers) to have common understandings. Moreover, our ontology would be feasible in providing a framework for common understandings in sharing and using the knowledge.

3 Method for Ontology Development

3.1 Develop Environment and Top-Level Ontology

Ontological engineering is one of methodologies to support describing knowledge systematically. From a knowledge-based viewpoint, "ontology is defined as a theory (system) of concepts/vocabulary used as building blocks of an information processing system [10]". In the ontology development environment Hozo,[1] each node represents a whole-concept and has slots that represent *part-of* or *attribute-of* relations (Fig. 1). Hozo supports describing *role concepts,* where a role depends on the contents of each whole-concept. An example is a teacher role, played by a human only in the context of school, and not outside of the school. In other words, every slot has a role under the whole-concept, implying a context. In the context, a class of instances that can play a role is defined by a *class constraint*, and is called a *role-holder* [11]. In this way, the role concepts permit distinction between concepts under different contexts. Inherited role-holders and class constraints imported from other ontology are shown at the right side of Fig. 1.

A top-level ontology YAMATO (Yet Another More Advanced Top-level Ontology)[2] was constructed based on the role concept theory [12]. According to

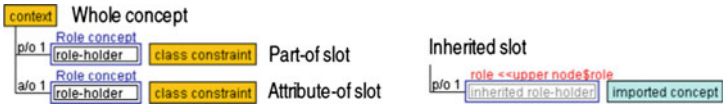


Fig. 1 Legend of nodes and slots in Hozo ontology editor

[1] http://www.hozo.jp/.

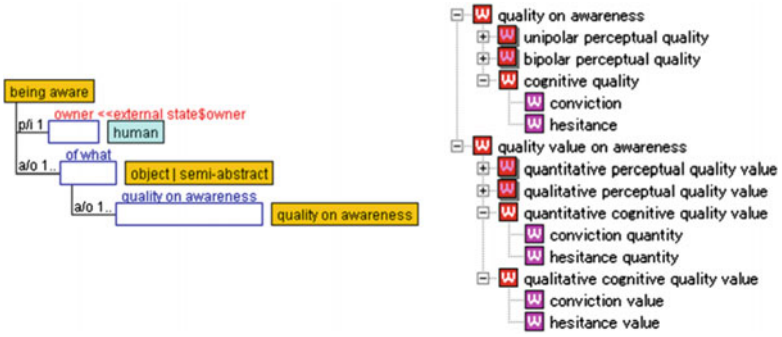
[2] http://www.ei.sanken.osaka-u.ac.jp/hozo/onto_library/upperOnto.htm.

YAMATO, an *entity* is divided into three classes: *physical*, *abstract*, and *semi-abstract*. While instances of the physical class need *3D space* and *time* to exist, instances of the abstract class need neither of them. Instances of the semi-abstract class need only time to exist, and the class contains *mind*, *representation*, *content*, and a *representation form*. Representation such as novels, poems, paintings, music, and symbols is distinguished from its proposition and form of representation [13].

The main features of YAMATO are the definitions of qualities and quantities, representations for them, and descriptions of inter-relationships among them in other top-level ontologies. Attributes of entities are represented as a quality, which takes a quality value. A quality value can be either *categorical* or *quantity,* the latter of which contains *quantitative quantity* and *qualitative quantity*. Quality is divided into *property* and *generic quality*. For example, quality of a color is defined as a subclass of the quantitative quality, and it takes a frequency quantity as quality value, which is defined under the quantitative quantity. On the other hand, a name of the color such as red, blue and so on is defined as a subclass of the categorical.

3.2 Concepts for Describing Emotional States

We have partially expanded YAMATO to describe a subjective evaluation regarded as an expression of a psychological quantity [14, 15]. More precisely, it is defined as a representation of quality (defined in YAMATO) based on a doer's awareness. Doer's awareness is described as a state of "being aware" (Fig. 2a), which is defined as a subclass of "external state" in YAMATO. Objects of awareness are represented by "of-what" role-holders played by a physical or a semi-abstract. A sub-slot of of-what is "cognitive quality," played by "quality on awareness," and represents a psychological quality that a doer subjectively feels. Qualities that exist on awareness, and their values, are sharply distinguished from physical qualities



(a) State of "being aware (b) Hierarchy of quality and quality value on awareness

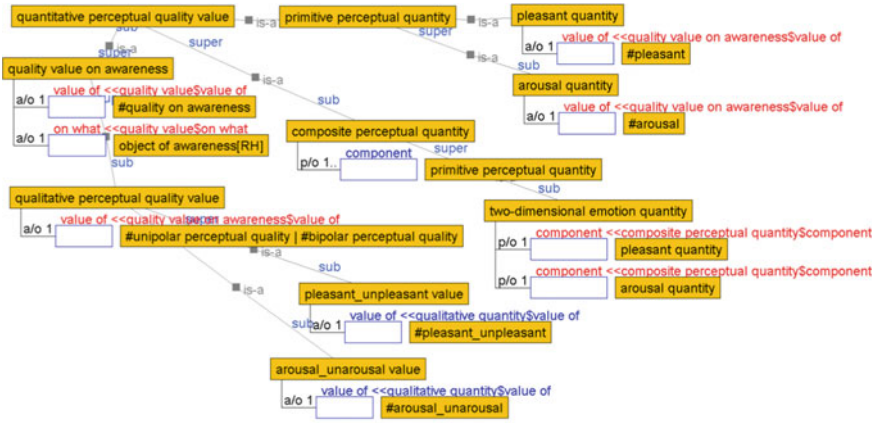
Fig. 2 State of "being aware" and quality on awareness **a** State of "being aware **b** Hierarchy of quality and quality value on awareness

and their values, which are defined in YAMATO. Figure 2b shows the hierarchy of "quality on awareness" and "quality value on awareness." Learners' psychological qualities such as conviction and hesitance are defined as a subclass of "cognitive quality" under the quality on awareness. For example, "conviction" has two "referring to" slots; one is played by "conviction quantity" and the other is played by "conviction value." The conviction quality is a subclass of the "quantitative cognitive quality value," and the conviction value is a subclass of the "qualitative cognitive quality value." Both quantitative and qualitative cognitive quality values are defined under "quality value on awareness."

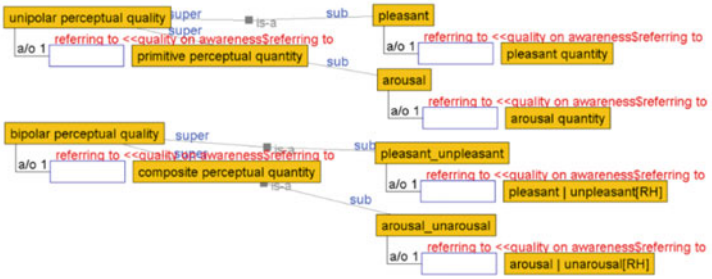
4 Ontological Descriptions on Emotional States

The quantitative perceptual quality mentioned above is divided into *unipolar perceptual quality* and *bipolar perceptual quality,* which take primitive perceptual quantity and composite perceptual quantity respectively as quality values. For example, color appearance judged through human perception such as light-dark, soft-hard, and warm-cool can be defined as the bipolar perceptual quality and take composite perceptual quantities such as the light-dark quantity, soft-hard quantity, and warm-cool quantity. Along with the definition of human color perceptions, the two-dimensional emotional states observed in the walking assistance can be similar definitions. That is, the *two-dimensional emotion quantity,* which has a *pleasant quantity* and an *arousal quantity* as components, is defined under the composite perceptual quantity. These quantities are defined under the primitive perceptual quantity, similar to conviction quantity mentioned in the previous section (Fig. 3a). In the case of two-dimensional emotional states, two types of quality can exist: unipolar and bipolar concepts (Fig. 3b).

The relationships between these quantitative and qualitative perceptual quality values can be specified under *perceptual large_small,* which is regarded as homologous with *large_small* in YAMATO (Fig. 4). In this context, *perceptual_large* and *perceptual_small* are played by the qualitative perceptual quality value, and the value and threshold are played by the quantitative perceptual quality value. Consequently, values qualitatively indicate larger and smaller are specified by introducing thresholds, which are assigned quantitative values. Along with this, "pleasant" and "arousal" can be defined and described as shown in Fig. 4. The quality value of "pleasant" is a role-holder in the *pleasant_unpleasant value_2* (the number indicates distinction from the ordinal *pleasant_unpleasant value*). Two values of the *value* and the *threshold* slots are linked by larger-than, which indicates the former value is larger than the later value. On the other hand, the values of the *threshold* and the *value* slots are also linked by larger-than.



(a) Two-dimensional emotion quantity under quality values on awareness.



(b) Two types of qualities that represent two dimensions of emotions.

Fig. 3 Qualities and quality values pertain to two-dimension emotions **a** Two-dimensional emotion quantity under quality values on awareness **b** Two types of qualities that represent two dimensions of emotions

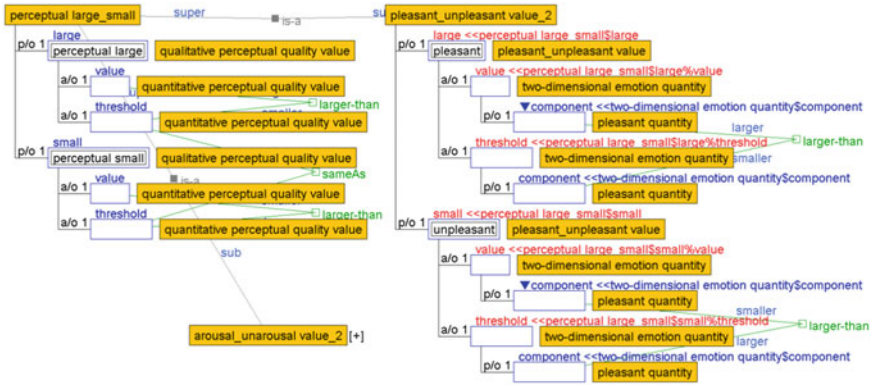


Fig. 4 Concepts of “large” and “small” in quality values pertain to pleasant and arousal

5 Conclusion

In the current study, we introduced ontological descriptions to represent user's emotions using walking assistance apparatus. The ontological descriptions play a part of a conceptual framework that helps create appropriate interpretations of values. This allows service providers to have common understandings with service receivers. Referring to a top-level ontology YAMATO, our ontology provides concepts of attributes on awareness, namely two-dimensional emotional states for the walking assistance service provider, which concerns patient's emotions, in addition to ordinary qualities and quantities, which are originally defined in YAMATO. Thus, our ontology will cover much of the knowledge on patient's emotions, and will ensure common understandings of them in emotional engineering, which is an interdisciplinary field involving mechanical engineering and psychology. In future work, we will develop a subset of this framework for more practical usage, in addition to expanding the descriptions of emotional states. After that, we will assess the validity and utility for design and implementation of software and hardware applications using this subset.

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Perceived Quality and Craftsmanship: An Engineering Approach to Trunk Lid Cutline

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Abstract Automotive customers nowadays decide to like-or-not with a perceptions of total quality and it effects purchasing intention as well. Style, materials, textures, colors, fit and finish and craftsmanship are the main ingredients of perceived quality. This paper, presents perceived quality and craftsmanship activities from the concept design to final product by a case study on trunk lid cut line of Fiat New Tipo. The aim of the study is achieving affective usability and esthetics for product.

Keywords Perceived quality · Craftsmanship · Trunk lid cut line · Gap and flushness · Tolerances · Automotive

1 Motivation

The global value chains dominating the automotive industry have forced automotive manufacturers pay attention to perceptions of customers. Automotive customers nowadays decide to like-or-not with a perception of total quality and it affects purchasing intention as well. Therefore, perceived quality—a measure of belief—is one of the most critical yet veiled areas for automotive industry today. Perceived quality is a total combination of five senses and constitutes a sixth sense on customer and the customer makes his/her decision with a feeling/thought that cannot be named. By considering this, traditional styling approach shall not fulfill the requirements because it induces only the sense of sight. Style, materials, textures, colors and craftsmanship are the main ingredients of perceived quality. Craftsmanship can be defined as tight fits, the right content and high-quality appearance. For globalized automotive industry, craftsmanship as an attribute, that is much in the same way as wind noise, ergonomics, fuel economy and driving dynamics. Besides, geometrical variation is a reality for the car manufacturers;

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unexpectedly it can distort intended appearance. In real life, a good-looking styling model may not be perceived as well as it in rendered form because off the geometrical tolerances.

This paper, presents perceived quality and craftsmanship activities from the concept design to final product by a case study on trunk lid cut line of Fiat New Tipo. The aim of the study is achieving affective usability and esthetics for product. Optimization activities begin as first style draft of trunk lid cut line is available, by considering all features of the trunk lid cut line. With this study, volume of the luggage is not changed, but by the effect of trunk lid cut line affective usability volume is increased.

Perception is directly related how customer looks to the vehicle so definition of gaps and flushes made in a certain height and distance that simulates the eye position of customer. The point is use of proper nominal values and with those the gaps could be perceived narrower and more proper. Besides, tolerances of production are calculated at the very early stages of the project and all of the tolerance conditions are simulated by virtual prototyping with aids of cad programs. Simulation the effects of manufacturing variations, including component shape variation and the induced gaps and flushness are evaluated. Use of tight tolerances, is not always enough to give aesthetic view. The aim is achieving the best view even with worst tolerances and aesthetics for product.

As a result, the authors are able to take corrective action, before it became a costly brand-threatening problem thereby improving perceived quality while saving time. This paper, has also contributed with affective design recommendations applicable for the entire design process of automotive industry.

2 Perceived Quality and Craftsmanship

2.1 Perceived Quality and Craftsmanship in Literature

Perceived quality is customer's perception of the total quality or positive sides of a product or service relative to alternatives [1].

According to Zeithaml, perceived quality can be defined as the consumer's judgement about a product's overall excellence or superiority [2]. Perceived quality has a direct effect on overall customer satisfaction and has indirect effect on customer complaint levels. Moreover, as perceived quality level increases, total customer satisfaction level increases too [3]. Perceived quality is not produced quality, because of human active interpretation and complexity of multimodality in perceptual processes [4].

Craftsmanship means that the product is done by skillfully way and has superiorities in the way of well design, usability, production process and quality achieved by well affective engineering and creative solutions to improve customer's perceptions [5].

2.2 Perceived Quality and Craftsmanship at Automotive Industry

The term "Automotive PQ and C" refers to the quality that customers acknowledge via the look, the touch, and the feel of a car. Automotive manufacturers are systematically working on techniques to enhance both the quality feel and the craftsmanship perceivable through the five senses. Understanding the customer sensitivity, paying close attention to the details, estimating anomalies of the production and taking preventive actions at project phases are the main aims of PQ and C teams [5, 6].

2.3 Ergonomics

Ergonomics is the scientific area that works on systems where the interaction among humans and their environment, optimization of overall system performance [7]. Ergonomics can be divided to systematic approaches like having a system; being design driven and focuses on performance and well-being [8].

Ergonomics is applied to car body design with the aim of reducing the effort required by the driver and passengers in the different conditions particularly as regards driving the vehicle [9].

3 Problem Domain Overview

3.1 Automotive Project Phases

After decision of a new product and concept, style begins to draw sketches of the vehicle. The mission of the style department is to create attractive designs for the excitement of customer's everyday life and try to achieve pleasure of the customers [10].

To industrialize the project, CAD modelling of the parts begins at the end of T2b section that figured out below. Style, creates continuous surfaces such as the car is only one part; in reality cars have a vast number of parts. Gaps are applied between parts and continuous surfaces of style distorts slightly. Even though gap is zero between parts, radius of parts can cause "rat holes" that could be perceived as poor engineering. CAD modelling of the parts and project stage can make the intended appear change in a noticeable way, so style freeze step is at the end of Step 1 of cad modelling [10].

Moreover, there is a reality of production, each part and production process has its own tolerances, as a result there is a certain tolerance chain. The aim of PQ and C activities is to try to ensure style intended view is achieved at final product [10] (Fig. 1).

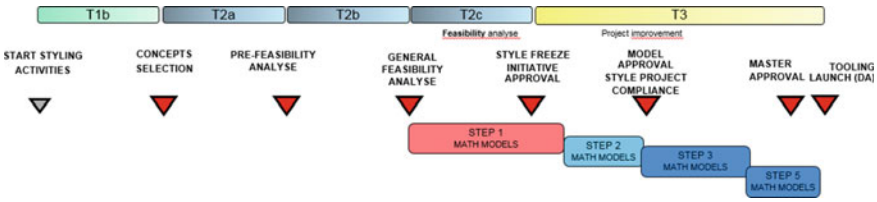

Fig. 1 The logical scheme of the main phases of the development process, with specific reference to the body

3.2 *Methods for Virtual Customer Point of View Evaluations*

For decision of style, aesthetically quality evaluation should be executed to guarantee customer pleasure. Moreover, such evaluations provide the optimal view of the vehicle which accurately reflects clients' expectations. Prototyping is a helpful way to see actual situation but it is always time and cost consuming technic, so virtual prototyping is chosen mostly. During project phases, all decisions should be taken instantaneously, on the other hand decisions should be correct as taking back them would be time and cost loss. There are two critic points for these evaluations; first one is quality of virtual-prototyping and the second point is which position of the vehicle, which distance and height of the view simulates customers' evaluation. For this project we have done simulations with the help of software that gives real time view.

In the beginning, evaluation criteria are discussed with the team. Fiat standards for ergonomics and customer quality view evaluation procedure are used as it gives correct simulating positions of the customers. The criteria are:

- Beginning from 1.5 to 0.5 m distance from the vehicle; as the customer approaches there should not be any unaesthetic view
- 0.5 m distance from the vehicle; correct position to evaluate
- Four main views are taken; from back, rear side and view ¾ side and view ¾ rear
- Customer height is taken as 1.8 m
- Vehicle should be considered on ground level
- Nominal conditions and with effect of tolerances max and min conditions are considered (Figs. 2 and 3).

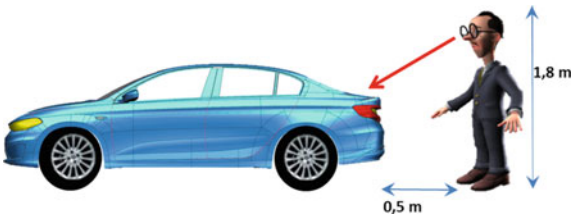

Fig. 2 Scheme showing point of customer view at 0.5 m distance from the vehicle and the height of the customer is accepted as 1.8 m

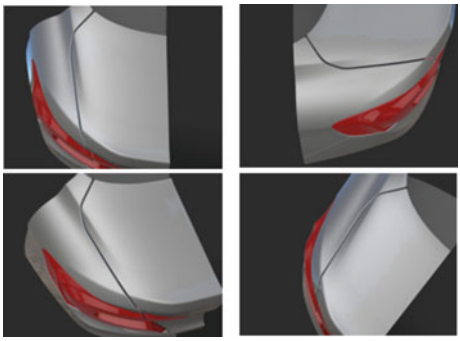

Fig. 3 This figure shows example of four main views; from back, rear side and view ¾ side and view ¾ rear

4 Problems and Solutions

4.1 Trunk Lid Cut Line and Affective Usability

In general customer expectations, bigger volume of the trunk is preferred. By using engineering methods, affective usability of the product should be presented to the customer avoiding dimensionally changing of the product.

First Draft Style Dimensions of Trunk Lid versus Competitors. At the beginning of the project, competitive vehicles are chosen by product team and these vehicles are analyzed deeply by quality, ergonomics, cost, product properties etc. aspects. All dimensions related to ergonomic of trunk lid are measured on competitors. Target values are defined to be better or at least to have same level of best competitor (Figs. 4 and 5, Table 1).

Problem Definition. The first trunk cut-line defined by style was technically feasible but; the trunk access dimensions were below the target values, in other words narrow trunk lid brings narrow accessibility to the volume of the trunk which cause loss of comfort and ergonomic.

Style Changes to Solve the Problem. In order to use available exterior surface for wider trunk opening and to have a more modern style, by using perceived

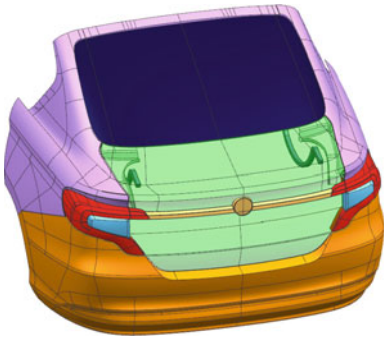

Fig. 4 Figure shows first draft style of 356 model, the cut line of trunk lid is towards inside of the vehicle

Fig. 5 Ergonomic dimensions for accessibility of trunk volume are indicated in the figure

Table 1 Dimensions related to ergonomic of our product and competitive

Vehicle	W203	W207	A (trunklid open)	A (trunklid half-open)	A (trunklid closed)
356 Target	**950**	1110	530	420	380
356 Status	**893**	1100	–	–	349
Competitive 1	**905**	780	530	420	380
Competitive 2	**960**	980	500	400	390
Competitive 3	**950**	–	495	320	300

Table 2 Dimensions related to ergonomic of our product and competitive, after trunk lid cut line change

Vehicle	W203	W207	A (trunklid open)	A (trunklid half-open)	A (trunklid closed)
356 Target	**950**	1110	530	420	380
356 Updated	***960***	***1110***	–	–	*383*
Competitive 1	**905**	780	530	420	380
Competitive 2	**960**	980	500	400	390
Competitive 3	**950**	–	495	320	300

quality approach, new cut-line have been studied. New proposals for cut lines are prepared to achieve the best style. Aim of this study is to have wider trunk lid and more easily accessible area for customers. In reality, volume of the trunk is same (510 lt), but affective trunk access is increased from 893 to 960 mm (Table 2).

As timing, we were before style freeze steps and early modifications carried out by saving time and cost. If style changes carried out at later steps it would be totally loss for the team and quality level of the vehicle.

4.2 Aesthetical Evaluations of Trunk Lid Cut Line

Problem Definition. Trunk lid cut line is aesthetically checked due to achieve style intended view with minimum and maximum tolerance conditions (Figs. 6 and 7).

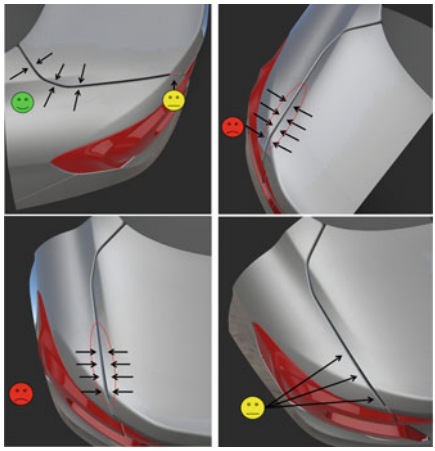

Fig. 6 This figure shows various views of evaluations and undesirable points

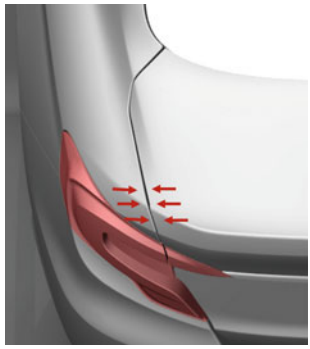

Fig. 7 This figure shows that although gap is constant (4 mm), the perception of the customer is inconstant gap

Although the gap between trunk lid and body is constant (4 mm), the perception of the customer is inconstant gap. All measurements are technically in standards, but the view is unacceptable as style's intended view is distorted.

Root Causes of the Problem. Style creates continuous surfaces, but by applying 4 mm gap between the parts distorts continues surface. Besides, 1 mm radius is achieved at the edges of trunk lid as a result of hemming process which is the best value comparing to competitive and the body side has constant 3 mm radius at the matching surfaces with the trunk lid.

Angle of the flange on the body side at the trunk lid opening area is changing from 50° to 100°. Considering limits of stamping technology, there should be a constant radius through cut line as minimum as possible. The distance between the apex point of the external surface and the flange intersection and the tangent of radius will be variable depending on the angle between two surfaces. In addition, the surfaces of the style change from convex to concave. By considering only with these variances, keeping the constant gap between trunk lid and body causes the anomalies (Figs. 8 and 9).

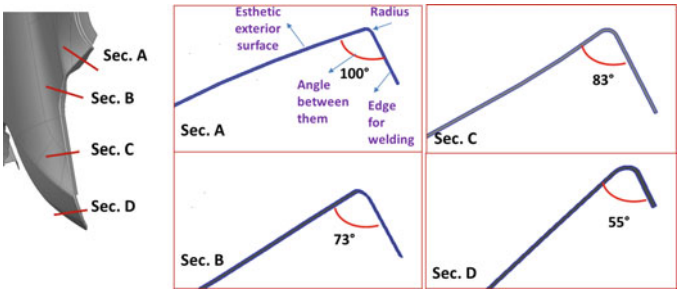

Fig. 8 Variable radius of the body side flange at trunk opening area; Section A-B-C-D figures out angle changes of body side

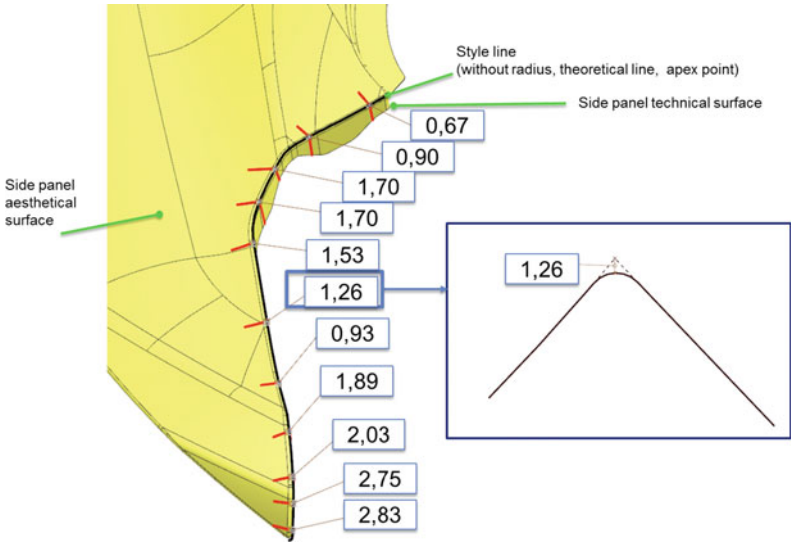

Fig. 9 The figure indicates style line change with effect of radius; the distance between the apex point of the external surface and the flange intersection and the tangent of radius will be variable depending on the angle between two surfaces

Solutions. In order to solve this challenging problem, priorities must be defined clearly. The priority is to improve perception of the customer, not changing engineering parameters; the trunk cut line and the style. To achieve constant gap perception of the customer on the trunk lid area, optimization of gap and flushness values are considered. Variable gap values are tried on CAD models but on these trials new anomalies are observed as the trunk lid does not give impression of a closed view. If the results on CAD models are not satisfactory the real life situation shall be worse (Fig. 10).

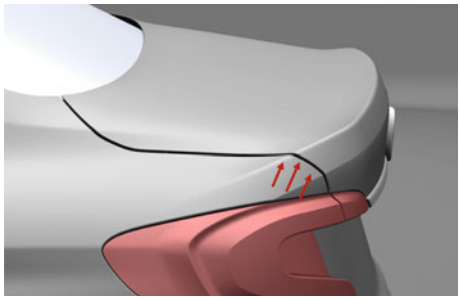

Fig. 10 The trunk lid do not give impression of closed view

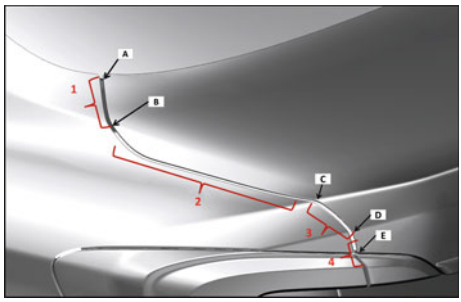

Fig. 11 To define flushness values, trunk lid style are divided into four different areas and each of them are considered by area specific perception requirements

At this point working on flushness values is required. This time variable flushness helps to have better perception on gap. Zero flushness between parts is perceived as high quality level. New Fiat Tipo trunk lid style are divided into four different areas and each of them are considered by area specific perception requirements. First area between A and B points, flushness must be zero to protect surface continuity. Second area between B and C flushness value respect to body side is defined −1.2 mm, third area between C and D flushness value respect to body is −3 mm. These values are decided by the team depending on the style, virtual analyses and tolerance chain of the vehicle (Figs. 11 and 12).

The desired view is reached finally, the authors underline that, all style and project studies are done at very early steps of the project by virtual evaluations.

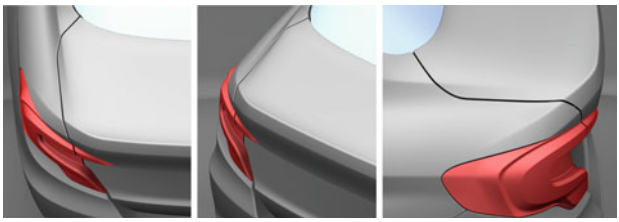

Fig. 12 Final views achieved after improvements

Otherwise, cost of prototypes, any modification on the mold's or realizing anomalies at the final product would be totally time, cost consuming and quality level cannot be as high as early stage activities.

5 Conclusions

Automotive companies are embracing PQ and C activities to improve total customer pleasure and competitiveness while facing the increasing markets internationalization. Automotive projects spreads to 2–3 years and any anomaly that realized at the final steps can cause cost and time loss or if it is not solved customers pleasure would decrease. In engineering approach to new car design, affective engineering and customer pleasure must be ensured that all variations and uncertainties affecting its performance are considered as far as practicably possible. In order to achieve it, it is advisable to apply PQ and C activities at early steps of the project. These activities allow for further development of quality of products due to perception of customer.

In this paper, activities at the early project steps are shared and it is a pleasure to realize and solve them by virtual prototyping. In the case of more complex car projects the above approach can be applied and the decisions of team founded by style, R&D design engineers and quality outputs early definitions of problems and solutions presented in the paper.

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Analysis of Brain Activity During Change of Indoor Thermal Environment

Keiichi Watanuki and Lei Hou

Abstract We measured brain activity during changing of indoor thermal environment with light stimulus by near-infrared spectroscopy. The experiment was composed of four parts (without-light trial, with-light trial [3000, 5000, 7200 k trial]) for the light stimulus. In the case of the 3000 k trial, the oxyHb level in the prefrontal cortex tended to increase earlier than the oxyHb level in the without-light trial when the room temperature increased. On the other hand, in the 6700 k trial, the oxyHb level tended to increase later than the oxyHb in the without-light trial.

Keywords Brain activity · Near-Infrared spectroscopy · Thermal comfort · Brain-Machine interface

1 Introduction

In recent years, air-conditioning equipment is essential to us. However, the energy consumption of air-conditioning equipment accounts for a large percentage of the total energy consumption in our life. In is accounts for 26 % of the annual energy consumption in homes and 27 % in industry [1]. So, it is important to reduce the energy consumption by reducing the are-conditioning load. The Ministry of Environment of Japan has recommended setting the temperature of air-conditioners to 28 °C in the summer and 20 °C in the winter. However, most people feel uncomfortable in such thermal environment [2]. Therefore, it is important to develop an air-conditioner that can save energy and keep thermal comfortable environment. To develop such a control, an index to accurately evaluate human thermal comfort is needed. In earlier study, methods such as the Predicted Mean

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Vote (PMV) [3] and the Standard New Effective Temperature (SET*) [4] were created for the evaluation of human thermal comfort. However, these methods are not suitable for a thermal environment with an irregular temperature distribution and have restrictions on usage [5, 6]. Thus, PMV and SET* are insufficient to evaluate human thermal comfort accurately and a new evaluation method is needed.

Our brain has functional localization [7]. When people feel comfortable or uncomfortable, their prefrontal area, which is involved in thinking and the feeling of emotions, is activated [8]. Therefore, measuring brain activity will reveal whether people feel thermally comfortable or uncomfortable. This study proposes a method to evaluate thermal comfort via brain signals and ultimately aims to develop an air-conditioning control system by brain-machine interface. In this paper, we describe the measurement of brain activity during changing of indoor thermal environment with light stimulus.

2 Near-Infrared Spectroscopy

During neural activity in the brain, humans transmit and process information and decide upon actions or responses. When neural activity occurs, blood flow and blood quantity increases in the tissue near the active neurons, and the ratio between oxygenated and deoxygenated hemoglobin in the blood changes. Hemoglobin characteristically changes in near-infrared (700–900 nm) absorbance in accordance with its oxygen content, and it is therefore possible to determine changes in the oxygen level in the hemoglobin by measuring this absorbance via Near-Infrared Spectroscopy (NIRS). In NIRS, the cranial target area of the subject is overlaid with a special holder for optical fibers, which are inserted into the holder at selected measurement regions on the scalp, thus enabling a non-invasive measurement of NIR incidence and reception. This configuration places little or no restriction on bodily movement of the subject, and, therefore, the measurements can be made with the subject in a natural state of posture and movement. In the present study, we thus used NIRS to determine the state of the hemoglobin oxygenation at the cerebral surface and, on that basis, performed real-time color mapping of the state of brain activity in the target regions. Since the device cannot measure light paths from a transmitting probe to the receiving probe, so NIRS date is relatively value [9].

3 Predicted Mean Vote

PMV is a method developed by P.O. Fanger to evaluate human thermal comfort. The PMV method provides a human thermal comfort index that correlates cold/warm sensations with the thermal load of the human body. The PMV was developed by using the principles of heat balance and experimental data collected in a controlled climate chamber under steady-state conditions. The index that is

Table 1 PMV

Cold	Cool	Slightly coll	Neutral	slightly warm	Warm	Hot
−3	−2	−1	±0	+1	+2	+3

provided pertains to cold/warm sensations, but not sensory temperature. This method was set forth in ISO7730 in 1994. The PMV can represent seven degrees of systemic thermal comfort (Table 1) by using six factors: (1) temperature t_a [°C], (2) emission temperature t_{mrt} [°C], (3) air speed v_{ar} [m/s], (4) relative humidity φ [%], (5) amount of physical exertion M [W/m^2], and (6) the amount of clothing I_{cl} [m^{2}K/W] [10].

$$\begin{aligned} PMV = {} & \{0.303\ \exp(-0.036M) + 0.028\}[(M - W) \\ & - 3.05 \times 10^{-3}\{5733 - 6.99(M - W) - p_a\} \\ & - 0.42\{(M - W) - 58.15\} \\ & - 1.7 \times 10^{-5} M(5867 - p_a) \\ & - 0.0014\, M(34 - t_a) \\ & - 3.96 \times 10^{-8} f_{cl}\left\{(t_{cl} + 273)^4 - (t_{mrt} + 273)^4\right\} - f_{cl}\, h_c(t_{cl} - t_a)] \end{aligned} \tag{1}$$

Here, W indicates work volume and f_{cl} represents the rate of body surface area, which is defined as follows.

$$f_{cl} = \begin{cases} 1.00 + 1.290\, I_{cl} & (I_{cl} \le 0.078) \\ 1.05 + 0.645\, I_{cl} & (I_{cl} > 0.078) \end{cases} \tag{2}$$

Here, t_a is dry-bulb temperature. Then discomfort index (p_a) can be obtained by using φ and the saturated water vapor pressure.

$$p_a = 0.01\, \phi[1000 \exp\{16.6536 - 4030.183/(t_a + 235)\}] \tag{3}$$

The surface temperature of clothing t_{cl} is calculated by using Eq. (5).

$$x = 3.96 \times 10^{-8} f_{cl}\left[(t_{cl} + 273)^4 - (t_{mrt} + 273)^4\right] + f_{cl}\, h_c(t_{cl} - t_a) \tag{4}$$

$$t_{cl} = 35.7 - 0.028(M - W) - I_{cl} x \tag{5}$$

The convection heat transfer coefficient h_c is calculated by using Eq. (6).

$$h_c = \begin{cases} 2.38|t_{cl} - t_a|^{0.25} & \left(2.38|t_{cl} - t_a|^{0.25} > 12.1\sqrt{v_{ar}}\right) \\ 12.1\sqrt{v_{ar}} & \left(2.38|t_{cl} - t_a|^{0.25} < 12.1\sqrt{v_{ar}}\right) \end{cases} \tag{6}$$

4 Measurement of Brain Activity During Changes in Room Temperature

4.1 Experimental Procedure

In our experiments, we used Shimadzu Foire-3000 for measuring brain activity. The measurement region was the prefrontal area, since this area is activated by feeling comfortable and uncomfortable (Fig. 1). We set eleven pairs of transmission-receiving probes in a reticular pattern for the prefrontal area. The interval of each probe was set to 30 mm, and the total number of measurement channels was 34. For measuring skin blood flow, we also set two pairs of probes in the measurement region. The interval of the two pairs of probes was set to 15 mm. The location of the probes were based on the international 10–20 system. Receiving probe 6, channel 31, and channel 28 were set as Fpz, Fp1, and Fp2, respectively. A flexible adjustable surface holder was used to set the probes. This experiment was performed in a chamber in which the temperature, humidity, and wind speed were adjustable. Our subjects were seven right-handed healthy males (age: 23 ± 3). We explained the purpose of the study to the subjects before the experiment. Sine NIRS data are of significant value, a base line needs to be set for comparison. We set 30 s rest period for the base line and set 600 s task period for changes in room temperature (Fig. 2). Our experiment was composed of four parts (without-light trial, with-light trial [3000, 5000 and 7200 k trial]). In the with-light trial, we used three different color temperature (3000, 5000, 7200 k) for the light stimulus, and the lights were turned on during the rest period and the task period.

