Importance of Considering User's Social Skills in Human-agent Interactions

Is Performing Self-adaptors Appropriate for Virtual Agents?

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Abstract: Self-adaptors are bodily behaviours that often involve self-touch that is regarded as taboo in public. However, self-adaptors also occur during casual conversations between friends. We developed a virtual agent that exhibits self-adaptors during conversation with users. Our continuous evaluation of the interaction between the agents that exhibit self-adaptors and without indicated that there is a dichotomy on the impression on the agents between users with high social skills and those with low skills. People with high social skills feel more friendliness toward an agent that exhibits self-adaptors than those with low social skills. The result suggests the need to tailor non-verbal behaviour of virtual agents according to user's social skills.

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 conversant are very relaxed (Blacking, 1977). Chartrand and Bargh have shown that mimicry of particular types of self-adaptors (e.g., 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 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.

Because self-adaptors have low message content and are low in relevancy to the contents of conversations, they are believed to be actions that are easily ignored during a conversation. Social skills, on the other hand, are personal characteristics that make interpersonal relationships smooth. They are defined as "skills that are instrumental in conducting smooth personal relationships" (Hayashi, 1982). People with high social skills are believed to be able to read nonverbal behaviours in communication with partners and use them advantageously in communication. Furthermore, persons with high social skills are believed to have a tendency to use a great amount of nonverbal communication behaviours in order to make communication with conversation partners richer. We focused on this characteristic of social skills and considered that it could have the same effect when applied to non-verbal behaviour of an agent.

Psychologists have found that people prefer personalities similar to their own (Izard, 1960, Duck, 1973). Reeves and Nass' research on the social responses of people to media indicated users showed a tendency to prefer computers with personalities similar to theirs (Reeves, 1996). These findings suggest that users would also prefer agents with similar personalities. Because of the characteristics of social skills, we conjectured that people with high social skills would consider self-adaptor-performing agents to have personalities similar to theirs. Thus, in this study, we made the following hypothesis: "Compared with people with low social skills, people with high social skills have a greater sense of friendliness toward an agent that exhibits self-adaptors." We conducted an experiment to verify this hypothesis.

Many research studies have been done on interactions between agents and users. However, most of these studies evaluate transient interactions; there have been few studies evaluating continued interactions between agents and users. One representative study is research on relational agents by Bickmore. They state that building trust is critical for continued interactions between users and agents (Bickmore, 2001, Bickmore 2010, Vardoulakis, 2012). In our study, we took the view that impressions of self-adaptors in informal communication are formed through multiple interactions. Thus, we did not evaluate impressions after one trial, but instead evaluated multiple interactions between agents and users by conducting multiple trials and evaluations. We believe the results of this study can be applied to the development of agent applications that require long-term interactions, i.e., counselling agents, by evaluating the effects of displaying self-adaptors with IVAs.

2 EXPERIMENTAL CONVERSATIONAL AGENT

We conducted a pre-experiment in order to examine when and what kind of self-adaptors occur during a casual conversation between friends. We invited four pairs who are friends for more than three years (they are university students who study together) to record their conversation. The recordings were more than 20 minute long but we evaluated the last 10 minutes when the conversation was active and they were not nervous about being videotaped. Based on the results of video analysis of the conversations, we found the following three types of self-adaptors occurred most frequently in most pairs: "touching hair," "touching cheek," and "touching nose." Each stroke occurred once as a slow movement. The timing was either at the beginning or at the end of an utterance. The self-adaptors implemented for the agents in (Neff, 2011) were repetitive quick hand scratches, rubbing, tapping, etc., as we see when the human conversant is nervous. We did not find those nervous repetitive movements during the casual conversations in the pre-experiment.

The agent character and animation of the three types of self-adaptors were created using Poser (http://poser.smithmicro.com/poser.html). Figure 1 shows the agent carrying out the movements of "touching hair", "touching nose", and "touching cheek". 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 pre-experiment. Besides these self-adaptors, we created animation of the agent making the gestures of "tilting its head" 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 ("head tilting" at the end of a question, "hand against chest" when addressing the agent itself) regardless of experimental conditions in order not to let self-adaptors stand out during a conversation with the agent.

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/). The contents of the conversations were casual (the route to school, residential area, and favourite food, etc.). 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.

