

Structural Comparison of Impression about a Character-Agent Derived from User Empathy

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Abstract: In today's information-communication society, it is important to establish a good relationship between humans and computers. Several human-agent interaction studies have succeeded in creating a more profound relationship with people, such as fostering empathy with agents. However, none of these studies has examined how human empathy is affected from the impressions formed about agents. We conducted an experiment to collect emotional response to a character-agent from participants. Then, we compared attitude structure to the agent between empathic and non-empathic groups of the participants. The results show that empathic participants evaluated the character-agent from various aspects and did not bestow low scores, unlike non-empathic participants.

Keywords: Human-Agent Interaction, Character-agents, Empathy, Impressions.

1. INTRODUCTION

In today's information-communication society, it is important to establish a good relationship between humans and computers. Many studies in the area of affective computing and affective engineering have made contributions in this regard. In particular, methods to foster human empathy to computer agents have been developed, where empathy is a more profound level of human-agent interaction. For example, Imai & Narumi (2004) proposed a communication strategy called *Directed Interaction*. In interactions between a human and an agent, the human shares the same sensation with the agent by speculating on the sensation that the agent has expressed. In the process, the human acquires the viewpoint of the agent through "mind reading" that is induced by the agent's affective utterance.

By designing the interaction between humans and agents on the basis of this strategy, humans are drawn into communication with the agent. However, the empathy evoked in the interaction is

limited to sharing information about sensations only. In ordinary communication, information about emotions is often used and is important for enriching the conversation. For example, emotional responses to color stimuli (color emotions), which are used to express objects' identities, include information about feelings in addition to sensations. Thus, we focus on empathy in the sense of sharing feelings. When empathy allows for feelings to be shared, humans' attitude to agents is expected to change from impersonal to personal. That is, the attitude to the agents is expected to allow humans to consider such agents as well-rounded characters. In the current study, we experimentally conducted user assessments to a software agent; then, we made comparisons between users who expressed empathy (empathic users group) and users who did not express empathy (non-empathic users group) in order to observe the differences in attitude to the agent.

2. EXPERIMENT

2.1. Procedure

We conducted an experiment to collect assessments made of a character-agent by empathic and non-empathic users. The users were asked to browse single colors with a software agent on web pages displayed on a thin-film transistor (TFT) monitor (Figure 1). Assuming interaction with an agent that provides information and assists with retrieval, we confined the issue to the impression of a character-agent displayed on the computer. The character-agent responded with a positive, neutral, or negative behavior to each color. The behavioral expressions were defined along with empirical data obtained from a previous study that measured emotional response to color stimuli.

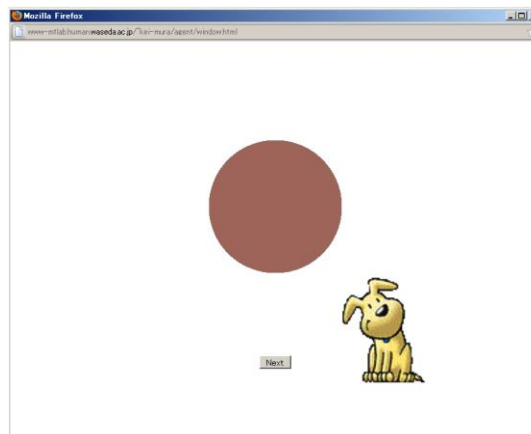


Figure 1: Character agent displayed on a screen

The experiment procedure is summarized as follows. First, the participants (27 university students) received an explanation that the goal of the experiment is to evaluate their impressions of a software agent; in addition, the participants were informed that they would browse web pages that displayed single colors and instructions from the agent. Second, the participants entered their names and e-mail addresses into an instruction page and browsed the web pages with the agent. The agent indicated on the initial instruction page: "Let's begin browsing various colors together. The colors are displayed in the center of the pages." On the final web page, the agent indicated: "I'll tell you about the most impressive color. I'll send an email about it soon." Last, the participants answered questionnaires that were composed of three categories of question items. The first category asked the participants for their impression of the color that would be sent by the agent. The second category asked the participants for their impression of the agent's personality. The last category asked the participants about their attitude throughout the experiment.