Our chamber can only change the room temperature by altering the air circulation, temperature-modulated wind was incorporated into the chamber to change the room temperature during the task period. The room temperature was increased as the task period was initiated and decreased during the remainder of the task period. The wind stopped being implemented after the task period ended. We lowered the room temperature at 250 s after the start of the task period, these details were not provided to the subjects. To ensure steady experimental conditions, restrictions were placed on the humidity (60 ± 10 [%]), wind speed (0.5 [m/s]), and amount of clothing worn by the subjects (0.7–0.9 [m^2K/W]). Subjects declared their thermal sensation by using a keyboard every 30 s during the task period.

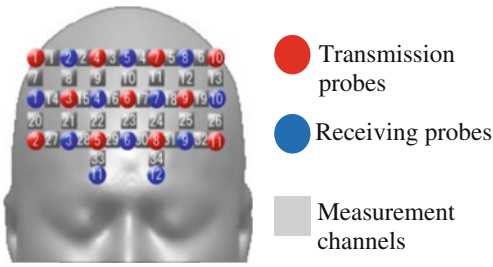


Fig. 1 Regions of the NIRS measurements

Fig. 2 Time chart of the rest and task periods

4.2 Analysis of Brain Activity

According to previous studies, oxyHb that was measured via NIRS was related to local cerebral blood flow [11], and oxyHb that measured by NIRS correlated highly with BOLD that was measured via fMRI [12]. So oxyHb is also a parameter that represents brain activity. Thus, we analyzed oxyHb in the experiment. We also used the smoothing filter (Savizky-Golay method) and band pass filter to remove noises.

As above, the measure data of the NIRS is relative value, so it is difficult to have a direct comparison for measurement data. Converting the measurement data to z-scores and applying the global average are useful procedures when making a direct comparison of the oxyHb changes in each channel [9]. This method has an advantage in the extraction of local brain activity. So we used the global average reference as shown in the following equations to analysis brain activity during the task period.

$$\Delta oxy_z(t) = \frac{\Delta oxy_r(t) - \mu_r^{\Delta oxy}}{\sigma_r^{\Delta oxy}} \tag{7}$$

$$\Delta oxy_g(t) = \Delta oxy_z(t) - \sum_{l=1}^{n} \Delta oxy_z(t) \tag{8}$$

Here, $\Delta oxy_z(t)$ is the z-score of the oxyHb change, $\Delta oxy_r(t)$ represents the data that were measured during the rest period, and $\mu_r^{\Delta oxy}$ is the average and $\sigma_r{}^{\Delta oxy}$ is the standard deviation of $\Delta oxy_r(t)$.

4.3 Results of the Experiment

Figure 3 shows that the oxyHb level in the prefrontal cortex during the without-light trial increased after the task period was started and decreased after the room temperature was lowered. As the figure shown, in the without-light trial, the changes in the oxyHb level correlated with the room temperature, the PMV, and the subjects' declaration of thermal sensation.

On the other hand, as Fig. 4 shown, the oxyHb level in the prefrontal cortex during with-light trials also changed after the task periods were started, but the timing of the changes in the oxyHb level was different from the result of the without-light trial. In the case of the 3000 k trial, the oxyHb level in the prefrontal cortex tended to increased earlier than the oxyHb level in the without-light trial

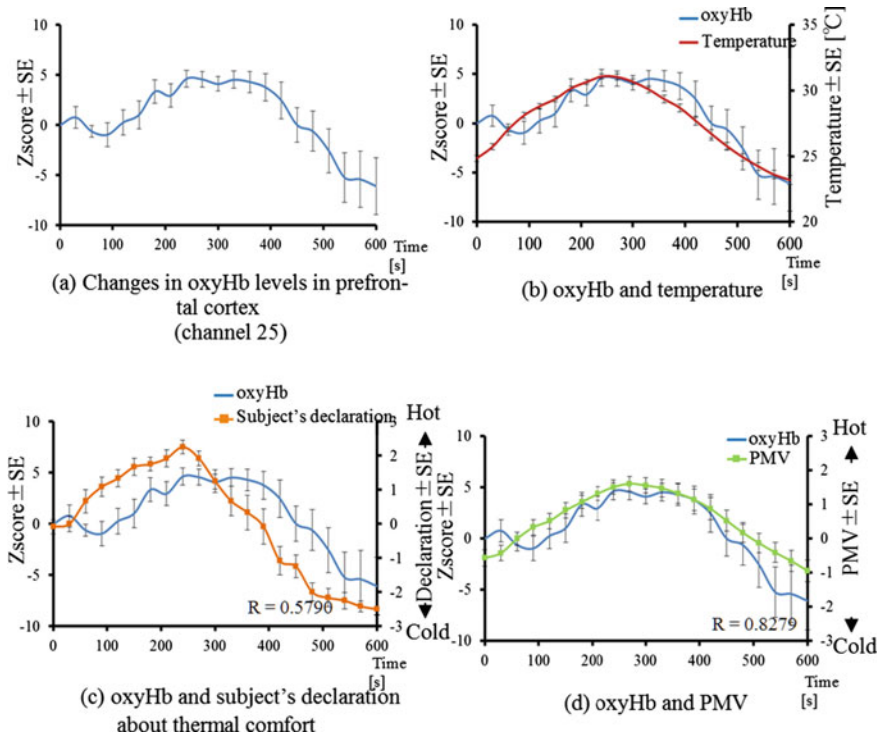
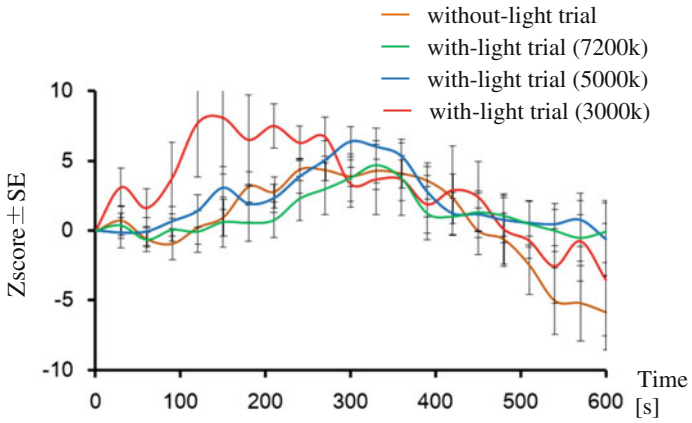


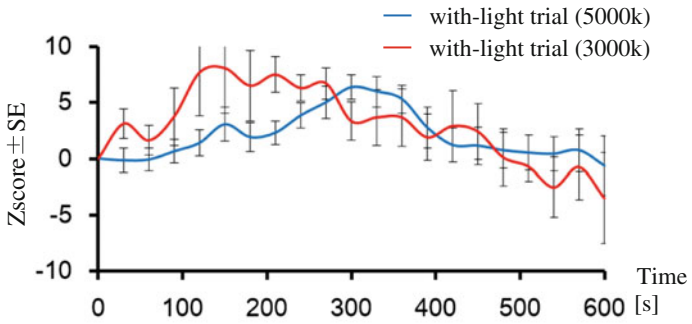
Fig. 3 Brain activity during the without-light stimulus **a** Changes in oxyHb levels in prefrontal cortex (channel 25) **b** oxyHb and temperature **c** oxyHb and subject's declaration about thermal comfort **d** oxyHb and PMV

when the room temperature increased. In the 7200 k-trial, the oxyHb level tended to increase later than the oxyHb in the without-light trial. The result of the 5000 k trial was same as the without-light trial.

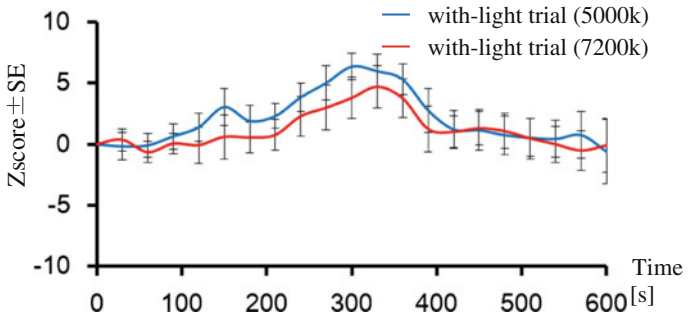
According to earlier studies, different color temperature case different felling [13]. For example, high color temperature lets people feel cooler and low color temperature lets people feel warmer. Color temperatures over 5000 k are called cool colors, and color temperatures lower 3000 k are called warm colors. In our experiment, the 5000 k light stimuli is same as daylight. so the result is same as the without-light trial. On the flip side, the 3000 k light stimuli is cool colors and the 7200 k light stimuli is warm color, therefore, the timing of the changes in the oxyHb level shifted. Thus the result of our experiment shows that the light stimulus cause the timing of the change in the oxyHb level and human thermal sensation.



(c) changing in oxyHb level during all trials



(b) changing in oxyHb level during 5000k trial and 3000k trial



(a) changing in oxyHb level during 5000k trial and 7200k trial

Fig. 4 Brain activity during the room temperature was varied **a** changing in oxyHb level during 5000 and 7200 k trial **b** changing in oxyHb level during 5000 and 3000k trial **c** changing in oxyHb level during all trials

5 Conclusion

We measured brain activity during changing of room temperature with/without light stimulus by NIRS. The result shows that the oxyHb level in the prefrontal area correlated with the room temperature, the PMV, and the subjects' declaration of the thermal sensation. In the case of the 5000 k trial, the result is same as the without-light trial. In contrast, the 3000 k light stimuli cause the oxyHb level increased earlier and the 7200 k light stimuli cause the oxyHb level increased later. These results reveal that different color temperature light stimulus cause different timing of the change in the oxyHb level. In the near future, we will measure brain activity when the humidity, wind speed, or other thermal elements are varied.

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Emotional Entrainment Enhancement Using an Active Display Interface

Teruaki Ito and Tomio Watanabe

Abstract Tele-presence robots enable video calls easier and more engaging with the combination of tablet tools' usability and web-controlled mobile functions. The lack of tele-presence issue has been significantly reduced by the idea of these robots. However, the lack of feeling for relationship with the person or with the robot is still an open issue. This study proposes an idea of remote individuals' connection through an active display systems called ARM-COMS: ARm-supported eMbodied COmmunication Monitor System and tackles these issues. ARM-COMS is composed of a tablet PC and a desktop-type robotic arm. ARM-COMS is based on the two types of modes, or intelligent tablet mode (IT-mode) and intelligent avatar mode (IA-mode). Under these modes, ARM-COMS has three types of functions; namely, autonomous positioning (AP), autonomous entrainment movement (AEM), and autonomous entrainment positioning (AEP). This paper presents the basic concept of ARM-COMS and overviews the active display interface of ARM-COMS to accelerate the emotional entrainment in remote communication.

Keywords Active display · Entrainment · Human interface · Tele-presence robot · Robotic arm

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1 Introduction

Tele-presence robots make video calls easier and more engaging by putting tablets into web controlled robots that pan, tilt, and rotate, which let us interact with people at a remote site. For example, Kubi [1], a non-mobile arm type robot, allows the remote user to "look around" during their video call by commanding where to aim at the tablet using intuitive remote controls over the web. Double [2] tele-presence robot makes it possible to roam around on a two-way video call without having to schedule a meeting beforehand. As a drawback of video call, which has been pointed out, the lack of tele-presence was significantly reduced thanks to the idea of these tele-presence robots technologies. However, the lack of feeling for relationship with the person or with the robot is still an open issue. This research tackles this issue using the idea of augmented tele-presence systems, which is called ARM-COMS, or ARm-supported eMbodied COmmunication Monitor System. First, this paper describes the overview of ARM-COMS, followed by the critical three functions under the two types of modes.

2 ARM-COMS (ARm-supported eMbodied COmmunication Monitor System)

2.1 Basic Concept of ARM-COMS

ARM-COMS is an autonomous robotic arm, which holds and manipulates a tablet PC, such as a smart phone or a small tablet PC, in favor of its user. When a user logon to the remote ARM-COMS, the tablet on the ARM-COMS behaves as if it understood the user, and collaboratively support the user by autonomously taking an appropriate position around the user.

Just like a mobile telepresence robot, when a user logon to a remote ARM-COMS, the user can manipulate it within the range space of its robotic arm movement on a remote site. In the remote logon connection, the ARM-COMS behaves as if it were an avatar of the logged-on person, by mimicking the head movement of the person as well as autonomously interact with the remote person (Fig. 1).

2.2 Overview of the Idea of ARM-COMS System Architecture

Figure 2 shows the overview of the basic concept of ARM-COMS mentioned in the previous section. The physical components of ARM-COMS is a general tablet PC and a robotic arm. As for the IT function, ARM-COMS works as an intelligent, attentive, and mobile ICT device on a local site, and supports its user through

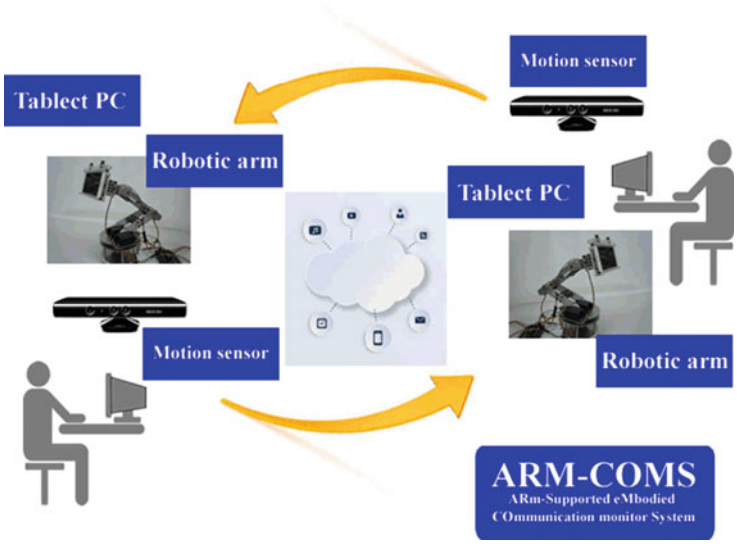

Fig. 1 Network-based interaction through ARM-COMS system

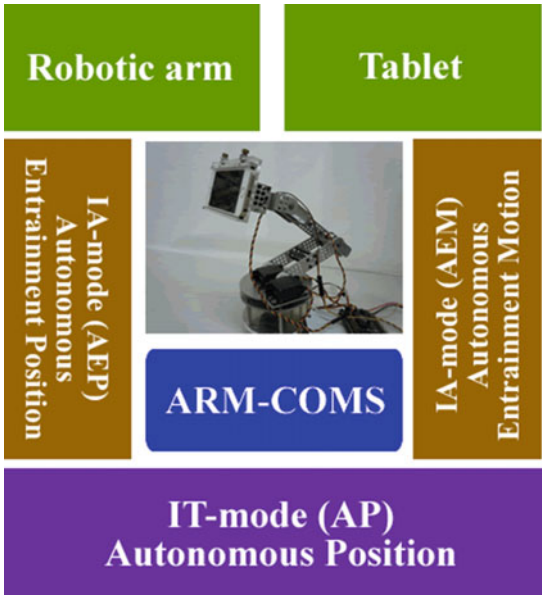

Fig. 2 Overview of ARM-COMS architecture

friendly interaction without disturbance. This feature of ARM-COMS is called "IT-mode". Then, ARM-COMS also works as an intelligent avatar on a remote site when a user logon to a remote ARM-COMS for video communication. For the

avatar function, ARM-COMS performs its avatar role in "IA-mode", which is composed of two types of functions; namely, autonomous entrainment motion (AEM) and autonomous entrainment position (AEP) functions.

3 Challenges of ARM-COMS Through Three Basic Functions

3.1 Autonomous Position Control Function (AP)

The first challenge of ARM-COMS tackles the issue of autonomous position control, where a tablet PC on ARM-COMS autonomously and automatically approaches to the user without disturbing him/her when he/she needs it as if ARM-COMS understands him/her. For example, suppose a user is working at a desk and receives an incoming video call. Considering behavior of the user based on image understanding techniques, ARM-COMS autonomously stretches out its arm to hold out the table PC towards the user to urge the response to the call.

3.2 Autonomous Entrainment Movement Control (AEM)

The first challenge mentioned above is not directly related to video communication. However, the second and third challenges are directly related to video communications.

It has been reported that entrainment among participants emerges during conversation if the participating subjects share the same physical space and engage in the conversation [3]. However, this kind of entrainment in a face-to-face meeting is different from that of remote communication. Tracking the head movement of a speaking person in a remote site, ARM-COMS manipulates the tablet PC [4] as an avatar to mimic the head movement of the remote person so that entrainment emerges as if the local person interacts with the remote person locally. As shown in Fig. 3, ARM-COMS mimics the head movement on a remote site to represent the speaking person on a remote site.

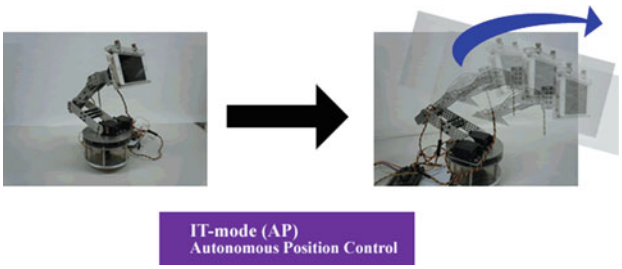

Fig. 3 Autonomous position control function (AP)

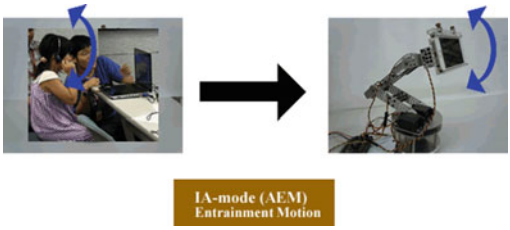

Fig. 4 Autonomous entrainment movement control function (AEM)

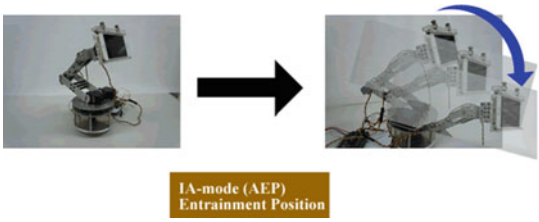

Fig. 5 Autonomous entrainment position control function (AEP)

3.3 Autonomous Entrainment Position Control Function (AEP)

In a face-to-face meeting, each person takes a meaningful physical position to represent the relationship with the others, or to send non-verbal messages to others. A closer position would be taken for friends, showing close relationship, whereas a non-closer position would be taken for strangers, showing unfriendly relationship [5]. ARM-COMS controls a tablet PC to dynamically locate an appropriate position in space and to explicitly represent the relationship with other participants, by sending non-verbal messages. For example, the tablet PC would be approaching to the speaking person to show that the remote person is interested in the talk. As shown in Fig. 4, autonomous entrainment position control enables this function (Fig. 5).

4 A Prototype of ARM-COMS and Its Feasibility Study

A prototype of ARM-COMS system is under development to study the feasibility of the ideas proposed in this research.

The prototype system is designed based on a five axis robotic arm controlled by a microcontroller using signals from a motion sensor either at a local site or a remote site. The prototype mimics the head motion of the connected user, which

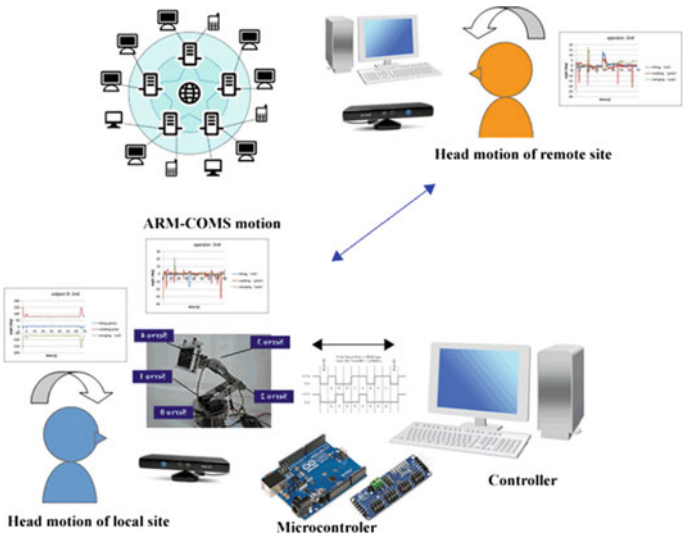

Fig. 6 Feasibility study of the ARM-COMS

enables the AEM function of ARM-COMS. The other two functions are under development (Fig. 6).

Feasibility tests of ARM-COM AEM function were conducted to compare the effect of ARM-COMS in video communication. Based on the video recording data for the movement of subjects, head movement data during the conversation, synchronization data between the subjects, etc., feasibility of ARM-COMS AEM was recognized as generally positive. During conversation, various types of body/head movements can be observed.

5 Concluding Remarks

The paper presented an idea of active display monitor named ARM-COMS with the two types of modes in ARM-COM system, or IT-mode and IA-mode, followed by the three challenges based on these modes. The three basic functions of AP, AEM and AEP were also presented. The future goal which ARM-COMS is pursuing is not only the tele-presence feeling of a remote person, but also implicitly shows the relationship between the remote person and the local participants by way of the entrainmental behavior of a table PC manipulation.

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Emotion and Decision-Making in an Age of Unpredictable Changes

Shuichi Fukuda

Abstract The word Emotion comes from the Latin word e=ex=out and mov ere=motion. So, literally it means to move out. To move out or to act, we have to make a decision. Thus, Emotion is closely related to decision making. Yesterday, the changes were small so we could easily make predictions. Therefore, we did not need to make decisions or even we had to, they were not too much critical. But today changes are frequent and extensive. And what makes the situation difficult is they are unpredictable. Therefore, we need another approach to make decisions with more flexibility and faster adaptability. This paper discusses the issue of awareness or perception and recognition of a problem, which precede a decision or to problem solving and proposes a versatile approach to defining a problem.

Keywords Emotion · Decision-Making · Problem awareness · Problem recognition · Problem definition · Problem solving · Wisdom engineering · Modularization

1 Changes: Yesterday and Today

Yesterday changes were not only small, but they were smooth. In other words, they were differentiable so that we can make predictions without too much difficulty. But today changes are not only frequent and extensive, but they are sharp so that they are not differentiable. Therefore, we cannot make predictions (Fig. 1).

Yesterday, we did not have to pay too much attention to decision making and we could spend most of our time in problem solving, because our world can be processed rationally and the decisions needed were in most cases one time at the very early stage.

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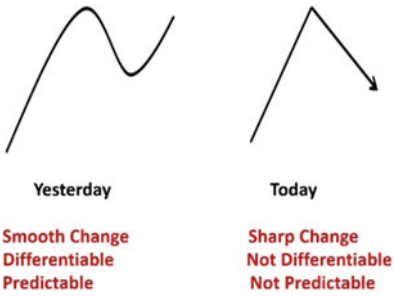

Fig. 1 Changes of yesterday and today

But today, in order to respond to the frequent, extensive and unpredictable changes, we have to make decisions by trials and errors. Therefore, we need another approach for fast adaptable decision-making.

Emotion has been left out of consideration yesterday when we could solve problems rationally, because it is not easy to rationalize. But if we remember that Emotion comes from the Latin words e=ex=out and movere=move and it means to move our or to act, we would realize emotion is deeply associated with decision making. In fact, we have to make a decision to take a next step forward or to take next action in a changing world at every step of the way. And we know emotion plays an important role in such decision-making.

2 Awareness and Recognition

First of all, let us consider the issue of awareness and recognition. To make the discussion simple, let us consider the problem of how we can identify the name of a river. A river is flowing and changing continuously. Even with the help of modern fluid dynamics, we cannot predict the exact behavior of a flow. Then, how can we know that a river is the Mississippi, for example?

From our experience, we know that there are things around a river, which do not change or if they do, change very slowly. So, we look for trees, etc. and we know that it is the Mississippi based on the shapes, locations, etc. of the trees and other things. We are aware that we are coming close to a river, but we do not know what river it is. This is a problem awareness. The problem is to identify the name of a river.

But in order to identify, we have to recognize its features or difference from other rivers. In other words, we have to define the problem. In this case, to identify the name of a river is the problem. We have to note that we are not really paying attention to the river itself, but we frame our scope and find the identifiable things around. We are defining the problem. Then once we can define the problem, we can solve the problem, i.e., we can identify the name of a river (Fig. 2).

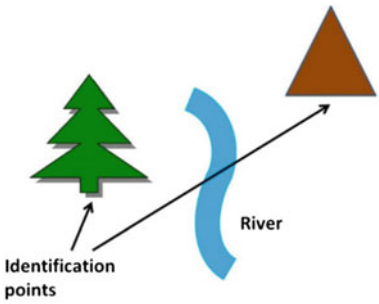

Fig. 2 Identification points

3 Controllable World and Rational World

Let us take another more complicated example in engineering. Arc is the most popular heat source for welding. Without arc welding, most of our building, bridges, etc. could not be built. There are many researches about arc, but we cannot predict its behavior rationally. If we could, we could prevent thunder and lightning.

Although we cannot predict its behavior, we can control it. That is why we can use arc for welding. Instead of paying attention to the molten pool, we look for surrounding areas, which do not change or change rationally. Once we can identify these areas, then we can apply rational approaches to control arc. In fact, welding robots control arc based on information from the surrounding areas, which bound the molten pool.

Thus, our controllable world is much wider than a rational world (Fig. 3). In fact, most of our engineering were developed outside of the rational world and they were successful because we found out how we could define the problem within our controllable world.

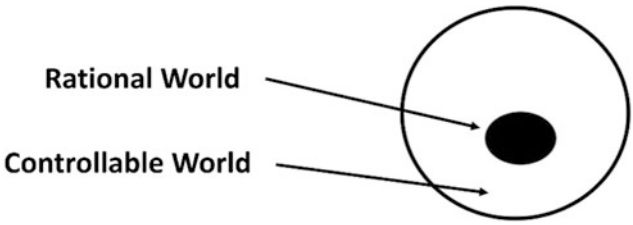

Fig. 3 Controllable world and rational world

4 Recognition-Primed Decision Making

In psychology, Recognition Primed Decision (RPD) Making has been studied extensively [1–3]. But their emphasis is primary on time pressure, i.e., how you can make an adequate decision in a very short time. So it is closely related to heuristics [4, 5]. What we would like to pursue here is not a quick decision, but how we can control the uncontrollable phenomena.

Arc is one of such examples. RPD emphasizes the importance of experience. And experience indeed plays an important role in reaching a quick decision. But to apply such an approach to engineering to control phenomena, we have to organize our experience. It would not be too much to say that almost all welding technologies were invented by experience. They were not invented by theories. In welding, material phase changes from gas to liquid to solid or from liquid to solid, etc. And their governing equations are different. There is no integrated governing equation that can be applied throughout all phases. We can analyze gas, liquid or solid independently, using the equation that govern its phase, but we cannot analyze them with one single equation.

Thus, as there is no single governing equation and we cannot rationalize the welding process as a whole, we have to observe and to find out how we can control the process.

Finding points or areas, which we can control was a great discovery and it was indeed through experience that we learned how we could control such uncontrollable phenomena.

Thus, what is proposed here could be called Recognition-Primed Control (RPC).

But RPC is not just an extension of Control Theories. Control Theories provides us with tools to control, but they do not tell us how to model the problem. In fact, most of the discussion there is how we control *after* the problem is defined. It is another problem solving. In an age of unpredictable changes what matters more is how we define the problem or how we come up with a model which permits the application of these techniques. The issue discussed in this paper is, to put it in other words, how we can model the problem, and utilize our current knowledge to control the uncontrollable.

5 Wisdom Engineering

We assemble our pieces of experience and structure them into knowledge. Our rational world is constructed that way. But we encounter many things that cannot be easily rationalized. Bicycle riding is one of them. Michael Polanyi coined the word tacit or implicit knowledge [6], which cannot be described by our explicit or rational knowledge. If we remember the case of arc welding, we soon find out that most of

our engineering are carried out based on tacit or implicit knowledge. It is our Wisdom to control the uncontrollable by utilizing explicit or rational knowledge.

We cannot deal with most of our daily life problems, not to say engineering problems, by applying our knowledge in a straightforward manner. This is because most of our daily life or our engineering problems are outside of the rational world and we have to find out clues to how we can control the non-rational world. It is Wisdom.

Wisdom is the way we learn how to control the uncontrollable. We find out points or areas, which follow our rational rules and we control the uncontrollable. Bicycle riding is not easy to model on a rational basis, but with the help of big data approach and rapidly progressing sensing technology, for example, we can find out clues to which points we should keep in mind to control it. The environment, situations and context vary from riding to riding, but we pay attention to such controllable points and we can control the bicycle and we can ride it beautifully.

Therefore, it is wisdom which built up engineering. Of course, knowledge contributed a great deal, but to apply it successfully, we have to know where and how we can apply it and we have to pick up applicable points or areas and apply knowledge in a wise manner.

6 Modularization

Let us look at the issue from another perspective. Modularization is attracting wide attention these days. But most discussion is about functional modularization. Today, modularization is touted as a very effective approach to respond to diversification and personalization. In passenger cars, the idea of the common platform is introduced to reduce cost, because by combing different modules with this common platform, they can come up with many different models with less cost and trouble and with more flexibility. But truck industries introduced modular design long time ago (Fig. 4). They design and manufacture different cargo bodies to meet the diverse requirements, but they use the same chassis for all purposes.

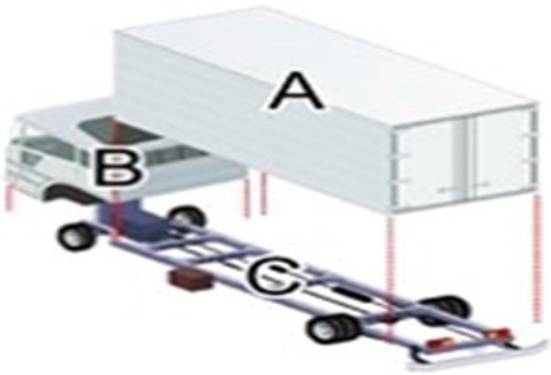

Fig. 4 Truck (*A*=Cargo body, *C*=Chassis)

And it should also be added that what automotive industries are doing right now was already introduced by fashion industry. Take for wedding dress, for example. Ladies would like to wear a wedding dress just for herself alone. But not all ladies are rich. So most of them have to compromise with a rental dress. However, rental dress makers cannot produce a wide variety of wedding dresses. So, they hold a fashion show and observe where ladies pay attention to. They prepare different parts (modules) and they produce the part where ladies do not pay much attention to as a common platform. They combine them in a different way and let ladies feel that the dress is just made for her.

The basic idea is the same, although the application is either to passenger cars or to wedding dresses, although the former focuses on functions, and the latter on emotions.

The idea of finding controllable parts is fundamentally the same with these examples. In this case, however, it is not function or emotion, but controllability. But all of these come from the same idea that if we separate things into appropriate elements, we can rationalize more easily (Fig. 5).

Let us take another example related to emotion in our daily life. We carried out a research on detection of emotion from face expression. There were many researches on this topic. But what we did was to utilize a cartoon face model and fitted it to the real face image and compared. Without too much difficulty and too much sophisticated image technology, we could detect emotion easily. That demonstrates why we can understand the emotion of cartoon characters so easily, even when the cartoon is in black and white. Cartoon faces vary from frame to frame, but we understand characters' emotions. What we did was to modularize a face into parts (modules) and observed the parts, which vary with emotions and we ignored the parts that do not change [7–9], (Fig. 6).

Detection of emotion from face may sound irrelevant to decision making. Then, why do we have to detect emotion of others? That is because we have to make a decision for the next step. We take the next action by observing what other people

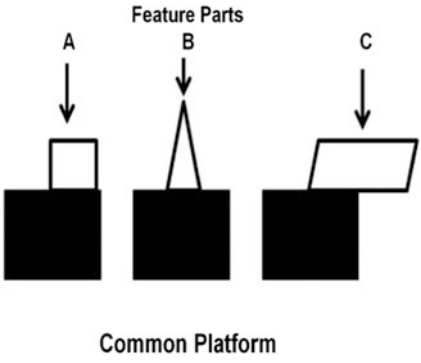

Fig. 5 Feature points

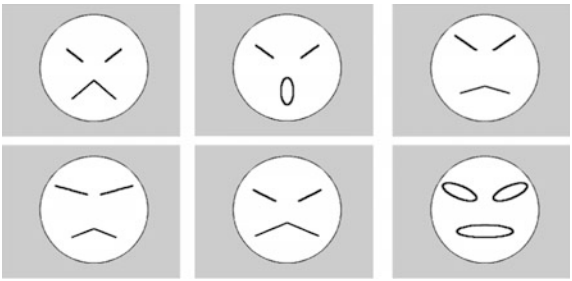

Fig. 6 Cartoon face model (Angry)

are feeling. This is very important in team working. Even in our daily communication, we have to detect emotion of the others for communication. Communication is not just to convey your message in one way, but to build up a common ground and to enjoy talking with each other.

And it must be added that communication is not only necessary between human and human, but between machine or product and human. If we can communicate better with our machines or products, we will be attached to them and evaluate them more highly. Then, we will cherish them for longer time. Thus, decision making plays an important role.

7 Summary

In an age of unpredictable changes, we cannot apply rational approaches in a straightforward manner. Yesterday, our world was small so that we could apply rational approaches easily and we could make decisions at the very early stages. But today, we have to make decisions to go ahead at each step of the way by trials and errors.

This paper points out that most of our engineering are carried out by finding appropriate controllable areas surrounding the uncontrollable region and thus controlling the unpredictable phenomena by applying rational approaches.

We are aware of the problem even in an age of unpredictable changes, but we do not know how to recognize the problem and to define it. Finding areas or parts that do not change or change slowly serves to find out how we can define the problem and solve it by applying rational approaches. It is very much of a decision making how we frame the situation and define the problem appropriately.

Emotion is our inborn tool to respond flexibly and adaptably to the frequently and extensively changing situations. Emotion plays an important role in awareness and recognition for decision-making.

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Part VI
Empathetic Design

Indirect Teaching for All and Autism Spectrum Disorder (ASD) in Design Class (ITAD) Encouraging Their Emotional Empathy

Hyun-Jae Jo, Seung-jin Chung and Debra Satterfield

Abstract The purpose of this study is to develop a specific design class for children and youth with ASD as the necessity of diversified educational approaches for them rises. And this study aims to motivate ASD students to feel emotional empathy through indirect questions. In this regard, this research focuses on indirect design class and suggests the strategies for instructors to encourage ASD's spontaneous language production, imaginative thinking and independent achievements. We pursue an indirect design class, which is expected to focus on design-thinking rather than design-outcome while concerning the identity of the students with ASD, improving their spontaneous communication and emotional empathy. More importantly, this study's ultimate long-term goal is to suggest a guideline of Individualized Educational Plans (IEP) based on the analysis of five-week ITAD proposed in this study.

Keywords Indirect teaching · Autism spectrum disorder (ASD) · Emotional empathy

1 Introduction

Most of classes for the students with ASD in various fields including art and design in South Korea implement directive teaching method concerning the outcomes from learning and focusing let them learn routine activities which is necessary in their

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Goal setting: ITAD to enhance emotional empathy ability	Literature review and participant-observation : Ethnographic observation	Identification of teaching themes : Creative design for my dear	ITAD design and test : based on Borich theory & NLF for ASD	Experiment (Teaching class) : five-week design class, 3 participants	Analysis and conclusion: ITAD & IEP guides

Fig. 1 We had reviewed the literature of design pedagogy for ASD students in U.S. and Korea for around one year to identify the potential of indirect teaching method (Hypothesis 1), leading to the design of Indirect Teaching for All and ASD Design Class (ITAD) (Hypothesis 2). This five-week design class consisted of analyzed categories reflecting social empathy, which was provided together with guideline for Individualized Educational Plans (IEP)

daily life. Unfortunately, even though design approaches for the problem resolution has a potential to draw positive abilities of the students, the design class for ASD in South Korea is not common. Therefore, we developed the design class curriculum for ASD students to encourage pervasive development, especially emotional empathy ability according to the Borich's indirect teaching theory.

This study's particular hypotheses are:

- Hypothesis 1. Indirect teaching is implementable for ASD students
- Hypothesis 2. Generic learning design in design class is implementable for ASD students.
- Hypothesis 3. Individualized Educational Plans (IEP)[1] for the long-term goal of ITAD is implementable.