The interaction between the agent and a participant was restricted as a pseudo conversation. 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 agent performs three self-adaptors during one interaction in the "with self-adaptor" condition. 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.

3 EXPERIMENTAL METHOD

The participants in the experiment were 24 Japanese undergraduate and graduate students (12 male and 12 female), aged 19-24 years. Their social skills were measured beforehand using KiSS-18 (Kikuchi's Scale of Social Skills: 18 items) (Kikuchi, 2004). KiSS-18 is a widely used scale for social skills in social, clinical, industrial, and educational psychology as well as nurse-education. Before the start of the experiment, they were separated into a high social skills (HSS) group and a low social skills (LSS) group. Because the average scores on the social skill scale for Japanese adult males and females are 61.82 and 60.10, respectively (Kikuchi, 2004), we used these scores as reference and

Figure 1: Agents that exhibit "touching hair" (top), "touching nose" (middle), and "touching cheek" (bottom) self-adaptors.

established the HSS group as having a score of 63 or above (11 participants) and the LSS group as having a score of 58 or below (13 participants).

The participants in the HSS group and the LSS group each carried out five rounds of conversation with either an agent that performed self-adaptors (7 participants in the HSS group and 7 participants in the LSS group) or an agent that did not perform self-adaptors (4 participants in the HSS group and 6 participants in the LSS group). Each participant conducted one conversation with the agent per day, and the type of agent (with or without self-adaptors) was kept the same for all trials of the experiment. The duration of one interaction is about 2 minutes. The difference between the two types of agents lay only in whether or not that the agent performed self-adaptors. The agents' appearance, voice, timing and number of gestures (tilting its head and placing its hand against its chest), and conversation contents were the same. Also, we prepared five conversation scenarios so that the contents of conversations would differ for each experimental trial. The order of the conversation scenarios for the trials was the same regardless of the type of agent. For the second trial and after, expressions such as "I'm glad we can talk again" were included to express the fact that this was not the first time the participant was conversing with the agent. The conditions of the experiment were

social skills (HSS group, LSS group), type of agent (with self-adaptors, without self-adaptors), and trial number (1st, 2nd, 3rd, 4th, 5th).

After each conversation, the participated rated their impressions on the agent using a semantic differential method on a scale from 1 to 6. For the participants' evaluation of impressions, a total of 23 pairs of adjectives, consisting of the 20 pairs from the Adjective Check List (ACL) for Interpersonal Cognition for Japanese (Hayashi, 1982) and three original pairs (concerning the agent's "humanness," "annoyingness," and "naturalness"), were used. The list of adjectives is shown in Table 1 in the result section. After the end of the 5th trial, a post-experiment survey was conducted in order to evaluate the participants' subjective impression of overall qualities of the agent, such as the naturalness of its movements and synthesized voice.

4 RESULTS

4.1 Analysis of Friendliness Factor

Factor analysis (FA) was conducted on the agent's impression ratings obtained from the experiment. The results of FA using the principal factor method are shown in Table 1. Three factors were extracted, and we named them as "friendliness" "cautiousness" and "tolerance." We see that when the participants perceive the agents interpersonally and rate their impressions, these three factors have a large effect. The first factor "friendliness" is composed of adjectives such as humanlike, friendly, natural, pleasant, and social. The second factor "cautiousness" is composed of adjectives such as cautious, mature, pertinent, and quiet. The third factor "tolerance" is composed of adjectives such as calm, and broad-minded.

We totalled the measured scores of adjectives highly correlated to each FA-extracted factor (high factor loadings), then we used the total score of each factor for analyses. We ran three-way ANOVA with factors "social skills" (HSS, LSS), "self-adaptors" (with, without), and "number of trials" (1st, 5th) (repeated measures). The dependent variable was the total score on perceived friendliness of the agent.

For friendliness, significant second-order interaction ($p<0.01$) was seen between the factors social skills, self-adaptors, and number of trials. Figure 2 shows the results of multiple comparisons of friendliness by social skills for treatments of self-adaptors and number of trials. Significant

Table 1: Results of Factor Analysis (after Promax rotation).