2.2. Agent Behavior

The character-agent was embedded in the web pages through support of a Clippy.js (<http://www.smore.com/clippy-js>) library, which is a JavaScript implementation of the Microsoft Agent. For this experiment, we chose the dog character *Rocky* and modified the script to define his behavior. When a single color is displayed on a web page, Rocky turns his eyes to the colored area and adopts a thinking posture; then, he expresses his attitude in a positive, neutral, or negative manner (Figure 2). The positive expression is presented as Rocky turning his face toward the user with a vigorous wag of his tail. The negative expression is presented as Rocky turning away from the colored area and prostrating on the ground. The neutral expression is presented as Rocky making no significant movements after the thinking posture.

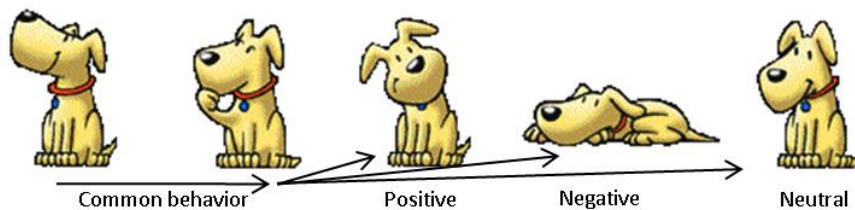


Figure 2: Sequence of the character agent's behavior

These behavioral expressions were matched to 15 single colors according to the reference described in this paragraph. The 15 single colors were composed by combining three hues (red, green, and blue) and five tones (dark, deep, vivid, brilliant, and light). A total of 30 web pages were prepared using the colors twice. The colors were ranked by a factor score of warmth estimated from a previous study (Muramatsu et al., 2011). We assigned the top three of these 15 colors to the positive expression, and the last three to the negative expression. The remaining colors were randomly matched to a positive, neutral, or negative expression with respective probabilities of 33% in order to prevent easy speculations of the agent's behavior.

2.3. Question Items

The question items in the first category of the questionnaire were adopted according to previous studies (Gao et al., 2007; Muramatsu et al., 2011). There are 12 adjective pairs used to evaluate color appearance: light-dark, soft-hard, warm-cool, turbid-transparent, deep-pale, vague-distinct, heavy-light, vivid-somber, strong-weak, passive-dynamic, gaudy-plain, and striking-subdued. The second category contains the following 20 adjective pairs: attractive-unattractive, close-distant, warm-cold, friendly-unfriendly, thoughtless-thoughtful, sociable-unsociable, responsible-selfish, inconsiderate-considerate, diligent-lazy, unsuccessful-successful, careless-careful, introvert-extrovert, strict-tolerant, unfaithful-faithful, attentive-inattentive, flexible-stubborn, exclusive-coordinative, assured-unassured, weak-strong, and rude-respectful were derived from a previous study by Fukayama et al. (2002); mechanical-humanlike and empathetic-unempathetic were also added to the list of 20, for a total of 22 adjective pairs. The question items in the third category considered (a) empathy, (b) friendliness, (c) naturalness, and (d) preference for dogs. All question items were answered with a seven-point rating.

3. RESULTS

3.1. Color Emotions and Agent's Personality

We analyzed data from the completed questionnaires of 25 participants (17 male and 8 female); the responses of the other two participants were discarded because their forms were incomplete.

First, we revealed the structure of the emotional response to colors that the participants imagined corresponded to the personality of the agent. The rated data from the first question category (12 pairs of adjectives) were analyzed by factor analysis (maximum likelihood method, promax rotation). As a result, four factors each related to brightness, saturation, activity, and clarity were extracted as listed in Table 1. A weak positive correlation between the second factor and the third factor was observed (Table 2).

