Analysis of Gender-specific Self-adaptors and Their Effects on Agent's Impressions

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Abstract: This paper reports how agents that performs gender-specific self-adaptors are perceived by Japanese evaluators depending on their gender. Human-human interactions among Japanese undergraduate students were analysed with respect to usage of gender-specific self-adaptors in a pre-experiment. Based on the results, a male and a female agent were animated to show these extracted self-adaptors. Evaluation of the interactions between agents that exhibit self-adaptors typically exhibited by human male and female indicated that there is a dichotomy on the impression on the agent between participants' gender. Male participants showed more favourable impressions on agents that display feminine self-adaptors than masculine ones performed by the female agent, while female participants showed rigorous impressions toward feminine self-adaptors. Although the obtained results were limited to one culture and narrow age range, these results implies the importance of considering the use of self-adaptors and gender in successful human-agent interactions.

1 INTRODUCTION

Intelligent virtual agents (IVAs) that interact face-to-face with humans are beginning to spread to general users, and IVA research is being actively pursued. IVAs require both verbal and nonverbal communication abilities. Among those non-verbal communications, Ekman classifies gestures into five categories: emblems, illustrators, affect displays, adapters, and regulators (Ekman, 1980). Self-adaptors are non-signalling gestures that are not intended to convey a particular meaning (Waxer, 1988). They are exhibited as hand movements where one part of the body is applied to another part of the body, such as picking one's nose, scratching one's head and face, moistening the lips, or tapping the foot. Many self-adaptors are considered taboo in public, and individuals with low emotional stability perform more self-adaptors, and the number of self-adaptors increases with psychological discomfort or anxiety (Ekman, 1972, Waxer, 1988, Argyle, 1988). According to Caso et al. self-adaptor gestures were used more often when telling the truth than when lying (Caso, 2006).

Because of its non-relevance to conversational content, there has not been much IVA research done on self-adaptors, compared with nonverbal communication with high message content, such as facial expressions and gazes. Among few research that has dealt with an IVA with self-adaptors, Neff et al. reported that an agent performing self-adaptors (repetitive quick motion with a combination of scratching its face and head, touching its body, and rubbing its head, etc.), was perceived as having low emotional stability. Although showing emotional unstableness might not be appropriate in some social interactions, their finding suggests the importance of self-adaptors in conveying a personality of an agent (Neff, 2011).

However, self-adaptors are not always the sign of emotional unstableness or stress. Blacking states self-adaptors also occur in casual conversations, where conversants are very relaxed (Blacking, 1977). Chartrand and Bargh have shown that mimicry of particular types of self-adaptors (i.e., foot tapping and face scratching) can cause the mimicked person to perceive an interaction as more positive, and may lead to form rapport between the conversants (Chartrand, 1999).

We focus on these "relaxed" self-adaptors performed in a casual conversation in this study. If those relaxed self-adaptors occur with a conversant

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that one feels friendliness, one can be induced to feel friendliness toward a conversant that displays self-adaptors. We apply this to the case of agent conversant, and hypothesize that users can be induced to feel friendliness toward the agent by adding self-adaptors to the body motions of an agent, and conducted two experiments.

The first experiment evaluated continuous interactions between an agent that exhibits self-adaptors and without (Koda, 2014a). The results showed agents that exhibited relaxed self-adaptors were more likely to prevent any deterioration in the perceived friendliness of the agents than agents that have no self-adaptors. In addition, people with higher social skills harbour a higher perceived friendliness with agents that exhibited relaxed self-adaptors than people with lower social skills. Thus, we expect that it would be possible to improve humanness and friendliness of agents by implementing self-adaptors in them. The second experiment evaluated interactions with agents that exhibit either relaxed self-adaptors or stressful self-adaptors in a desert survival task. The result suggests the need to tailor non-verbal behaviour of virtual agents according to conversational contents between an agent and a human (Koda, 2014b).