The process of this study is as follows: (Fig. 1)

2 Literature Review and Participant-Observation (Ethnographic Observation)

2.1 Background of ASD

ASD is a comprehensive terminology encompassing various categories. ASD is usually defined by its three major characteristics rather than notion about it; Defects in (1) communication, (2) socialization, and (3) interests and activities [1]. ASD patients are more likely to be obsessed by individual interests on limited areas instead of following social norms, and their interests are mainly concentrated on objects' physical features in lieu of social stimuli such as people. Although the

[1]There has been consistent research and review on Individualized Educational Plans (IEP) for young children with disabilities since 1970s.

defect levels of ASD can vary by individual, overall characteristic of ASD can be defined as lack of social skill and empathy, which has similar implication with Pervasive Developmental Disorder.[2]

2.2 Design Education for ASD

Ethnographic observation was used to familiarize the research team with the specific idiosyncratic behaviors and habits of children with neurodevelopment disorders. Each of two ethnographic observation sessions had been administrated in Korea and U.S., respectively, in order to examine teaching methodology and its impact on ASD students in design education. The results from classes in Korea showed that students with ASD can be more limited to their biased thoughts when their learning was directed by teaching methods using their obsessive concentration. On the other hand, case study in U.S. revealed that indirect teaching method was even applicable to students with the severe symptoms of ASD compared to the students with ASD in the case of Korea.

2.3 Indirect Teaching for ASD

Based on the literature review on ASD and the observations in actual design and art classes for ASD students, the major implications of indirect teaching in such design classrooms are shown in the following section:

First, the actualization process and visual communication of designing enhance ASD students' understanding. Visual materials have been widely used to improve ASD students' understanding for new process or complicated subjects, which are generally recommended. The process of visualization in designing is useful to easily communicate with ASD students and to teach them in step-by-step approach.

Second, indirect teaching in design class can provide a new opportunity for ASD students to improve their social skills. During an interaction with ASD students, there is a tendency that people frequently show somehow extreme attitudes such as

[2]The ethnographic observations were conducted on-site at respite weekends. Based on the DSM-5 [2] a set of criteria were set as a basis for observing the children with neurodevelopmental disorders. According to the DSM-5, Intellectual disabilities are characterized by the following three main sets of deficits:

(1) Intellectual functions such as reasoning, problem solving, planning, judgment, academic learning, and experiential learning;

(2) Adaptive functioning that result in failure to meet developmental and socio-cultural standards for personal independence and social responsibility; and

(3) Onset of intellectual and adaptive deficits during the developmental period.

being coercive to control the students' unpredictable behaviors or being negligent due to the difficulties in communicating with the students. These patterns of behaviors, however, would not improve the ASD students' social skills. Instead, motivating the students to lead them to higher self-esteem can help the development of the social skills with emotional stability.

Third, through the indirect teaching program, students' communication level and problem type can be easily recognized, so that it can be used as a basis for establishing Individualized Educational Plans (IEP). Given that autism is usually patient-specific, IEP with long-term goal can be particularly effective in this context.

3 Design and Test of ITAD

3.1 Components of Indirect Teaching

Based on natuerliche Lernformat (as below, NLF)[3] for ASD and seven types of Indirect Teaching suggested by Borich, we drew the components of indirect teaching as below:

- Use of Visual Board: To provide an activity plan with the format of picture image
- Conceptual exercise using induction and deduction.
- Transformation of ideas through cases
- Guide for problem solving through indirect questions
- Use of a student's interest and experience
- Self-appraisal and group discussion

3.2 Components of Social Empathy

We invented the following the components of social empathy to clarify this ITAD-based program's uniqueness from other general design classes and to provide a new direction under the theme of "Creative design for my dear" for ASD (Table 1).

[3]Since the intensive action therapy, Diskrete Lernfomat (DLF), would not be effective if situation has changed, Natuerliche Lernformat (NLF) emphasizing self-motivated learning approach has been developed [2].

Table 1 Evaluation components of ASDs' social empathy

Component	Evaluation criterion	Description
Basic understanding	Basic communication skills	Proper communication skills enabling opponents to understand
Spontaneous expressions of opinions (Preference)	Extent of student's self-motivation based on ITAD	Ability to actively express one's likes and dislikes
Social empathy ability	Objectives of education (Terminal goal of this study)	Ability to deeply understand the situations and thoughts of other stakeholders in relationships

Table 2 Five-week ITAD class design

Title	Creative design for my dear	
Objectives	– Through indirect teaching class, students can spontaneously set their goals and find ways to achieve the goals – Students can use diverse strategies in thinking by focusing on process and potential	
Details	– Five-week class for ASD students (Weekly, 1 to 2 h per each session) – One (1) to two (2) students per teacher – Teachers and assistants should understand the pedagogy of 'indirect teaching', avoiding direct instruction and adopting consistent encouragement – Minor changes reflecting students' interests and feedbacks are allowed to achieve the goals of the class – There is no limitation for final outcomes – Over six-year-old student is recommended to enroll	
Week	Objects	Contents of indirect teaching
1	To understand five-week curriculum	Making Visual Board (Students can understand the process of five-week class.) Identification of students' interest and talent
2	To select 'my dear'	Use of visual stimuli like photo. Exploration and selection of objects through indirect questions
3	To select an item/service for 'my dear'	Preparation of photo images of objects that 'my dear' loves or is likely to love The selection of an item/service after questions and case reviews
4	To actualize the design	In addition to the item/service selected previous week, actualization of the idea by bringing more specific and diverse photo images
5	To finalize and present outcome	Self-actualization by spontaneously making and presenting the item/service for 'my dear' with diverse materials (Awarded compensation)

3.3 Curriculum of ITAD

By adopting the indirect teaching approach, we planned five-week class for ASD to induce the self-motivation of students and to improve their emotional empathy ability step-by-step.

As experts suggested, an orientation session was added to the teaching curriculum design for establishing rapport. During this orientation, students' parents or guardians could participate in sharing the information (e.g., likes and dislikes) of the students even though following regular classes would proceed independently from them (Table 2).

Detail plan by week was prepared separately. This plan includes key processes, required materials, expected questions, and so on according to weekly goals.

4 Classes and Analysis

One course consisted of one orientation session and five-week-class sessions through six weeks. Every session was recorded on video and audio tapes with the consent of students and their parents, and the final outcomes of the students' verbal and non-verbal communication were extracted and analyzed through script.

4.1 Participants

We recruited the participants from a pool of autism students were active in an orchestra. Thus, the participants can be defined students who can communicate in certain level and physically well-functioning, but cannot be diagnosed as high-functioning autisms. Four students were recruited[4] and paired into two teams. We assigned one instructor and one helper by each team (Table 3).

4.2 Contents of Analysis

The scripting for each student's current status of weekly class was analyzed based on the three categories of (1) *Basic Understanding,* (2) *Spontaneous expressions of opinions (Preference),* and (3) *Social Empathy Ability* while summarizing individual students' key motivator for further long-term customized plan for each student. Script analysis examined the students' behavioral aspects such as seat-breakaway and eye contacts as well as verbal communication, and the observations summarized as weekly average score reflecting general communication levels and social skills (Table 4).

[4]One of the fours participants was excluded in analysis stage due to failed scripting.

Table 3 Participants' profiles

Name	Sex	Age	Likes	Dislikes	Other information
Park	M	13	Deep interest in fine art (detailed drawing), obsession in eating, and interest in objects	–	Never diagnosed, in adolescence while experiencing a sexual awakening, and verbal discipline works fine for me
Kim	F	16	Drawing	Loud sound (e.g., firecracker and balloon)	Level 2 ASD
Seo	M	8	Loves drawing	Getting pressure to do something he does not want	Main subjects for drawing are cartoon/character/game, Level 2 ASD

Table 4 Evaluation scales for social empathy

Category	Level	Attribute
Communication	Unidentified	Unidentified
	Level I	Not accurate but guessable expression (Confusion derived from echolalia, unclearly expressed intention/feeling with non-word form)
	Level II	Enumeration of words or relatively clear and easy-to-understand expression
	Level III	Expression with complete sentences, and easily understandable intention and contents of the expression
Spontaneous self-expression about intention (preference)	Unidentified	Unidentified
	Level I	Selection between yes or no is possible
	Level II	Selection between multiple choices is possible
	Level III	Expression without selectable option is possible
Social empathy	Unidentified	Unidentified
	Level I	To show basic interest in other people
	Level II	To have somehow consistent and appropriate empathy to opponent's words
	Level III	To predict and deal with opponent's needs

In each category, we summed up total score by counting the incident of corresponding level whenever there was a valid communication with the participants.

4.3 Results

Instructors (researchers) categorized weekly scripts by analysis category. Three participants attended all five class sessions whereas other one student attended four sessions and missed one. Because audio and video records for one student among these four participants were in an unusable condition, this student was excluded in final analysis while we conducted the analysis on other three students with at least three weeks' comprehensive data allowing sufficient quality and quantity.

The results of analysis revealed that the most counted category was *Communication*, which means that this category was the easiest to determine. But, *Spontaneous self-expression about intention (preference)* and *Social empathy* categories showed notably fewer counts. In addition, non-ignorable number of the inappropriate communication cases (i.e., *Unidentified*) implies that the participants were able to communicate but still below a normal level.

Even though the results were based on significant incidents of verbal and non-verbal communication by category, interpretation on the results does not necessarily rely on absolute numbers. The number of cases may need to be treated as relative numbers.

In sum, it is possible to determine the individual differences between participants in terms of communication and social skills, and the current status by category. The levels were introduced for convenient analysis, but these can provide an additional opportunity to analyze in various angles by the different pattern of the participants (Table 5).

Table 5 Checklist of participants

Category	Level	Park	Kim	Seo
Communication	(Unidentified	16	3.333	21)
	Level I	11.667	3.667	2.5
	Level II	22.333	11.667	1.667
	Level III	0	8.667	4.333
Spontaneous self-expression about intention (preference)	(Unidentified	3.667	12	7.333)
	Level I	9.833	7.167	0
	Level II	0	3.333	0
	Level III	0	0	1.833
Social empathy	(Unidentified	9.833	7.333	6)
	Level I	13.333	13.5	0
	Level II	0	0	0
	Level III	0	0	0

We averaged the total count after reviewed the detailed contents of each case (with three-decimal-place), so that we can comprehend the overall current status of the students in communication, spontaneous self-expressions, and social empathy.

4.4 Guideline for Individualized Educational Plans (IEP)

We expect that our analysis on the ITAD class can help ASD students in setting and achieving long-term learning goal. Capable instructors administrating accurate evaluations and objective analysis tables from these instructors can provide proper feedback for the long-term learning plan (Fig. 2, Table 6).

4.5 Guideline for ITAD

ITAD designed and examined in this study provides the following final implications:

1. Establish a bond or connection with the students would enable to drag meaningful communication (It is important to form rapport with students).
2. It is effective to start conversation by using topics students are interested in.
3. Positive feedbacks such as immediate attention and praise are more appropriate to modify the improper behavior and encourage the motivation.
4. Successful indirect classes could be guaranteed under parent's appreciation and the communication consistency between the class and at home.

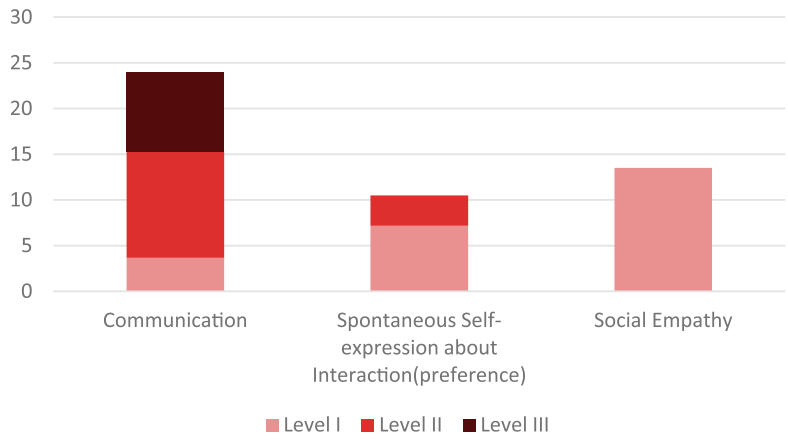

Fig. 2 Results

Table 6 ITAD final analysis table by category (Sample: Kim)

Category	Level	Comprehensive evaluation
Communication	Level II ~ III	Overall, we couldn't find considerable problems in general communication. She is able to complete sentence and express relatively clear preference. Thus, we conclude that she can communicate with completed sentences in everyday life
Spontaneous self-expression about intention (preference)	Level I	There is no problem in selecting either like and dislike. But, in the setting of multiple choices and open-question, she tried to evade answering or replied "I don't know" and "I have no idea", implying that she still has difficulties in this area. Nevertheless, she showed improvement in Week 2 compared to Week 1 by increasing her response rate of Level II and III, which means that there is a possibility that she can be more competent in communication with multiple choices and open questions when asked more questions in Level II and III. Thus, class sessions for Level II and III are necessary
Social empathy	Level I	She is attentive to other people. But, her interests are limited into people's age, zodiac sign, and family status while having difficulty to talk about other topics the opponents would like to. In other words, there is an issue with social empathy and the consistent communication. But, her deep interest in people can entail appropriate communication with social empathy if she can take a series of classes focused on social empathy and consistent conversation
Overall suggestion		
Kim is likely to have interest in other people, but particularly limited to age, zodiac sign, and year of birth. So, she seems to be still lack of social empathy She is good at choosing between two things, but less competent at multiple choices and open questions by trying to avoid answer or turn the attention to different topics such as opponents' family status, age, zodiac sign, and so on. In other words, she tends to continue the conversation with what she is able to talk about. So, we conclude that she is at Level I in the categories of *Spontaneous self-expression about intention (preference)* and *Social empathy* Thus, we suggest that Kim would benefit from the following teaching approaches. First, the communication partners of Kim may need to understand that Kim is having difficulties in conversation when she tries to continue focusing on the partners' family, zodiac, and age or to suddenly change to different topics, then the partners can try a different approach to improve the situation. Second, following classes are required to emphasize Level II and II in *Spontaneous self-expression about intention (preference)* and *Social empathy* given that there are no problem in Level I in both categories and all levels in *Communication* category		

5. Even though video and audio recording can be helpful for accurate analysis, comfortable setting and atmosphere are more important to motivate students' spontaneous participations than strict experimental settings.
6. It is required to prepare weekly-based detailed curriculum and to update the list of expected questions by analysis category.

7. Although it seems obvious that several experts should administrate the ITAD for objective analysis, an expert having close relationship with students in actual classroom may provide more accurate analysis.
8. Children's emotional empathy and spontaneous social communication about ternary relationship[5] could be improved gradually via visual communication and creative problem solving process of the design.

5 Conclusion

Regardless of ASD, students must have opportunities to experience indirect teaching encouraging independent problem-solving in order to achieve the process of a true learning emphasizing self-oriented individual thoughts. Obviously, this applies to ASD students. If we particularly want to maximize the potential of ASD students, it is necessary to prioritize self-regulating and creative education than external regulation, helping the students in harmonizing with our society. Design demands not only social empathy centered on users, but also rationality (i.e., technical detail) corresponding to ASD personality. Through ITAD, individual ASD students' current statuses will be evaluated and understood, and have chances to take well-prepared customized classes to improve self-motivation and social skills for better social empathy. To conclude, this study contributes to more effective and productive design classes for ASD by providing more structured and organized evaluation process, which can be an extended new area for conventional design education.

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[5]The symptom of autistic disorder is a difficulty in understanding relationship among me, you, and an object (i.e., ternary relationship) spontaneously. A cognitive status of patient with autistic disorder tends to be interpreted as a single focus or mono-track process.

Affective Multimodal Story-Based Interaction Design for VR Cinema

Jiyoung Kang

Abstract Wearable devices are gaining increasing attention with the smartphone market slowing down. As many major consumer electronics manufacturers are undertaking expanding the wearable device market, the future is suggested to consist of a "year of the wearable devices". Because wearable contents are still newly created, many interaction design issues of wearable devices like HMD still exist. This study focuses on the affective interaction design for HMD contents. It focuses on the cinematic content that the user experiences with the VR cinema in a very personal environment. We suggest a novel method of affective multimodal story-based interaction methodology for the VR cinema of HMD to maximize the users' emotional responses. Contextual and implicit interactions enable the users to be more engrossed in the narrative of the cinema and affected emotionally through the experience. The research results have significant effect on future directions in designing the affective interaction method for HMD contents.

Keywords Affective design · Wearable interaction design · Affective multi-modal interaction

1 Introduction

In recent years, the smartphone industry has grown exponentially; however, as the industry approaches saturation, the smartphone manufacturers are now showing an interest in the wearable device market for a new source of profit. Furthermore, a number of countries that could not gain leadership in the smartphone industry express a strong motivation to take up an advantageous position in the wearable device industry by entering into the market early on.

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According to a recent survey conducted by a market research firm—Juniper Research—2018 is expected to see an increase in the smart-wearable devices shipment, 130 million devices including smart watches and smart glasses, which is ten times more than it was in 2014. The global IT companies foresee a future in which wearable devices become the next, main growth engine of the IT industry after smartphones. A market research company—Super Data Research—expects to see a growth in the mobile VR industry of up to 861 million dollars by the end of this year. It also foresees the leadership of low-price VR headsets in the market growth. They can play VR games and applications when linked with smartphones in the market growth [1]. Accordingly, Google and Samsung Electronics acquired the preoccupancy in the mobile VR headset market and content platform, starting to gain leadership in the mobile VR market, which attracts attention as the next-generation platform.

The VR industry has a high growth potential as well. According to investment company Goldman Sachs, the anticipated scale of the VR industry, if it includes augmented reality (AR), will reach 110 billion dollars in 2020. Despite the rapid growth of the VR industry, the public interest in VR content is faint yet. What is necessary for the success of HMD devices like that of smartphones?

Although most of the technology installed on smartphones already existed before, smartphones were a success because they did not simply end up with combinations of technologies, but gave a new value, so that they could rapidly penetrate into the market. In short, smartphones can be considered as the 'connection to the world.' Wearable devices like HMD face the challenge of being able to create a higher value than that of smartphones in its climax, with respect to both technology and platform; several attempts for differentiation have been made. Microsoft enables enhanced consumer experience by utilizing the game console; Qualcomm displayed the Beacon model for use in the commerce area (transaction).

The major companies of HMD, Google and Samsung Electronics regulate the download method of VR contents through Google Play and Oculus Home to expand their influence on the market. The Google Play Store already provides dozens of applications for VR, and Google expects to create new profits from this content. However, there is no powerful, killer content exclusively for wearable devices yet. To popularize a new form of wearable devices such as HMD, the introduction of powerful, killer contents will be the milestone that determines the success and failure of wearable devices, though the development of technology that is not always obvious to the consumers is also important.

An interactive movie in which users are directly involved in inducing its direction is one of the most suitable contents of personalized media HMD environment, showing a differentiated narrative structure from the existing, one-directional film narrative with characteristics of a simulation game in which the user selects the characters and story lines.

With the evolution of digital technology, the integrated content production of a new form is increasing through the combination of existing contents such as a movie, broadcast, music, game, and animation. To respond to new environments of incessantly emerging new media, and the expansion of media integration, the

development of a new type of user-oriented interaction far from the traditional way of interaction is necessary. The existing keyboard of a computer and touch-screen of a smartphone suggested intuitive, efficient ways of interaction. In contrast, the wearable device environment of devices being worn on the head, such as HMD, provides diverse opportunities for interaction, including hands-free interaction. However, research on the interaction design suitable for the VR interactive movie content in HMD environment has not been conducted yet. A movie is a narrative-oriented, highly emotional medium, and the HMD is a device through which the movie can be watched from the most personal, audience-centered perspective. Hence, the simple and intuitive interaction of existing HMD devices, focused on conveying information, cannot maximize emotions from movies. In this study, we propose an interaction method that can amplify the emotional response of a user from the VR movie content to resolve the problems of existing interaction methods. For this, in this study, we designed affective multimodal story-based interaction (AMSI) suitable for a VR movie and examined the emotional effects through user study.

2 Related Researches

The VICTEC (Virtual ICT with Empathic Characters) project [2] applied synthetic characters and emergent narratives to the Personal and Health Social Education (PHSE) for children, in the UK, Portugal, and Germany, by using 3D self-animating characters to create improvised dramas. The goal of VICTEC was to support affective interaction between a child and the synthetic characters resulting in empathic engagement for the user in a social and emotional learning situation. The aim of this project was to affect users and evoke empathy and empathic engagement through social and emotional learning for bullying and coping strategies, using mediation via both the situation and expression.

Fear Not! [3] considers affective interactions to achieve empathic engagement with synthetic characters in virtual learning environments to support and induce the expression of empathy in children. Fear Not! presents a school based virtual learning environment, populated by synthetic characters used for personal, social, and health education, specifically bullying issues in schools. An empirical study of the children's results shows that affective interactions resulting in the expression of empathy increased when the children had high levels of belief and interest in character conversations and if they believed that their interactions affected the characters' behaviors.

AR Teleport [4] was a former project of this author, which uses affective multimodal interactions for mobile AR environment to improve users' interests and awareness levels. AR Teleport is a mobile-augmented-reality application for reconstructing such aspects or mobile phones. The users can travel to the past from the present sites via AR Teleport and can attempt rich movement-based interactions like jumping, blowing a breath, wiping with a finger, and touching buttons on

a phone. In this study, the effect of these rich interactions on the interests and awareness levels of the users was looked into.

Similarly, affective interaction methods have been developed through research in various fields. Particularly, all these methods are designed to increase the users' emotional responses. However, the VR movie in HMD environment proposed in this study, different from the previous research works in other fields, is more personalized and has a narrative-emphasized environment. Therefore, suitable research regarding the affective multimodal interaction design is necessary.

3 Affective Interaction for VR Cinema

By addressing human emotions explicitly in the design of interactive contents, we hope to achieve both better and more pleasurable and expressive systems. The study presented here is inspired by the field of affective computing [5], even if our aim is to take a slightly different stance towards designing than that normally taken in the field—a more user-centered approach.

Affective interaction relates to, arises from, or influences feelings and emotions [6] and generates actions between the user and computer that have a reciprocal effect on feelings and emotions. Evoking affect in users has been achieved through a range of approaches and for a variety of motives, including making systems simpler to use [7], affecting the user's physical and mental health [8], reducing stress levels [9], and improving the learning experience [10]. This research highlights the potential of affective interaction based on the narrative in the VR cinema. Through affective interaction, users can foster emotional involvement to create a coherent cognitive and emotional experience, which results in empathic relations between a user and a synthetic character.

Based on the recognized emotional state of the story in the film, the aim is to achieve as natural interaction as possible, seamlessly adapting to the user's emotional state and influencing it by using various affective expressions [11].

Whereas existing affective interaction research works design the interactions based on the emotional responses from users, this research derives emotional elements from a movie's story and, based on them, develops an interaction method that amplifies the emotional responses of users. That is, by proposing the contextual, implicit interaction method based on the story in the most personalized movie content environment of the virtual reality movie environment, the affective interaction appropriate for the story of a movie, and not the interaction that simply emphasizes the efficiency for users, is designed. For this, first, three representative major feelings among emotional elements from a movie are selected; based on these, the story of the movie is written, and the movie is created. Second, gesture interactions suitable for the story, those that represent each emotion, are designed. Lastly, we verified the effects of affective interaction from user study and survey.

4 Extraction of Emotional Elements from Movie

Charles Darwin states that the emotions expressed by humans and animals are not learned but innate and inherited, in his book titled "The Expression of the Emotions in Man and Animals" published in 1872 [12]. Emotion is expressed in facial expression as nerves stimulate muscles; animals including humans have general emotions such as anger, happiness, sadness, disgust, fear, and surprise; emotions in facial expression and fundamental gestures appear to be the same globally. The universality of emotion, as it has evolved because it helps humans to quickly respond to various situations, plays the role of an effective communication system. In other words, the emotions that users assimilated into the characters through the story of the movie will feel can be expressed with gestures or interactions and can be an effective communication method.

In this study, we design affective interaction by using the three most expressive emotions in humans—anger, happiness, and fear. As these are emotions that users can directly associate with the most through the narratives of movies and films and they can be expressed using gestures and sounds, we selected them. A 10 min long VR movie that includes anger, happiness, and fear is created; embedded in the movie are three interactions in total, which are set up one at a time. The experimental short film is created through a 360° VR camera in the interactive movie format through interaction (Fig. 1).

The brief storyline of the movie that represents these three emotions is as follows.

- Happiness: the happiness felt for each moment spent with the daughter in daily life
- Fear: the fear felt when he found out that his beloved daughter was kidnapped, thus ruining the happy moments
- Anger: the anger felt when the father whose daughter was kidnapped encounters the kidnapper

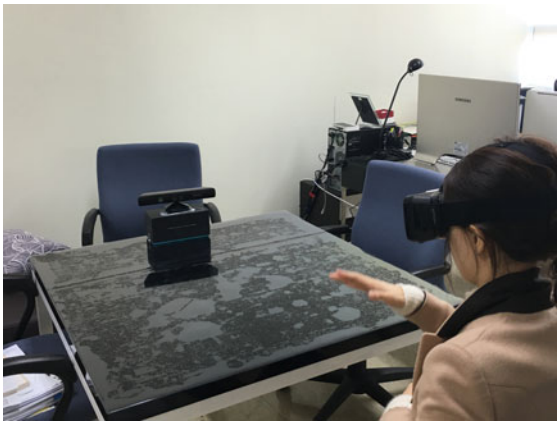

Fig. 1 User experiencing the interactive VR cinema 'Abduction'

5 Story-Based Contextual and Implicit Interaction Design

According to Norman's [13] seven stages of action, the actions focus on user cognition. The user can easily get used to the idea of petting, shouting, and punching because they already know the "why." Ulmer [14] called "expressive representation(ER)" one's "reading" and interpretation of representations, acting on, modifying, and creating them in interactions.

For affective interaction design that amplifies the emotions of happiness, fear, and anger proposed earlier, in this study, we designed petting, shouting, and punching interactions. The users feel happy as they affectionately pat their beloved child through petting interaction and feel fear as they scream the name of child on finding out that their beloved child has been kidnapped. Furthermore, they swing a knife the moment they meet the kidnapper of the child. The affective interactions proposed likewise are designed as highly closely-related interactions to the story of the movie and as the implicit interaction that implies the users' emotional reactions. Through this, we allow the users to feel the emotions of the story of the movie and to express their emotions.

The petting interaction has a context wherein the father affectionately pats his daughter as she runs into him, smiling happily and sweetly on the day the father, mother, and the daughter went for a picnic together. Moreover, the interaction that an action of petting implies, as all of us know, is an action of love and affection. That is, the petting interaction is related to the story of the movie and at the same time, it also expresses an emotion the users associate with through the movie characters.

In the second shouting interaction, the story begins from the perspective of the father when on an ordinary day; he receives a call informing him that his daughter has not returned home on the time she usually returns from school, in the narrative side of movie. Then, the father screaming out his daughter's name, which does not come back even though it is late at night, is an interaction that reflects the narrative surrounded with the father's fear of losing his daughter. In general, shouting reflects a general psychological state of the users when in fear or surprise. In other words, the shouting interaction reflects the situation in the movie's story of a father who lost his daughter and expresses fear, which the users experience together in the story.

Third, the punching interaction is an interaction of punching the kidnapper who keeps mocking the father when he meets the kidnapper in the story of movie. This is a user's emotional status that leads to unbearable anger.

Similarly, the three affective interactions designed through the narrative of movie are the most appropriate interactions to the context of the story of the movie and, at the same time, the expressions of emotional responses the users experience through the story of the movie. This means that the interaction design method that

integrates both aspects of the story and emotional responses of user is proposed, different from the existing interaction design, which considers both aspects separately. Through this, users can feel a sense of engagement and ambience to the story of movie, and the emotional effects are amplified by directly expressing the emotion with interactions, different from the existing movie audiences who passively hide the emotions they feel.

I used these non-verbal interactions for expressing the user's emotional state because these non-verbal interactions sometimes reveal more accurate emotional expression. Many investigators have explored nonverbal appraisals and expressions of emotion [12] since Darwin's now classic study of facial expression [15]. Much emotional communication occurs through nonverbal channels. Moreover, individual differences in the clarity of the perception of these signals are illustrated in its expression, sometimes termed "nonverbal sending accuracy" [16].

In the study experiment with affective story-based interactions conducted, the device users experienced the application more physically, which enhanced the users' emotional responses. According to Gibson's ecological theory of perception [17], the world unfolds in possibilities for action. The world is perceived in terms of what people can interact with in it. It is through these interactions that people create meaning. Thus, affective story-based interactions with their own meanings were created herein.

6 Multi-modal Interaction

Rigid designs that assume that users will be explicit and fully attentive while interacting with the computer and do not protect against errors provide help at all times except at the right moment, and overall, frustrate users, and they are likely to become quickly extinct because of their poor usability [18]. However, designs that include adequate attention to individual differences among users, support (natural) multimodal and context-sensitive.

Multimodal signifies the interface environment in which humans communicate with systems like a machine or computer with more than one sense. 'Multi' means 'more than one', and modal can be understood as a concept that includes both the mode and modality. A multimodal system indicates a combination that can operate with both natural input mode (voice, pen, touch, hand gesture, staring, head, and body movement) and multimedia system output [19].

Such multimodal interactions frequently happen in our daily lives. For instance, we use speech and gestures in communication with other ordinary people; the sensory modalities such as visual and auditory senses also use multimodal interactions [20].

The objective of research in this study is to design a multimodal interaction method to eliminate existing limitations, which uses these senses together towards a more natural interaction by users for VR environment.

In restricted HMD circumstances such as the case presented herein, complementary modalities are integrated through multiple interactions like petting, shouting, and punching [21], in a manner that brings a synergistic blend in such a way that each mode can be capitalized on and can be used to overcome the weaknesses of other modes.

In particular, the user who wears an HMD device on his or her head participates in the interaction under an environment completely separate from real world; this may be a factor that restricts the user's free visual interaction. To compensate this, using multimodal interaction can be a factor that supplements the restricted visual interaction from the real world. Particularly, active hand gestures, such as petting and punching, and expressive interaction like shouting that uses voice, allow the users in virtual reality to freely interact as if they are in the real world; this serves as a factor for the users to be more engrossed and to expressively respond to the virtual world.

7 Technical Description

To develop the AMSI, we used an image-based gesture interface in this study. The image-based gesture interface is a technology that uses image processing and computer vision technologies to recognize the movement information of users and classifies gestures into head, hand, body, facial expression, etc. The interaction proposed by this study requires user's hand gesture recognition and voice recognition technologies and uses a Kinect sensor. Kinect, of Microsoft, is a peripheral device of Xbox3 (home machine) with which a user can experience a game and other forms of entertainment using his or her body without a controller. A camera module is installed on it that captures motions to recognize the user's movement; a microphone module is installed as well that enables voice recognition.

The image taken using a Kinect camera is recognized as it is converted into a form of points, like a 3D image, and it keeps track of the position of the hand by recognizing the position of the user's waist, shoulder, elbow, and wrist, and separates the nearest user's image to the camera from the background to keep track of the movements.

To recognize hand gestures like petting and punching proposed in this study, we kept track of the interaction using the information like vertical, horizontal, left, right, and rotating movements of the hand and the 3D depth distance value. We used Kinect SDK to recognize the hand gestures and voice and Nite 2.0 driver for OpenNI 2.0 and hand tracking (Fig. 2).

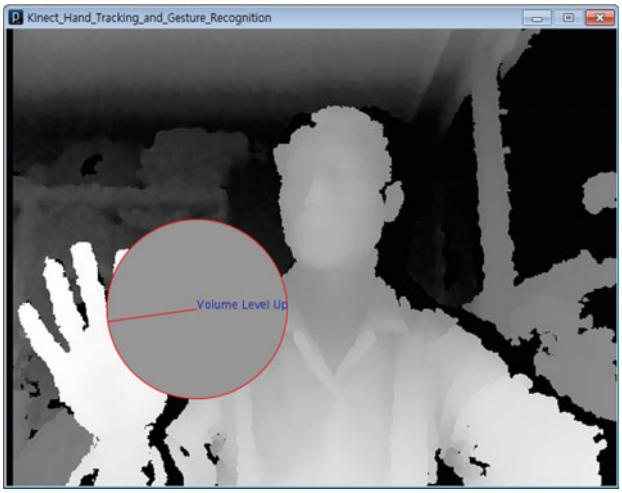

Fig. 2 Hand tracking and gesture recognition using Kinect

8 Project 'Abduction'

'Abduction' is an interactive VR movie created with a 360° VR camera. It is a 12 min long virtual reality movie through which users can directly feel the change of emotions that the father in a happy family experiences as his beloved daughter is kidnapped. Different from how most of existing VR films have exhibited the trial contents of experience type, 'Abduction' is focused on a narrative and sets the goal of enabling the users to get engrossed in the characters of the movie and share the emotions.

As a type that adopts mutual interactivity of the game into the movie, the interactive movie has a characteristic that the story is influenced by audiences who are directly involved in the story of the movie. As it displays the characteristics of a game, the interactive movie does not use the third person's perspective adopted by existing movie styles, but the first-person perspective frequently used at FPS (first person shooting game) and role-playing game. First person POV allows the player to perceive the game through the eyes of the character, observing the world around them up close, giving a clear view of the scenery in front of them. This perspective is believed to provide the most immersive feel for the player [22, 23]. This movie is created using the perspective of a father whose daughter is kidnapped as first-person perspective to maximize the engagement and ambience of the first-person perspective.

The movie has three intervals; each centered at three emotional interactions, and is designed such that the user can watch the next junction's movie through interactions. That is, the linear story of a traditional type of a movie, not a structure of multiple plots like the multi-plot used by existing interactive movies and games, is used to enhance the user's engagement to story.

9 User Study

We conducted user tests with 20 people to investigate the emotional responses of users through the AMSI. The users are men and women in their twenties and thirties; among which, 13 of them, more than the majority, wore the HMD device for the first time and were new to VR contents. The study is designed by dividing the 20 users into two groups: 10 of them watching the VR movie applying AMSI, and the other 10 people using a simple click-hand gesture to watch the next film clip.

The content of the survey conducted after watching the movie is designed with questions through which the emotional effects of AMSI can be measured. The questions are as follows.

1. Happiness: How happy did you feel when the family was enjoying the picnic with the daughter?
2. Fear: How much fear did you feel when the father found out that the daughter had been kidnapped?
3. Anger: How angry were you when the father encountered the kidnapper?

The answer to each question is evaluated within the range of 1–10 to measure the level of emotional response.

The experimental results show a higher happiness measure for the group that watched the VR movie using the AMSI with an average of 7.8 as compared to the simple interaction group with an average of 6.2. Furthermore, the AMSI group showed higher measures for fear and anger as well. This shows that AMSI amplified the intended emotional response of users more than the interaction of a simple click method (Fig. 3).

This means that AMSI is more effective in the emotional aspect than the existing simple, intuitive interaction and is suitable for the content that emphasizes a narrative like a movie. Although the emotional response evaluation conducted in this

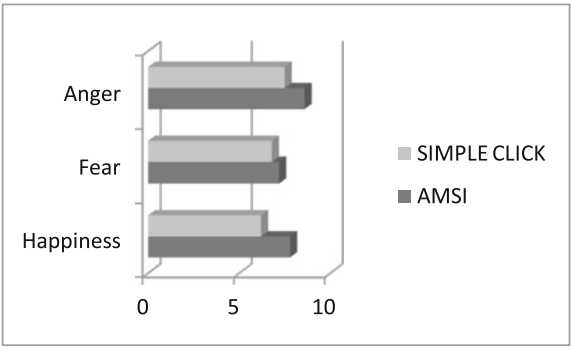

Fig. 3 Result of AMSI and simple click interaction effect

study is only comprised of a survey from users, in-depth user studies are required through the biological response signal measurement and FGI from users in the future.

10 Conclusion

In this study, the AMSI for improving the emotional response of users in VR interactive movie environment for HMD is designed, and the effects of the interaction are examined through experiments. The story-based contextual and implicit interaction design become the medium for expressing the users' emotional status relevant to the story of movie; lack of the visual interaction in virtual reality is compensated by active multimodal interaction such as petting, shouting, and punching, which produce synergy effects altogether. This interaction allows the audiences of VR movie to more effectively feel the emotions of happiness, fear, and anger as compared to existing simple, and intuitive interaction.

The development of affective interaction for VR movie content of HMD like this will be used as an important guideline in the development of various movie contents based on story in the future. The wearable content industry is very rapidly growing even now, and hence, is a field that highly requires related research work. If an affective interaction suitable for the story of wearable contents based on this study is designed, a more effective emotional response will be obtained from users.

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Can Digital Signage in Subway Stations Serve as a Valid Communication Platform for Citizens?

Minjeong Kang

Abstract As digital signage has spread throughout cities, researchers and artists have come up with various projects to use interactivity and networks for civil communication. In doing so, they have encountered problems, including difficulties in controlling content posted by citizen, and a lack of public participation. This study conducted a survey to find out what contents and forms of interactivity members of the public would prefer when using the digital signage installed in Seoul subway stations as an aid to communication. Our results showed that citizens wanted to post content and to read recommendations relating to Seoul and healing messages. The personal information they were most willing to expose was their own age, and the desired exposure time for their own content varied. For interactions to express empathy, they preferred touching the screens in the public space to using their smartphones. The data collected from online and offline will be classified and analyzed by area, age, and category; it will be used by citizens and the government to monitor and understand the thoughts of members of the public.

