THE STUDY OF KAWAII FEELING BY USING EYE TRACKING

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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.

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 several years. It was defined as "the translating technology of a consumer's feeling and image for a product into the physical design elements" (Nagamachi, 1995). 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 (Ministry of Economy, Trade and Industry, 2007). The examples of kansei value toward the products that have been widely applied are enjoyment, coolness, and user friendliness. In addition, kawaii has also been proposed as kansei value. It has such positive meanings as cute, lovable, and small. It has an important role in the worldwide success of many products such as Hello Kitty (Kovarovic, 2011) and Pokemon (Allison, 2003). 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 (Ohkura, et al., 2014). 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 sensation (Ohkura, et al., 2009). 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 (Sami, 2005) and mobile phone (Markus, et al., 2014) were evaluated by using eye tracking to explore the product components that attract user's attention. Therefore, eye tracking is considered to be the effective biological signal to evaluate the mental states or implicit needs of human.

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 selecting one of the six kawaii illustrations on a display (Ohkura, et al., 2015). 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 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 selecting 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 (Ohkura, et al., 2012). 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.

Fig. 1 The illustrations

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 selection should be performed by using keyboard's left or right arrow keys.
(4) Selection of illustrations: 30 pairs were displayed in random order for each participant.
(5) Questionnaire: There are 3 questions including the reason for selecting the illustrations (free description), the most kawaii illustration, and the most preferred illustration.

2.2 Experimental Setup and Procedures

The web questionnaire was accessed through a web browser, i.e. Google Chrome. The eye tracking system employed EyeTech TM3 and QG-PLUS. A 19-inch LCD monitor with a resolution of 1280x1024 pixels was used.

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 calibrated the participants' eyes
(4) Experimenter showed the web questionnaire and started recording the eye tracking.
(5) Participant selected illustrations and answered questionnaire.
(6) Experimenter stopped recording the eye tracking.

3. EXPERIMENTAL RESULTS

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 Table 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.

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.

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>

3.3 Result of the eye tracking data

We ranked the cumulative results again from 21 participants with eye tracking data to use them with the analysis of eye tracking data.

To analyze the eye tracking data, we employed a fixation and an 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 as shown in Fig.4. The AOIs were created as ellipse with the same size for all illustrations. We analyzed four eye tracking metrics as described in the following sections.

3.3.1 Total duration in AOI (sum of durations of all fixations that hit in AOI): We analyzed this metric with the participant groups and the illustration groups including highest kawaii score, lowest kawaii score, most selected kawaii, and most selected preferred. The result from paired t-test showed that there was a significant difference between illustrations with highest and lowest kawaii scores ($p<0.05$) for females in their 20's as shown in Fig. 5. For other illustration groups and other participant groups, there were no significant differences.

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 this metric with the participant groups and the illustration groups. The result of all participants from paired t-test showed that there was a significant difference between highest kawaii and lowest kawaii scores ($p<0.05$) and between most selected kawaii and lowest kawaii score ($p<0.05$), as illustrated in Fig. 6. In addition, the result of grouped participants showed that there was a significant difference 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 as shown in Fig. 7. For other groups of illustrations and other participant groups, there were no significant difference.

3.3.3 Number of transitions between AOIs (sum of times that the fixations move between two AOIs): We analyzed this metric 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. The result from a Pearson product-moment correlation showed that there was a negative correlation between the number of transitions and the difference of kawaii scores, which was statistically significant ($p<0.05$).

For each participant group, the results also showed a negative correlation for both males in their 20's and females in 65 years old or more with statistically significant ($p<0.10$). The result of females in their 20's showed a similar tendencies of a negative linear relationship as in other participant groups.

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. The result, as illustrated in Fig. 8, from paired t-test showed that there was significant difference in number of matching ($p<0.01$) for all participant groups.