Table 1: Factor loadings of first question category

	Factor 1	Factor 2	Factor 3	Factor 4	Commonality
heavy-light	0.92	0.04	0.25	0.14	0.76
deep-pale	0.81	0.28	0.16	-0.06	0.58
light-dark	-0.66	0.44	-0.05	0.01	0.69
strong-weak	0.57	0.28	-0.30	-0.17	0.60
soft-hard	-0.48	0.38	0.39	0.18	0.71
gaudy-plain	0.02	0.91	-0.09	-0.09	0.85
vivid-somber	-0.10	0.82	0.01	-0.12	0.70
striking-subdued	0.35	0.77	0.08	0.20	0.68
passive-dynamic	0.21	-0.04	1.04	-0.09	1.00
vague-distinct	-0.01	-0.16	0.11	0.72	0.53
warm-cool	-0.08	0.29	-0.38	0.64	0.69
turbid-transparent	0.31	-0.26	-0.11	0.48	0.46

Table 2: Correlation between factors of first question category

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	1.00	-0.15	0.11	0.08
Factor 2	-0.15	1.00	0.38	0.09
Factor 3	0.11	0.38	1.00	0.04
Factor 4	0.08	0.09	0.04	1.00

Similar to the first question category, we conducted the factor analysis (maximum likelihood method, promax rotation) to the rated data from the 22 adjectives pairs of the second question category. As a result, four factors were extracted, as listed in Table 3. The factors were interpreted and called the factor of unfriendly properties, the factor of diligent properties, the factor of coordination, and the factor of non-dominance based on their factor loadings. Moderate negative correlations between the first and the third factor and between the first and the fourth factor were found. Moreover, a moderate negative correlation between the second and the third factor, and a moderate positive correlation between the third and the fourth factor were observed (Table 4).

3.2. Comparison of Emotions and Attitudes

After the basic analysis of the first and the second question category described in the previous section, we compared the participants' color emotions and attitudes toward the agent. We classified the participants into empathic and non-empathic groups; the former group is considered to have expressed empathy toward the agent, and the latter group is considered not to have expressed empathy toward the agent. The participants were classified on the basis of their response to the question item "warm-cold". Ten participants who scored three or less on this question were

classified as empathic, and nine participants who scored five or more were classified as non-empathic. The other six participants who scored four were excluded in this analysis. Then, we compared the distribution of the factor scores obtained from the factor analysis of the second question category between the empathic and non-empathic groups.

Table 3: Factor loadings of second question category

	Factor 1	Factor 2	Factor 3	Factor 4	Commonality
attractive-unattractive	1.05	0.16	0.05	0.14	0.85
close-distant	0.98	-0.04	0.32	0.08	0.79
warm-cold	0.82	0.13	0.05	0.16	0.50
friendly-unfriendly	0.72	0.11	-0.32	0.21	0.64
thoughtless-thoughtful	-0.54	0.19	0.25	0.01	0.68
sociable-unsociable	0.53	0.01	-0.28	0.01	0.48
responsible-selfish	0.49	-0.14	0.02	-0.22	0.48
inconsiderate-considerate	-0.38	0.16	0.00	0.36	0.51
diligent-lazy	-0.14	-1.14	0.58	0.07	0.80
unsuccessful-successful	-0.04	0.71	0.30	-0.18	0.76
careless-careful	0.26	0.70	0.21	-0.02	0.49
introvert-extrovert	-0.10	0.65	-0.12	-0.30	0.35
strict-tolerant	-0.20	0.49	-0.32	0.34	0.53
unfaithful-faithful	-0.19	0.25	0.16	0.23	0.40
mechanical-humanlike	0.16	-0.19	0.69	-0.11	0.35
attentive-inattentive	0.38	-0.04	-0.54	-0.08	0.71
flexible-stubborn	0.38	-0.02	-0.51	0.03	0.57
empathetic-unempathetic	0.53	0.12	-0.58	-0.24	0.92
exclusive-coordinative	0.06	-0.12	0.37	-0.03	0.10
assured-unassured	0.08	-0.67	-0.20	0.98	0.96
weak-strong	0.01	0.13	0.52	-0.76	0.68
rude-respectful	0.26	0.25	0.13	0.71	0.65