Adjectives	Factor 1	Factor 2	Factor 3
Unhumanlike – Humanlike	1.009	-.098	-.205
Unfriendly – Friendly	.930	-.309	.118
Unnatural – Natural	.906	.006	-.030
Unpleasant – Pleasant	.889	.050	.002
Unsocial – Social	.856	.075	-.217
Inert – Active	.784	.020	-.044
Gloomy – Cheerful	.784	-.185	.098
Hateful – Lovable	.775	.069	.135
Hard-hearted – Soft-hearted	.736	.219	-.007
Passive – Positive	.700	-.140	-.125
Hostile – Amicable	.681	-.145	.333
Unkind – Kind	.681	.205	.076
Unreasonable – Reasonable	.509	.204	-.089
Irresponsible – Responsible	.488	.485	.008
Incautious – Cautious	-.181	.751	-.069
Immature – Mature	-.148	.645	.188
Impertinent – Pertinent	.403	.502	.012
Annoying – Quiet	.069	.434	.155
Short-tempered – Calm	-.211	.143	.863
Narrow-minded – Broad-minded	.297	.001	.527
Servile – Grand	.162	-.014	.177
Unconfident – Confidente	.238	-.006	.096
Shy – Unshy	-.148	-.242	.062

differences of friendliness ratings ($p<0.05$) are seen between the social skills in the condition of "with self-adaptors in the 1st trial" (HSS group: 64.0 (SE 8.0) > LSS group: 51.9 (SE 11.6)) and of "with self-adaptors in the 5th trial" (HSS group: 69.1 (SE 6.5) > LSS group: 52.0 (SE 13.2)). Compared with the LSS group, the HSS group rated significantly higher friendliness toward the self-adaptor-performing agent after both the 1st and the 5th trial.

Next, the results of multiple comparisons of friendliness by self-adaptors for treatments of the factors social skills and number of trials are shown in Figure 3. No significant difference between with self-adaptor and without could be seen for any of the treatments of social skills and number of trials.

The results of multiple comparisons of friendliness by number of trials for treatments of social skills and self-adaptors are shown in Figure 4. A significant difference of friendliness ratings ($p<0.05$) are seen between the 1st trial and the 5th trial in the condition of "high social skills and with self-adaptors" (1st: 64.0 (SE 8.0) < 5th: 69.1 (SE 6.5)), and of "low social skills and without self-adaptors" (1st: 51.9 (SE 11.6) < 5th: 55.2 (SE 16.3)). Participants in the HSS group evaluated agents that performed self-adaptors to be significantly friendlier after the 5th trail than after the 1st trial. Participants in the LSS group rated agents that did not perform self-adaptors to be significantly friendlier after the 5th trial than after the 1st trial.

Three-way ANOVA of social skills, self-adaptors, and number of trials was con-ducted using cautiousness's scale of measurement. None of the factors showed significance in their main effects and interactions.
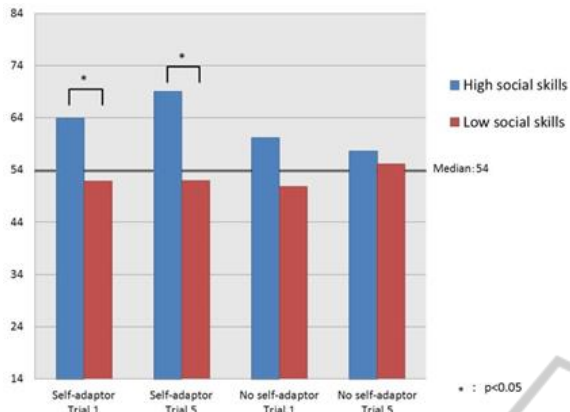
Figure 2: Results of Multiple Comparisons of Friendliness Scores by Social Skills for Treatments of self-adaptors and Number of Trials.
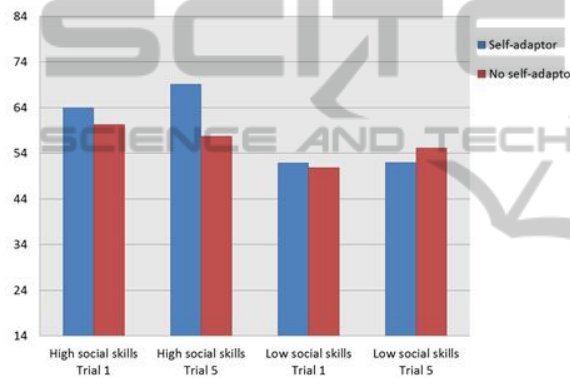