This paper reports a preliminary result of our consecutive experiment that deals with gender issues. Our two previous experiments used a female agent only and did not consider the effects of appearance of the agent's gender. Moreover, as some self-adaptors are gender-specific (Hall, 1984), i.e., "crossing arms" self-adaptors are more frequently found in males, and "covering mouth" self-adaptors are mostly found in Japanese females, we need to consider gender of the agent, gender-specific self-adaptors, and gender of participants. As Cassell points out in (Cassell, 2002), considering gender effect is essential for successful and comfortable human-computer interaction, so as for human-agent interaction.

We evaluate the impression of the agents with male/female appearance and masculine/feminine self-adaptors in this experiment. We hypothesize that "when the participant's gender, agent's gender, and gender of the gender-specific self-adaptors are consistent, participants feel higher naturalness and have better impression toward the agent than any other combinations".

2 VIDEO ANALYSIS OF SELF-ADAPTORS AND IMPLEMENTATION OF AGENT ANIMATION

2.1 Video Analysis of Self-adaptors

We conducted a pre-experiment in order to examine when and what kind of self-adaptors are performed, and whether/what kind of gender-specific self-adaptors are found during a casual conversation between friends in a Japanese university. We invited ten pairs (5 male pairs and 5 female pairs) who are friends for more than three years (they are university students who study together) to record their free conversation for 20 minutes.

The video analysis were made in terms of the body parts touched, frequency of each self-adaptors, and number of participants who performed each self-adaptors during the conversation for all 20 participants. The results of the video analysis is shown in Table 1 and 2. Table 1 shows the top five types of self-adaptors performed most frequently and most participants (how and which body parts were touched, how many times for each self-adaptor, and by how many people for each self-adaptor) by the male participants and Table 2 by the female participants. We identified the following gender-specific self-adaptors in Japanese university students. There are three types of self-adaptors occurred most frequently in male participants: "touching nose", "touching chin," and "scratching head." We call these self-adaptors as "masculine self-adaptors" hereafter. The most frequent self-adaptors performed by female participants are "touching nose", "stroking hair", and "touching mouth (covering mouth)". We call these self-adaptors as "feminine self-adaptors" hereafter. Figure 1 shows typical masculine self-adaptors seen in the video recordings performed by Japanese male students, and Figure 2 shows those by Japanese female students.

We implement those masculine/feminine self-adaptors to our conversational agents for the experiment. In terms of the timing of self-adaptors, 50% occurred at the beginning of the utterances in the video recordings.

Table 1: Self-adaptors performed by male participants in video recordings (left: number of times, right: number of people).

Male participants		n=587
Order	Self-adaptor	Frequency
1	touching nose	61
2	toucing chin	55
3	scratching head	35
4	touching cheek	30
5	scratching nose	29

Male participants		n=10
Order	Self-adaptor	Number of participants
1	scratching head	9
2	touching nose	9
3	scratching forehead	6
4	touching chin	6
5	scratching neck	6

Table 2: Self-adaptors performed by female participants in video recordings (left: number of times, right: number of people).

Female participants		n=617
Order	Self-adapator	Frequency
1	Touching nose	66
2	Stroking hair	49
3	Touhcing sleeves	40
4	Toucing mouth	38
5	Touching fingers	31

Female participants		n=10
Order	Self-adaptor	Number of participants
1	Touching mouth	8
2	Touching nose	7
3	Stroking hair	6
4	Touching bangs	6
5	Scratching nose	6

Figure 1: Male participants perform three masculine self-adaptors (from left: "touching chin," "scratching head," and "touching nose".

Figure 2: Female participants perform three feminine self-adaptors (from left: "touching nose", "stroking hair", and "touching lips (covering mouth)".

2.2 Agent Character and Animation Implementation

The agent characters (male and female) and animation of the six types of self-adaptors were created using Poser (http://poser.smithmicro.com/poser.html). Figure 3 and 4 show the agents carrying out the three masculine self-adaptors and three feminine self-adaptors respectively. We created the following four types of animations in order to examine the combination of gender of the character and self-adaptors; "male agent performs masculine self-adaptors", "male agent performs feminine self-adaptors", "female agent performs masculine self-adaptors", "female agent performs feminine self-adaptors."

We found no literature that explicitly described the form of the movement (e.g., how the nose has been touched, in which way, by which part of the hand etc.), we mimicked the form of the movements of the participants in the video recordings. We adjust the timing of the animation of self-adaptors at the beginning of the agent's utterances as found in the video recordings.