Table 4: Correlation between factors of second question category

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	1.00	0.33	-0.58	-0.43
Factor 2	0.33	1.00	-0.44	-0.21
Factor 3	-0.58	-0.44	1.00	0.52
Factor 4	-0.43	-0.21	0.52	1.00

The distributions of empathic and non-empathic groups are shown in Figures 3 and 4, respectively. Here, the factors indicate indices of friendly properties, diligent properties, coordination, and dominance by inverting the polarity with respect to the first and fourth factor scores. The panels in the upper right show the correlation coefficients, and the panels in the lower left show the scatter plots. In the non-empathic group, the correlation coefficients are high in a combination of each of the first, second, and third factors, and the scatter plot is distributed over the first and third quadrants. Low correlation coefficients are observed in a combination of factor four and the other

factors, and the scatter plot is widely distributed over all quadrants. On the other hand, the scatter plot of all combinations of the four factors is widely distributed in the empathic group. Last, when comparing the average of the four items in the third question category between the two groups, statistically significant differences are not observed in all items (Table 5).

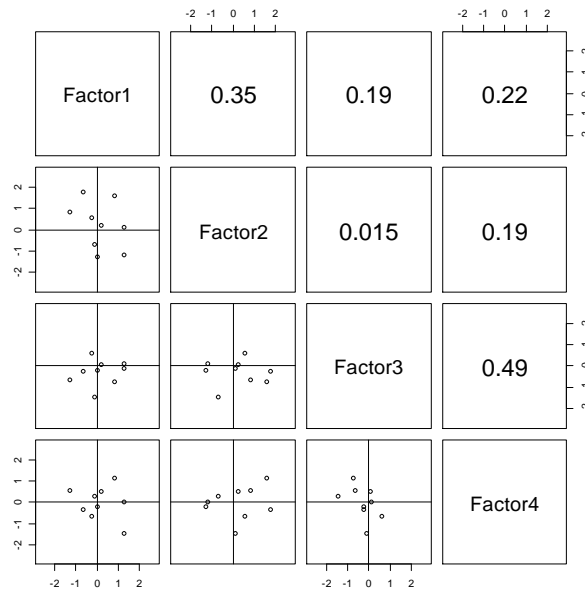


Figure 3: Scatter plot of factor indices in empathic group

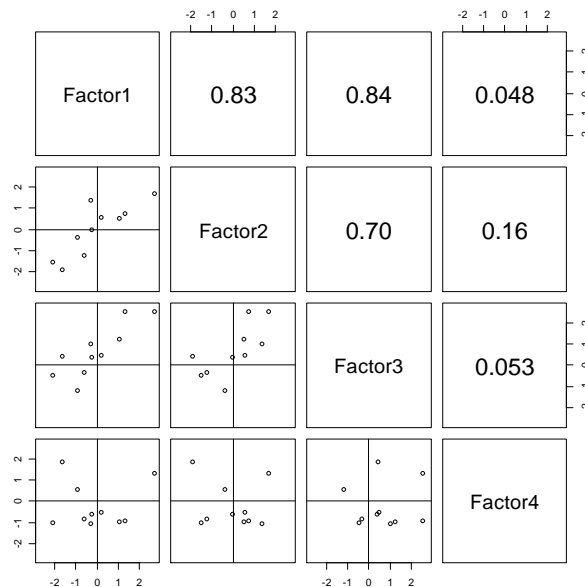


Figure 4: Scatter plot of factor indices in non-empathic group

Table 5: Comparison of scores in third question category between empathic and non-empathic groups

	empathy	friendliness	naturalness	preference for dogs
Empathic	3.11	3.89	3.22	4.89
Non-empathic	3.40	3.60	3.40	5.30