Figure 3: Results of Multiple Comparisons of Friendliness Scores by Self-adaptors for Treatments of the Factors Social Skills and Number of Trials.
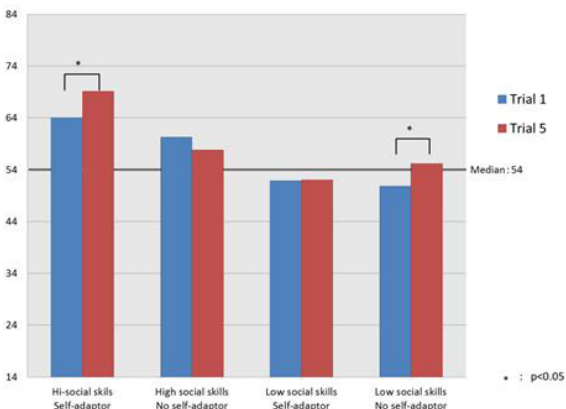

Figure 4: Results of Multiple Comparisons of Friendliness Scores by Number of Trials for Treatments of Social Skills and Self-adaptors.

4.2 Analysis of Tolerance Factor

We ran three-way ANOVA with factors "social skills" (HSS, LSS), "self-adaptors" (with, without), and "number of trials" (1st and 5th) (repeated measures). The dependent variables were participants' ratings on perceived tolerance of the agent. Significant first-order interaction ($p<0.05$) was seen between social skills and number of trials. The results of multiple comparisons of tolerance scores by social skills for treatments of number of trials are shown in Figure 5. For the 1st trial, a significant difference between social skills is seen ($p<0.05$; HSS group: 8.9 (SE 1.4) > LSS group: 7.2 (SE 1.9)). In the case of the 1st trial, compared with the LSS group, the HSS group evaluated the agent to be significantly more tolerant.

The results of multiple comparison of number of trials for the treatment of social skills factor are shown in Figure 6. For participants with low social skills, significant difference is seen between the number of trials ($p<0.05$; 1st trial: 7.2 (SE 1.9) < 5th trial: 8.1(SE 1.6)). Participants in the LSS group evaluated the agent to be significantly more tolerant after the 5th trial than after the 1st trial.
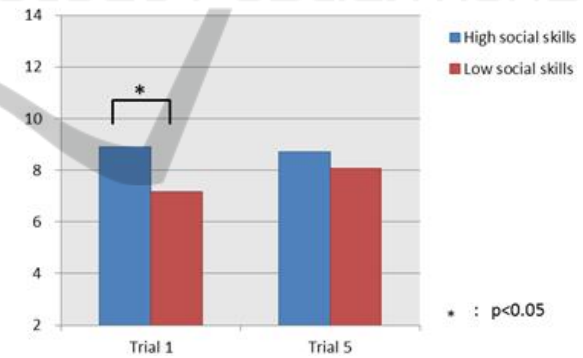

Figure 5: Results of Multiple Comparison of Tolerance Scores by Social Skills for Treatments of Number of Trials.
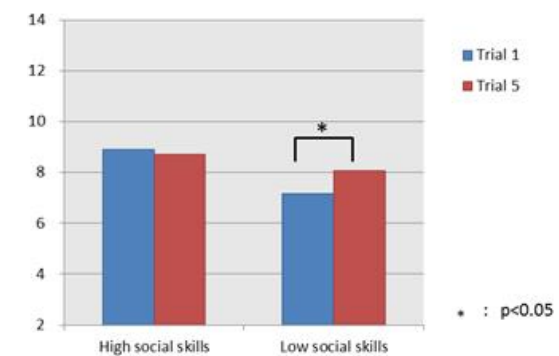

Figure 6: Results of Multiple Comparisons of Tolerance Scores by Number of Trials for the Treatment of Social Skills.