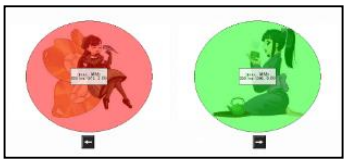

Fig. 4 Example of AOIs

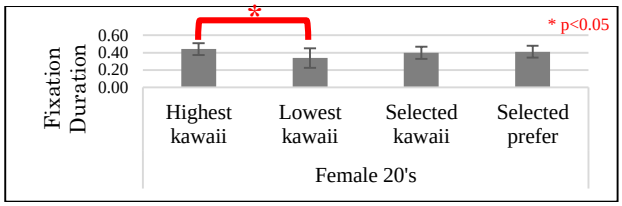

Fig. 5 Total duration in AOI vs. illustration groups of females in their 20's

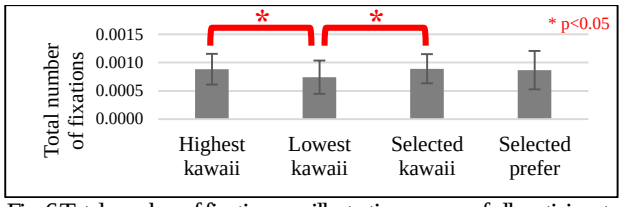

Fig. 6 Total number of fixations vs. illustration groups of all participants

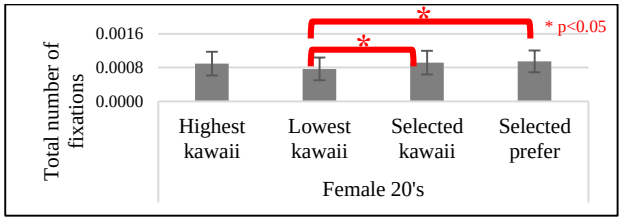

Fig. 7 Total number of fixations vs. illustration groups and participant groups of females in their 20's

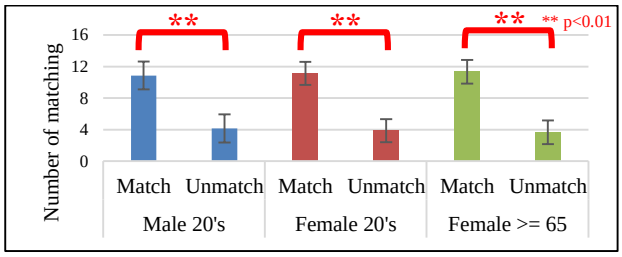

Fig. 8 Number of matching between last-fixation and selected illustration

During the process of this experiment, we had faced with some problems which might cause the difficulty.

- The participants do not have default eye position before they started seeing each pair of illustrations.
- Some participants used mouse instead of keyboard which might effect to the eye movement.
- Lights had effect to the eye tracker.

4. DISCUSSION AND CONCLUSION

This article introduces our improved experiment from our previous study (Ohkura, et al., 2015) 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.

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 from five eye tracking metrics was described as follows:

- Total duration in AOI of females in their 20's showed significant difference between illustrations with highest and lowest kawaii scores. Other participant groups showed average attention to all illustration groups. Thus the females in their 20's tended to look longer on the kawaii illustrations.
- Total number of fixations of all participants were significant difference between the illustrations with highest kawaii scores and selected kawaii illustrations versus the illustrations with lowest kawaii scores. It showed that 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 significant 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 a negative tendency which was similar to other participant groups. It showed that all participants tended to take longer time to compare the pairs when their kawaiiness were similar.
- Number of matching between the last-fixation illustrations and the selected illustration showed that there was significant difference between them for all participant groups. The larger number of matching showed that the participants tended to look lastly at the illustrations they selected.

For future work, we will improve the experiment based on the problems of the web questionnaire system and the experimental environment. More number of eye tracking data will be collected and used for the detailed analysis of between kawaii feeling and eye movement.

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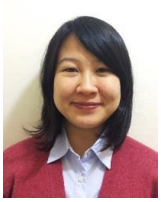

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