4. DISCUSSION

4.1. Occurrence of Empathy and User Attitude

The structure of color emotions that participants imagined is different from the structure of color emotions that are described in the three factors that correspond to lightness, chroma, and hue in previous studies (Gao et al., 2007; Muramatsu et al., 2011). However, the adjective pairs that consist of the first and the second factors are similar to the factor that corresponds to the lightness and chroma in previous studies. Moreover, pairs of adjectives that consist of the third and fourth factors are derived from the factor that corresponds to hue because they are similar to the hue factor. Thus, we consider that there is no significant distinction between the structures of the current and previous studies. Therefore, by screening the upper and lower scores in the question item "warm-cool," the participants were adequately divided into empathic people who speculated on the color emotion assumed in the agent's behavior, and non-empathic people who speculated on the color emotion opposite to the assumed behavior.

According to the distribution of indices, strong correlations were observed among the first, the second, and the third factors, whereas they are not correlated to the fourth factor (Figure 4). This indicates that the structure of attitude to the agent in the non-empathic group is formed mainly by two factors. On the other hand, the structure of attitude to the agent in the empathic group consists of four factors, because there are weak correlations between the first and the second factors, and between the third and the fourth factors (Figure 3). These weak correlations suggest that the people in the empathic group evaluate the agent from more varied viewpoints than the non-empathic group. Further, according to the scatter plots of the two groups, fewer samples in the empathic group are distributed in the third quadrant than in the non-empathic group. This suggests that the empathic participants are more likely to bestow higher scores to all indices than the non-empathic participants. Because attitudes to the agent are different in each group as described previously, the occurrence of empathy in individuals is implicated in their attitude to the agent.

4.2. Designing Empathic Interactions

In designing empathy in human-computer interactions, important suggestions are provided from the results of our experiment. One suggestion is that empathy can be evoked by sharing the feelings that are expressed through the agent's behavior and without providing explicit information about sensations, as adopted in the Directed Interaction. The other suggestion is that users' empathy can be enhanced positively, and multilateral evaluations can be conducted according to the users' attitude to the agents. Although the empathy observed in our study occurred only with empathic users, its occurrence seems to be operable by designing agent behavior based on shared feelings. Therefore, sharing the knowledge of feelings will become a priority when designing empathic interactions.

In the sense of sharing knowledge, content-oriented approach, such as ontology engineering in artificial intelligence, is effective. Ontology engineering is one of the methodologies that support describing knowledge systematically. From the knowledge-based viewpoint, "ontology is defined as a theory (system) of concepts/vocabulary used as the building blocks of an information processing system" (Mizoguchi et al., 1995). Once the knowledge of feelings is described on the basis of an ontology as attempted by Muramatsu et al. (2011), it is not an exaggeration to say that humans and computers can share the knowledge to have empathy. This will result in more sophisticated interactive systems that aim for the realization of human-computer interactions at a more profound level.

5. CONCLUSION

In the current study, we compared structures of attitude to the agent between empathic and non-empathic groups of participants. The structures of attitude to the agent were analyzed through factor analysis, and the participants were categorized on the basis of measurements of emotional responses to color stimuli (color emotions). The results of the comparison showed that the empathic participants evaluated the character-agent from more varied aspects, and were likely to bestow higher scores than the non-empathic participants. Consequently, empathy seems to be implicated in positive and multilateral evaluations. In future work, we will develop a method to design empathic interactions on the basis of ontological engineering.

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BIOGRAPHY

Keiichi Muramatsu has been a research associate of the Faculty of Human Sciences, Waseda University, since 2012. He received his Doctor of Human Sciences from Waseda University in 2014. He was a Japan Society for the Promotion of Science (JSPS) Research Fellow (DC2) in 2010-2012. His current research interests are ontological descriptions on the structure of the human mind in the research fields of aesthetics, color science, and learning sciences.

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