Keywords Digital signage · Subway station · Communication · Empathy

1 Introduction

Digital signage has been popularly installed throughout the city [1] as the hardware becomes increasingly inexpensive and accessible. Digital signage is now able to provide network and interactivity, leading to bilateral communication via digital screens installed in public places [2]. However, if content that is suitable for advanced bilateral communication technology is not provided, digital signage will have limited value and usefulness. For example, Daum Kakao, a South Korean Internet company, installed 913 "Digital View" devices with 46 in. digital screens

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and internet access in 117 locations on Lines 1–4 of the Seoul Metropolitan Subway Stations in 2010 to provide map, transportation, station, and entertainment information. However, as the widespread use of smart devices has caused the use of digital screens to decline, the project stopped in February 2015 [3]. Industry officials explained that, "the use of digital view devices has declined due to the popularity of smartphones; this means that digital view devices have to change. If we just sit on our hands, they will simply become advertising boards, offering no useful or convenient functions." [3]. This comment implies that interactive digital signs installed in public spaces should provide new content that people cannot experience through their smartphones.

In themselves, public places have often become a kind of urban communication medium [4]. Traditionally, public walls have been used for communication. Scribbles on walls express suppressed political and economic views. People scribble on walls when they feel repressed by society and unable to communicate with those in power [5]. The digital SNS wall has a similar function to that of an ordinary wall in a public place. Occupying walls, as a means of resistance, is a tactic that has been widely and effectively used; the SNS walls are used in the same manner [5]. Individual acts of protest in areas of Seoul that have a large floating population can be understood in the same context. A one-man demonstration represents the individual versus the group structure, with unequal power relations [6]. In Korea, according to the law on assembly and demonstration, a demonstration is defined as a gathering of more than two people, so one-man demonstrations are sometimes held in order to avoid legal restraints [7]. Because a one-man demonstration in a public place involves communication through a physical meeting, it can be more appealing than online media. However, its impact is necessarily limited, because the demonstrator can only reach out to citizens who are passing by. In addition, one-man demonstrations are not recorded and are easily forgotten, unless someone takes a photo and posts it online media such as an SNS. Although SNSs are designed as personal media and play a major role in promoting individuals, they have their limitations when it comes to delivering the real life impact and the atmosphere of an offline place. In addition, people tend to look for likeminded others when communicating via the Internet, and this can sometimes lead to a polarization of perspectives in online communications [8, 9]. It is therefore necessary to use online and offline modes of communication to complement each other, since both have limitations.

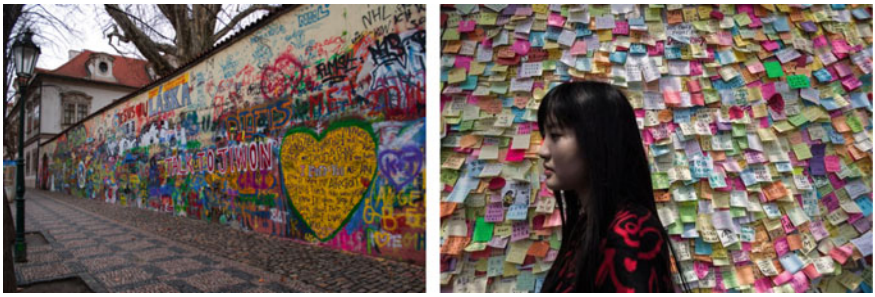
Jeff Porter, the president of signchannel, argues that the content on digital screens in public places should be related to the place where the users live [10]. It is often said that the right place to hold a one-man demonstration is somewhere with a floating population that will empathize with the issue you want to talk about. For this reason, subways and streets are recommended [6]. Subways have an enormous floating population, and are good places for attracting the interest of people waiting to catch a subway train [11]. In addition, since subways are located in every corner of the city, they generally reflect local culture. A Seoul Metropolitan Subway Station is an optimal place with both online and offline features, where digital screens that provide access to a network have already been installed. This study

aims to propose a new direction for platform design, which will enable citizens to communicate, empathize with each other, and participate in activities through interactive digital screens installed in subways.

In addition, this study will conduct literature review to reveal the adaptability and value of digital signage as a public communication platform. It will propose a design direction based on the opinions of members of the public, collected through a survey. First, it will examine the types of content that is most appropriate for people to communicate through digital screens at subway stations. Second, it will propose an appropriate direction for interactions that people are willing to take part in. This study will constitute valuable data for designing a platform enabling citizens, not only at Seoul Metropolitan Subway Stations, but also in other cities to communicate through digital signage.

2 Communication in Public Places

There are various kinds of communication walls in cities around the world. The Lennon wall in the Kampa Island of Prague is a good example of a communication wall on which citizens have scribbled anti-communist government slogans and called for freedom and peace (Fig. 1-left picture). A similar wall—inspired by the Lennon wall—was created in Hong Kong. The pro-democracy protesters set up a "Lennon wall" at the center of the Hong Kong protest camp. Hong Kong's Lennon wall was covered with colorful sticky notes with messages of support for the protesters. All night, volunteers took photos of approximately 15,000 messages before the police cracked down. After the wall was removed, the protesters said that they would create it again in a digital version [12]. The case of Hong Kong shows that messages on paper can be destroyed at any moment but digital messages can be automatically stored, transformed, and distributed in various forms. The messages in the camp supported democracy, which automatically led to the wall filling up with messages defending democracy, without the need for any external guidance.



The Lennon wall in Prague　　The Hong Kong version of the Lennon wall

Fig. 1 Examples of communication walls

The Speakers' Corner in Hyde Park, London is the world's most well known symbol of free speech. With its history spanning more than 140 years, this is a place where anyone can freely speak and share his or her views. To date, many researchers and artists have tried to launch digital versions of Speakers' Corner, allowing people to express everyday thoughts in public spaces through an SMS on a mobile phone. However, [13] has argued that it is necessary to have a strategy in order to prevent the misuse of screens and encourage high quality submissions. The technology to screen out slang and swear words is sufficiently advanced. However, to ensure high quality content, some guidance will be needed. Just as people left messages about freedom and peace on the Lennon wall, it must be assumed that the name or location of the platform will significantly affect the content of messages.

Another problem with interactive digital signage installed in public places is the lack of public participation [14]. Citizens resist participating because they feel socially embarrassed in the eyes of others [15]. For this reason, Brignull and Rogers have suggested that potential users will only be induced to interact with digital signage when they have answers to the following questions: How long will the interaction take? What will I get by doing it? Which steps will the interaction involve? Will it be convenient to do? Will it be easy to stop and leave? It should also be possible to see what the system is about at a glance from relatively far away. As a large, empty space near the screen may discourage people from approaching, the display should be placed near the flow of people to attract as many participants as possible [14].

The Samsung Life Insurance Company's 2013 Interactive Screen Door Project was produced in accordance with the guidance mentioned above. As seen in Fig. 2, this project was a campaign designed to provide adolescents with hope and courage through the use of a digital screen installed on a subway screen door [16]. The screen, which was installed near people waiting for the subway train, had no trouble persuading them to interact. The large image of a sullen boy made up of negative

Fig. 2 Samsung life insurance campaign

words, with a palm print beside him, showed people what sort of interaction was expected. When they used their palms to high-five the image, the boy's gloomy face changed into a bright smile. Through this simple interaction, people could see how a negative image could change into a positive one.

The Interactive Screen Door Project was able to attract high levels of audience participation through its well-chosen location and theme, its precise and clear visualization, and its positive experience of the feedback. However, it was a one-time event planned for a specific purpose by a company and its content was not updated, so people who initially participated in the campaign eventually lost interest in it. To find out how interactive digital screens might function as communication walls where citizens could regularly participate, this study will explore the perspective of members of the public, revealing the content that people want to communicate and the methods of interaction they want to experience.

3 Communication Channels for Citizens of Seoul

The Seoul city website currently offers various channels through which citizens can communicate with city officials. The site is divided into categories, including complaints and suggestions, reporting fraud and human rights violations, and requesting a meeting with the mayor [17]. Many channels are closed, so it is impossible to know what sort of communication experience they provide. There are also SNS channels, which enable people to communicate with the city in public through a real-time Twitter feed. Although some of the Twitter stories relate to the whole of Seoul, many are about the issues associated with specific neighborhoods, making it difficult for the SNS to gain the empathy of people from other neighborhoods. It is also difficult to attract people's attention because they have to enter these special interest sites.

As an offline means of communication, Seoul has operated a Citizens' Speakers' Bureau (just like Speaker's Corner) since 2012. Citizens who want to share their thoughts can apply online or offline [18]. A person may speak for up to 10 min. Any subject is fine, as long as the speaker does not use abusive language, slander specific persons, or make political remarks. Those speaking are videotaped and recorded, and then classified into one of the following categories: personal stories, suggestions, and proposals. Recorded remarks about city projects are sent to the relevant departments, enabling them to reflect the public opinions in their policy-making; in addition, videos are shared via the Seoul city website. "We are going to create a place for real communication, enabling frustrated citizens to experience healing and those with policy ideas to talk freely without complicated procedures," according to Kim Sun-soon, a government official responsible for the program [19] (Fig. 3).

Speakers' Corner

The Seoul version of Speakers' Corner

Fig. 3 Free speech in a public space

Unlike Speakers' Corner, the government of Seoul, which records, documents, and classifies people's remarks, has organized this offline event so that there might be difficulty to manage such a program. Nevertheless, the sincerity and sense of reality provided by offline channels will attract the empathy of other citizens.

Table 1 shows the strengths and weaknesses of the online and offline channels mentioned above. To solve the problems of online and offline channels, this study suggests better ways to use the interactive screens installed in subway stations. Digital signage installed in public places includes features drawn from both online channels (management efficiency and convenience) and offline channels (sincerity, public exposure, and regionality). For this reason, we have used a survey to identify the best content and interaction methods for digital signage.

Table 1 The strength and weakness of on/offline communication channels

	Online wall	Offline wall
Strength	• Not limited by time, location, or weather • Easy to record • Easy to manage • Easy to express empathy	• Conveys a sense of realism. • Trustworthy • Can create physical interactions
Weakness	• Not easy to generate an atmosphere of realism or attract attention • Difficult to reveal regionalism • May attract people with specific interests	• Accessible only to passers-by • Difficult to record data. • Difficult to fully explain a topic. • Difficult to express empathy. • Affected by weather

4 Survey

We conducted a survey to establish the content and methods of interaction that would best enable the interactive digital screens installed on Seoul subway station platforms to be used as a public communication channel. This survey was conducted online during February 2015, and a total of 53 people participated in the survey: 32 men and 21 women between the ages of 20 and 40. The survey questions (listed below) consisted of demographic, content, and interaction questions (Table 2).

When asked about using a subway screen for public communication, 65 % of respondents thought it should be used for the purpose of healing, and 33 % wanted to use it to collect opinions about Seoul government policies. Respondents made various suggestions about the types of content they would leave; this included healing words, such as Biblical quotations and maxims (32 %); ordinary small talk (36 %); suggestions for the Seoul government (46 %); and suggestions for the national government (32 %).

Respondents revealed a rather striking discrepancy when it came to the content they wanted to read, as content consumers. Policy suggestions for the city government ranked the highest (53 %), followed by healing messages (40 %). These results show that subways are places where many people pass through and wait, often experiencing high levels of stress. This may be why there is such a strong desire for healing content. Given that respondents showed more interest in Seoul than in the nation, it can be inferred that local content would attract more attention.

Interaction questions explored how long they would want their content exposed, whether personal information should be disclosed, how comments should be

Table 2 Questions

Category	Questionnaires
Demographic	1. Gender, 2. Age, 3. Educational background, 4. Job, 5. Number of subways used
Content	1. If there were a digital screen in subway screen door that enabled citizens to communicate, how would you want it to operate? 2. What sort of content would you want to leave on it? (multiple choice) 3. What sort of content would you want to read? (multiple choice) 4. How long would you want your message to remain on the digital screen? 5. If you were to leave a message on a subway digital screen, what information would you want disclosed to the public? (multiple choice)
Interaction	6. How would you want your message displayed on the subway screen? 7. If a public communication platform were installed on a subway screen door, would you be willing to participate? 8. Do you prefer to express empathy with the messages of others by saying "Like"? 9. How would you wish to express empathy with messages that appeared on the subway platform? 10. If a public communication platform were installed in a subway station, do you think it would help people heal themselves?

viewed, and how best to express empathy. When it came to exposure time, there were various opinions from 1 min to a month. It was clear that people chose different exposure times depending the type of messages they wanted to communicate. There were also other opinions (including views on the frequency of exposure) that should be considered.

As for the disclosure of personal information, 58 % of respondents thought that age was the most appropriate information to disclose, followed by ID (36 %), occupation (35 %), residence (29 %), and Facebook profile photo (8 %). Some people wanted complete anonymity (8 %). Above all, age is an important element for understanding the messages of others since the same content would be understood differently if contributed by a ten year-old, or a person in his or her 60s. Respondents also preferred quick and easy ways to express empathy, such as "Like" (49 %) and emoticons (43 %). As for the method of interacting, respondents preferred a touch screen (62 %) or smartphone (28 %). As participants were responding to a virtual situation, actual results could differ. It may be that fewer people preferred using smartphones because they did not want to go through several inconvenient steps to express empathy, rather than just touching a screen.

As for the question about making use of a digital wall installed in the subway, 42 % responded that they were likely to participate, while 28 % said they did not know; 30 % chose no participation. It is necessary to have a lot of courage to expose oneself in a public place. All things considered, it is encouraging that more than half the participants gave positive responses. In addition, 59 % thought that the platform was likely to help citizens have healing experiences. According to [18], people who frequently post messages on SNSs tend to feel less isolated and lonely than those who do not. However, they are not significantly affected by the feedback of others. Therefore, leaving messages in public places may have enough healing effects regardless of the feedback.

5 Conclusion

This study aims to establish a fruitful design direction, so that digital signage installed on subway platforms can function as a communication platform for citizens. Through a literature review, we have analyzed the strengths and weaknesses of both online and offline communication channels. The problems associated with offline channels include difficulties in managing the channels, expressing empathy, and sharing the contents. Meanwhile, online channels lack a sense of reality and attractiveness. Also, it can be troublesome to access the information in online channels.

To compensate for the weaknesses of online and offline channels while taking advantage of their strengths, we recommend to use digital signage in public places as a public communication channel. Subway stations throughout a city are appropriate place for local people to communicate with each other. The contents displayed in the digital signage in a subway station would easily reflect the information, problems, and culture of the region.

A survey was conducted to identify the best possible content and method of interaction to use in subway digital signage. 65 % of participants wanted to use this signage to help people heal themselves. In particular, stressed workers navigating a crowded subway might prefer comforting maxims and Biblical quotations. Although respondents wanted to write many different kinds of messages, the themes they preferred to read about were suggestions for the Seoul government and healing messages. This indicates that the purpose of leaving messages in public places is not necessarily that they should be read, but to help the writers healed. In addition, respondents preferred suggestions for the Seoul government rather than the national government; this shows that users prefer themes that relate directly to themselves. One good way to encourage participation might therefore be to ask people to post messages about the region in which the subway station is located.

When leaving messages via digital signage, respondents were most likely to reveal their ages. As mentioned above, age colors the characteristics and seriousness of a message and can therefore encourage readers to sympathize with the author. When asked about exposure time, respondents chose times ranging from 1 min to one month. It therefore seems appropriate to allow citizens to choose whether to promote themselves or preserve their anonymity. Allowing people to set the length of time and frequency of exposure, with only a maximum time limit, would increase participation. Respondents indicated that a one-step click to express empathy with a posted message would be appropriate. As networking is possible on these screens, it would be meaningful if people could access them through their personal devices, reading the content on the screen in real time and expressing empathy online.

Communication through digital signage installed in public places could provide a significant way to collect individual voices—equivalent to resistance scribbles and one-man protests—and to archive them in the form of data, rather than allowing them to disappear. Archiving voices that would otherwise be lost would make it possible to analyze a new strand of public opinion, which could be useful in resolving social problems. If members of the public could choose the categories and themes they were interested in, their comments would provide a useful source of big data, enabling others to understand their thoughts. For example, categories could include welfare, women, the economy, safety, housing, the environment, culture, health, transportation, taxes, and administration—just like the Seoul city website. Categorizing content would enable policy makers to use the accumulated information to create policies, by accessing public views on particular, categorized issues. It would thus be possible to analyze the data by region, subject, period, and age. Expressions of empathy are primarily intended to console the person who posted the original comment; these ultimately provide an index of citizens' interests, offering important information for those providing practical solutions. In conclusion, this study suggests that the government should create an online/offline platform as a regional communication channel to discover the thoughts of citizens by increasing their interest and levels of participation and visualizing the accumulated data in real time.

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Designing for People's Pleasure: Amusement Parks in North Korea

Heesun Choi

Abstract Since 2012, North Korea has paid close attention to amusement parks. Kim Jong Un, its new leader, underscored the need to build more theme parks suitable for the cultural and aesthetic desire of people. And North Korea underwent rapid change with construction of several new parks. I wonder why DPRK had to build amusement parks after the recent leadership change. In this paper, I examine the design characteristics of North Korean amusement parks and its social value through the analysis of the newly built or renovated several cases. This research found that there are three main characteristics of North Korean amusement parks. First, North Korean amusement parks are mostly located in historic sites of Pyongyang, which are related to the establishment of the state of DPRK. These amusement parks would become a great urban public space to carry positive communal meanings and to increase empathy for Pyongyang citizens. Second, lots of amusement parks were designed to cater specially to young people's leisure time and activities. As for big-sized theme parks such as Rungna people's pleasure ground newly opened in 2012 in Pyongyang, it has grown to include more rides and 3D attractions for youth and children in addition to existing facilities like dolphin aquarium, swimming pool and a mini golf course. Third, amusement parks represent well-designed urban green space in North Korea. Recently landscape architecture like designing parks and public space is recognized as one of highly civilized city conditions in DPRK. The green amusement park seems to be seen by North Koreans as a political symbol to show their happy living and developments of bioengineering. In conclusion, a close analysis reveals that the position of amusement parks remains subordinated to North Korean cultural policy, although it appears that recent media has emphasized its large role to produce people's pleasure and provide the people with happy spare time under Socialism.

Keywords Design · Leisure Park · Amusement Park · North Korea · Pyong-yang · People · Pleasure · Socialism

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1 Introduction

The People's happiness has been an issue in North Korean public policy on social welfare and domestic politics. In the North Korean Constitution, the happiness of its people is enshrined on chapter one Politics, chapter two Economy, and chapter five People's rights and duties. The Article 64 in chapter five is that nation guarantees the democratic duties, freedom and happy material culture of all North Korean people. And it inserts an additional provision that people's duties and freedom will enlarge as the nation develops a more socialist system.

North Korean parks belong with cultural products for the happiness of the people. Public journals and television service of DPRK frequently release details about citizen's happy lives enjoying their leisure time at parks. Based on the article in North Korean architecture journal, it is generally supposed that there are more than one hundred twenty parks inside of this country [1, 2]. North Korean amusement parks are not well known outside of this country, but they have been to the fore at moments of leaders' changes. A new leader Kim Jong Un has paid more attention to amusement parks than former leaders. He underscores the need to modernize equipment of amusement rides in order to build a theme park which is suitable for the cultural and aesthetic desire of people. Korean Labor Party built two more parks than Kim Jong Il's era and renovated old amusement rides in parks.

I wondered what the intention of DPRK was to emphasize innovation of amusement parks after the recent leadership change, and what it is aiming at. In this paper, I survey the present state of leisure parks in DPRK and examine the design characteristics of North Korean amusement parks and its social value through the analysis of the space organization for newly built or renovated several cases in Pyongyang.

2 Leisure Parks in DPRK

In modern industrial society, free time increased and the concept of leisure was widely diffused [3]. Leisure might be a matter of individual time use and personal interest. Rojek [4], however, believed that contemporary leisure has become much more commercialized, becoming a major industry in itself [5: 164]. He argued that leisure activities are the product of modern capitalist society. Henri Lefebvre, the Marxist sociologist, also explained us that the leisure spaces are produced specifically for consumption of the mass tourism and they are highly controlled by capital [5: 162–163].

From the Lefebvre's point of view, the leisure spaces in North Korea have never been commercialized nor industrialized by economic value. Alternatively, these leisure spaces are designed and produced by political value. North Korea, a communist country, has reinvented the leisure space of people as the fruit of collectivized life style. As the rights and duties of people are based on the collectivist

principle "one for all, all for one" (DPRK Constitution Article 63), people's leisure space are subordinated to the public life [6]. North Korean people, formally starting the organized activity at the age of 7 as a member of children's union, have to do the compulsory group activities such as political meetings in their spare time. They tend to spend their rear free time by playing sports or games, and by relaxing with family at the nearest park to their location (NK News, Oct. 13th, 2015).

It's not known how many leisure parks for the people are really built in DPRK because the architectural papers on North Korean parks are rare and they fragmentarily provide scraps of information. This paper exploits the sources of the articles in North Korean journals and newspapers to examine the status of leisure parks in DPRK. This paper also uses the online references in the national e-DPRK portal website of South Korean (http://nkinfo.unikorea.go.kr) which introduces parks into two groups: 56 playgrounds(*Uwonji*, 유원지) and 62 parks. As I observed that these parks are incorrectly classified due to the lack of information-based data, this paper sorts all the parks in DPRK into leisure parks and green parks again.

The following is a list of North Korean leisure parks classified by regional groups. This paper found that DPRK has more than 50 leisure parks and 7 middle or large-scale amusement parks (Table 1).

From this table, we can see three characteristics of the leisure parks in DPRK. First, North Korean leisure parks have been developed into different types by geographical condition of regions. Botanical parks are usually located in southern DPRK, such as south Hwanghae province, Nampo city and Pyongyang. And beach parks with traditional seaside amusements are distributed over eastern coast area of DPRK. Second, the youth and children parks are built over the province. The youth parks are designed on the middle or large scale with funfair rides, they are used both to educate young people and provide a leisure space for local people. According to the History of Chosŏn Architecture [7] North Korea constructed fifty-three children parks in major cities in the late 1950s after the Korean War ended. It is supposed to be a policy line based on an equal distribution of welfare.

Third, the table above also shows well the concentration of parks in the capital area. Pyongyang has the highest ratio of leisure parks with 31.5 % and contains more youth and children parks than others provincial cities, even though it has about ten percent of the population. Interestingly, the majority of large-scale theme parks built in 1970s–1980s, such as Rungna People's Pleasure Ground, Taesongsan Amusement Park, Mangyongdae Funfair, and Kaeson Youth Amusement Park, are located in Pyongyang. There are only a few amusement parks in other regions, Sinŭiju near the Chinese border and Wonsan. Amusement parks of Pyongyang have usually been limited to the use of non-Pyongyang inhabitants.

Through a comparative analysis of leisure park distribution, this paper founds that North Korea idealistically tried to provide the public with free leisure-oriented facilities, but realistically gave given the special privilege to use amusement parks to a small number of people.

Table 1 Leisure parks in DPRK

No.	Location	Leisure park (opening year) ***Amusement park**	Number (%)
1	**Pyongyang** (capital city)	***Rungna people's pleasure ground** (1965 open, 2012 renovated) – Rungna people's Sports Park – Rungna Water Park (2012 open) – **Rungna Amusement Park** (2012 open) Taedong River Park (2005 renovated) ***Taesongsan Amusement Park** (1977 open) Moranbong Youth Park (1959) ***Mangyongdae Amusement Park** (1985 open, 2004 renovated) Munsu Water Park (1994 open, 2013 renovated) Botong River Park (1960) Korea Central Zoo (1959 open, 2012 renovated) Korea Central Botanical Garden (1959 open, 2009 renovated) ***Kaeson Youth Amusement Park** (1984 open, 2008 renovated) 4.15 Children Bakhwa Parks (1992) Pyongyang Ethnography Park (2012) Mirim Equestrian Riding Centre (2013) Taedongmun Children Park (1959) Kyungrim Children Parks Samma Children Parks Otan Children Parks Bipa Children Parks	**18** (31.5 %)
2	**Nasun city** (East side of border special zone)	Bipado Beach Park Youth Park	2 (3.5 %)
3	**Nampo city**	Bakhwawon Botanical and Animal Park Samwha Botanical Garden Youth Park	3 (5.2 %)
4	**Gangwon province**	Youth Park Masikrryong Ski Resort Mount Kumgang resort ***Wonsan Songdowon Beach Resort** (1960, 1993, 2013 renewal) Wonsan Zoo	5 (8.8 %)
5	**Yanggang province**	Samjiyon Ski Resort	1 (1.8 %)
6	**Jagang province**	Kanggae Zoo Kanggae Children Park (1945-1950)	2 (3.5 %)
7	**South Pyeongan province**	Sukam Park Songjung Resort	2 (3.5 %)
8	**North Pyeongan province**	Sinŭiju Eunduk complex Resort ***South Sinŭiju Yousang Park** ***5.9 Sinŭiju Amnok River Park** (2012 renewal) Youth Park Children Park	5 (8.8 %)

(continued)

Table 1 (continued)

No.	Location	Leisure park (opening year) ***Amusement park**	Number (%)
9	**South Hamgyong province**	Majon Beach Resort Hamhung Zoo Youth Park	3 (5.2 %)
10	**North Hamgyong province**	Musan Youth Park Chongjin Youth Park (50s) Udaejin Beach Park Younghyun Beach Park	4 (7.0 %)
11	**South Hwanghae province**	Monggumpo Beach Park Yongsupo Beach Park Jingangpo Beach Park Mountain Suyang Resort Haeju Botanical Garden Ongjin Branch of Central Botanical Garden Children Park	7 (12. 2 %)
12	**North Hwanghae province**	Kaesong Water Park Songlim Play Park Sariwon, Mountain Jeongbang Resort (1997) SongRim, Shinhung Boat Ride Park SongRim, Sanseo Children Park	5 (8.8 %)
Total			57

3 Pyongyang's Amusement Park as a Happy Set

North Korea designed parks in major cities according to "microdistrict", the principle of urban planning. The microdistrict is the socialist concept that dates back to the 1920s in the Soviet Union. It is based on a residential complex consisting of residences, commercial area, educational facilities, cultural facilities, and green spaces. North Korea built small parks in the green space of microdistrict, and constructed large-scale cultural leisure parks in open space of the city center.

Pyongyang is the most typical socialist city of them all. This city is called as the capital of the revolution by North Korean media, but it formally became the capital city in 1972 when the Socialist Constitution of DPRK was amended and supplemented. This "utopia city" was planned by Kim Jung Hee (History of Chosŏn Architecture, Korean Central News Agency in DPRK, Dec. 16, 2013). Kim Jung Hee, the first generation of urban planner who studied in Moscow, he was in charge of Pyongyang reconstruction project during the Korean War. He tried to transform Pyongyang into a revolutionary capital consisting of micronuclear districts with neighborhood green space [8].

Pyongyang has gone through the development process of green parks. The urban green space of Pyongyang is analyzed in chronological order by Dong Woo Yim's book, titled "Pyongyang—Urban Transformation in Program, Scale, Structure (2011)". He illuminates characters of socialist green space, and then defines Pyongyang as the city of green as well as the city of production and symbolism. In

his book, the green space of Pyongyang is divided into three types: agricultural zone, natural greens and parks. It is said that there are about thirty parks in Pyongyang and the capital offers an average of 40 m^2 green spaces per citizen [8].

The parks of Pyongyang began to be built near squares to provide urban places for relaxation and education to the citizens after the liberation. In the late 1950s, a leisure parks and children parks are equally created throughout Pyongyang [7]. In the 1960s, North Korea constructed a large-scale cultural facilities for citizens and leisure facilities for foreigners according to Pyongyang's development strategies. As the 1970s and 80s brought on the modernization of parks with a huge playground equipped with high-tech funfair rides, exotic amusement parks began to appear in Pyongyang; Taesongsan Amusement Park was opened to the public in 1977, Kaeson Youth Amusement Park in 1984, and Mangyongdae Amusement Park in 1985. Throughout the 1990s, the economic crisis and leadership transfer made further park construction impossible. Since the economic recovery has stared after the 2002 Economic reforms, North Korea has renovated and modernized the old facilities of amusement parks in Pyongyang (Fig. 1).

North Korean people call an amusement park "*Uheejang*(유희장, 遊戱場)". In Pyongyang, it is estimated that there are four large scale amusement parks having funfair attraction and rides for adults or kids. They have the three most distinctive characteristics of park design principles.

First, amusement parks are mostly located in historic sites which are related to the establishment of the state of DPRK and the idolization of Kim's family. The map above shows well a direct correlation between the location of amusement parks

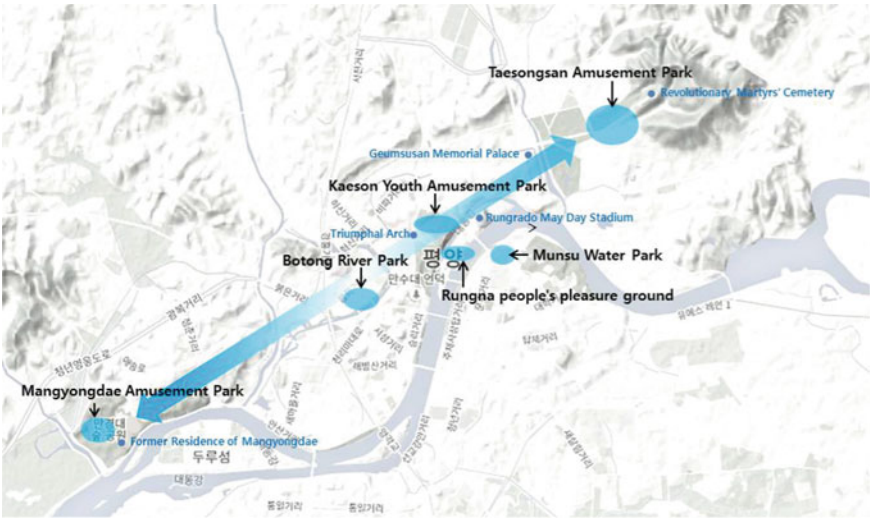

Fig. 1 Location map of the major leisure and amusement parks in Pyongyang: Rungna People's Pleasure Ground, Taesongsan Amusement Park, Mangyongdae Amusement Park, Kaeson Youth Amusement Park, Botong River Park, and Munsu Water Park

and politically important places in Pyongyang. Major amusement parks are situated close to symbolic places: the Former Residence of Mangyongdae (birthplace of Kim Il-sung), Triumphal Arch, Kim Il-sung Stadium, Rungrado May Day Stadium, Geumsusan Memorial Palace (Kim Il-sung's residence during his lifetime), and Revolutionary Martyrs' Cemetery. They are situated along the diagonal axis of city, from the southwest to the northeast, on the main symbolic axis from the Former Residence of Mangyongdae to Revolutionary Martyrs' Cemetery.

Kaeson Youth Park is the most modern amusement park equipped with high-tech funfair rides in Pyongyang. This amusement park is a famous place visited by Kim Jong Il and his son Kim Jong Un on Dec. 4th, 2011, just two weeks ago before he died. Kim Jong Un inspected this park again (May. 25, 2012) after North Korean leadership change. This park covering 40 hectares was constructed in 1984, renovated in 2008 and reopened on April 2011. Kaeson Youth Amusement Park is located in Moranbong Park having a theater, Kim Il-sung Stadium and historical monuments to Kim Il-sung's and Kim Jong Il's deeds (the red stars in the map below). In terms of architectural design, the main axis of park is emblematically designed to extend into the Revolutionary Martyrs' Cemetery and Triumphal Arch (Fig. 3). This park becomes one of the Pyongyang's must-sees for foreigners visiting DPRK. Kaeson Youth Park provides an extravagant staged view from the main entrance by showing the happiest people in the world and the high-tech rides imported into North Korea (Fig. 3) (Fig. 2).

Second, Pyongyang's amusement parks are concerned with policies to inspire youth's patriotism and instill confidence into the young people. They were designed to educate the children and cater specially to young people's leisure activities. Rungna people's pleasure ground is a good example showing this political purpose. This big-sized park complex is built in 1965, and newly opened in 2012 after the reconstruction of amusement park and swimming pool facilities. We can observe the increase of young people's leisure space in the park complex through its areal change; the amusement park and sports park areas in Rungna people's pleasure ground (Fig. 4, lower image) are recently expanded further as compared with the

Fig. 2 Location map of Kaeson Youth Amusement Park in Moranbong Revolution Historic Sites (*left*), Map of Kaeson Youth Amusement Park (*right*)

Fig. 3 Kaeson Youth Amusement Park at night (Photos by DPRK's Uriminzokkiri)

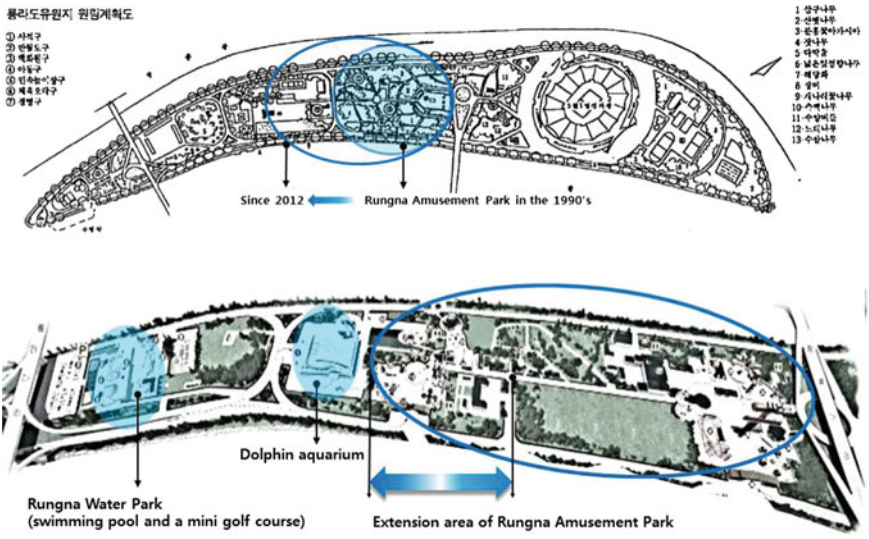

Fig. 4 Master plan of Rungna People's Pleasure Ground designed in 1993 (*upper image* Chosŏn Architecture) and after 2012 (*lower image* http://www.ojakyonews.com/113)

master plan designed in 1993. Since 2012, North Korea also installed more rides and 3D attractions for youth and children in addition to new facilities, such as dolphin aquarium, swimming pool and a mini golf course. Having such the increase of amusement park area may appeal further to the Pyongyang's young citizens.

In the case of Rungna people's pleasure ground, an amusement park enhancing their cultural life is simply for privileged classes living in Pyongyang. This selected group has its own leisure activities. In the showcase capital, Pyongyang, the Rungna people's pleasure ground is well designed as a happy place, so nothing is negative. A Pyongyang's amusement park is for political means in order to capture the mind of intelligent people and help strengthen their solidarity of its new regime.

This park is surrounded by the outer ring road of Rungna island called "*Chungryun* (youth) road". Recently, the amusement park for the youth takes a large part of Rungna people's pleasure ground.

Table 2 DPRK's urban development projects for people's relaxation in 2011

No.	Location	Construction	KCNA
1	Pyongyang	**Pyongyang Ethnographic Park**	Aug. 16
		Service facilities and outdoor ice skating rink	Sept. 23
		Flower shops	Oct. 1
		Colored street pavements and street neon sign light from Pyongyang station and Botong gate	Oct. 7
		Chang Kwang Won's (a sport center with saunas)	Oct. 26
		Football ground in Rungna island (with a large digital scoreboard)	Nov.11
2	North Pyeongan province	5.9 Sinŭiju Amnok River Park	May 9
		Youngbyun 's scenic resort	Oct. 5

Since the early 2000s, North Korean authority has paid close attention to projects for greening the cities to implement the DPRK's "2012 *Kangsong Taeguk* (strong and prosperous country by 2012)" policies. DPRK's projects for greening urban landscape began in earnest from 2007, and they started the development of main cities. Table 2 shows the urban development projects in 2011. We can see that Pyongyang has tried to make efforts to improve and color its greening urban landscape for days and nights.

In DPRK, an amusement park is recognized as one of conditions to be a highly civilized city. Pyongyang has used its own software program "*Moranbong* 2.0" for urban greening system developed by the city management research center of North Korean Science Institute. Pyongyang renovated the old amusement parks and opened most of them before 2012.

After leadership change, news of leader's inspection of amusement parks got out very often through the foreign press. Kim Jong-un visited also the Pyongyang Vegetable Science Institute many times to emphasize the importance of his green city concept. As for North Korean people, the green amusement park largely concerned with internal politics and foreign policy, may be seen as a political symbol both to show their happy living and developments of bioengineering.

4 Conclusion

King [9, 57–58] explained that the idea of the first amusement park, Disneyland was born in 1955, and that it gave rise to succession of various types and subtypes, proliferating across the world in her paper, "The New American Muse: Notes on the Amusement/Theme Park". She argued that the amusement park has long been an eloquent image in the American landscape of entertainments, escape, and the extraordinary.