Besides these self-adaptors, we created animations of the agent making gestures of "greeting" and "placing its hand against its chest." These gestures were carried out by the agent at appropriate times in accordance to the content of the conversation regardless of experimental conditions in order not to let self-adaptors stand out during a conversation with the agent.

Figure 3: Male agent performs three masculine self-adaptors (from left: "touching chin," "scratching head," and "touching nose".

Figure 4: Female agent performs three feminine self-adaptors (from left: "touching nose", "stroking hair", and "touching lips (covering mouth)".

3 EXPERIMENT

3.1 Experimental System

The agent's conversation system was developed in C++ using Microsoft Visual Studio 2008. The agent's voice was synthesized in a woman's voice using the Japanese voice synthesis package AITalk (http://www.ai-j.jp/). Conversation scenarios, composed of questions from the agent and response choices, were created beforehand, and animation of the agent that reflected the conversational scenario was created. By connecting animated sequences in accordance of the content of the user's responses, the system realized a pseudo-conversation with the user. The conversation system had two states. The first

state was the agent speech state, in which an animated sequence of the agent uttering speech and asking questions to the user was shown. The other state was the standby for user selection state, in which the user chose a response from options displayed on the screen above the agent. In response to the user's response input from a keyboard, animated agent movie that followed the conversation scenario was played back in the speech state.

3.2 Experimental Procedure

The interactions with the agents were presented as pseudo conversations as follows: 1) the agent always asks a question to the participant. 2) Possible answers were displayed on the screen and the participant selects one answer from the selection from a keyboard. 3) The agent makes remarks based on the user's answer and asks the next question. The contents of the conversations were casual (the route to school, residential area, and favourite food, etc.). The reason we adopted the pseudo-conversation method was to eliminate the effect of the accuracy of speech recognition of the users' spoken answers, which would otherwise be used, on the participants' impression of the agent.

The participants in the experiment were 29 Japanese undergraduate students (19 male and 10 female), aged 20-23 years, who did not participate in the video recording pre-experiment. The experimental is conducted as 3 x 2 factorial design. The experimental conditions are participants' gender (male/female), agent's gender (male/female), gender of self-adaptor (male/female). Each participant interacted with all four types of agents (male agent performing masculine self-adaptors, male agent performing feminine self-adaptors, female agent performing masculine self-adaptors, female agent performing feminine self-adaptors) randomly assigned to them. Thus, there are four interactions with different combination of the agent and self-adaptor for each participant. The conversational topics are different for each interaction and the topics are randomized. Each agent performed three all gender specific self-adaptors in any interaction.

After each interaction, the participants rated their impressions on the agent using a semantic differential method on a scale from 1 to 6. A total of 27 pairs of adjectives, consisting of the 20 pairs from the Adjective Check List (ACL) for Interpersonal Cognition for Japanese (Hayashi, 1982) and seven original pairs (concerning the agent's "humanness," "naturalness," "annoyingness", and "masculinity" etc.), were used for evaluation. The list of adjectives is shown in Table 3 in Section 4. At the end of the experiment, a post-experiment survey was conducted in order to evaluate the participants' subjective impression of overall qualities of the agents, such as the naturalness of their movements and synthesized voice.

4 RESULTS

4.1 Results of Factorial Analysis

Factor analysis (FA) was conducted on the agent's impression ratings obtained from the experiment in order to extract the factors that composes our interpersonal impressions toward the agents. The results of FA using the principal factor method extracted four factors (shown in Table 3). The First factor is named as "Tolerance factor (composed of adjectives such as calm, broad-minded, kind, soft, and sophisticated), the second as "Sociability factor" (composed of adjectives such as active, cheerful, confident, and social), the third as "Gender factor" (composed of adjectives such as lovable, feminine, and delicate), and the forth as "Naturalness factor" (composed of adjectives such as natural and humanlike).