In the case of DPRK, we can see that amusement park is treated as a Utopia's emblematic space for people's happiness. Even ChosŏnShinbo (Sept. 13, 2012) reported that four Pyongyang's amusement parks can accommodate up to sixty thousand people a day. It also means that all the Pyongyang citizens can enjoy an amusement park once a month at a cheap national price. North Korean amusement park is one of integral policy tools to maintain social order, promote government's accomplishment by offering people a modern leisure space, and increase empathy between with Pyongyang citizens.

In this research, I found that there are three main characteristics of North Korean amusement parks. First, North Korean amusement parks are mostly located in historic sites of Pyongyang, which are related to the establishment of the state of DPRK. These amusement parks would become a great urban public space to carry positive communal meanings and to increase empathy for Pyongyang citizens. Second, lots of amusement parks were designed to cater specially to young people's leisure time and activities. As for big-sized theme parks such as Rungna people's pleasure ground newly opened in 2012 in Pyongyang, it has grown to include more rides and 3D attractions for youth and children in addition to existing facilities like dolphin aquarium, swimming pool and a mini golf course. Third, amusement parks is a political symbol to show their happy living and developments of bioengineering. In conclusion, a close analysis reveals that the position of amusement parks remains subordinated to North Korean cultural policy, although it appears that recent media has emphasized its large role to produce people's pleasure and provide the people with happy spare time under Socialism.

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Comfort Experience in Everyday Life Events

Naseem Ahmadpour

Abstract This paper explores what constitutes a comfortable experience in daily events, based on descriptive accounts of such experiences submitted by 35 participants. The results outline nine themes, eight of which are similar to the themes of passenger comfort in the flight context. Those are 'peace of mind', 'pleasure', 'physical wellbeing', 'proxemics', 'satisfaction', 'social', 'association' and 'aesthetics'. It is assumed that these are universal elements of comfort and could potentially inspire design of everyday products or services that bring about comfortable experiences to users. However, the specific characteristics of a situation are expected to dictate the concerns of users relevant to those themes and consequently the comfort experience associated with the design. In addition, the results revealed the importance of the theme 'esteem' for comfort in daily situations, which is justified by a focus on self and a mental state directed at enjoyment in daily activities.

Keywords Comfort · Wellbeing · Experience · Design

1 Introduction

This paper presents a study on comfort experience; with a view to the 'experience design' approach [1] that is increasingly attracting designers. This approach puts an emphasis on creating meaningful and positive experiences through design that overall enhance wellbeing and quality of life. Essential to this view is acquiring knowledge about the 'experience patterns' [1] that once isolated, could potentially serve as design objectives. Consequently, two major advantages are expected from taking an experiential approach towards comfort. First, it provides opportunities for

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innovations that reinforce positive experiences, beyond the confines of standardized ergonomics guideline for comfort, which traditionally aim at reducing negative bodily effects. Handcock, Pepe and Murphy explained this view as emphasizing "commonalities across all human beings" and "individual-based design" [2, p. 9]. He described those commonalities as combinations of ergonomics and hedonic needs. Fulfilling hedonic needs are expected to promote pleasure and enjoyment in life. Second, it supports the link between ergonomics design as a practice concerned with pragmatic issues, and user experience design as a practice that extends beyond those issues and tackles hedonic qualities [3].

Comfort as an experience has been linked to various notions including the perception of the contextual influences [4], satisfaction [3] and psychological needs [5]. In a recent research, Ahmadpour et al. [6] asserted that comfort experience is the subjective perception of the contextual inputs evaluated against one's personal concerns. This view, summarized in a framework shown in Fig. 1, was further examined in a study of passenger comfort experience in the flight situation.

The perceptions of the contextual inputs (e.g. cabin environment design elements, service, social inputs) were identified and then grouped into eight subjective themes of 'peace of mind', 'physical wellbeing', 'proxemics', 'satisfaction', 'pleasure', 'social', aesthetics' and 'association' [6]. Each theme was then described further in terms of one to three personal concern related to the flight experience. For instance the passenger's perception of how peaceful the environment is ('peace of mind') was related to his/her concerns for security, tranquility and relief. Figure 2 highlights the relationship between the themes of comfort experience during the flight and their subsequent passenger concerns.

The implications of the above framework for the design practice were argued by Ahmadpour et al. [6]. In an experiment with a group of designers, they showed that a holistic framework of comfort experience, contextualizing the various elements involved in shaping that experience, helps designers to establish explicit design objectives and facilitates communication in creative efforts. In addition, they suggested that knowledge about the experiential aspects of comfort enables evaluation of user's response to and experience of the design.

The study presented in this paper is motivated by the above argument. The aim of this paper is to determine whether or not the factors of passenger comfort experience [6] could be generalized to describe comfort experience is daily events.

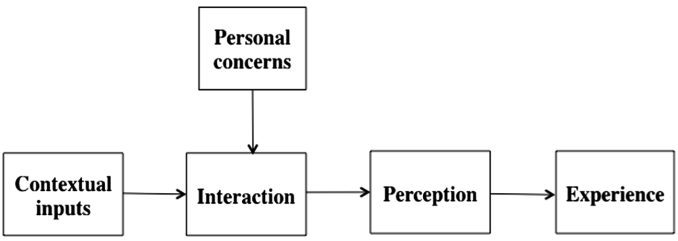

Fig. 1 Comfort experience as the subjective perception of the contextual inputs

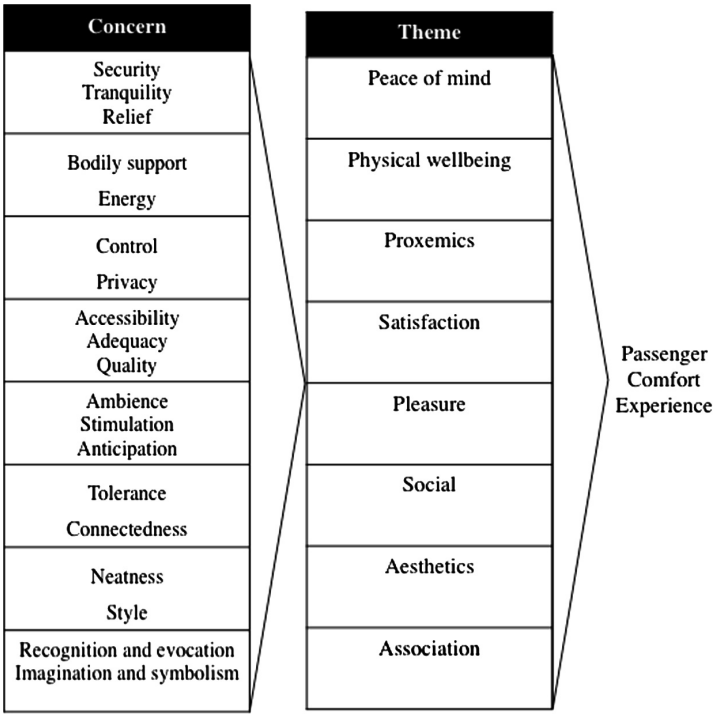

Fig. 2 The themes of passenger comfort and the concerns associated with them [6]

2 Method

An online questionnaire was design to capture the essence of comfort as a positive experience. Using an open-ended question, participants were encouraged to disclose descriptive accounts of one comfort experience of their choice in daily life. The question was formulated to inquire about a particular situation in which the respondent felt comfortable. They were asked to include the feelings associated with experience and to explicitly mention the people, objects and places involved in the experience. Overall, 35 (22 male) participants gave complete answers, aged between 18 and 64 years (M = 36).

The results were analyzed thematically. Using similar technique as Ahmadpour et al. [6], the responses were reduced to a set of comments, yielding 253 comments. These were categorized based on their commonalities, resulting in 20 concern categories, which were in turn grouped together to form themes of comfort experience in everyday life events. This was performed with a view clearly to the themes of passenger comfort.

3 Results

The results highlighted nine themes of comfort experience in a variety of daily situations and the personal concerns associated with each were isolated. These are summarized in Table 1, arranged chronologically based on the overall number of comments identified in each theme. The sum of comments in all concern categories of a theme is also calculated, shown in bold letters. An example from the respondents' reports is provided for each concern category. Overall, comments related to the theme 'peace of mind' were most frequently mentioned (70 comments) while comments denoting the aesthetics aspects of daily comfort experience were least frequent (10 comments).

The daily situations described by the respondents (N = 35) revealed five typical situations as follows: home (N = 15), socializing with friends (N = 10), office (N = 4), airplane (N = 5), and café (N = 1), giving prominence to interior environments, particularly home, as a place of comfort.

A comparison to the themes of passenger comfort experience [6] reveals a great similarity between the eight passenger comfort themes [6] and comfort experience in everyday life events. However, an additional theme of comfort emerged from the respondents' comments in the present study, which is shown in Table 1 as 'esteem'. Furthermore, the compositions of several themes in present study were somewhat different to passenger comfort themes [6]. A short summary of all nine themes and their similarity and differences to those of passenger comfort experience follows.

Peace of mind is described in relation to a person's concern for security (not faced with unforeseen events), tranquility (being in a calm and quiet environment) and relief (being relieved of daily obligations and able to relax). These three concerns describe a similar theme for passenger comfort experience.

Pleasure aspect of comfort in everyday events is mainly concerned with stimulation of one's senses such as enjoying a beautiful scene. In comparison, the pleasure aspects of passenger comfort experience [6] are more complicated and divers, entailing concerns for the ambience of the environment and anticipation of pleasant surprises. Another difference between the two studies is that while pleasure appears as the second to most important aspect of comfort in daily events, it emerged on the fifth place in relation to passenger comfort experience.

Physical wellbeing in daily events is described in terms of concerns for energy (resulting from optimum levels of fresh air and temperature) and bodily convenience (minimum physical pressures on the body). Similar concerns described physical aspects of passenger comfort experience.

Proxemics is described as one's perceived level of control over their situation (e.g. being able to do as desired) and privacy (recognition of personal space as a personally defied construct). Proxemics, first coined by Hall [7], is a term commonly used to refer to a person's intrapersonal space in relation to object or people [8]. The composition of concerns in this theme was similar to those of passenger comfort experience.

Table 1 Themes and concern categories elicited from reports of 35 respondent

Themes	Concerns	Examples	N
Peace of mind	Security	Nothing unexpected was likely to happen. The situation was very predictable	17
	Tranquility	It was quiet and calm without too many people around	19
	Relief	I could finally sit down and think about nothing but the present moment	30
	Total		**70**
Pleasure	Stimulation	I was at home, looking out the window, listening to music and watching the snow falling	38
	Total		**38**
Physical wellbeing	Energy	The air was clean and the temperature was mild	14
	Bodily convenience	My seat cushions were very comfortable, offering good lumbar support	21
	Total		**35**
Proxemics	Control	I felt free to do whatever I wanted without any constraint	16
	Privacy	I had the whole place to myself and no one disturbed me	12
	Total		**28**
Satisfaction	Accomplishment	I was able to concentrate and complete the task that I had planed in a shorter time	14
	Competence	It was very easy to use all the controls and buttons, they were not too complicated	14
	Total		**28**
Social	Connectedness	I sat with my friend in the cafe and we chated for hours	2
	Empathy	As I closed my eyes, my parrot came and tucked itself under the blanket next to me	9
	Total		**21**
Association	Recognition	Comfort is feeling like being at home!	14
	Total		**14**
Esteem	Self sufficiency	I felt I was using all my potentials in solving the problem	5
	Confidence	I was not criticized by others and I felt that my efforts were appreciated	8
	Total		**13**
Aesthetics	Neatness	The office was clean and tidy	2
	Style	The cafe was uncluttered, decorated very nicely with pastel colors	8
	Total		**10**
			253

Descriptive examples for each concern category are provided next to it

Satisfaction in present study is described in terms of concerns for accomplishment following the completion of a task and having the competency to do the task. Satisfaction, although a valid theme, was described through different concern categories for passenger comfort experience. Those were concerns for accessibility, adequacy and quality of the environmental elements.

Social aspects of comfort in daily situations are described in terms of concern for connectedness to others and empathy. The latter in the flight context was replaced by concerns for tolerance in relation to other passengers, which was deemed relevant to the limited seat space in commercial flights [6].

Association of daily events to prototypical and familiar experiences (recognition) such as being at home was quite similar to that of the flight situation. However, concern for symbolism of designed elements mentioned by Ahmadpour et al. [6] did not emerge in daily contexts.

Esteem as the experience of feeling confident to perform tasks and feeling self-sufficient to complete tasks, is a theme particular to comfort in daily situations. This theme did not emerge in the study of Ahmadpour et al. [6]. Similar to this study, Sheldon et al. [9] deemed self-esteem important for satisfaction in daily events.

Aesthetics aspects of comfort in daily life, denoted by concerns for neatness of the space and its style (e.g. being uncluttered, having nice colors), was similarly described as an aspect of passenger comfort [6].

4 Discussion

The underlying themes of comfort experience in everyday events were compared to a set of context-specific themes of comfort in the flight situation. The two sets display a highly similar disposition. With the exception of ‘esteem’, it seems that the eight proposed themes of comfort in the flight context similarly described comfort in everyday events ranging from home to public places such as office or a café. Two arguments emerge from this revelation.

First, it is possible that the experiential aspects of comfort are consistently understood across various types of situations. This is not a controversial idea. Previous research has shown that fulfillment of ten psychological needs sufficiently describe the satisfying nature of everyday events [9]. Some of those needs are comparable to the comfort experience themes discussed in this paper. Those are autonomy, competence (referred to as ‘satisfaction’ theme, in this paper), relatedness (referred here as ‘social’ theme), physical thriving (similar to ‘physical well-being’ theme), pleasure, security (under theme ‘peace of mind’, in this paper) and self-esteem. Note that, the argument on the generalization of comfort experience themes in daily life is based on the quality of those experiences, how they are perceived and their meaning or significance to a person. It is expected, however, that the activities associated with different aspects of daily experiences differ depending on variables such as personality traits or lifestyle choices. Uncovering those activities create incredible opportunities for new design ideas.

Second, some variations were observed in the composition of concern categories across themes of daily comfort compared to passenger comfort. In addition, 'esteem' emerged as a theme specific to comfort experience in daily events. These can be explained based on the contextual differences of those situations. While the thematic structure of passenger comfort highlights an emphasis on the perception of the environmental inputs, the themes of comfort in everyday events are more internalized and focused on self-perception. This may be due to the specific contextual constraints imposed by the limited space in the aircraft cabin during the flight, its highly situated and temporal characteristics and the inevitability of its social components. Moreover, the differences between the underlying themes and concerns of the two experiences can be further explained based on the differences between one's mental state, referred to herein as the experience mode. Hassenzahl [10] categorized those modes as goal mode and action mode. These modes are triggered by the situation. Once in the goal mode, one aims at completing a task and achieving a certain result while in the action mode, one is predominantly concerned with performing activities with the aim of enjoying them, i.e. the activity is "an end in itself" [10, p. 40]. An individual is concerned with efficiency and effectiveness in the goal mode, and with stimulation in the action mode. Based on Hassenzahl's argument [10], 'taking a flight' can be described as a goal-oriented experience whereby the aim of the passenger is going from one place to another. This means the flight and everything it entails (e.g. the cabin environment, the service, etc.) is merely a mean to achieve that goal of arriving at a destination. Therefore it is not surprising that concerns for self-esteem (i.e. self-sufficiency and confidence) is not an important aspect of this experience. This situation is inherently different to the daily life events whereby comfort is experienced due to a sense of personal fulfillment and enjoyment. Subsequently, feeling self-sufficient and confident is a rightly an important aspect of comfort in daily events.

4.1 Implications for Design

Good ergonomics, as a pre-condition for comfort, is sensitive to individual differences. This paper, however, suggests there are some elements of comfort experience, which are universally understood. The proposition implies that designing for comfort experiences should indeed go beyond meeting ergonomics consideration. This approach aligns well with the current movement, which encourages designers to reflect on where the positive experiences stem from [1] and to use that knowledge as a source of inspiration to creating products that enhance positive experiences such as happiness. Hassenzahl et al. [1] asserted that such products should incorporate elements that ascertain the experience of meaningful moments. The study presented in this paper elucidates the factors (i.e. themes) that describe comfort as a positive experience and uncovers the concerns that should be fulfilled through design in order to deliver those meaningful moments. In doing so, the situatedness of those experiences (e.g. the experience mode) should be considered carefully in order to account for specific user concerns.

5 Conclusion

This paper aims at creating a holistic framework to inspire design of everyday products or services that bring about an experience of comfort to users. It is argued that some elements of those experiences are universally understood, although contextually situated. Those elements are introduced as 'peace of mind', 'pleasure', 'physical wellbeing', 'proxemics', 'satisfaction', 'social', 'association' and 'aesthetics'. This conclusion is drawn from the similarities found between comfort in everyday life events and comfort in the flight context. The user concerns are linked to the specific characteristics of the situation and what it means to them. This is evident from the results presented in this paper. The theme 'self-esteem' was deemed an important aspect of comfort in daily situations while it was found immaterial to passenger comfort experience in the flight situation.

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Uplift: Happiness and Communication in the Context of Cancer

Salih Berk Ilhan

Abstract *Uplift*, addresses the quality of life of cancer patients—identifying opportunities that cultivate joy and happiness, and strengthening the support group around the patient. Based on a hypothesis that through design, joy and humor can positively change most experiences—and inspired by the revolutionary physician Hunter Doherty (popularly known as "Patch Adams"), advocate of humor, fun, and love in healthcare—Ilhan (author) investigated how design could touch people at an emotional level, especially in situations where they feel most vulnerable. The Uplift project aims to help improve the quality of life of cancer patients and caregivers by using design to provide new tools and services that support them—both emotionally and socially. Most of the concepts created in the thesis can be used by a variety of people suffering from a wide range of conditions—from chronic to life-threatening—but can also aid in the everyday context of a hospital visit.

Keywords Human-centered design · Health care · Service design · Speculative design · Delight as design material · Empathy · Joy · Laughter · Happiness · Subjective wellbeing · Health related quality of life · Cancer · Caregiver · Social support · Morale

1 Introduction

Design is a superpower that has been used by humankind to shape the life: Sometimes with good intentions and bad consequences; Sometimes with evil and selfish intentions and bad consequences; and rarely with good intentions and good consequences.

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Charles Chaplin told the story of industrial revolution and its tragic impacts on human life with his movies. He used caricaturized industrial designer figures in his movies "Modern Times" [1] and "The Great Dictator" [2] which clearly illustrated how capitalism used designers as pawns. In the movie The Great Dictator, the industrial designer figure works for the dictator, "Hynkel", who represents Adolf Hitler. Throughout the movie, this character constantly develops war machines for Hynkel which is the reason for his existence. In another Chaplin movie, Modern Times, there is a designer who works for the owner of the factory by designing practical mechanisms to feed workers while they screw the nuts on the production band. The automatic feeding machine removes the necessity of lunch breaks by boosting the efficiency of production made per work shift in exhausting and sometimes brutal environments. Although Chaplin uses a whimsical language to illustrate these characters, it reflects the sad reality very well. Decades later, in today's modern capitalism, people suffer just as portrayed in Chaplin's movies. There are life threatening consequences of this "revolution", indeed.

According to a scientific research conducted by Rosalie David and Michael Zimmerman of the Manchester University, cancer is the second cause of death in industrialized societies, whereas cancer was very rare in ancient times according to the historical investigation they conducted. David and Zimmerman claim "There is nothing in the natural environment [in ancient times] that can cause cancer. So it has to be a man-made disease, down to pollution and changes to our diet and lifestyle" [3].

On the other hand, there are promising design movements such as Positive Design. The goal of Positive Design is to increase people's subjective well-being by considering three main elements: design for pleasure, design for personal significance, and design for virtue [4]. That said, there is always hope for a better future and present time.

2 Framework

School of Visual Arts MFA Products of Design program emphasizes the importance of having a perspective and encourages students to cultivate their unique point of views. The program has a unique framework for thesis projects. The framework includes different lenses to look at the investigation areas. Some of these lenses are: speculative design, social enterprise, service design, design research, co-creative design, experience design, business modeling and branding practices. The challenge is to explore and investigate the theses topics by making. Creating physical and digital assets leads to constructive discussion, hence, new insights and learnings could be gained. In this book you will see a body of work that addresses issues that have not been addressed by the healthcare industry in the way I did. You will see a design approach beyond the conventional attitudes in traditional industrial design.

3 Goals and Objectives

Uplift has multiple goals and numerous objectives under one main idea: uplifting people who deal with cancer, including cancer patients and their caregivers. Uplift addresses two areas in the journey of coping with cancer: morale and communication.

Uplift evaluates and approaches patients' and caregivers' experiences through the lens of the Health-Related Quality of Life (HRQL) concept. HRQL is defined as people's happiness or their subjective well-being in consider to the aspects of life as they are affected by an illness [5]. In other words, the purpose of this investigation is not about curing cancer, but to help cancer patients and caregivers to improve their morale by using exercise methods to encourage them to smile and laugh more. To identify service concepts that connect cancer patients and caregivers to effectively communicate with each other.

In order to achieve this greater goal of uplifting, there are five sub-goals, which address different stakeholders' roles from a general standpoint:

1. To reveal design opportunities within complementary medicine (particularly laughter therapy)
2. To raise awareness about the communication problems that cancer patients face
3. To imagine an integrative healthcare system that approaches general health by considering the body and mind as one
4. To improve the Health-Related Quality of Life of the patients and their relatives
5. To envision and create futuristic scenarios that lead to constructive discussions about the future of cancer and the potential solutions to improve coping experiences.

4 The Ecosystem of Uplift

In the observation of the emotional and psychological journeys of cancer patients through their battle with cancer, Uplift stands on the positive design side of the ecosystem. Positive design includes designing for happiness, subjective well-being and joy. Putting the stakeholders in the center—in most cases the patient—Uplift offers tools for communicating with each other and with the self. These communication tools aim to nurture positive feelings and healthy social interactions between stakeholders such as cancer patients, caregivers, support systems and physicians. To understand what kind of ecosystem Uplift belongs to, it is essential to observe other positive design initiatives including:

1. Educational platforms (websites, apps, organizations) that aim to increase awareness about cancer
2. Social platforms that works on a voluntary-based structure in order to help patients.

3. Storytelling platforms that meet social needs of patients and caregivers.
4. Design companies and projects that aim to increase subjective well-being.

5 Research and Methodology

To address valid problems and identify fruitful opportunities that will help to achieve my goals within this study, it was essential to conduct a comprehensive research that reveals the invisible reasons behind the complex problems that cancer survivors, family caregivers and doctors face. As a designer, I needed to get rid of OR validate my biases. With invalid and biased assumptions in pocket, it is impossible to design for real world problems. Therefore, I conducted a variety of research methods to gather useful and groundbreaking insights that will take me to the next steps in my study.

For conducting this research, I used a variety of research methodologies under the main categories titled primary research and secondary research. Primary research stands for the research methodology which is conducted first hand by the researcher to collect original research data. Secondary research means that the researcher gathered the data by reading and analyzing other researchers' findings. Under these two main categories there are some particular research methodology that I used; which are:

Primary Research: Conversational Interviews, Field Research, Method Acting as Design Research, User Journey, Happiness and Communication Survey, Co-Creative Design; Secondary Research: Literature Research.

5.1 Conversational Interviews

Conversational interviewing is an alternative kind of survey interviewing that enables alteration from the criterion of standardized interviewing. Within the conversational interviewing research, researchers can ask participants whether they understand the question or not and provide spontaneous feedback to clarify the meaning of questions as necessary [6]. Conversational interview is an informal type of interview that is like a normal conversation. This method was one of the very first types of research that I conducted in the early phases of the thesis research. It helped me to get a grasp on the topic in a very short period of time thanks to the level of expertise that the interviewees had. I not only used this research method in the first part of my thesis research but I, also, applied it during the advanced phases. The people I interviewed are from a wide range of subjects. Interviewing with cancer patients, family caregivers, and oncologists helped me to understand the

audience better, to get rid of the biases I had and to identify problems and opportunities much better. Interviewing with designers, researchers, scholars, authors and thinkers enabled me to observe different perspectives.

6 Speculative Design

With the purpose of initializing ideas, I designed a set of speculative objects that addresses the problems and needs in the existing healthcare systems. Thanks to the helpful method I followed, I came up with many speculative object ideas; some of which I prototyped. By using lateral thinking methodology, which is an important and helpful method for generating as many ideas as one can, exploring different territories and different opportunities in healthcare became much more convenient.

Lateral thinking is a method invented by Edward de Bono, who is the author of the "Lateral Thinking" book which teaches how to be open minded, which explains how to be more creative and playful to generate more ideas easily. In his book he talks about looking at things differently and opening all of our senses up to see as many opportunities as possible. As stated by Bono, it is essential to unleash the mind and play with numerous "irrelevant" concepts irreverently. By having no limitations and no fear, one can easily come up with tons of ideas, most of which will probably sound silly and nonsense. However, as the journey goes on, magic happens and unthinkable ideas occur one by one. It is very surprising to see how the human brain loves being creative and playful and doesn't prefer judgmental comments. This could also be observed in kids' behaviors. They don't have the fear of making mistakes. They play, they run, they do silly things but at the end of the day they never fail to surprise adults with their magical creativity.

Using this method was very enjoyable and delightful to think about the healthcare topic and try to come up with interesting ideas. The outputs of the exercise were sketches and prototypes. Starting questions with "what if…" clauses I started to dream about the ideal healthcare experiences. What if the tools were less scary? What if the doctors were friendlier? What if the needle was not sharp? What if hospitals looked like lovely coffees? What if the newspapers only had good news? The lateral thinking method and personal questions helped me to put my thoughts and insights on the paper. I was able to see my initial ideas and opinions much more clearly. By doing so, I realized that I was mainly playing around with three main categories. First the interaction between the patients and the medical devices, secondly the interaction between patients and doctors and lastly the relationship between patients and their long term diseases. There are certainly many other elements in this area but these three were the areas I took the most interest in.

Medical tools and devices, or any product and artifact that get in touch with patients in hospitals have an impact on their psychology and on their experience. Designers design new products that aim to eliminate those bad impacts for sure, but,

unfortunately, hospitals lack medical instruments that are less frightening to better serve their clientele during their visits. The IV drips, needles, multi-functional patient beds, surgery tools, examination tools, knives, scissors and many other necessary tools have not changed for a long time. There may be a rational reason behind it but it doesn't mean that interventions are impossible. It seems as though the medical industry strives to make instruments for precision but do not take into consideration the people that have to be worked on by these tools. I started with what in my opinion is the scariest tool. The syringe is most commonly used. A syringe has a long cylindrical body with level marks on it, and a long needle at the bottom. Some children and adults have small fears of needles but some have irrational phobias of needles making shots a real chore and a lot of anxiety to undergo. Regardless, most if not all people typically do not enjoy getting poked with needles. One of the initial concepts on my speculative objects work is a syringe that hides its needle like a bee. The idea was that it might be less intimidating if the patient doesn't see the long needle but only a big balloon-like smooth ball approaches his arm.

The interaction between patients and doctors was the second issue in my speculative objects work. Doctors are the core of the hospital experience for patients who see them to receive treatment for their illness. The experience of visiting a hospital might be awful or wonderful depending on the attitude of the doctors. A friendly doctor who approaches his/her patients with respect and care will definitely lead a healing and calming experience; whereas, a tired and angry doctor who has poor bedside manner and doesn't respond to their needs will probably cause a terrible experience. Empathy is an essential tool in order to build bridges. Because of long and tiring days that doctors often endure throughout the week, patients sometimes have to suffer their resentment. It is unfair to expect patients not to depend on doctor's behaviors since doctors are the most important source of information that they are wanting to learn about. The concept I've developed to address this issue is a necklace that makes emotions visible through color coding. By using this necklace both doctors and patients can constantly communicate their emotions to each other.

Finally, the third issue is the relationship between patients and their long term illnesses. Some diseases are acute, some are chronic and some are fatal. There are many people in the world who have to live with debilitating diseases for the life time. Mental wellness and emotional support have become much more essential factors in these scenarios. For instance, a cancer patient who is dealing with tiring and exhausting treatments crave love and support. Communicating with family and close friends become key. On the other hand, seeing bad things, bad news, and hearing tactless comments might affect them terribly. Third concept focuses on this issue, re-thinking a newspaper for mentioned type of users. The concept is a special newspaper called "The New Your Times" which is curated by the New York Times. The purpose of the New Your Times is to filter the bad news and deliver the good news to patients. Good news might be from all around the world and from

patient's social environment such as his/her friends, family, partners, co-workers, etc. By creating a platform that only delivers the good news, the intention of the concept is to celebrate life and to keep the morale high.

7 Design Interventions

7.1 Oval Syringe

Oval Syringe is one of the speculative object concepts developed to question and re-think the existing experience of going through frustrating healthcare experiences. Asking the question of "What if the syringe was not that scary?", Oval Syringe concept was developed to change the perception of syringes. It hides the needle by showing a smooth and harmless shield to patients.

7.2 Emotion Necklace

Emotion necklace helps patients, doctors, and hospital staff to visually express how they feel in order to understand each other and have better communication. Using a color code system provides a quiet language design without embarrassing the users. Each color translates to a certain feeling such as anxious, angry, grateful, tired, and confused. The concept emphasizes the importance of empathy in the context of healthcare.

7.3 Dare

Dare is a provocative blood drawing concept that questions the hierarchy between patients and doctors. By turning the blood drawing setting into a double sided action, where patients draw doctor's blood as the doctor draws patient's blood, dare aims to empower patients.

7.4 The New Your Times

The New Your Times is a positive newspaper concept. It is curated by the New York Times to serve cancer patients. The New Your Times only gathers the happy news about loved ones and filters out the bad news. Therefore, it aims to support the cancer patient emotionally.

7.5 Smile Mirror

A magical mirror that lets users see themselves only when they smile. It aims to remind and provoke people to smile more, and see themselves smiling, because making a facial expression, such as a smile, can produce effects on the body that are similar to those that result from the actual emotion, such as happiness. Moreover, smiling is a contagious act; because, of the mirror neurons in our brain we naturally smile when we see a smiling person even if we're only seeing ourselves. Smile Mirror provides the user with a delightful and meaningful experience. It consists of three elements: a smart switchable film that becomes transparent or opaque according to its electrical status, a smile detecting software and Arduino open source circuit prototyping board.

7.6 Talk to Me

"Love and attention are critical tools for helping patients get better. If it were a form of medication, we would prescribe it." says Ronnie Nathan, Chief Barker of the Variety Club. Hospital visitations are very important for in-patients. Seeing a friend or a family member helps them to recover faster. Talk to Me is a voice recorder device that enables patients to capture the joyful moments from guest visitations and re-listen to them. By picking one of the colorful interactive sticks and plugging it into the base, the user starts recording a personal voice message to his/her loved one who is sick. Thereafter, the patient could tap on each stick and listen to those heart-warming messages when they are feeling lonesome.

7.7 Laughter Box

Laughter Box encourages people to take a short break from their daily routine and to enjoy funny videos which promotes laughter. Depending on the user's taste, Laughter box delivers different types of humorous content (i.e. giggling babies, outrageous accidents, and scrambling cats, etc.) thanks to the accompanying YouTube channel which users can access the videos by using their own smartphones.

After imagining a device that would provoke its users to laugh, I decided to prototype this idea very quickly in order to try it with real people. With the original rendering that I made (in Speculative Press Release: Laughter Device), my aim was to dream a collaboration between Philips Healthcare, Jimmy Kimmel and Memorial Sloan Kettering Cancer Center. The purpose of this collaboration is to provide patients with a magical headset that makes them laugh as they use it. Emphasizing the important health benefits of laughter, the idea is to bring laughter as a therapy to the cancer patients, most of whom suffer from depression.

In order to test the concept, I downloaded Google Cardboard layout from Google, then changed the size and shape to create a different experience. Afterwards, I chose several entertaining and funny videos such as cats and laughing baby videos. I opened these videos on my phone and placed my phone into the cardboard prototype.

I tested the prototype with approximately ten people from different ages ranging between 24 and 32. Similar initial reactions were, excitement to engage with the product, dropping chins in awe, disassociating self from the physical environment, and engaging the stimuli at a high level. Some of them expressed their feeling as "being in a movie theater" and "forgetting where actually I am." I also tested this concept at Sports Medicine at Chelsea and at the Integrated Family Medicine center. As seen in the diary studies section of the research, it increased patients happiness levels while they waited for their appointment.

7.8 Smart Smile

Smart smile is a smart switch that could be attached to electrical appliances. Communicating with the smart wall plug, Smile Switch could turn any kind of appliance into a smile-triggered system. For instance, you can make a cappuccino by smiling. It provokes users to smile more often.

According to the facial feedback hypothesis facial expression could change how we feel. Smiling is a powerful tool to reduce the stress caused by an upsetting situation. Therefore, I designed the smart smile switch as a spirit lifting tool for cancer patients.

7.9 Giggle up

Giggle Up is a design performance and interactive experience to investigate the idea of spreading contagious laughter. The event took place on March 28th, 2015 in the Flatiron District. Three actors, including me, dressed in white Tyvek suits carried wooden frames that have on/off toggle switches and LED indicators on them. The experience is designed to have three main parts:

- Attraction: The noticeably large toggle switches and actors who were dressed funny, attracted people. Many people stopped and watched the show curiously.
- Engagement: When the audience became engaged with the actors to turn on the switches, actors started to laugh loud, which also caused the audience to laugh.
- Takeaway: In the end, people who were engaged in the activity were given stickers, which allowed them to have a "giggle up" button, too. Then they started to play the game with each other by pushing each other's button and laughing.

7.10 All Together

Beyond improving morale, the second important factor that can positively change the cancer patient's experience is social support. According to the American Cancer Society, 1-in-4 people with cancer face clinical depression, and not being able to ask for help from family and friends is one of the biggest reasons. I investigated the factors surrounding this issue, and conducted a survey with 208 participants—including cancer patients, family caregivers, friends and family. Results revealed that 1-in-3 cancer patients didn't ask for help with daily activities—although they needed that help. And, in fact, 1-in-2 patients said that performing daily activities such as cooking, going to the pharmacy, and grocery shopping were extremely difficult for them. Admitting that the need for help was found to be problematic for patients, as they "did not want to burden caregivers"—especially their family members. I created a service platform concept to create a kind of connective tissue between these various stakeholders, and took initial inspiration from the wedding gift registry. *The insight was that the current social contract of "asking for help" is not liberating for patients. The All Together app is an easier way to ask for that help.*

Since most people carry a mobile phone, I chose to design All Together, a mobile app that allows patients to share their tasks with their friends and family. In effect, "All Together is an easier way to ask for help." Both "warrior" (patient) and friends/family download the app and sign onto the platform. The patient creates daily tasks to share, adding personal notes and setting deadlines. Friends and family can see active tasks on their calendars, responding when they feel most helpful. (Both mobile phone and watch apps are location-aware; when a task matches up with the location of the helper—say picking up a prescription when the helper is near the pharmacy—the device will receive a notification from the platform.) Both the warrior and the helper can track the task activities, and the service helps to expand the patient's support group by activating a larger social network through a common goal.

8 Conclusion

In the end, the *Uplift* project aims to help improve the quality of life of cancer patients and caregivers by using design to provide new tools and services that support them—both emotionally and socially. Most of the concepts created in the thesis can be used by a variety of people suffering from a wide range of conditions—from chronic to life-threatening—but can also aid in the everyday context of a hospital visit. It is my hope that these projects will continue to evolve and find their way into multiple contexts.

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Part VII
Designing Affective, and Pleasurable Interactions

Designing Alternative Interactive Techniques to Aid in Prosthetic Rehabilitation for Children

Matt Dombrowski, Peter Smith and Ryan Buyssens

Abstract In 2014, a team of University of Central Florida engineering students gained national media exposure when they developed a customized prosthetic 3D printed arm for a six-year-old boy. This team of UCF engineers known as Limbitless Solutions, is a non-profit organization devoted to bringing designers together who aim to use their skills to improve the world around them. Using their vast knowledge of engineering and multiple 3D printing facilities they are able to create cheap, and accessible prosthetics for children. In the late spring of 2015, the School of Visual Arts and Design (SVAD) was approached by Limbitless Solutions to assist in the further design development of their products. Limbitless reached out to SVAD to obtain students who could customize and design personalized decorations on the prosthetics to suit their recipient. During those initial meetings it became clear that there was a great opportunity for collaboration between the School of Visual Arts and Design and Limbitless. Limbitless showed interest in the Game Design program at SVAD and proposed a research opportunity to integrate the controls of the Limbitless prosthetic arm with game developed by SVAD students. When the children receive their prosthetic, many of them still need to learn or, in many cases, relearn elements such as grabbing, squeezing and other range of movement with their newly fitted prosthetic, the games developed by SVAD are used to train these movements.