Cronbach's coefficients alpha for the factors are 0.84 for "Tolerance factor", 0.79 for "Sociability factor", 0.67 for "Gender factor", and 0.62 for "Naturalness factor", which show high enough internal consistency of the extracted factors. The result of the factorial analysis indicates when the participants perceive the agents interpersonally and rate their impressions, these four factors have large effects. Thus we will use the factors and factorial scores for later analysis to evaluate the gender effects.

4.2 Analysis of Tolerance Factor and Sociability Factor

We performed three-way ANOVA (repeated measures) with factors "participant gender", "agent gender", and "gender of self-adaptor". The dependent variables are total factorial score of each factor.

The result showed there are no main effects of participants' gender, agent's gender, and gender of self-adaptor on "Tolerance factor" and "Sociability factor". There are significant second-order interactions in the "Tolerance factor" ($p<0.05$) between participants' gender and agents' gender. Figure 5 shows the tolerance factor score of each condition. The male participants rated the female agent performing feminine self-adaptors significantly

Table 3: Four factors and adjectives for interpersonal impressions.

		Facter						
		1	2	3	4	5	6	7
Tolerance	Short-tempered - Calm	.921	-.029	-.118	-.054	-.120	-.054	.100
	Narrow-minded - Broad-minded	.782	-.049	-.072	-.135	-.080	.070	.011
	Unkind - Kind	.700	.223	.060	-.001	-.079	.148	-.011
	Rough - Soft	.644	-.149	.195	-.074	.064	.061	.219
	Unsoficticated - Sofisticated	.571	-.047	.440	-.033	.064	-.033	-.057
	Annoying - Quiet	.413	-.040	.332	-.137	.322	-.082	-.073
	Unpleasant - Pleasant	.343	.247	.101	.108	.250	.249	-.076
Sociability	Inert - Active	-.039	.833	.064	.022	.029	.126	-.117
	Gloomy - Cheerful	-.105	.714	.333	.153	-.228	-.162	.067
	Unconfident - Confident	-.058	.678	-.082	-.064	.067	-.095	.204
	Unsocial - Social	.151	.548	-.087	.089	-.016	.118	.009
	Servile - Grand	.004	.452	-.317	-.116	.211	-.090	.314
	Unshy - Shy	-.004	-.385	.313	.064	.213	-.033	.243
Gender	Hateful - Lovable	-.063	.306	.786	.347	.055	-.020	.100
	Masculine - Feminie	.005	.146	.758	-.399	.003	.135	.254
	Tough - Delicate	.088	-.297	.645	.124	-.096	-.132	-.148
	Immature - Mature	.247	.162	-.407	.224	.222	-.044	-.189
Naturalness	Unnatural - Natural	-.076	.137	-.088	.655	.077	.073	-.031
	Unhumanlike - Humanlike	-.141	.020	.005	.628	-.094	.029	.078
	Unreasonable - Reasonable	-.110	-.055	-.069	.105	.668	.215	.202
	Incautious - Cautious	.250	.058	.035	-.180	.613	.028	-.132
	Passive - Positive	.248	.042	-.249	.322	-.491	.037	.247
	Impertinent - Pertinent	.335	-.305	-.076	.228	.361	-.014	.109
	Hard-hearted - Soft-hearted	.064	-.005	.001	.069	.138	.879	-.086
	Irresponsible - Responsible	.332	.152	-.119	.127	.231	-.344	.166
	Hostile - Amicable	.141	.146	.159	-.027	.012	-.160	.610
	Unfriendly - Friendly	.021	-.098	.149	.262	-.007	.280	.544

higher than the same agent performing masculine self-adaptors (F: 4.58, $p<0.05$). While the female participants showed tendency for higher rating to the female agent performing masculine self-adaptors (F: 2.55, $p=0.122$). There are no difference in the tolerance factors when the participants evaluated the male agent. While to the case of female agent, the tolerance scores were higher when the female agent performs different gender's self-adaptors from the participants' gender. There are no significant main effects nor second-order interactions found in the "Sociability factor" (shown in Figure 6).