Keywords Games for health · Gamed based training · Game design · Gamification · Human computer interaction · Augmented reality · Interactive design · Rehabilitation games

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1 Introduction

The concept of integrating alternative controllers to improve accessibility is not a new one in the world of gaming. However, the idea of creating a worldwide community of shareable, but most importantly, widely accessibly technology seemed unachievable up until a few years ago. Online communities such as Thingiverse, along with the advent of consumer-level 3D printing, have made it possible to provide cost effective solutions to achieve maximum exposure of cutting edge technology and make it readily available to a larger community. Research efforts from Limbitless Solutions Inc. and the Open Hand Project have utilized the growing industry of 3D printing and EMG controlled prosthetic limbs to allow this community to become a reality. Utilizing of 3D printing to print prosthetic limbs for children, helps to make typically expensive prosthetic technology much more accessible to the masses.

The goal of this work is to help further develop the community of making rehabilitation tools more readily accessible to the masses. This is to be achieved by the creation of gamified experiences that aid in training children to control their prosthetic and contribute to the children's rehabilitation process. The University of Central Florida's School of Visual Arts and Design (SVAD) have partnered with Limbitless Solutions to take their 3D printed prosthetics and address challenges that the recipients of the limbs are facing.

SVAD researchers are using the prosthetics to interface with games built by university students. These games utilize EMG data to create an alternative interactive experience. In turn, these game design efforts will help train a child to interface with their 3D printed prosthetic. Realizing that there are many different practices and factors involved, the research team is made up of a game designer, digital maker, and digital artist. Each team member brings their individual skills into the development of training interfaces and gamified experiences. This paper discusses the visual and hardware based benchmarks that were considered in the development of a digital gamified rehabilitation experience.

2 Background

The implementation of gamified experiences will be utilized to address the current need of training those learning to use their newly acquired prosthetic limbs. Awareness of how the technology works is an important factor in fully operating the controls of the prosthetic.

2.1 Accessibility History

Computer interface accessibility is an evolving topic. Each technology addresses these issues in their own unique way. The Internet, for instance, addressed

accessibility issues by requiring federal websites to be accessible to the disabled. Section 508, required federal websites to develop standardized rules in order to make the human-computer interaction more accessible to the masses. This is one of many early occurrences in the effort to make widely available digital tools more accessible to those who previously could not interact with them. Strong accessibility standpoints, such as Section 508, also inspire others in the digital community to adopt standardized accessibility practices [1].

Any field in which mass audiences are expected to interact with computers for long periods of time are not immune to accessibility issues, the video game industry was no different. According to 1997 US Census data, 25 % of the United States population suffers from some sort of visual, auditory, mobility and/or cognitive disorder [2]. Since 1997, these numbers have only continued to grow. Disabled gamers encounter many frustrations that their non-disabled counter parts do not. As seen in the World Wide Web, there was a strong need for accessibility in video games. The International Game Developers Association (IGDA) forms the Game Accessibility Special Interest Group (SIG). The IGDA assists in defining the needs of gamers with disabilities and assists in the development of technology to aid accessibility [2].

Accessibility for games can be categorized into two specific areas. Area one consists of specially developed software and equipment that can assist the user with commercial games and, in area two, games that are designed specifically for disability rehabilitation [3]. In today's vast commercial market, some games are designed from the start to be accessible, while others are not developed with accessibility in mind. With the aid and suggestions of the IGDA digital practitioners have developed accessibility tools in the form of screen readers, magnifiers and speech recognition. Specialty controllers and other hardware have been created to best suit those with accessibility needs. There is always more room for further development of accessibility tools and it is an evolving process. What the IGDA successfully achieved is bringing awareness of these concerns to the forefront so that new interactive tools can be created, implemented and enjoyed equally by all users.

2.2 Gamification and Rehabilitation

Games and interactive experiences are not simply meant for commercial entertainment. The idea of using digital media as a form of rehabilitation has only recently become viable. Many researchers have begun the process of the creation and implementation of new technology to aid in health-based rehabilitation. In a 2009 research study, researchers performed a meta-analysis related to the effects interactive computer play (ICP). The common thread of these studies was that they focused on children with sensory motor deficiencies [4]. Researchers gathered data back all the way from 1995; the researchers came to the conclusion that the use of ICP in rehabilitation was a "highly promising area" in which further research was

encouraged [4]. Not only was it effective they also determined that the children had fun while doing the rehab.

In 2012, researchers gamified rehabilitation to help retrain balance in those with lower limb amputees. The study focused on the implementation of a commercially bought balance board utilized with AAA entertainment games. The study looked into, not only the effectiveness but also the safety of incorporating alternative gaming experiences in the rehabilitation process. The results of this study were positive. Findings concluded that amputation gained greater balance with the use of interactive gaming experiences, as well as the commercially bought balance board [5]. The importance of this study was that its results determined that video game based therapeutic treatment could benefit those with disabilities. Being the study used commercially produced AAA titles, an issue that remained was that these titles were not designed specifically for those with limb amputations nor was the gameplay focused on rehabilitation. This paper further explores the process of developing both hardware and software for those undergoing rehab for limb amputation and digitally interactive training techniques for those learning to use prosthetics for the first time.

The field of custom rehabilitation game design is an area of interest to many researchers. Researchers recommend that future research should focus on increasing measuring and recording of data throughout digital based training and investigating how these training tools are impacting treatment [6, 7].

2.3 Limbitless Solutions Inc.

In 2014, the team of researchers at University of Central Florida's Limbitless Solutions met a boy named Alex. Alex was born without most of his right arm and due to the high prices of modern day prosthetics the likely hood of Alex's family being able to acquire one was low. In a short span of only 8 weeks, researchers at Limbitless utilized the relatively new, low cost technology of 3D printing to print Alex a prosthetic arm. Alex's new prosthetic arm was printed out of a type of plastic and Alex could control the arm via electromyography (EMG) sensors. Best of all, Limbitless provided Alex's family the arm for no cost [8].

Limbitless, taking their philanthropy further, open sourced their 3D printed arm, software and hardware on the 3D printable object-sharing site Thingiverse [9]. Their goal was to share their technology so others could continue to development and make more products available to those who are in need.

The Limbitless prosthetic arm has a fixed elbow and a hand that opens and closes and is made of a durable plastic material. The arm is mechanized by the inclusion of a small Arduino micro-controller embedded within the print itself. The Ardunio takes input signals from the user's muscle function, which results in a small motor moving the fingers of the hand. By flexing their muscles, the user can control the opening and closing of their hand. The motion of the hand does not affect factors such as power and length of grip. This design is meant for child users

and to help eliminate muscle fatigue for the children. Since the typical person is used to a squeeze and release motion rather than an on and off motion the learning curve in utilizing the 3D printed limb can be a challenge for the child. The research presented follows the design process in the development of rehabilitation tools utilizing custom made video games in efforts to train the child to better acclimate themselves to their newly acquired prosthetic.

3 Design Methods

The achievement of an effectively designed training interface is based off of two factors, the hardware and the software. As mentioned, the first is the Arduino powered hardware found inside the preexisting 3D printed Limbitless Prosthetic Arm with EMG input. The other is a custom-built software interface that takes the inputs from the Limbitless hardware and interfaces it into digital game experiences - developed using the game engine Unity3D.

3.1 Design Considerations

In efforts to design rehabilitation-based training games, it is important to consider the transferability of a task. When designing games for a user that has only partial use of their limb this task becomes more challenging. Typically, a child holds a controller in their hands and plays a game by pressing buttons. Yet, in the terms of this study, the prosthetic plays a crucial part in the game play. The prosthetic limb itself is replacing the pre-existing hand held controller—the limb becomes the controller. The games are developed to train in the act of grabbing, gripping and closing of the hand. Games that focus their gameplay efforts around this functionality will, in result, have greater impact on training outcomes.

With the goal of designing and testing as many game concepts as possible, the Limbitless Prosthetic Art interface was implemented into 14 games that were develop for the course “Casual Games Production” in the University of Central Florida’s School of Visual Art and Design’s Digital Media Game Design track, in the Spring Semester of 2016.

The games were designed by groups of approximately 4 students each with a varying range of skills in artistry and programming. It was required of the students that the core mechanics of the game were to be based on the Atari 2600. In addition, they were instructed to add a new mechanic as well as change a mechanic. As a result, the games have the simple controls of an old school Atari game while having unique qualities making them different from what has been played before.

An example of one of these games is Sushi Smash. This is a game based loosely on the game Volt Assault, an Atari 2600 game where the player would shoot enemies approaching from 4 directions. This version, however, has the player take

on the role of a giant squid crushing sushi chefs that are trying to turn it into sushi from 8 directions. While the game is reminiscent of the classic game, it still feels original. The player selects an attack direction and uses the prosthetic controller to issue attacks.

Once the games were designed, the students were provided the code to allow them to connect to the prosthetic interface. This interface was easily implemented and the EMG replaced a button in the game. Since the participant was to be using only one prosthetic arm, the games still maintained other controls commonly found in other games. This provided the ability to not only practice with the EMG interface, but coordinating that practice between their prosthetic and actual hand.

3.2 Hardware

Need for Direct Feedback. The prosthetic arm operates much like a garage door—trigger it once and it opens, trigger again to close. The trigger message can be interrupted yet; if the command is held continuously, no extra response is gained in the game. This is counter to what game designers are accustomed. They often program functions around holding a button down when doing things like charging an attack or increasing jump height. The lack of this typical design pattern provided some difficulty for the game designers.

The EMG can produce a response at 16 times per second (16 Hz) yet it can take up to a half second (2 Hz) to see a reaction in the prosthetic arm. With this delayed action, the controls must be created accordingly. This means that fast, twitchy responses that can increase fun cannot be used. Even though the hardware can handle the information at a higher rate (and even simulate the delay), the controls have to react at the rate that the actual prosthetic hand can respond. Furthermore, the games must also be designed to include this delay during game play.

Need for Precision of Movement. Games could be designed that would only use the prosthetic controller. This would limit the input to one button and allow the user to concentrate on learning only the control and its nuances. However, this approach would severely limit the types of games that could be made. It is assumed that the user has an existing hand to use in conjunction with the prosthetic. With this as a possibility, the control can be mapped to prosthetic as well as game controller buttons and/or keyboard and mouse. As mentioned before, this will also allow the user to train their prosthetic and actual hands to work in unison.

3.3 Software

The software side of design can be broken into four categories. Visual elements, user interface, level of difficulty, and replay value all directly affect the human computer interaction process. These categories were explored both by the

researchers and the students in efforts to produce a successful training game that is both engaging and, most importantly, fun to play.

Visual Elements. When developing visuals for interactive experiences it is first most important to know whom your audience that you are developing the experience for is. In this study, the artistic goal for this project was for the games to appeal to an audience of pre-teen children. What visuals appeal to children? Why are children drawn to those images? What imagery will be most effective to hold a child's attention and promote replay? University of Central Florida Game Design students were tasked with answering these questions. In turn this would allow them to developing art styles that appeal to this specific age group. They sought answers, influence and inspiration from researching art styles utilized in children's picture books. The purpose behind this research is to understand why the artists of those picture books use simplified design methods when producing visually interactive content to engage children. The students noted trends and were inspired by simplified shapes, bold color choices and strong use of texture to help visually engage their young users. By activating these multiple visual cues, the child user is more likely to be engaged with the training game longer and be more immersed in the end product.

User Interface. The students design goal was to focus a game specifically designed for prosthetic arm rehabilitation in preteen children. This by no means meant that commercial AAA gameplay was overlooked and/or discredited. Existing commercial games were used as influence tools for game play purposes. Though engaging and entertaining, AAA commercial titles have not been designed with the goal of training for prosthetic arm use in mind. The students were tasked to steer the game design to the specific training objective at hand. Therefore, by focusing the theory, design and development of these games solely for prosthetic arm use, the students can eliminate any negative training outcomes that could unexpectedly occur when trying to redevelop a commercial game for rehabilitation use.

Level of Difficulty and Replay Value. Balancing the design of an engaging but physically challenging gaming experience can be difficult. One goal of the designers was to take into consideration the difficulty of the games and their replay value. The purpose of the designed games is that the child may practice using their new prosthetic. These games have to be engaging but more importantly must be challenging enough to keep the child coming back for more training. The outcomes of the games should support multiple play sessions and provides more practice opportunities.

Being that the users are pre-teen children, the game play should be fast paced to hold their attention. The gameplay should be easily understood so that the learning curve is minimal. If the child can be challenged but see the end tasks are achievable they will return to play the game. If the game is too hard the child will be discouraged to pick it back up again to continue their rehabilitation.

Students were tasked in determining the length and depth of their games. The goal of the designers was to avoid creating an epic role-play game scenario. In other words, game play experience in which the gameplay is drawn out over a long period of time. The students were encouraged to design more of a casual or arcade

game experience. Through the development of the casual arcade experience, users can utilize repeatable, fast paced training methods. Think of these methods like circuit weight training in your local gym. You have multiple tasks at hand but you can move on to the next to avoid boredom or plateauing. By instituting a casual arcade style of gameplay, the user can also be rewarded as a means of motivation. The act of achieving and surpassing high scores, and even perhaps the future outcome of interacting and developing friendly competition with other children utilizing the same game would be beneficial for replay value.

Ultimately when approaching game design focused around children, the games need to be fun. Those there will be motivation to learn how to use their prosthetics, the game play must stand on its own in order to compete with other commercial based media that the children will have access to. Though the students did not simply redesign currently existing commercial games it would be an oversight if they had not utilized those games mechanics in efforts to great an engaging and compelling game experience. Having the students understand design and user testing patterns of the commercial games allows them to make more effective decisions in their game design experiences. Making a commercial game that is engaging to a mass population is a difficult task, making a game designed for rehabilitation and that is also fun much more difficult.

4 Conclusions and Future Directions

When designing rehabilitation training game for children it was very important to focus both on visual and usability factors. Continuing to make the games stimulating to children will be the research team's priority. The process of design is an evolving process. Not all the games designed in the Spring 2016 game design class were successful but this allows the team to alter methods for the next round of games. With the partnership of Limbitless and their constant push to have their products reach as many children as possible, the evolution of further training games is bright.

4.1 Future Work

The future goal of this research is to follow suit with Limbitless Solutions selfless practices. All designs and interfaces will be available to download for free from the Thingiverse webpage next to the Limbitless Arm design. The goal of this research will be and has always been to touch as many lives as possible for the greater good.

The possibilities for this interface could span from VR applications to augment reality. Anything that could use input from EMG could be developed into an interactive gaming experience. Researchers could take the designed technology incorporate it into interactive experiences in rehabilitation for other disabilities.

Imagine utilizing this technology to develop meditation games for mental health, or even aiding in mechanics for those with motor disabilities. The goal of this research team has always been to develop technology that can be introduced to other developers with a seemingly relatively low learning curve yet, achieve high impact results. The ultimate goal is continuing to create and be a part of a community that uses technology to influence social change.

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Towards Joking, Humor Sense Equipped and Emotion Aware Conversational Systems

Pawel Dybala, Motoki Yatsu, Michal Ptaszynski, Rafal Rzepka and Kenji Araki

Abstract In this paper, we present our progress so far in realization of project aimed to create a complex, modular humor-equipped conversational system. By complex, we mean that it should be able to: (1) detect users' emotions, (2) detect users' humorous behaviors and react to them properly, (3) generate humor according to users' emotive states and (4) learn each user's individual sense of humor. The research is conducted in Japanese. We chose puns as a relatively computable genre of humor. We describe a general outline of our system, as well as its four modules: humor detection module, emotion recognition module, response generator module and individualisation module. We present the algorithm of systems used in each module, along with some evaluation results.

Keywords Humor · Puns · Emotions · Artificial intelligence · Natural language processing · Human-computer interaction

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1 Introduction

In recent years the world of science has begun to realize that designing systems able to interact with humans in a natural manner requires considerations of such human factors as humor or emotions. These are especially important in conversational systems that interact with us on daily basis—e.g. virtual companions or interactive car navigators. To be perceived as friendly, natural and human-like, such systems need to be capable of detecting users' emotive states and react to them properly. Also, as humans sometimes tend to react to particular emotions with humor, these emotion-aware systems should also be able to detects and perform humorous behaviors.

That said, these reactions and humorous behaviors are highly individual and subjective issues, i.e. they strongly depend on particular human's personal traits, such as emotional intelligence and sense of humor. Thus, when constructing emotion-aware humor-equipped systems it is crucial to implement also an individualization procedure, that would allow the system to learn each particular user's humor sense and use this information to individualize its performance.

To summarize, the goal of this research is to create a conversational system able to: (1) detect users' emotions, (2) detect users' humorous behaviors and react to them properly, (3) generate humor according to users' emotive states and (4) learn each user's individual sense of humor. As humor is quite a broad issue, we decided to focus on its linguistic genre, known as verbal humor (or puns), which is said to be relatively easy to process (with Natural Language Processing tools). Puns are generally present in almost every culture, but in highly homophonic languages there are more possibilities of their creation. Therefore, we decided to conduct our research in one such language, namely Japanese.

This paper describes the progress of our project so far. First, we summarize the outline of our project. Next, we describe the system's modules: humor detecting module, emotion recognition module, response generating module and individualisation module, at their current stage of development (along with some evaluation experiments' results).

2 State of the Art

In this section, we briefly present state of the art in the fields of humor detection, emotion recognition and humor generation.

2.1 Humor Detection

As far as state of the art in the field of humor detection is concerned, here we focus on works that deal with detecting Japanese puns (*dajare*), as they are quite

characteristic and thus require individual approach. A system classifying *dajare* was proposed Yokogawa [1]. Basing on results of morphological analysis, the system was able to successfully detect punning sentences—however, only those found as ungrammatical. Yokogawa also focused on imperfect puns, while perfect (full homophony-based) puns are also an important group.

Amaya et al. [2] proposed a method of automatic detection of word similarities based narrative jokes extracted from Twitter[1] entries. To do so, they used WordNet and methods such as bag-of-words and machine learning.

Also worth mentioning is the work of Kitagaki [3], who proposed a fuzzy-logic based method of measuring *dajare* funniness (laughableness). This approach, however, a priori assumes that inputted texts are puns, and the author does not propose any method of distinguishing them from non-humorous texts.

2.2 Emotion Recognition

Text based affect analysis is defined as a field focused on developing natural language processing techniques for estimating the emotive aspect of text [4]. Research in this field has flourished rapidly through several years. Elliott [5], for example, proposed a keyword-based system which used an affect lexicon (including words like "happy", or "sad") along with intensity modifiers (like "extremely", "somewhat"). Liu et al. [6] proposed a model of text-based affect detection based on a generic common sense database. Alm et al. [7] applied machine learning methods for affect analysis, which they tested on fairy tales. Machine learning was also used by Aman and Szpakowicz to perform affect analysis of blog entries [8].

Some work on affect analysis was also done for the Japanese language. Tsuchiya et al. [9] proposed a system using association mechanism to estimate emotive aspect of utterances. There were also attempts of using the Internet as a source of potentially emotive sentence examples [10, 11]. One such Web-based technique was also used by Ptaszynski et al. [12] as a support for his affect analysis system for Japanese text-based utterances.

2.3 Humorous Responses to Emotional States

In the last decades, numerous research projects were conducted on humor generation. In this section we focus on verbal humor and mostly on those works in which humor generation was placed in interactions with human users.

One of the first and most notable attempts at creating a computer system able to tell puns was Binsted's JAPE punning riddles generator [13]. It was a stand-alone

[1] www.twitter.com.

application, i.e. it generated riddles (such as: "-What do you call a murderer with fibre?—A cereal killer") in isolated forms. However, JAPE was later used by Ritchie et al. [14] to create STANDUP—a system described as "a language playground, with which a child can explore sounds and meanings by making up jokes, with computer assistance". This gave the riddles environment and context, in which they are used naturally by humans.

Also worth noting is Tinholt and Nijholt's ConceptNet-based cross-reference joke generator [15], implemented into a conversational system. Toward users' utterances the system, when possible, would generate humorous misunderstanding including responses, using syntactic ambiguities (like: "User: Did you know that the cops arrested the demonstrators because they were violent?, System: The cops were violent? Or the demonstrators?"). Unfortunately, experiments showed that this type of cross-reference ambiguity occurs very rarely in real-life conversations, and thus the use of such generator in daily dialogues with conversational systems would be marginal. However, it would be interesting to investigate this issue also for languages other than English—Japanese, for instance, is a highly contextual language, with very limited range of grammar forms, and thus more potential syntactic ambiguities.

Another important work in the field of humor generation during conversations with users was done by Sjoebergh and Araki [16]. Their Japanese chatterbot used humor modules: database jokes module (from preprepared DB), similar dirty words module (generates dirty misunderstanding jokes, based on word similarities) and user jokes module (checks if user's utterances can be found in jokes DB). This system received positive reactions from users.

However, to the authors' best knowledge, no system able to react to users' particular emotional states with humor has been created so far. Also, no humor-equipped chatterbot has been built that would include individualization module, i.e. that would be able to adapt to users' humor sense. Thus, here lies the originality of our project—the system we are working on not only represents what we defined as multi-stage approach to humor and emotions [17], but also will probably be the first system able to model users' individual humor preferences.

3 System Proposal

As mentioned above, some interesting work has been done in the fields of humor generation and recognition. There were also attempts at placing such systems in conversations with human users.

However, when constructing a system able to use humor in natural manner in daily interactions with users, we must ask ourselves a question: what should such system be able to do?

This would probably trigger a long lasting debate, but if we consider traits humans use when dealing with humor, we can state, that to do so, such system should at least be able to:

- detect user's humorous behaviors
- react to them adequately
- recognize users' emotions
- on this basis—decide whether or not use humor
- generate humorous contents
- recognize users' reactions to humorous contents
- construct users' humor sense models to individualize its performance.

Needless to say, humor is a quite complex process and these requirements may seem general and not sufficient. However, as to our knowledge no system exists that would fulfil them, we decided to launch a research project aimed at creating one.

Thus, the abovementioned requirements define our main research goal. Currently we are working on implementation and improvement of particular modules of the final system. Its general algorithm outline is presented on Fig. 1.

The system is modular, i.e. it is constructed from several modules: humor detection module (see Sect. 4.1), emotion recognition module (Sect. 4.2), response generation module (with three submodules: humorous response generator, non-humorous response generator and reaction to humor generator—see Sect. 4.3) and individualization module (Sect. 4.4).

As shown in Fig. 1, the algorithm works as follows: during a conversation between a user and the system, user's utterance is first analyzed by the humor detection module. If it recognizes the utterance as humorous, the response generation module generates an appropriate response. If the utterance is recognized as non-humorous, next it is analyzed by the emotion recognition module. Based on this analysis results, the system decides if humor should be used to enhance the user's mood. If yes, the system's response is generated by the humorous response generator. If no, the response is generated by the non-humorous response generator (i.e. baseline, non-humor—equipped chatterbot).

All these modules are linked to the individualization module, which, using the results of affect analysis, gathers data needed to build the user's individual humor sense module. If, for example, the user after being told a joke reacts to it with anger, the individualization module stores this data to be used in further interactions. The more such data the system gathers, the more complex model it is able to build. Complex individual models of users' sense of humor, in turn, will result in better and more personalized interactions.

More detailed modules description is given in Sect. 4.

4 Modules

In this section we describe the modules of our system. Currently we are focusing on improving the humor detection module's performance and implementation of the individualization module's algorithm. We are also working on adding new humor generation patterns to extend the humorous response generator's possibilities.

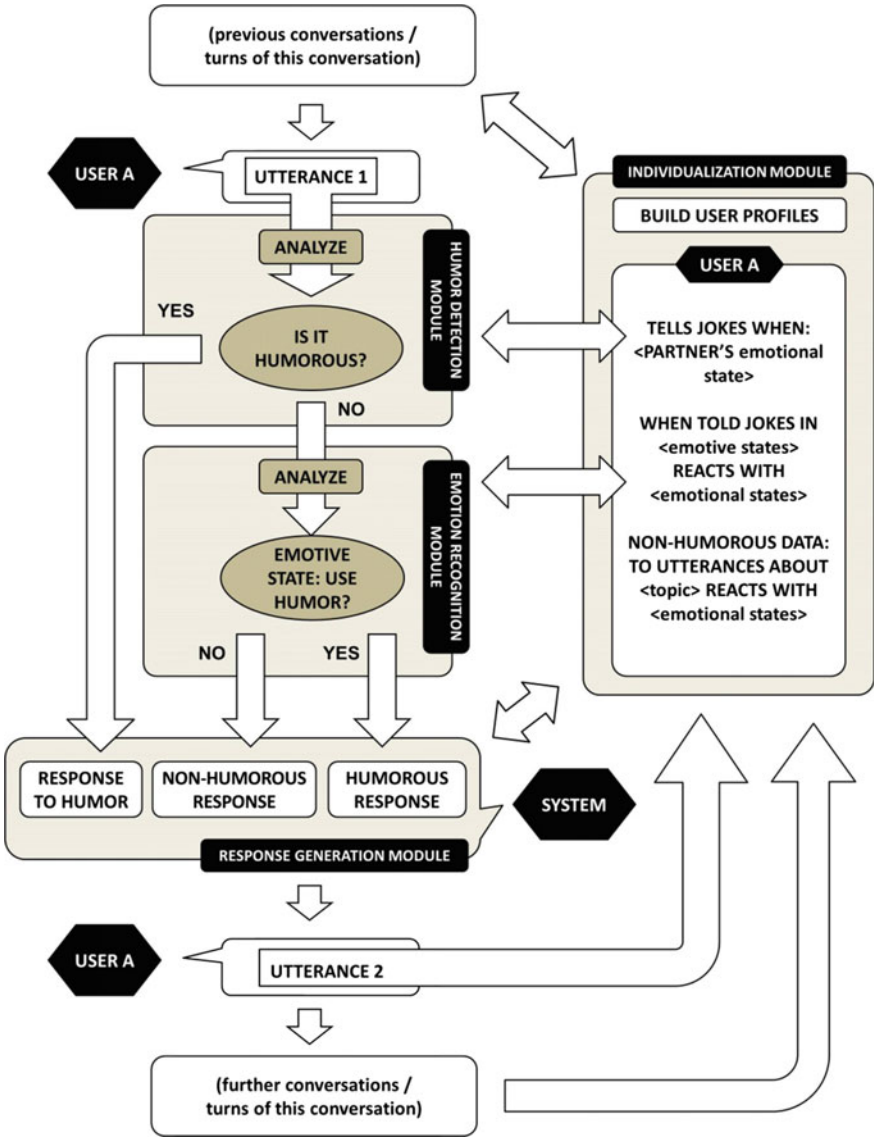

Fig. 1 Proposed system's algorithm outline

4.1 Humor Detection Module

We prepared a pun/non-pun classifier using an Support Vector Machine [18] with the features listed in Table 1. The positive examples were all obtained from existing websites that collect Japanese puns. The negative examples were sentences with

Table 1 Feature sets used in the classifier performance measure experiment and its results

Set	BOW features	Exact-match	Similarity	Euphonic sounds	Precision	Recall	F-measure
F_1	–	O	O	O	0.908	0.861	0.884
F_2	O	–	–	–	0.873	0.824	0.848
F_3	O	O	O	O	0.915	0.633	0.749

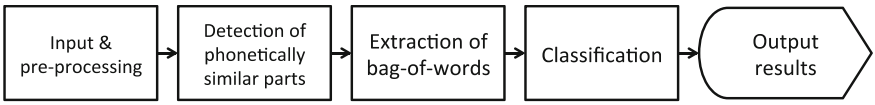

Fig. 2 Process flowchart of pun detection module

limitation of sentence length, which was in order not to have too long sentences classified as false positive, as such sentences are more likely to be detected as puns (Fig. 2).

The feature sets include phonetic similarity feature in addition to bag-of-words and phonetic exact-match feature. The phonetic exact-match feature checks whether there is a morpheme in the input sentence which sound is entirely equal to an additional part in the sentence. On the other hand, the phonetic similarity feature is related to how similar consonants in the input sentence are. It has value of 1 if the mean of the similarities for all combinations of consonants p1 and p2, which are calculated preliminary using development corpus data, is larger than the threshold that is given by pre-tuning. Formula (1) shows the method of this calculation. In this equation, Np1, p2 stands for the number of consonant pair p1 and p2 which occurs sequentially in a pun sentence, Npair for the number of all such pairs, P(p) for relative frequency of consonant p in all sentences, and c for a real number determined empirically.

$$\mathrm{OER}(p_1, p_2) = \log \frac{\mathrm{N}_{p_1,p_2} + \mathrm{N}_{p_2,p_1}}{\mathrm{N}_{pair} \cdot \mathrm{P}(p_1) \cdot \mathrm{P}(p_2)} + c \tag{1}$$

In order to verify performance of the pun detection module, we performed a 20-fold cross validation of the classifier. The size of both the examples were 23,984 sentences, which were divided into 22,784 versus 1200 sentences for training and tested data, in which the same numbers of positive and negative examples exist.

The results of the experiment stated above are shown in Table 1. Using the feature set F_3, there was 0.14 point of improvement in F-value compared to the rule-based feature set (F_1). This suggests that it appears to have effectiveness to take vocabulary features into consideration in detecting sentences that include puns.

The results, albeit not perfect, show that this pun detection algorithm can be used in our system. Currently we are working on its full implementation, which will be evaluated experimentally in the nearest future.

4.2 Emotion Recognition Module

The main part of the emotion recognition module is ML-Ask system—a text-based affect analyzer for Japanese, developed by Ptaszynski et al. [19, 20].

ML-Ask is a keyword-based language-dependent system for automatic affect annotation on utterances in Japanese. It uses a two-step procedure:

1. Specifying whether an utterance is emotive—i.e. if it contains emotive elements (like "whoa!" or "Oh!"), which indicate that a sentence is emotive, but do not detail what specific emotions have been expressed, and
2. Recognizing the particular emotion types in utterances described as emotive—by detecting if it contains emotive expressions, i.e. words or phrases that define specific emotional states (like "happy" or "sad").

To perform these two steps of analysis, ML-Ask uses a lexicon of emotive elements created by Ptaszynski et al. [19], as well as a database of emotive expressions. These expressions in ML-Ask were also mapped on Russell's two dimensional affect space [21], which assumes that all emotions can be represented in two dimensions: their valence (positive/negative) and activation (activated/deactivated).

Another important feature of ML-Ask is the use of Shi et al.'s web mining technique [10] to extract emotion associations from the Internet. This algorithm uses noun-plus-verb and noun-plus-adjective phrases found in inputted utterance to extract emotive associations, i.e. emotive expressions that co-occur with these phrases most frequently. For example, if for the input "I lost my job" the system would extract associations like "sad" or "angry", as these are the groups of emotions most frequently used after this phrase.

ML-Ask is also able to detect specified emotions from emoticons (see [22] for details). This should be particularly useful in detection of users' humorous utterances, as people generally tend to mark funny contents with emoticons.

The ML-Ask system is currently under further development. Particular focus is laid on automatic construction of an emotive expressions dictionary, based on sentence annotations performed by humans. Also, Ptaszynski et al.'s SPEC system […] will be used to analyze patterns that occur in emotive sentences.

The ML-Ask system plays also a pivotal role in the individualisation mode (see Sect. 4.4), in which it is used to analyze users' emotive states during conversations. On this basis the system builds each user's personal model of preferences.

4.3 Response Generation Module

The system's response to user's utterance is generated by the response generation module. Depending on the individualization module's decision regarding the type of response, it is generated by one of three submodules: non-humorous response generator, humorous response generator and response to user's humor generator.

Non-humorous Response Generator (**Chatterbot**). This submodule is responsible for generating responses, that are neither humorous nor reactions to humor. In other words, it functions as a standard chatterbot that performs conversations with users. In our previous works we used Modalin, developed by Higuchi et al. [23] Modalin is a keyword-based chatterbot that uses the Internet to generate word associations to phrases extracted from users' utterances. Experiments showed that Modalin's utterances received fairly good evaluation from users; however, some of them were found not natural or ungrammatical. Also, as Modalin performs many queries on the Internet, its processing time is sometimes too long to use the system in real time conversations.

Thus, for the needs of this project, we decided to improve Modalin's performance. The previous version of the system used sentence modalities in a random manner, i.e. it added randomly selected modal phrases to sentences generated by the system. In the second version, we decided to create a dictionary containing modal expressions and grammar forms they tend to co-occur with. This allows the system to avoid generating unnatural and grammatically incorrect sentences. In addition, to avoid Internet lag issues, we switched the system to an offline text corpus.

Humorous Response Generator. As at this stage of our research we focus on verbal humor (puns), the system's humorous responses are generated by a pun generator. Its basic version, PUNDA system, was developed in our earlier works [24]. The system first extracts particular words (nouns, adjectives and verbs) from inputted sentence and then uses them as potential pun base phrases, i.e. it attempts to transform them into other phonetically similar words. Next, the phrases are transformed using phonetic patterns based on our Japanese puns classification [25]. Then, the system uses the Internet to detect which candidates are relevant to the input and uses sentence templates to generate humorous utterances. The system generates pun candidates with 75 % accuracy (compared to human level). Below is an example of the system's process:

User: *Kaeru daikirai*! (I hate frogs!)

Base word: *kaeru* (frog)
Pun candidate: *tsukaeru* (be able to use)]

System's response: *Kaeru to ieba tsukaeru ne*! (Speaking of frogs, we can use them!)

In our previous research [24, 25] PUNDA system was implemented into a conversational system. Experiments, in which human users were asked to perform conversations with two systems: with and without humor, showed that the former was evaluated as better, more human-like and triggering more positive emotions than the latter.

Currently we are working on improving this submodule's performance. This will be achieved by adding more pun generation patterns and sentence templates as well as refining the association generation algorithm.

Response to User's Humor Generator. When the humor detection module recognizes that user told a joke, the system's response is generated by the response to user's humor submodule.

The easiest method to make the system react to users' jokes is to make it return replies like "hahaha" or "that was funny!"—as it was done by Sjoebergh and Araki [16]. At this stage of our research, we present similar approach. We prepared 5 different phrases that can be used in reaction to users' humorous utterances.

However, needless to say, humans do not react to all types of humor in similar manner. There is high possibility that poor or old jokes may not be found particularly funny. Depending on topic, some jokes may be perceived as offensive or aggressive. This, on the other hand, is also highly individual, as what seems offensive to one person might be found funny by another.

Therefore, in the nearest future we are planning to modify the humor detection module and add to it what we call a humor evaluation submodule—a system that will be able to assess the quality of users' humor. To do so, we are going to have human evaluators assess existing examples of humorous utterances and use the statistical results in the system.

Another issue linked to the humor assessment is the system's sense of humor. In our research so far we have been focusing on the system's ability to personalize its performance according to users' preferences. However, a question should be asked, whether such system should be able to develop its own original sense of humor, and to what extent should it influence its performance. In the future we are planning to investigate this issue.

4.4 Individualization Module

The individualization module is responsible for the system's ability to adapt to users' personal preferences. It uses the ML-Ask affect analyzer (see Sect. 4.2) to gather data about users' emotive states during conversations. On this basis the module builds each user's individual model of sense of humor. The data acquisition is performed as showed in Table 2.

Table 2 Subjects of affect analysis and data acquired by the individualisation module

Subject of affect analysis	User data acquired
The system's utterance preceding user's humorous utterance User's utterance preceding the system's humorous utterance User's utterance following the system's humorous utterance	Emotive states to which the user tends to react with humor – User's emotive reactions to the system's humorous utterances (humor genre, topic etc.) – User's emotive reaction to the system's humorous utterances generated toward user's particular emotive states

If, for example, the emotiveness analysis module detects that User A's emotive state is <sadness>, the individualization module analyzes his/her humor sense model to check this user's reactions in similar situations that occurred in previous conversations. This entry of humor sense model may look as follows:

User A
emotion changes when told jokes in emotive state <sadness>:

- to positive: 7/10
- to neutral: 2/10
- to negative: 1/10

On this basis, the system decides that it should use humor (i.e. the response should be generated by the humorous response generator), as there is high probability that it will make User A feel better.

User A's reaction to the system's humorous utterance is also analyzed by the ML-Ask affect analyzer, and the output of this analysis is again stored in the humor sense model.

Similar process occurs when users joke. The system's utterance that precedes the joke is analyzed by the individualization module, and the data is stored in the user's humor sense model. For example, if the system's utterance is classified as containing the emotion of "frustration", and the user's reaction to it is recognized as humorous, the individualization module will store this information to use it in further interactions (<tells jokes when partner's emotional state is <frustration>).

This individualization module's algorithm allows the system to "learn" users' humor sense by gathering data during conversations. Such approach, however, has one serious drawback: in order to build such model, the system has to perform numerous conversations, in which it's performance will not be personalized. This means that there is a risk that some users may not be willing to continue the interactions after being told jokes that do not match their sense of humor.

In our previous works [24, 25] we used a simple rule: if user's emotive state was negative or neutral, the system would use humor to make him/her feel better. This rule could also be used as an initial setting of the individualization module. However, in our opinion it is overly general and thus we are currently working on another, statistical approach.

Although humor is a highly individual issue, there are some regularities of its perception depending on receiver's age, sex, education background or social status. Japanese puns (*dajare*), for instance, are often called "old men jokes" (*oyaji gyagu*), which suggests that they are liked the most by males above certain age. Dirty jokes may be preferred by male audience, while more subtle humor could be appreciated more by females. In order to investigate this issue, we are currently conducting a survey, in which we ask participants to assess examples of several types of humor.

The results will be used to set the initial settings of our system. Knowing that, for instance, middle-aged male company workers tend to like jokes on politics, the system will use this knowledge in initial humor sense model of every user

representing this group. Such models will later be modified according to the data acquired for each particular user.

In our research we focus on the role of humor in conversations between the system and users. However, the proposed individualization module can be used also to gather other types of data, such as users' reactions to particular topics of conversation.

5 Conclusion and Future Work

In above sections we briefly presented current development stage of our project, aimed at creating a conversational system that uses humor in an individual manner, to make its human users feel better. This is still an ongoing work, and currently we are focusing on improving its particular modules. In the nearest future we are planning to conduct initial evaluation experiments and use their results in the system's further improvement.

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Human Avatars in Playful and Humorous Environments

Anton Nijholt

Abstract In future smart environments sensors and actuators know about the environment's inhabitants and visitors. This knowledge allows them to predict and suggest activities and behavior and even to take care that certain activities and behavior are enforced on inhabitants and visitors. For example, in a potential dangerous situation a car driver can be alerted, can be given a limited number of choices or the car can take over. Similar environmental behavior, not necessarily involving danger, can happen in domestic, urban and office or other professional environments. Humans have now become part of the Internet of Things. Wearables, clothes, body sensors, smart tattoos and implants allow the environment to monitor a user, but also to guide and steer a user in a way and a direction that suits the environment and those who own or maintain the environment. In this paper we investigate how a smart environment can use its smartness to create funny and humorous situations by suggesting or enforcing particular activities and behavior of its human inhabitants. In order to do so we have to look at how actor behavior and activity is modeled in storytelling research. In this research we have actors, but sometimes also directors or the environment is called upon to act as a smart director. Rather than aiming at efficiency when guiding 'actors' in these environments, we can as well guide human and virtual actors towards situations that are humorous or potentially humorous.

Keywords Smart environments · Sensors · Actuators · Smart technology · Playable cities · Human-computer interaction · Multi-modal interaction · Entertainment technology · Augmented reality · Virtual reality · Game environments

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1 Introduction

Game engines help to develop video games. They offer software tools for rendering graphics, for creating physics, for realizing animations, integrating artificial intelligence and other requirements of software that is needed for the creation of (networked) games. In games we have software sensors and actuators, for example, a collision detection sensor and a collision response actuator. Scripting takes care of confronting the gamers with problems that have to be conquered in order to reach a certain goal. Gamers can be offered different paths and a variety of hurdles, including negotiating about cooperation and having to compete with other players, to reach their goal.

In action and adventure games players can be represented as avatars, embodied, human-like and animated characters. There is not always a need to represent the body. In shooting games the visualization of the gun barrel and its direction is more important than the visualization of the shooter. Often it is 'just' the viewpoint of the gamer that is important and needs to be represented for the game to play. However, even if the body of the gamer is not visualized, it can be subjected to and affected by the designed virtual properties of the environment and its designed virtual physic laws. Even if our body is not visible in the virtual environment it does not mean that our actions and activities do not take into account our physical properties.

There is no way to look away from physical properties of players when we are interested in 'real world' or 'urban game' implementations of videogames. This has been done for some iconic videogames such as (Super) Mario, Pac-Man, Space Invaders, and Quake. These are interesting applications, in particular when they make use of advanced digital and software technology such as virtual, augmented and mixed reality technology. We have players moving around in the real world but their behavior and actions are controlled by decisions that are made by the game environment. In this paper we elaborate on stimulating playful activities and guiding citizens of playful cities towards playful activities.

We investigate how a smart environment can use its smartness to create playful and humorous situations by suggesting or enforcing particular activities and behavior of its human inhabitants. In Sect. 2 we survey examples of videogames that have found real-life implementations. Some observations on narratives in theme parks and city environments are included. In Sect. 3 we shortly discuss how technology enforces humans to become nodes in the Internet of Things (IoT). In the IoT they are subjected to expectations about their behavior, subjected to persuasion, and subjected to rules that apply to their routine activities (activities of daily living such as eating, bathing, dressing) and professional or recreational activities. Actor behavior and activity is also modeled in storytelling research. In this research, discussed in Sect. 4, we have actors, but sometimes also directors or the environment is called upon to act as a smart director. In particular we look at attempts to model human behavior in such a way that things go wrong, leading to humorous situations. That is, rather than aiming at efficiency when guiding, advising and persuading 'actors' in these environments, we can as well guide human and virtual

actors towards situations that are humorous or potentially humorous. Finally, in Sect. 5, we have some preliminary observations and conclusions how to integrate these viewpoints in future research.

2 Moving Avatars from Videogames into the Real World

We mention some early examples of games that have moved outside the monitor and into the real world, whether it is an indoor location or an outdoor urban environment. Augmented Reality Quake was introduced in 2000 [1]. It is a first-person shooter game using GPS and various sensors and a laptop carried in a backpack. It is claimed to be the first augmented reality game for outdoor use. ARQuake has only one player. A more elaborate real-life version of a videogame requiring multiple players is Human Pac-man [2]. It has teams of interacting players (Ghosts and Pacmen), equipped with head mounted displays, wearable computers, GPS and inertia sensors, and they are wirelessly connected with remote helpers. Physical cookies with embedded Bluetooth devices can be collected by the players, similar to what can be done in the videogame. Players can swap from the augmented reality view to a linked and continuously updated full virtuality view of the Pac-world. We mention these examples because they make clear that in smart environments, that is, digitally enhanced physical environments, patterns of activity, stereotypical behavior and suggestions provided by others who have access to sensors and can control actuators, can guide and persuade inhabitants of smart environments to desired behavior or activity in situations that are created for that purpose. Our interest, also becoming clear from the next sections, is in investigating how facilities of smart environments can help in creating situations that are humorous.

In videogames we have the possibility to introduce game elements that cannot be realized in real life versions of these games or that are not meant to be realized in real life. Obviously, people can get inspired by games to perform actions in real life that are not appreciated by others. In movie versions of games, for example Lara Croft: Tomb Raider featuring Angelina Jolie and released in 2001, we can get closer to the videogame versions on which they are based. But generally we have to make concessions when moving a game from a monitor to a real-life environment or an augmented reality environment. These concessions concern not being allowed to walk around in an urban environment and shoot at whoever is a threat to your goals or not being allowed to steal cars. They also concern the impossibility to transfer certain science fiction visions and technology to the real world. In real life we don't navigate a spaceship, drive a F1 car, let alone that we have more than one life, can recover from deadly injuries, or are able to fight with ghosts or zombies. And we don't have the possibility to use Portal-like guns to shoot holes in places so that we can 'teleport' ourselves from one place to the other.

In more recent years we see other attempts to realize videogame behavior, situations and effects in real life. Usually they are limited to one particular scene or activity, or have physical implementations of virtual weapons. Some examples are

the illusion of setting opponents ablaze in a real life version of Street Fighter II, games that inflict real pain by electrical shocks, and real escape rooms. But often they realize just one or a few aspects of a videogame and do not implement a game's narrative.

Some videogame elements cannot be copied in real life, but gamers are sometimes happy to produce video clips in which they fake they can use Portal guns to create portals that allow them to pass through one portal and then emerge from another. Such activities cannot be implemented in a straightforward way in real life. However, using sensors and actuators (real, augmented and virtual reality display and interaction facilities), it is not impossible to create ambiguities and illusions in smart environments that come close to the real-life impossibilities that are accepted by gamers and that are believable in a videogame context. Not only in theme parks we can have narratives in which illusions and other special effects can be embedded, but also cities tell stories and allow narratives in which we can embed incongruities and illusions [3, 4].

3 Humans as Avatar Nodes in a Playful Internet of Things

Nowadays we see sensors and actuators exploited everywhere. It is not yet the case that we have a fully implemented Internet of Things, where we not only have 'things' that are part of the network, but also human beings that have sensors and actuators embedded in their skin and body, on their body, weaved in their clothes, in their pockets or part of other wearables. Sensors may monitor, predict and anticipate our activities. They provide actuators, whether they are on our body, in our wearables or embedded in the environment, with information that allows them to provide relevant feedback. This feedback may be explicit (consisting of an answer to a question or the execution of a command with immediate response to a user), or implicit (make changes to the environment or updating a user's preferences).

Humans become nodes in the Internet of Things. They are tracked and monitored in all their activities by their wearable and bodily position, motion and physiological sensors. Moreover, because of knowledge about the context, knowledge about activities of daily living, common-sense knowledge about human behavior, an individual's history, preferences and characteristics that have been learned from previously monitored behavior, activities and behavior of these mobile human nodes can be predicted and anticipated. It is also the case that, as we surveyed earlier [5], there are situations that only require 'thin slices of behavior' monitoring in order to make decisions about the personality of a user and use this information in interpreting and predicting his or her behavior.

In smart environments or in the Internet of Things we can assign different roles to human inhabitants, controllers and owners of such environments. In this paper we are interested in the role they can play to make such environments more playful and whether they can manipulate sensors and actuators in such a way that they help to increase playfulness and playability and maybe even help to create humorous

situations. In this context we look at the various ways humans can be involved in creating playability and humority, and experiencing playful and humorous situations. Clearly, the question is, who is in control of sensors and actuators. We distinguish three relevant views.

The environment can be offered as is, defining activities and interactivities that are allowed and supported. It can persuade or enforce the user to do things in a way the environment prefers or requires in order to be able to support the user or to satisfy those who maintain, control and own the environment. It does not mean that the user cannot blunder or led into a situation that is playful or humorous. The environment and its control of the user's artificial and natural sensors can be responsible for that. In entertainment and recreational situations it is quite acceptable to confront the visitor with confusing and contradicting information, wrong directions, perceptual illusions, or incongruities. It should be mentioned that in such an environment users usually have control over their own wearables, can use them to interact with each other, have them display information about themselves or use them to cheat or persuade others, for example for playing a prank on someone.

The environment allows the user some control over its sensors and actuators. In a limited way, you can physically and virtually reconfigure your home automation devices (light control, thermostats, smoke alarms, heating, audiovisual equipment, energy monitoring, et cetera). Such possibilities can also be offered, maybe for special events, in office or public spaces. Communities can be allowed to reconfigure or redesign networks or they can decide themselves, fitting in the DIY, Hacking, and Maker Movement to design their own networks, including networks that allow real-time changes in sensor and actuator configurations. Especially in the latter case there is the possibility to play with sensors and actuators embedded in the urban environment in interaction with the wearables users own and control themselves.

The third view builds on Constant Nieuwenhuys *New Babylon* vision [6]. In the 'Ludic Society' envisioned by Constant humans are freed by automation from productive work and can follow their need for playing and constantly transforming their environments according to these needs. Constant assumes movable assembly systems, technical devices for controlling climatic conditions (light, temperature, ventilation) that are accessible to everybody, and similarly the use of audiovisual media:

> The audiovisual media will be used in the same spirit. The fluctuating world of the sectors [the basic construction element] calls on facilities (a transmitting and receiving network) that are both decentralized and public. Given the participation of a large number of people in the transmission and reception of images and sounds, perfected telecommunications become an important factor in ludic social behavior.

And, this is what Constant says about the members of this Ludic Society:

> They wander through the sectors of New Babylon seeking new experiences, as yet unknown ambiances. Without the passivity of tourists, but fully aware of the power they have to act upon the world, to transform it, recreate it. They dispose of a whole arsenal of technical implements for doing this, thanks to which they can make the desired changes without delay.

Being able to play with the elements that make up the environment is the important message, where the environmental elements refer to architectural elements, elements defining the quality of space and psychological elements (effects on behavior and communication). One can discern visual, sonorous, tactile, olfactory and gustatory aspects of elements.

In Constant's view transforming the environmental elements is decided upon and performed by the human members of the society. Nowadays we can add the possibility to have the environment itself to decide upon changes based on preferences and needs of the stakeholders of smart environments. Apart from, let's say, traditional digitally controlled sensors and actuators embedded in our environments, its buildings and (street) furniture [7], its tangibles and robotic devices, we can now look at employing smart materials that change appearance and other properties due to changes in their environment and we can especially look at research on robotic or animate architecture, including DIY architecture, that addresses the architectural elements mentioned by Constant. But clearly, in a way that goes many steps further than envisioned by him. This human, hardware and software controlled robotic architecture will allow users to make changes to their or others physical living and playing environment, increasing the playability of these environments. Moreover, smartness embedded in robotic architecture makes autonomous decision making about architectural reconfigurations of living environments possible [8].

In the previous section we looked at attempts to move videogames into the real world. In these attempts we see that game situations and game narratives are transformed to real world situations and narratives. Players in the real world have to follow the videogame rules. These rules maybe slightly different because in the real world, although it can be augmented with virtual reality displays, Bluetooth devices, laptops, GPS and other sensors, we cannot realize the same audiovisual effects that are possible in fully controlled videogames. In [9] we discussed how mischief behavior in videogames can be expected to emerge in game-like smart environments. Here, in the current section we looked at opportunities to play with and play in digitally enhanced physical environments (home, office, public spaces, urban environments) by giving users control over sensors and actuators.

4 Learning from Controlling Embodied Actors

In this section we will return to playful artificial environments, but with the aim to see how we can control the behavior and activities of embodied characters by providing characters and environments with artificial intelligence. Ultimately the aim is to see whether we can translate knowledge of control possibilities to knowledge that helps us to design smart environments in which sensors and actuators help us to guide inhabitants (guests, visitors) into situations that can be considered playful and humorous. Clearly, there is some kind of contradiction here. On the one hand we want to make characters more autonomous (more human-like), on the other hand we aim to understand how we can introduce conditions that

increase the chance that their behavior leads to—usually unintended—humorous situations.

4.1 Virtual Actors in Storytelling, Games and Smart Environments

In storytelling environments we have interacting virtual characters that usually have certain knowledge of the environment, have goals and a limited form of reasoning (choose plans) to achieve these goals. In addition to this intelligence characters can have a personality and an emotion model that both can have effect on actions to be chosen and the way these actions are performed. Interaction with other characters, including a human actor that plays a role in the story, and 'external' events may lead to the development of a believable storyline. Emerging stories can be visualized in an interactive virtual world that allows interactions with one or more human actors, where a human actor is either visualized as a fully embodied character in the virtual world, or represented by a camera-like view on the environment, its characters and events. Obviously, this is not really different from what we see in MMORPG's or in FPS games, except that in these games we usually have a single-minded role-playing character and opponents (non-playing characters) that have 'canned' behavior, or the emphasis is on human actors represented in opposing teams that can use human intelligence and emotions to decide about actions in the virtual (videogame) environment.

In training environments there has been research on how to plan activities of a virtual agent in order to get certain virtual tasks done. This research involves the movements of a virtual character that are needed to get a certain task done and to show how to perform this task (see [10] for an early example), modelling the verbal and nonverbal communication between characters in a visualized environment [11], the planning and execution of a sequence of activities (including walking, opening doors, picking up objects, et cetera) [12]. This research is useful in making serious gaming (training) environments more realistic. In entertainment game research there are also attempts to provide the virtual non-playing characters with intelligence, emotions, communicative capabilities and autonomy. That is, making it possible for them to assess situations and act in human-like ways. Research on intelligent agents, emotional agents and embodied conversational agents is becoming part of game research. In (serious) game and storytelling research we see also attempts to give a 'director' role to a mediator who is able to assign roles to participants, who can guide their actions and who can introduce new events in the environment and make changes in the narrative.

In smart public spaces we will also meet these agents. They assist us on our mobile and other wearable devices and they will appear on public displays, in tangibles, as holograms or as physical social robots. Humorous interactions and humorous cooperation will be possible with devices that have human-like

characteristics (appearance, intelligence, emotions, sense of humor). Also here we can consider the possibility of introducing a 'director' who mediates between the human and artificial agents in the smart environment, assigning them roles and guiding them into particular situations and activities. Such a 'director' role can also be given or taken by someone who has access to the sensors and actuators, whether embedded in the environment, its devices, its human-like artificial characters or in wearables owned by the humans present in the environment.

4.2 Providing Actors with Plans and Reasoning

We shortly survey some research in game and storytelling environments that addresses the modelling of action planning and reasoning for agents in smart environments, where planning and reasoning aim at creating humorous situations. And, moreover, as is discussed in this literature, it should be possible to give a human player or someone monitoring the game some responsibility for guiding others into some preferred behavior and involvement in activities. As mentioned in [13] when we want interesting behavior we need planning mechanisms and models that not necessarily aim at rational and optimal problem solving behavior. A smart environment can try to understand and affect human behavior using such models, for example with the aim of creating humorous situations. Similarly, a smart environment can use such models to affect or direct the behavior of 'autonomous' agents, tangibles, and other devices that inhabit the smart environment, whether they are human or artificial. And, of course, tools based on such models and mechanisms can be used by smart city dwellers, including pranksters and mischief makers, to control and personalize their part of the smart world. And this may include cheating and hacking.

In [14] Cavazza and co-authors introduce planning mechanisms that allow agents to continue following their aims despite that certain preconditions are not fulfilled. In their research an attempt is made to visualize the failure of the continuation of regular behavior or adhering to the narrative in the hope that a corresponding animation of the situation will be comic. Hence, failing plans need to be considered as a dramatic mechanism. When translating these ideas to playable cities, as human city dwellers we can participate, initiate and 'just' be observers of humor creation caused by activities that fail. In [15] heuristic search planning (HSP) techniques are used to 'control' the characters in a 'Pink Panther' script. Script writing, narrative control and role authoring are issues that need to be considered when embedding action failure and its dramatic visualization in a game narrative or in a smart environment narrative in which we want to include humor. From a humor research point of view a comic act of (action) failing usually can be explained using viewpoints from superiority and incongruities theories of humor [16].

Carvallo et al. [17] also look at modelling the behavior of agents that act in a storytelling context, but in addition to action failures they look at incongruities that emerge with expected (pre-determined) behavior and personality of an agent.

Personality aspects in their architecture follow the well-known OCC model [18]. This allows them to introduce characters in a narrative that behave differently from regular characters. Again, as in the Cavazza et al. paper [15], this research provides us with handles to create humorous situations in smart environments. We can model the behavior of artificial agents (representing smart environments, intelligent displays, tangibles, social robots, virtual agents, et cetera) in attempts to generate humor or potentially humorous situations, but with the help of these models we can also embed real-time human behavior in these models—where the humans are agents in the smart environment—and where the models help to predict and anticipate human behavior and embed it in the smart environment. And, as is the aim of this paper, the models also help to introduce humor or potentially humorous situations in smart environments.

A third example we want to mention here is research reported in Olsen and Mateas [19]. In this research we have a game environment that resembles a Wile E Coyote and Road Runner cartoon. So we have characters (the Coyote and the Road Runner) with particular goals and a game engine that is fed by a planning mechanism in order to make decisions about the characters' actions. Usually Coyote needs objects to reach his goal (to catch Road Runner). 'Gag plans' can interfere with Coyote's plans. The player or gamer in this game environment can direct the story by the manipulation of objects in this world. For example, he or she can decide to make certain objects with variable attributes available to Coyote. Entering a 'gag' plan with, for example a rocket that will explode, will result in a failure of the original plan (to catch Road Runner). Planning to generate Mr. Bean-like sketches is discussed in [20].

We think that these research examples nicely illustrate how future smart environments can model and guide the behavior of artificial agents and their human partners. The smart environment can offer opportunities that seem attractive and are expected to suit the goals of a human participant, but will nevertheless cause failure of his or her plans. This may lead to a humorous event. It can also be the case that someone (player, gamer, hacker, mischief maker) has control of the environment and can make changes to it in order to create humorous events in which human and artificial agents are involved, because we can model their behavior, predict and anticipate their behavior, and, probably most of all, can provide them with plans and reasoning that leads them into humorous situations.

5 Discussion and Conclusions

In this paper we discussed various developments in research on human and agents representing humans in virtual, videogame, digital storytelling and smart environments in general. The aim was to see how the different approaches and results can

possibly converge into research that attempts to find ways to create humorous situations in smart environments such as, for example, playable cities.

First we looked at some early attempts to transform videogames into real life games using real life sensors and actuators. Rather than being an urban game that can be played by getting messages on the screen of a smartphone, these games were designed in such a way that the players became immersed in a visual augmented reality view of the physical play environments.

In our second viewpoint we considered possibilities for inhabitants of smart environments to control, configure and design networks of sensors and actuators. Sensors and actuators are embedded in wearables. In this way we can also assume the control of human activity in smart environments, not only by wearables, but also by the environment and its devices itself. This allows us to look at smart environments as game environments with behavior of role playing and non-playing characters. It also provides us with ways to configure an environment and to lead inhabitants or visitors of such an environment into playful or humorous situations and activities. In addition, robotic architecture allows for changes in form and dimensions of smart environments. Human behavior in these environments can be predicted and anticipated and we have the possibility to let unexpected and incongruous events happen. Rather than having game engine tools to design videogames we can introduce general or domain specific game engine tools to design a narrative and voluntary or involuntary 'player' involvement in smart domestic and public spaces.

With our third viewpoint we looked at research on virtual storytelling that aims at creating humorous situations in storytelling environments. The behavior of the virtual actors in these environments is dependent on their knowledge and their goals and preferences. There can be conflicts with other actors and there can be events beyond their control that require them to re-plan how to reach their goal and to make new sub-plans in order to deal with an unexpected hurdle. Hence, there is goal-directed autonomous behavior, but at the same time the environment, someone having control of the environment, or other actors with their own goals can disrupt this goal-directed behavior. To let an actor become the butt of a visual joke can be a goal of an environment, a human mediator or some other actors that participate in the story.

We conclude that the introduction of digital technology in physical environments makes it possible to view and control human behavior in a similar way as we can view and control human and avatar behavior in videogame and storytelling environments. This can be done by controlling sensors and actuators, reconfigure, design and redesign networks, use them to lead the human nodes, voluntarily or involuntarily (that is, not being aware of) towards situations and activity that are unusual, unexpected and humorous. Controlling these human nodes in the network can be done by letting them operate in a context of plans and reasoning where they are not necessarily aware of.

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Designing a Humorous Workplace: Improving and Retaining Employee's Happiness

Marvin Andujar, Anton Nijholt and Juan E. Gilbert

Abstract In this paper, we discuss the possibilities of adapting humorous smart technologies to the workplace. Also, we discuss the precautions that need to be taken when introducing the theories of humor. We explore adapting the theories of humor and the pros and cons of integrating it in the workplace. We believe the adaptation of this technology will help current and future employees at companies to improve and retain their happiness. We also provide a brief explanation of the different types of humorous technologies: mobile, physical, and virtual and how they can be beneficial in the workplace. Suggestions of how to evaluate these systems are also provided.

Keywords Humorous workplace · Computational humor · User experience · Human-computer interaction · Humorous smart technologies

1 Introduction

The workplace can be considered a person's second home. People spend at least 8 h a day performing several work and non-work related tasks. In many cases, a lot of people spend more time at work than at home for various personal reasons. This requires the workplace to have good amenities for comfort to keep their employees happy and comfortable. For example, Google let their employees bring their dogs to

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work. They understand people treat their dogs as family and they would feel at home if they bring their "family" with them. The company also contains sleeping pods, laundry free of charge, free food, game rooms, and other amenities that allow their employees to keep a positive attitude or emotional state. So, if amenities that facilitate the employee's life may contribute towards their happiness, why is there an absence of humorous smart technologies in workplace offices? Humorous technologies can contribute towards the employee's happiness.

The workplace can be a tedious and stressful place where negative interactions with other employees could hinder the outcome of projects. Specially, disagreement among colleagues causes disengagement, which can lead to under-performance from the employees [1]. It is also known that people use humor to deal with difficult and negative situations [2]. Therefore, in this paper we discuss and propose the idea of adapting humorous smart technologies to improve and retain a positive emotional state of employees in the workplace. In this paper, we define humorous smart technologies as a technology that supports users' interaction for the purpose amusement. We also discuss the amount of incongruities the workplace should contain. Too much incongruity may let people perceive the workplace lacks professionalism. Incongruous humor has to be controlled and monitored in the workplace as it is a professional place and incongruity could express unprofessionalism, which may lead towards violation of human resources regulations. We believe that the workplace can benefit from humorous interaction to keep their employees engaged and happy for better productivity. This concept is similar to the concept of humorous interaction for playable cities [3]. The author provided examples of existing entertaining ways to have a better user experience while performing daily activities in the city. Some of these presented experiences may be implemented in the workforce and others may emerge to better fit the given environment, in this case the workplace.

2 Humorous Smart Technologies

Humorous smart technologies are either physical, virtual, or mobile representation of humorous content for the purpose to provide playable, fun, and humorous experiences to the users. These technologies often contain Artificial Intelligence algorithms, which provide the "smart" aspect of the technology. In the following sub-sections, we provide a brief background to the three types of humorous smart technologies, which gives a more detailed explanation of what these technologies consist of.

2.1 Physical Humorous Smart Technologies

A physical smart technology can be defined as a physical representation of humorous content where the user interacts with the content for the purpose of amusement. These technologies can require the user to use their whole body or certain part of it. Also, it can take form of a physical robot programmed to provide jokes to the users.

A good example of a physical humorous smart technology is the piano stairs in Stockholm [3]. The users are able to make piano sounds once they step on the piano stair keys. They are able to create a song while they jump or run up and down the staircase. The piano provides two combinations of enjoyment: fitness and music. It is known that many people enjoy doing exercises for their health. They feel relieved and stress free. Music can relax and at the same time provide a feeling of enjoyment to the user. Therefore, the piano provides two types of enjoyment to the user, which may provide more enjoyment to the user compared to other physical technologies that provide one type of enjoyment.

Another good example is the talking postbox [3]. The users are able to talk to a postbox once they are about to drop their letters to be sent to someone else. In this case, the user interaction is verbal, but the postbox is physical and not a virtual environment. Unlike the piano, this does not require the user to perform any muscle movement. The user may be able to ask the postbox when the mail will be picked up to be delivered. On the other hand, the postbox can tell some jokes to the user that may enlighten someone's mood. The postbox can also recall some exchange with previous visitors, tell something or ask something about its environment. In an office environment, the workplace can have coffee machines or bulletin boards that operate in similar ways.

There also exist humorous products that are not necessarily technologies. These products take form of objects that people would use in a daily basis. The bearded beanie is a winter hat with a beard. Therefore, when a person wears the hat, the person looks like they have a beard on as well [4]. These types of products are not necessarily technologies. However, these can serve as a model to incorporate them as a form of technology. They can contain Internet of Things (IoT) capabilities that allow the humorous aspect of the object reach the users like it never did before.

2.2 Virtual Humorous Smart Technologies

Virtual humorous smart technologies take many different forms such as: video games, virtual agents, simulated robots, videos, and others. A virtual humorous smart technology is considered as such when it involves a user interaction with a digital technology for the purpose of amusement. Virtual technologies have already been adapted in places like the city as described by Nijholt [3].

Video games are good examples of virtual humorous smart technologies. Their AI makes them smart and the content in the story makes it humorous, fun and enjoyable. The game Grand Theft Auto (GTA) is a massive game that contains a lot of AI obstacles or components and at the same time contains a lot of incongruous jokes, hence it is rated for mature audiences. We think one of the best parts of GTA is that the jokes can be related to real life and of a movie; it is safe to say is combination of both worlds. Nijholt also discusses on how video games have been implemented to reflect the real world, but digitally [5]. He discusses how game designers do not necessarily use humor techniques to incorporate humor into a video game, however the users recognize it.

Videos can be also considered humorous virtual technologies. There are different types of videos: animation, movies, and fan made videos. Animations, specifically anime made from Japan contain a lot of incongruous jokes. They are usually based on high school kids going through the different stages of a teenager. These stages can include a lot of incongruous jokes and events. The realistic aspect that the story takes in a school provide that sense of relationship with the viewer and the provided jokes can add to their amusement. The best about videos is that they the video makers understand what make the viewers laugh and enjoy the sequence of pictures. Although, these are not necessarily smart from the technology part, it is still smart from the maker's perspective. There are also videos that exist in YouTube that are fan made. The purpose of these videos are to demonstrate how people react in different situations, but in a humorous perspective. These bring a lot of joy to the users, because many of them can relate to the situation and once they see it from a funny perspective, it brings joy and a lot of fun.

2.3 Mobile Humorous Smart Technologies

Mobile humorous smart technologies can be classified as on the go devices that can take the form of a cell phones, tablets, or wearables that allow the user have humorous experiences in different locations. The piano staircase and the postbox are not considered mobile, because they are not mobile, but stationary. They can only be experienced at the exact location where they were mounted/built. Video games in tablets and mobile phones can be mobile humorous technologies. It is a combination of both virtual and mobile. Games like Clash of Clans can only be played in a mobile device, can be humorous. Although, it is a very competitive game, it provides humor to users when another gamer attack their base and the gamer AI do something awkward that make them lose, so the user ends up winning. Clash of Clans is a mobile strategy game where gamers build their village and train soldiers to attack other villages to steal their gold and resources.

Wearables can be designed humorously. The bearded beanie can be transformed to a wearable computer. It can be added lights that form face expressions on the beard that can change with the facial movements of the user. It can also be customized through the mobile application for color use or even the type of expression the user would like to express at the moment.

3 A Humorous Workplace

3.1 What Can Be Considered a Humorous Workplace?

A workplace can be considered humorous when it contains humorous smart technologies or humorous non-technologies with a main purpose to provide recreation and enjoyment for the employees. The employees interact with these physical,

virtual, or mobile technologies to laugh or improve their current mood. Some companies already provide some humorous infrastructure in their offices, like Google. They have a slide that allows employees to go from the second floor to the first floor without taking the stairs. This humorous infrastructure provides employees a physical enjoyment that is reflected in their mood; this also provides them a remembrance of their youth, which can many times be a positive enjoyment. Most of the companies also provide game rooms that have billiards, table tennis, and sometimes even bowling. This games allow employees to relax and share an activity with their colleagues. During gameplay, they share funny moments in their life and laugh during gameplay. However, these games provide a limitation that not everyone plays those games and this can vary per person unique experiences or cultures. This leads to a handful amount of people still not experiencing humorous experiences at their jobs.

The applicability of humorous smart technologies into the workplace can include those that do not take advantage of the offered usual game facilities. In this case, they are able to interact with technologies that can benefit their physical and mental wellbeing.

3.2 Incongruity in the Workplace

The workplace is known to be a physical location where a group of people go to work on various projects for the benefit of the company. A lot of serious projects and discussions in meetings happen on a daily basis at that specific location. Therefore, introducing humorous technologies to the workplace should be carefully explored prior to implementation, specially when it contains incongruity. The theory of incongruity articulates that people laugh because something seems inappropriate [6]. This is a very familiar way of people enjoying their time by laughing at what are considered inappropriate comments or jokes. The classification of a joke containing incongruity varies per culture. Therefore, the question we face is how much incongruity is appropriate for the workplace? If the workplace is considered a serious and professional place, does incongruity add unprofessionalism? If there are ways to keep the professionalism and have incongruity, how can they be implemented? These are questions that researchers may need to address through investigation to see what fits best. Also, if incongruity content within a joke varies per culture and the workplace has people from all over the world, how can this be controlled or shown to specific people? Let's consider having a projector that projects a mini game to the floor similarly how some shopping malls have for children to play. In this case, it would be in the workplace for employees enjoy themselves. Now, the game contains certain jokes for those of who lose in the game and the joke includes incongruity. The person may take it as a joke, but another person from another culture or even gender may feel insulted [7]. Perhaps, adapting

methods from computer vision and machine learning to these technologies may allow the technology to identify the set of jokes that would fit best with that particular person.

3.3 Relief Theory in the Workplace

Freud refers to the relief theory *as the description of humor as a necessary means to release frustration originating in unpleasant experiences or social and sexual taboos* [8]. As aforementioned, employees in the workplace experience a lot of frustration and stress for several reasons. It can be that they had a non-productive meeting and one of the members or managers were really mean to him/her. They can also be behind in their task when their deadline is approaching quickly. All of these situations can build up a lot of frustration at once, which may cause poor mental health, poor work performance, and disengagement. Therefore, introducing humorous smart technologies that offer relief humor may be useful for their well-being. However, just providing these technologies that offer relief may not be enough. They would have to be offered at an appropriate time. For example, companies perform in a quarterly basis, incorporated of four quarters, each quarter last three months. By the end of specific quarters, employees have to deliver certain deliverables or in some cases called required action (RAs). Providing the relief humorous content within the smart technologies at the time the quarterly is about to end may be appropriate.

3.4 The Theory of Superiority or Disparagement in the Workplace

Employees in the workplace may already experience some sort of superiority or disparagement joke in a daily or weekly basis. In this case, the joke can come from their managers, but in other cases are actually serious statements more than a joke. The theory of superiority or disparagement was mentioned in the humor text book by [9], but initially introduced by Plato, Aristotle, and Hobbes. *It assumes that people laugh at the misfortune or inferior position of others*. The question that we face is, are these appropriate humorous content that a technology in the workplace should contain? Assuming that employees already experience this at their workplace at some level, would introducing more jokes about the inferior, even if it is not directly correlated to them, may contribute towards more disengagement? Introducing this theory into the workplace may contribute towards some negative experiences instead of a positive one. The experience of course may vary by person and by what they are experiencing on that day or week. The implementation of this

theory should be explored further and longer than the other theories to achieve the most appropriate implementation. This may need to be adapted based in the specific culture of the company and its population.

3.5 Knowledge-Based Humor in the Workplace

The knowledge-based humor is not categorized as a theory, but as a type of humor. It requires the user to have some knowledge in an area in order to understand the joke [10]. The following jokes require some knowledge in a field to get the amusement behind it:

- "It's as easy as 01 10 11."
- "Why do programmers always get Christmas and Halloween mixed up? Because DEC 25 = OCT 31."

These jokes require some Computer Science knowledge for the user to understand. In a technology workplace like Google, Intel, and Facebook, their employees would be able to understand these jokes and get humor out of it. Other employees in other areas like Business may not get the joke, because they do not understand it. This is when non-knowledge base humor is needed.

We think the knowledge-base humor can be a good content for the humorous technologies in technological workplaces. They can also be adapted in other type of businesses, but the aforementioned jokes are restricted to those in the Information Technology (IT) department as they would be the one to "get" the jokes. Of course, it is good to have in mind that other disciplines like law, history, and others have their unique knowledge-base jokes similarly to computing.

4 Humorous Smart Technologies Within the Workplace?

Humorous smart technologies can take different sizes and forms. It is important to identify key locations within the workplace where these humorous technologies can be located. Having a robot in the cafeteria telling jokes might not be ideal due to the amount of noise happening in that location. Although, there is work done addressing the issue of utilizing robots in noisy environments [11]. Therefore, having a robot in a break room or even in the game room can be beneficial. In the case of a musical piano, this should not be placed close to meeting rooms and cubicles, because it could irritate those who are working. Therefore, it should be placed close to a laundry room or even cafeteria. These may be places where people may not be working often.

It is more difficult to place humorous technologies in the workplace than in a city or home, because it may bring interference and annoyance to others who are

performing job-related tasks. Therefore, it is essential to understand each specific company architecture and work culture to determine where specific technologies may be placed. Some companies may prefer to have a piano stair close to the cafeteria and others may have them far away from it. As jokes are depended on cultures, placement of these technologies are also determined by the company culture instead of country.

5 Humorous Robots in the Workplace

We believe robots in the form of humanoid or drones can be a good adaptation for the workplace. Robots can be considered both physical and mobile. Robots like the humanoid Nao, created by Aldebaran, can be ideal for telling jokes to employees in cafeterias or other break areas Specialized rooms could also be used for joke telling. These areas could consist of multiple robots that recognize voice and gesture communication.

The field of Human-Robot Interaction (HRI) has started to look to investigate the uses of disparaging and non-disparaging jokes [12]. The authors applied the theory of incongruity in comparing humans and robots saying the same type of jokes. They found that their participants perceived non-disparaging jokes to be more humorous when it was performed by a human. However, they showed less disgust toward disparaging jokes when they were performed by the robot. They proclaim that humor can be an effective way to enhance the human-robot interaction, but the types of jokes have to be carefully selected for the robot. This is a good example that current humanoids can be good for amusement, but certain types of jokes do not apply to them.

There is other research in using social robots to recognize or produce jokes or humorous statements in a conversation [13].

6 Digital Memes in the Workplace

Memes have shown to be a very effective way to provide humor to something serious. Coleman defined online memes as images, videos or catchphrases that are modified by users for the purpose of entertaining audiences [14]. Researchers from Carnegie Mellon and Microsoft Research came up with a computer-aided humor chat system named CAHOOTS that provides humor to conversations. The users are suggested humorous images to respond questions asked by the other users. The pictures are in form of memes [15]. The authors compared CAHOOTS with a plain chat and found that people found the author's chat system more fun and allow them to express their sense of humor more.

Recently, it seems that meme is an effective way to provide humor to audiences. Users use and access different types of memes through various social media. Specially, when special events happen, users obtain the pictures of those precise moments and create various memes. For example, in the Oscars 2016, the comedian and Oscars host Chris Rock's daughters were selling girls scouts cookies at the event. The camera caught the famous Oscar actor winner Leonardo DiCaprio opening one of the boxes with an amused face. Users created several memes regarding the actor opening the box of cookies with a lot of excitement, saying he would prefer the cookies over the Oscar.