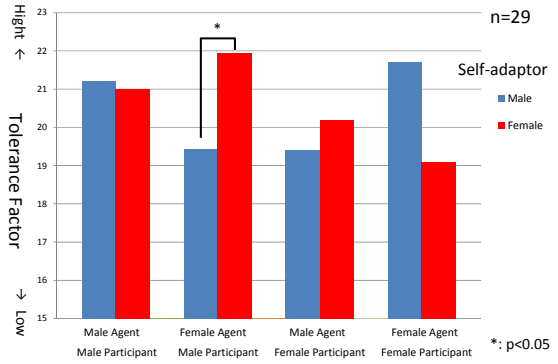

Figure 5: Tolerance factor score of four conditions compared by participants' gender.

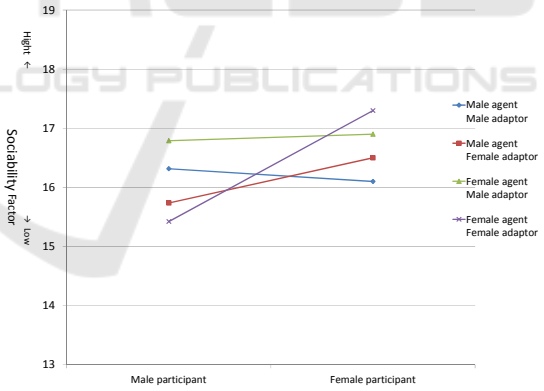

Figure 6: Sociability factor score of four conditions.

4.3 Analysis of Gender Factor

We performed three-way ANOVA for total factorial scores of gender factor. Figure 7 shows gender factor scores of four conditions. The main effect of agent's gender on gender factor is found ($p<=0.01$). Significant second-order interactions are not seen in gender factor. These results mean the agents' appearance made significant differences in impression of gender. The male agent were perceived as more masculine than the female agent regardless

of the gender of self-adaptors, and the female agent were perceived as more feminine than the male agent regardless of the gender of the self-adaptors by both gender of participants.

However, when we focus on the gender factor score of the female agent, a significant difference in participants' gender was found. As shows in Figure 8, in the case of female agent, the male participants perceived significant higher femininity to the female agent performing feminine self-adaptor ($F: 4.88$, $p<0.05$) than the same agent performing masculine ones. While the female participants showed no difference in the gender scores of the same agent conditions.

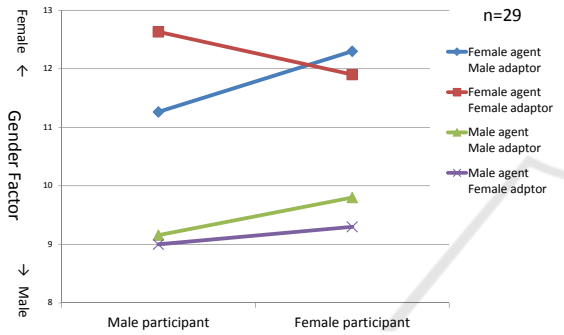

Figure 7: Gender factor scores of four conditions compared by participants' gender.

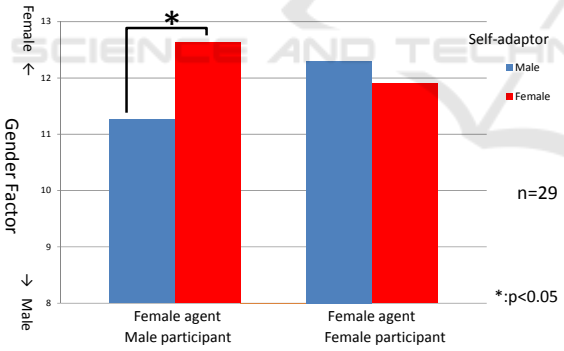

Figure 8: Gender factor scores of female agent conditions compared by participants' gender.

4.4 Analysis of Naturalness Factor

We performed three-way ANOVA for total factorial scores of "Naturalness factor". Figure 9 shows naturalness factor scores of four conditions. There are no significant main effects nor second-order interactions found in the naturalness factor. This means the participants perceived agents with all conditions as equally natural.