In the workplace, memes can be really entertaining. Let's say having on the wall small monitors showcasing the meme of the day can provide amusement to the worker. It has to be the right meme illustration. A meme related to the Oscars may not reach a lot of people's amusement, however something related to work can reach a wide variety of employees. From a mobile point of view, the meme can be seen from the internal company's website that serves as a central hub for news about the company. The illustration can be the first thing an employee sees when they get to their desks instead of a negative e-mail. The meme can be chosen randomly from the internet (as long as it is associated with work) or generated for the purpose to associate it to the specific company.

Another form of humorous illustrations are comics. PhD comics are famous humorous comics regarding obtaining the doctoral degree and after becoming a professor. The students and faculty can relate to the comics and find it amusing, because they have experienced it. There are also memes related to education and not necessarily comics. These also show realistic scenarios that students experience (not necessarily PhDs) from a humorous perspective. The workforce can also apply digital comics, where it takes real life work situations and explain it from a humorous point of view. This can provide pleasure to the employee's wellbeing where they may commence their day in a happy state.

7 Evaluation of Humorous Technologies Effectiveness in the Workplace

One of the biggest challenges is to understand the effectiveness these technologies would have in the workplace. As previously mentioned, jokes and humorous moments varies per culture. This also means that some humorous content can be offensive towards some people. Some questions we face are, how much amusement do these technologies provide to the employees? Do they get boring through time? How can we improve and retain employee's happiness, so they would keep themselves engaged at work? These questions should be addressed through evaluating these technologies through user studies or focus groups. In the case, a repository of memes related to work are displayed in several TVs for people to read

and laugh, we should understand, which memes were more amusing and the time they were accessed. These can be evaluated in different ways:

- Provide a physiological wearable device (skin conductance, heart rate, wearable electroencephalographic device) to employees to understand their emotional state when they interact with these humorous technologies. This method can be quite expensive and difficult to implement to obtain a big amount of data.
- Provide a list of emoticons showcasing different emotions at the bottom of each humorous content to receive feedback from the user on how humorous it was. This would be instantaneous and it could be one of the most accurate feedbacks we can obtain from users.
- Incorporate laughter and smiling recognition within the technology.
- Administer a survey certain amount of time to understand how these technologies are affecting people's emotions. Through this method some users may not complete the survey in a timely manner and they may not recall their experience very well the longer they wait to complete the survey.
- Incorporate a camera within the system to obtain the emotional expressions from the user's face.

The evolution of the content of these technologies is essential to keep the users interested to interact with them. Therefore, learning about the use experience with these technologies may help us understand more on how to adapt them in the workplace better and keep improving and retaining their positive emotional state. Principles from Affective Computing (AC) can also be adapted to understanding the effectiveness of colors and shapes used in the physical, virtual, and mobile technologies, if any. As AC deals with the understanding of how people feel when they interact with different technologies, their principles and theories can be useful to understand the experiences with these humorous computers.

8 Conclusion

In this paper, we discussed the possibility and benefits of adapting humorous smart technologies to the workplace. We believe that the adaptation of these technologies can be beneficial for the retention and improvement of employees' positive emotional state. However, these adaptations need to be carefully explored when including incongruity, relief, and superiority humor. Further, we believe robots are advanced enough to perform basic smart jokes or humorously interact with the employee. These technologies may also be useful to be adapted in a smart city, home or building. In the future, virtual robots or agents can be well adapted for humorous interaction in self-driving autonomous cars as well by considering the aforementioned humor theories and the precautions that need to be taken. Lastly, we provide suggestions of how these technologies can be evaluated in the workplace for constant improvement.

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The Analysis of the Impact on the Interface Design for Mobile Device in Relation with Brand Preference

Bongkeum Jeong, Seung-In Kim and Sanghee Hah

ABSTRACT To a Graphical User Interface (GUI) designer, typeface design used to mean creating text that would deliver information to users in the most effective way. In typography, however, moveable type has evolved beyond being a simple means to deliver messages. In fact, typefaces must now accommodate individual users' preferences and tastes by also serving as an image information system. An interface that can satisfy the basic needs for reading and also provide aesthetic pleasure is now available through typography. Typography transforms the interior system of language into a visual imagery system. Additionally, future adoption of kinetic typography within GUIs will enable interaction with users and set a new stage for the evolution of operating systems. In other words, the interface is considered a living being that evolves alongside mobile devices as a computer application. The objective of this study is twofold. First, we examine the role of typography in the process of configuring user identity and interactive interface design strategies that provide users with a pleasurable experience. We define *brand involvement* as a variable that may affect typography preferences. We suggest incorporating a verification process in the GUI that allows experimentation with various user preferences. Second, this study attempts to examine the problem of distortion, which occurs when trying to evaluate users' emotional needs concerning device preferences, and the association between evaluation processes and changes in user preferences. To meet these objectives, the concept of *brand involvement* is used as an important measurement parameter.

This is the follow-up research on "Research on typography to integrate transparency and reflectivity in interface design", *International Association of Design Research* (2009).

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Keywords Graphic user interface (GUI) · Typography · Movable type · Space · Arrangement · Involvement · Usability and aesthetics

1 Introduction

This study explores how typography, as one of five components [1–3] of GUI, plays an active role in the process of configuring user identity. In addition, we present interactive interface strategies that provide a pleasurable user experience throughout the configuration process. Through experimentation, we investigate the problem of distortion, which arises when trying to determine users' emotional needs with regard to typography preferences for particular mobile devices, and try to identify the association between the determination process and changes in emotional satisfaction. To achieve these objectives, operational definitions of *typography* and *brand involvement* were established as important parameters. We hypothesize that brand involvement of mobile device affects the user selection process for typography as well as the information processing process. *Brand involvement* is defined as a basic variable that affects typography preferences. Verification of brand involvement was needed to determine the validity of the results obtained from the mobile device GUI user preference survey. The results of the verification indicate that the evaluation process was indeed significant in accurately understanding user interface preference through a usability test.

Typography refers to "drawing with movable type" and "handling movable type" [4]. Movable type is a core element of typography and typography, in turn, is a key component of GUIs. Generalizing typography as a mere element of movable type is an error that is often committed when referring to typography in the context of interface components. The initial role of movable type was to deliver language in a written format. That is, movable type was created with the express purpose of enabling people to acquire information through text, and typography enhanced text readability [5]. However, in modern typography the meaning of type has greatly expanded, taking on a new dimension as a key component of GUIs and as a backdrop in rapidly evolving digital devices.

Tschichold [6] once observed that "typography is arranging components in two dimensional space". However, limiting typography's domain to two-dimensional space is extremely limiting in today's world, which is flooded with computer app interfaces dominated by typography. Modern typography is a facet of all media, ranging from the two-dimensional nature of printed matter to the three-dimensional environment of digital cyberspace. If, for designers, interface space were real three- or four-dimensional space, rather than the two-dimensional plane generally encountered, today's general typography would not be applicable. In a previous study [3], we argue for the importance of users' emotional satisfaction for increased usability of mobile Internet services. For this, we attempted to prioritize the importance of design as an evaluative basis for GUI design. Accordingly, a GUI evaluation model was suggested that can be used to predict a user's design needs

and interface trend by targeting the five elements of color, shape, layout, text/typeface, and graphic/icon. This model was conceptualized as a GUI support system, which provides direct support for prototype design and the evaluation process by structuring key content of the GUI design evaluation method. Our study is significant because the emotional needs of users were considered in the interface design process. In a follow-up study [1], we focused on the emotional needs of users regarding typeface/font (typography) among the five GUI components. Furthermore, we argued that typography that integrates transparency and reflectivity in interface design would be a design trend of the future. This remains significant in that it suggests a direction for typeface/font design by grafting the theory of "windows and mirrors" as posited by Bolter and Gromala [7]. If previous studies [1–3, 8, 9] presented an interface design strategy through evaluation of users' emotional satisfaction, this study, as an extension of research by Jeong and Chen (2009), presents an in-depth view of the design strategy by examining the effects of brand involvement on user preferences in GUI typography. Our research methods were developed in light of an academic literature review, prior studies, and various types of verification after completing a user-centered design (UCD) project. The investigation methods used include survey, heuristic evaluation (HE), and focus group interview (FGI). Study participants were selected through a survey that measured unconscious and natural expressions; interaction between subjects was carefully observed to collect extensive and in-depth data to be used to meet the research objectives.

2 Background on Interface Attachment

Nielson [10] defined usability as a complex concept composed of multiple sub-concepts. In the international standard ISO/IEC 9126, usability is defined by ease of use, understanding, and operation. Although a usability evaluation has been conducted numerous times in the past, the reality is that evaluating emotional satisfaction [3], which reflects users' aesthetic needs, has been overlooked due to difficulty in quantization. In these circumstances, the attempts to develop an aesthetic assessment [1–3, 8, 9], namely an emotional satisfaction evaluation system, by melding interface design aesthetics and Nielson's definition of usability could be called innovative. More than 70 % of human perception is visual, so the importance of the GUI cannot be overstated. A good interface rejects the notion of competition between function and aesthetic elements because design works within the range defined by the demand for resolving communication problems. Unlike the fine arts, GUI design always has consequences in real-world implementation. In many aspects, aesthetic elements that do not meet the minimum standards of usability should be discarded. Fortunately, the range for aesthetic expression is still wide open, within certain constraints [11]. The success of any given product happens when consumers prefer it to competitors [12], and consumer preference is influenced mostly by design [13]. The framework of Bloch's consumer response model [13]

makes it possible to define the relationship between preference and design, and image and design by analogy. This shows that personal preference and situational factors interact to work as the intervening variable for final preference [1]. If Renaissance painters applied linear perspective to gain transparency, a GUI aims to maintain transparency on computer screens [2]. Computer designers and Human Computer Interaction (HCI) professionals still assume that the best interface is "obvious, simple, and natural." These precepts are nothing but variations on the theme of an "invisible computer" (i.e., a computer is meant to be unobtrusive) [14]. There are two perspectives on interface design. One is the practical perspective espoused by Norman [15, 16] as well as other HCI professionals. Interface design to them is in service of information only. The other perspective is of interaction designers. These two views compete against each other in the sense that each has an influence on culture [7]. Indeed, we found a clear distinction between these two perspectives of interface design [1]. As Sigel [17] notes, design influences user experience—after all, web pages are a visual experience—and typography in today's interface design has become the core element in the communication experience. As designers, we must create technologies that let users experience digital media clearly. However, we need to let users see the media reflectively as well. Both views are necessary to produce desirable digital products. *Reflection* has the meaning of rethinking something by seeing it from a different perspective, as of an object reflected in a mirror. Examining an interface by seeing it as a window (*transparency*) as well as a mirror (*reflectivity*) will help designers evaluate future needs [1].

3 Related Study

Tschichold [6], whose work has defined visual language, has identified the object of transparency as clarity. However, Jeong and Chen [14] have pointed out transparency and reflectivity on the limited small screen such as mobile device should be integrated and harmonized in applying and utilizing fonts in interface design. Assuring that fonts are easy to read guaranteed the success of typography in devices with small screens, such as mobile phones [18]. Yet, Jeong and Chen [1] tried to identify user tastes and found that typography design as a reflective interface provides users with an entertaining experience that also should be considered. Kim and Jeong [8] claim that a GUI should be developed according to the designer's understanding of users' emotional needs (for a new product called "interactive TV" at the time), but addressed typography only in terms of "readability" and "legibility" without considering the element of aesthetics. They adopted a usability evaluation for the interface design of interactive televisions. In subsequent work, Kim and Jeong [3] presented a typography concept, design, and guidelines for its application in the "development of a design evaluation method for a wireless Internet standard GUI." Unlike television, typography must account for the limited display environment of a small-screen device and consider issues of eyestrain, legibility, and readability. As such, their guidelines suggest an 11-point font size

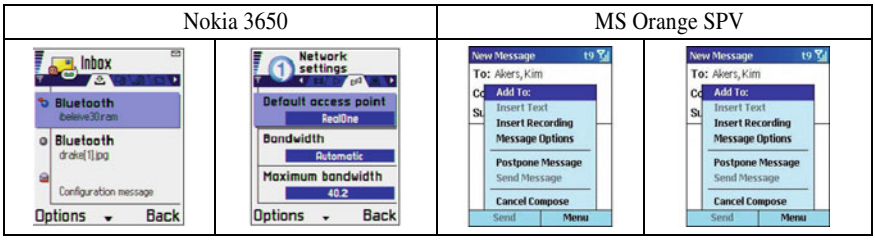

Fig. 1 Comparison of design preference on typography between Nokia and MS Orange

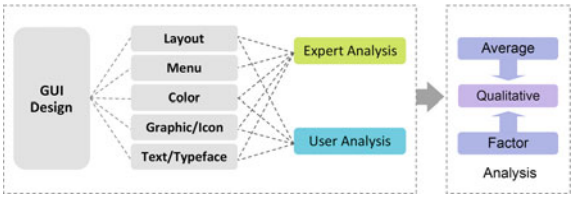

Fig. 2 GUI component (layout, menu, color, graphic/icon, text/typeface)

with a maximum of three kinds of typeface and a minimum of 3.3 mm including the space between the type lines. To ensure readability on LCD screens, a minimum 11-point sans-serif font was recommended type [9]. Also, Kim and Jeong argue for the importance of precise and clear menus and instructions as a form of typography, and they recommend setting aside a portion of the screen exclusively for title design. In particular, Jeong and Song [2] attempt to enhance accessibility of the interface menu via effective design; they examined in detail the comparative experiment on interface design preference between Nokia and MS mobile phones in terms of text legibility, readability, and visibility, as well as typography aesthetics (Fig. 1).

Kim and Jeong [3] identified layout, menu, color, graphic/icon, and text as the five elements for interface design for wireless Internet (Fig. 2).

The design evaluation standard is largely classified into four distinct criteria based on the results of a previous study on aesthetic engineering, with three detailed properties subsequently defined for each criterion. In order to quantify users' emotional satisfaction, the 12 properties of the evaluation standard (3 properties for each 4 criteria) were analyzed according to the relative importance of emotional satisfaction via the analytic hierarchy process (AHP) and then quantified with weighted average (Fig. 3).

Among the five elements of interface design, Jeong and Chen [1] focused on typography preferences for mobile interfaces. Since the survey was not intended for professional users, the word typography was replaced with font to make it easier for lay users to understand the survey's contents. The ultimate goal of the research was to find a justifiable reason to develop a more experimental typography, rather than to redesign existing fonts. The ideas are of a game being played between images and words [1].

Fig. 3 Design preferences: sensuous, descriptive, estimation, and preference aspects

4 Typography Preference and Involvement

Numerous studies have defined the meaning of typography with a general focus on movable type. Although movable type is considered as "text expressed in design," its meaning is expanding. For example, the empty space created between and around movable text is also raw material for typographers. By giving meaning to space, the emotional satisfaction of associated with typography may be viewed in a new light. What designers should notice before arranging type and engaging in geometric modeling is the arrangement within individual elements. Given the fact that once separate syllables form a word through arrangement, and individual words form a sentence through arrangement, it can be said that text possesses the fundamental property of arrangement. Take the Korean alphabet (Hangul) as an example. Hangul bears a very strong property of arrangement, as it features a phonetic and featural writing system. This characteristic is well-reflected in the *Hunminjeongeum*: Hangul uses consonants, vowels, and final consonants. We considered involvement as a psychological stage that a user goes through when selecting typography, and began our study with the hypothesis that the degree of brand involvement for selecting interface typography varies according to a user's product preference.

4.1 Characterization of Typography

Typography (from the Greek words τύπος *typos*, "form," and γράφειν, *graphein*, "to write") is the art and technique of arranging type to make written language most appealing for learning and recognition [19]. The arrangement of type involves selecting typefaces, point size, line length, line spacing (leading), letter spacing (tracking), and adjusting the space within letter pairs (kerning) [20]. Type design is a closely related craft, sometimes considered part of typography; most typographers do not design typefaces, and some type designers do not consider themselves typographers [5, 21]. In modern times, typography has played a role in film, television, and online broadcasts to add emotion to communication [18]. Designs for typefaces can be created faster with new technology, and for more specific functions [22]. Ahn limited the meaning of typography to movable type, the definition of which follows. Typos is a Greek noun meaning "blow, mark of the blow,

figure," the origin of which is found in the Indo-European language's (印歐語)'(s)teu-'; graphia, which has its root in the Indo-European language's "gerbh-," originating from *graphien*, which itself refers to "expression by line or writing and drawing" and means "writing or drawing." The Greek *typos* originated from the Latin word *typus*. Later, the word changed to "type," referring to archetype, model, symbol. After the invention of Gutenberg's movable type, the word also referred to typography. On the other hand,—*graphia* became—*graphy* and was used in a combined form that came to mean a style of painting; the art of drawing or calligraphic style; mood; writing. *Typography* eventually became "drawing by movable type" or "writing by movable type," and later on "ways to draw by movable type; ways to write by type." Through this process, *typography* came to mean the art of "letterpress printing" [23]. Tschichold [6] claimed that "typography refers to arranging the components within two-dimensional space". Jury [24] stated that typography means "all kinds of things written in text". Ruder [25] claimed that "the obvious duty of the typographer is to deliver information in writing," and Craig [26] defined typography as "a form of technology (art) that designs with the use of movable type". As seen above, the general meaning and etymology of typography focus on movable type [5].

4.2 Movable Type, Space, and Arrangement

Movable type is a system of printing and typography that uses portable components to reproduce the elements of a document, usually individual letters or punctuation [4]. However, today's movable type is regarded as text that is expressed in design and typography. Moveable type, as an element of typography, has evolved from a mere lead letterpress used to relay information to a modern communication tool that uses abstract composition and geometrical components to convey meaning [5]. According to Schmid [27], "Typography is language delivery via visual interpretation. There is no such typography where only reading takes place. A printed message is all visual impression." In typography, *space* generally refers to areas unoccupied by movable type. A formative characteristic of empty space is that, in a sense, it is an extension of the moveable type that created it. Therefore, it is awarded the same amount of meaning imbued to the initial geometric shape that created it [5]. Likewise, the typographer determines arrangement of type (i.e., geometric composition according to a plan). Typography is a combination of "type" and "drawing" (*graphy*). What needs to be noted here is the expression "drawing," which implies that the act of "drawing" is just as important as "type" in defining the meaning of typography. The meaning of *graphy* is tied to space, for type containing a meaning comes to life only when the intended meaning is expressed through the act of "drawing" in space. For typographers, the element of meaning is the extended meaning of *space* [5]. In an era when typography was limited to the technical task of letterpress printing, type was probably just a tool that reproduced text on paper.

As argued by Jan Tschichold, one important task of a typographer is to arrange components in the given space on a small screen. This task includes figuring out a meaningful pattern for arranging the movable type or geometric composition containing meaning. *Un Coup de Dés Jamais N'Abolira Le Hasard*, by Mallarmé[1] (1897), is considered a great representation of the spatial concept of modern typography. "By using seven different type sizes and throwing his dice on a large white space in a spread-open book, he performed arrangement using the sense of a composer rather than the logic of a compositor" [23]. This statement ascribes a poetic sensibility to typographic arrangement, which had been previously conveyed through language only. Park [4] mentions works such as *Calligramme*, by Guillaume Apollinaire, and *Un Coup de Dés Jamais N'Abolira Le Hasard* as the first attempts at elevating typography beyond a means for facilitating effective reading and to expand its role into symbolic imagery [4]. This implies that once the characteristics of typographical arrangement inherent in type and space are recognized, type, as well as any design elements, can be rearranged to reflect a typographical sensibility.

4.3 The Involvement of User Preference in the Interface

The concept of *involvement* has its roots in the social judgment theory of social psychology [28–30]. Social judgment theory focuses on the psychological process occurring at the root of attitude expression and attitude changes through communication. Using this theory, distinction and categorization of stimulation are involved in the evaluation process for users of mobile devices. Freedman [31] defined *involvement* as the attention, interest, and obsession regarding a given issue from a particular point of view. Using this definition, Freedman argues that obsession increases as one insists on a particular point of view, and increasing obsession, in turn, makes it more difficult to change one's attitude. Accordingly, Freedman sees specific intervention for issues as an important component of involvement [32]. The concept of involvement was first applied in the field of consumer behavior by Krugman [33]. Krugman defined *involvement* as "the extent to which one connects the content of persuasive stimulus provided with the content of one's life." Adopting the degree of a product's relevance to consumers, Engel (1989) studied the relevance of price, complexity of product, differences with alternative products, and their association with the concept of self [34]. Zaichkowsky [35] points out that the degree of involvement is affected not only by the importance of products to consumers, but also by emotional resonance with the consumer, and further claims that different consumers react differently to the same message. Antil [36] regards involvement as a degree of personal importance recognized by the consumer and defines it as the degree of stimulation caused in

[1]Stephane Mallarmé (1842–1898) was a French poet and critic.

special circumstances. As stated above, the definition of *involvement* varies by scholar in the field of consumer behavior. Nevertheless, in general it refers to the degree of personal relevance or interest that a consumer holds toward a certain object [35].

5 Design Research Process

The font usage of six mobile device producers in Korea was compared. The survey on users preference of leading computer fonts and mobile fonts showed the preference types and trend, and the result revealed the users' tastes. The results could be applied to the basis of emotional satisfaction and cause analysis for future typography on small screen devices.

5.1 Definition of User Groups

The typeface, which the users can select in the mobile interface such as they prefer, were divided into four groups. 'Group 1' consists of the default fonts that the users interact first after purchase. 'Group 2' includes the loaded fonts that come with the phone. Seven to ten fonts were pre-loaded in each phone by various makers. These pre-loaded fonts are available to users when they prefer to alter the default fonts in the devices. 'Group 3' includes fonts that are available for downloading to their phones. 'Group 4' consists of favorite fonts that are available in PC computers (Table 1).

5.2 Research Method and Process

We have considered several ways to develop design strategy that could provide entertaining experience to the users. We also planed the most appropriate method to justify proposed typography strategy in mobile devices. The survey participants were mobile phone users in Seoul. The age of subjects was between 15 and 29 spreading out evenly in each age bracket (Table 2).

Table 1 Grouping for experiments

Preference test in font group	Comparison test in user group	Verification experiment
Group 1. Default Group 2. Loaded Group 3. Downloaded Group 4. PC font	1. Premier 2. General users 3. Trendsetter	1. Premier 2. Premier seeker

Table 2 Characteristics of the subjects

	Premier	Trendsetter
Characteristics	– Uses with expensive phones – Uses for business – Has the longest call time	– Sensitive to trend – Values function, design, Brand – Adopts innovation
Profile	– 20–29 Male – Self-employed, white collar	– 15–24 years -Students
Key buying factor (KBF)	– Functions, brand – Battery, additional functions	– Design, functions – Additional and Basic Functions
Replacement period	– 21.5 months	– 22.2 months
Usage	– Business – Entertainment	– Personal Calls – Entertainment/Info
Calls (per day)/SMS/MMS (per week)	– 15/33/1.8	– 12/31/1.8

First, users were divided into three groups. The "premier" group comprised users with expensive phones. This group used their phone mainly for business and had longer call times. The "general" group included users who attempted to change the typeface on their mobile devices. The "trendsetter" group included users who were very sensitive to prevailing styles in technology; design and brand were important to them, and they were conscious of new features on various mobile devices. Participants were further consolidated by including the general group members with the premiers. Therefore, there were two groups: group 1 (the premiers + general users) and group 2 (the trendsetters). It was hypothesized that these two groups preferred different fonts (Table 3).

There were 197 subjects who responded to the survey. A pilot study and pre-test were conducted to determine if the survey was properly designed. The process for user research was as follows: an interface expert, a visual art designer, and a typographer divided users according to their characteristics based on a heuristic evaluation, and analyzed the interface environment. A pilot test followed with five subjects to determine preferences for font choice among normal users. Afterward, a survey was designed based on the results of this test. A pre-test of the survey was done with 10 people to check validity. After correcting for a few minor errors, the survey was done with all 182 subjects (Fig. 4).

Table 3 Participants in the user groups

2 Group (premier + trendsetter)					Premier + seeker	
Group1	Premier	23	71	182	10	Total 197
	General user	48			5	
Group2	Trendsetter	111			15	

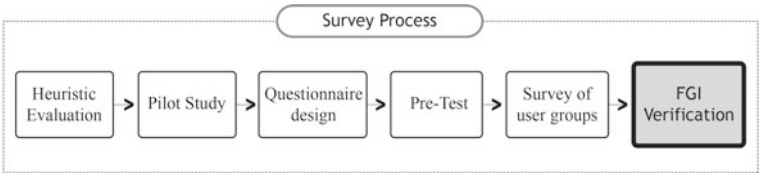

Fig. 4 The research process for interface design of mobile device in relation with brand preference

5.3 Survey Results and Analysis

The user survey showed a preference for a reflective interface in response to the need for pursuing transparency [18]. Considering women preferred a cute style for font/typeface and men preferred the default typeface in prior research on the aesthetics of typography [13], this result hints that user needs have evolved.

Group 1. Default typography by producer
The preference of default type was in the following order: Anycall 27.9 %, CYON 25.7 %, CASIOI 21.8 %, MOTOROLA 11.7 %, SKY 8.4 %, KTF 4.5 % (Fig. 5).

Group 2. Preference of loaded font typography
It is interesting to see that LG's Malgum (Clear) and Choco-Cookie, which have extremely different characteristics, share the top rank in loaded font category. Also, the top seven fonts, Rosemary, Hand Writing, Baby Crab, Kwangsoo and Balggurak (toe), are all cute hand written type, except for LG's Malgum. This result shows that the users prefer more feminine and cute fonts over more masculine default fonts (Fig. 6).

Group 3. Preference of mobile loaded font typography
Choco-Cookie tops the mobile download font rank as well. The others following in the rank, Cute Pparo, My Sea, Ungttung-I, and Neat Head, are all cute hand written type (Fig. 7). The preference of mobile download fonts was in the following order: Guiyumdoongi Pparo (Beloved Pparo) 12.9 %, Choco-Cookie 10.1 %, My Ocean 7.3 % of Anycall, Ungttung-I of CYON 6.7 %, Neat Head 6.2 %.

Fig. 5 [Group 1] default font preference

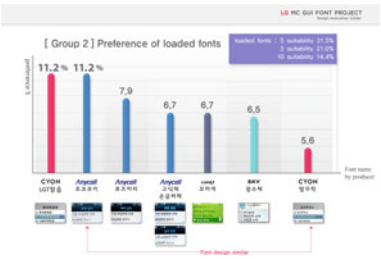

Fig. 6 [Group 2] preference of loaded font

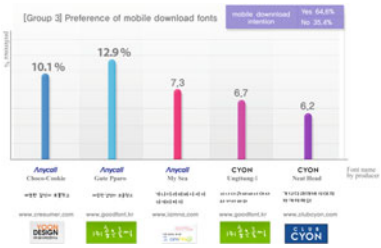

Fig. 7 [Group 3] preference of download font

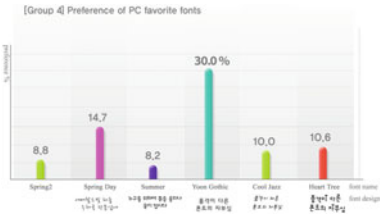

Fig. 8 [Group 4] preference of PC font

Group 4. Preference of PC favorite font typography

The preference of PC favorite fonts was in the following order: Yoon Gothic 30 %, Spring Day 14.7 %, Heart Tree 10.6 %, Cool Jazz 10.0 %. It was found that the users were influenced by the name of fonts in the research on PC favorite fonts (Fig. 8).

A preference map was created to show the distribution of user preferences. Overall, the map shows higher preference for more emotional and modified font types. This finding supports our argument that a theory focusing strictly on readability and legibility in typography is insufficient anymore. In addition, the distribution of user preferences shows an evolution in their needs. For example, users preferred basic fonts as evidenced by their demand for simple and clear design for small screens in prior research, but in our research users showed a higher preference for more emotional, calligraphy-like fonts.

Table 4 Tasks for focus group interview (FGI) verification

Objects	Typography preference test
Task 1	Preference for default font by producer
Task 2	Preference for loaded font in device
Task 3	Preference for downloaded fonts + PC fonts
Task 4	Combination of default type + loaded fonts

6 Involvement Verification

Despite the findings of the user preference survey, it is unclear whether the results strictly reflect typography preferences, given that mobile phones are high-involvement products. This is because the screen, which serves as the background for typography, varies in design layout and color by manufacturer, which potentially causes involvement in typography of their own. To verify whether brand involvement affects GUI typography preference results, an operational definition of the main variable affecting the survey was needed. As such, additional experiments were conducted regarding four tasks (Table 4).

6.1 Conceptualization and Operational Definition of the Main Variables

The key concepts of the variables described in our hypothesis were redefined into measurable variables, the operational definitions of which are as follows:

Typography
The narrow view of text was extended to what it came to mean in design and typography. The empty space (negative space) created between and around type was also considered material for typographers, thus giving it formative meaning. Before devising a blueprint for devices, however, designers need to note arrangement within the text itself. Hangul was selected as the study language because of the strong arrangement element inherent in its characters. Arrangement, as a design in typography, serves to reflect the symbolic image. In our actual experiment, we wanted to use a non-technical term that anyone can readily understand in order to ensure study participants' comprehension. Accordingly, the technical term *typography* was replaced with general terms such as *typeface* and *font*.

Involvement
Users' typography preferences involved differentiation and categorization of stimulation such as frequency of exposure to an existing interface. The concept of *involvement* was used as a main variable to examine the process of preference identification and associated changes, as well as the problem of distortion, which arises when users go through the process of determining preferences.

Fig. 9 Card sorting task

Fig. 10 Screen design for mobile

Card Sorting Task
Participants were asked to represent the typography they want to use on their personal mobile phone by arranging cards. To prevent sharing of ideas between participants, the experiment was conducted on an individual basis (Fig. 9).

Standardization of Background for Typography
To confirm whether brand involvement affects user preferences, an identical environment and conditions needed to be established. As such, we decided to use a single background design for the screen display as opposed to the various background designs predetermined by manufacturers. A basic screen background was designed by our design team using gray and blue color only. They were CYON 10, Anycall 7, canU 6, KTF 5, SKY 3, MOTOROLA 3 cards. The design was created by selecting four screens and downloaded fonts that were highly preferred for the PC. Participants were permitted to check user preferences only for the typography itself (Fig. 10).

6.2 Result and Analysis of Involvement Verification

As typography was set on a unified screen, as opposed to varying screen layouts and designs predetermined by mobile phone manufacturers, participant preferences for movable type, space, and arrangement could be clearly distinguished.

Task 1. Default Typography by Producer
Preference for the Anycall Gothic font was high at 40 %. On the other hand, a preference for Casio, KTF, and Sky, which had a colorful background screen of green and red, did not emerge. This proved that color, layout, and arrangement affect preferences (Fig. 11). We can see that simplicity and clarity are required to

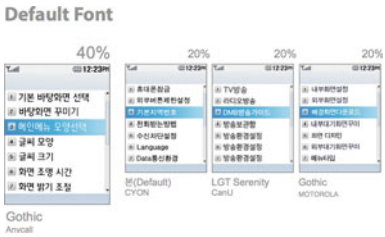

Fig. 11 [Task 1] default font

Table 5 FGI for comments of default typography

	[Task 1] FGI
Gothic (Anycall)	– Basic and slim, easy to read and organized
CYON	– Good readability, comfortable regardless of bolding or negative space
LGT (Serenity)	– Although it is general Gothic, it is also well balanced – Positive that that the font is not too square
Gothic (Motorola)	– It is neat at a glance, stands out and is easy to read, highly readable

develop a successful default font; that is, geometric structure, simplicity of typographical elements, moderate expression, tall characters (slim shape), legibility, and readability all need to be considered. The simplicity, slimness, readability, Gothic family, and balance are strong determinants of preference for the default fonts offered by the four mobile phones (Table 5).

Task 2. Typography Loaded on Devices

The trend for device typography development includes an amalgamation of sans serif, Gothic, handwriting typefaces. A preference emerged for visual characteristics similar to handwriting as well as typography evocative of fairy tales (Fig. 12). Reasons behind preferences for loaded fonts included style of handwriting, legibility, perceived "personality," familiarity, slimness, and differentiation (Table 6).

Task 3. Preferring Typography on Download + PC

As for user preference for downloaded fonts, including PC fonts, the results varied from existing data. This is where brand involvement emerges as a consideration, given that Anycall fonts were not included (Fig. 13).

In the case of Yoon-gothic on PC and Oddball for downloads, the reasoning for preference was divided. This is because, if Yoon-gothic is classified as rational typography, Oddball is considered emotional typography (Table 7).

Fig. 12 [Task 2] preferring font in device

Table 6 FGI for comments of typography in device

	[Task 2] Interviews in FGI
Choco-cookie (Anycall)	– Feeling good for a style of handwriting – Comfortable to see and has personality
Drops (CanU)	– Compared to "fancier" typefaces, it is easier to read – Compared to Gothic, it is more familiar
Kid font (CanU)	– It easier to view than general Gothic – Differentiated and highly visible
Iris (Anycall)	– It is not common, but not so different as to stand out – It has its own personality, it is slim and easy to read

Fig. 13 [Task 3]

Table 7 FGI for comments of typography on download + PC

	[Task 3] Interviews in FGI
Yoon-gothic (PC)	– Easy to view and highly readable, soft and legible
Oddball (download)	– It has personality and a lasting quality – Feels charming, other fonts are too formal, traditional, or rigid

Table 8 Composition preferences for typography on screen

	[Task 4] Interviews in FGI
Font composition	– I want to make changes with bold typography – Handwritten and fancy typography are refreshing – When I tire of one fonts, I will surely use a different type that is easy to read – I usually end up using only 2–3 typefaces. There is no need for more – I want to use my own fancy typography – Legibility is more important than fancy type – I don't like fussy typography

Task 4. Compose Typography

By arranging cards, the participants created typography they wanted to install on their mobile phones (Fig. 15). Funky or fancy typefaces, variation, alteration, style of handwriting, legibility, readability, and identity were considered (Table 8) (Fig. 14).

Fig. 14 Task 4 result

Other suggestions provided by the participants include:

Task: Interviews in FGI

- "Because of familiarity, I tend to download a style of handwriting frequently used
- "I want to change the typography according to my mood of the day."
- "I prefer emotional typography be developed rather than rational typefaces."
- "I hope a typeface preferred by young people will be identified."
- "A beautiful font to me is not one with bells and whistles.
- "I like typography that softly conveys an emotional mood, like 'my sea.'"

7 Findings

The experiment results confirmed that brand involvement affects typography preference to some extent. However, as the correlation was not strong, values should be placed in design itself identity (Fig. 15). Geometric modeling for abstract forms, which consists of dots, lines, and shapes, is the main element of typography, along with movable type. Consequently, it becomes the main element of interface design. According to Jan Tschchold, for a typographer, arrangement is the problem of figuring out how an object is to be situated in a virtual space called the *interface*.

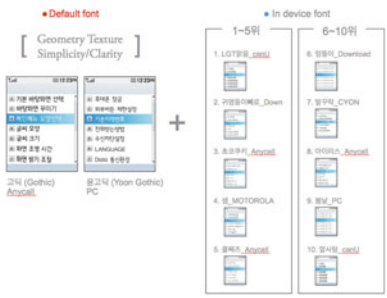

Fig. 15 Composition direction

It also involves figuring out by what means geometric modeling contains movable type or its meaning in space. An interface designer should consider the interaction effect in typography composition. Typography, which exists as movable type, and space interact with each other, giving particular importance to their complementarity.

8 Conclusion

Although brand involvement may affect user preference in the processes of involvement verification and emotional satisfaction evaluation, its effect was not significant. Given that mobile phones are high-involvement products, it may be obvious that typography preference is affected by the product's brand identity. However, as evident in naming conventions, typefaces/fonts have an identity that appeals to each person's unique emotional disposition. Donald Norman, who has been a leader in outlining the theoretical foundations for usability and rational design, now studies the importance of design aesthetics and argues that the best design practices realize all levels of instinct, action, and reflection [15]. Consequently, interface design for computer products is an evolving process. Movable type arrangement in space has different aspects, including Aldus Manutius' work (Pietro, Bembo, and italic type), Experimentelle Lyrik by Mallarmé, the asymmetric typography argued for by Jan Tschichold, and modern deconstructive typography. Hangul, which was born from Oriental philosophies and science, opens up the possibility for an infinite interface typography design that is familiar and beautiful. Hangul, in particular, is a writing system that bears an inherent sense of arrangement. The need for a new typography will increase, as Hangul constantly evolves and typography becomes a means to express one's personality and identity on mobile device interfaces.

8.1 Limitations and Suggestions

It is time to approach interface design with a sense of adventure and extraordinary ideas. We suggest a follow-up study that experiments with interface design and induces optical illusions. It is expected that this approach will significantly increase brand involvement for mobile products, as it will allow users to have a fun and interesting experience customizing their devices. Off-the-wall ideas for interface design, optical illusions, and interactive kinetic typography are expected to be a new turning in the evolution of mobile interface design.

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