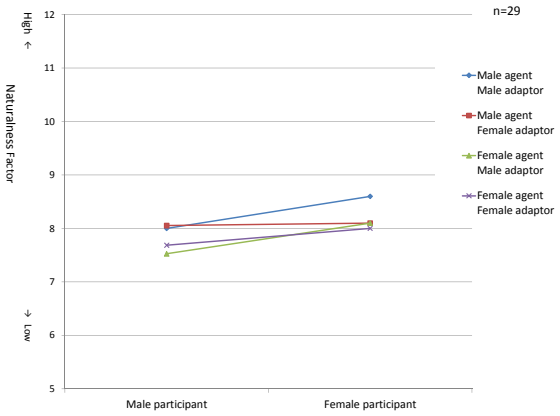

Figure 9: Naturalness factor score of four conditions.

5 DISCUSSION AND FUTURE DIRECTIONS

The above results showed we did not find deterioration in the perceived naturalness of agents when the agents' appearance and gender of self-adaptors don't match. In the case of the female agent, there are interactions between the participants' gender and gender of self-adaptors in the tolerance factor. Specifically, the female participants had lower impression on the feminine self-adaptors performed by the female agent. Thus, our hypothesis "when the participant's gender, agent's gender, and gender of the gender-specific self-adaptors are consistent, participants feel higher naturalness and have better impression toward the agent than any other combinations" was not fully supported. We will discuss why the hypothesis was not supported below.

When the participants evaluate the impression of the agents used in the experiment, the four factors forms the overall impression of the agent, namely, tolerance, sociability, gender, and naturalness. The analysis of gender factor showed the participants of both gender correctly perceived the gender of the agent. Only male participants perceived the feminine self-adaptors performed by the female agent as most feminine, while such correct perception did not occur in the case of the female participants, nor of the male agent, and the masculine self-adaptors. On the other hand, all agents in four conditions are perceived as equally natural even when the gender of the agent and the gender of self-adaptors don't match. In terms of perceived tolerance, the female agent's performing the feminine self-adaptors resulted in opposite impressions between the male and female participants. The male participants perceived the female agent performing feminine self-adaptors as most tolerant,

while the female participants rated the same condition as least tolerant in all conditions.

The results suggest interesting gender differences in perceiving the feminine self-adaptors. The Japanese male participants are in favour of the feminine self-adaptors, while the Japanese female participants have rigorous impression on them when they are performed by the female agent, without noticing the difference as all conditions are rated as equally natural. This suggest there is a dichotomy between participants' gender in the perception of combination of self-adaptor and agent's gender.

This research is still at a starting phase, thus has several limitations. Firstly, we need to conduct more fine grained study on the self-adaptor in human-human interactions. Extraction of self-adaptors was made from the video recordings of only 20 participants, who are undergraduate students in Japan. The evaluations of self-adaptor performing agents were made by 29 Japanese undergraduate students (different subjects from those who were videotaped). Given the enormous inter-subjective variability in gesture use, we need to conduct close observations on the form and movements of self-adaptors with larger samples with wider age range and cultures.

Secondly, although we compared only masculine/feminine self-adaptors in this experiment, we need to compare impressions with non-self-adaptor condition in order to evaluate the masculinity and feminity of the self-adaptors solely.

Thirdly, future work should also consider cultural diversity in expressing and perceiving self-adaptors. There are culturally-defined preferences in bodily expressions (Johnson, 2004, Rehm, 2007, Rehm, 2008, Aylett, 2009) and in facial expressions (Koda, 2009, Rehm, 2010), and allowance level of expressing non-verbal behaviour are culture-dependant. Japanese male tend to perform self-adaptors around their nose and chin more frequently than other cultures by observation, and Japanese female tend to cover their mouth while talking, which is considered as typical Japanese female self-adaptor. We will investigate culture specific self-adaptors from video recordings of human-human interactions from other cultures. Furthermore, we will implement them with agents, and conduct a cross-cultural evaluation study.

6 CONCLUSIONS

Our evaluation of the interactions between the agents that exhibit self-adaptors typically exhibited by Japanese male and female indicated that there is a dichotomy on the impression on the agent between participants' gender. Japanese male participants showed more favourable impressions on agents that display feminine self-adaptors than masculine ones performed by the female agent, while Japanese female participants showed rigorous impressions toward feminine self-adaptors. These results implies the importance of considering the use of self-adaptors and gender in successful human-agent interactions.

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