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4.3 Analysis of Post-Experiment Survey

A two-way ANOVA of social skills and self-adaptors was conducted using the post-experiment survey's scores (given on 8-point scale from 1: Low to 8: High). Significant interaction ($p < 0.05$) between social skills and self-adaptors is seen for the question, "Were you bothered by the agent's actions?" The results of multiple comparisons of self-adaptors for each level of the social skills factor showed a significant difference in self-adaptors ($p < 0.05$; with self-adaptor: 5.43 > without self-adaptor: 3.83) for the LSS group. The LSS group felt significantly more bothered by the agent with self-adaptors than by the agent without self-adaptors.

Concerning the question, "Was it easy to listen to the agent's voice?" social skills' main effect was significant ($p < 0.05$). Compared with the LSS group (4.69), the HSS group evaluated the agents as significantly easier to listen to (6.18).

5 DISCUSSION

5.1 Discussion of Results of Analysis of Friendliness Factor

From Figure 2, we see that compared with the LSS group, the HSS group felt a significantly higher sense of friendliness toward the agent with self-adaptors, both after the 1st trial and the 5th trial. From this finding, we can say that regardless of the number of trials in this experiment, the HSS group had a significantly higher sense of friendliness toward the agent that performed self-adaptors than the LSS group did. Also, because there was not much difference between the LSS group's scores for the condition of self-adaptors and number of trials, we believe that it was not the case that the LSS group did not have a sense of friendliness toward the agent with self-adaptors; rather, the HSS group felt a stronger sense of friendless toward the agent. This result supports the hypothesis, "Compared with people with low social skills, people with high social skills feel a greater sense of friendliness toward the agent that exhibits self-adaptors."

From Figure 3, we see that the results of multiple comparisons of friendliness scores by self-adaptors for treatments of the social skills and number of trials show that there was no significant difference between "with self-adaptors" and "without self-adaptors" for any of the treatments of social skills

and number of trials. This result suggests that there was no significant difference in friendliness due to only self-adaptors. Although not significant, there was relatively a large difference in the friendliness scores between self-adaptor conditions for the HSS group, but only a small difference was seen for the LSS group. This finding also suggests that it was not that the LSS group lacked a sense of friendliness toward the agent with self-adaptors, but rather, the HSS group felt a stronger sense of friendliness toward the agent with self-adaptors.

Figure 4 indicates that the HSS group rated the agent with self-adaptors as significantly friendlier after the 5th trial than after the 1st trial. The LSS group rated the agent without self-adaptors as significantly friendlier after the 5th trial than after the 1st trial. From this finding, we can say that when it comes to continued interactions with an agent, a sense of friendliness increased for the HSS group as a result of the agent's performing self-adaptors. In contrast, a sense of friendliness increased for the LSS group as a result of the agent's without self-adaptors. This result also supports our hypothesis. Also, because in continued interactions with the agent the LSS group experienced an improved sense of friendliness toward the agent without self-adaptors, in contrast to the HSS group's experiencing an improved sense of friendliness toward the agent with self-adaptors, we can say that there is a dichotomy between the evaluation of friendliness by the HSS group and the LSS group with regards to the agent performing self-adaptors.

From these results, our hypothesis was supported. They also suggest the need to develop agents that meet the level of the users' social skills when enabling agents with self-adaptors. Also suggested by the results is the possibility that a sense of friendliness toward the agent by users can be increased in a continual manner by taking into account the level of the users' social skills and whether or not to have the agent perform self-adaptors during continued interactions.

5.2 Discussion of Results of Analysis of Tolerance Factor

Figure 5 indicates that compared with the LSS group, the HSS group rated the agent as significantly more tolerant after the 1st trial. Figure 6 indicates that the LSS group rated the agent as significantly more tolerant after the 5th trial than after the 1st trial.

These results suggest that although the LSS group did not rate the agent as tolerant compared with the HSS group, their evaluation of tolerance

increased during continued interactions with the agent. On the contrary, the HSS group's evaluation of the agent's tolerance did not increase during continued interactions. However, the HSS group rated the agent as more tolerant than the LSS group did from the first interaction.

5.3 Discussion of Post-Experiment Survey

Regarding the question, "Did you feel bothered by the agent's actions?" the LSS group was significantly more bothered by the agent with self-adaptors than the agent without. This result is related to the LSS group's low evaluation of the friendliness of the agent with self-adaptors. Being bothered by the agent's actions affected the evaluation of friendliness negatively. For the LSS group, "being bothered" was probably considered the same as "not being able to stand it." Because no difference in the bothered-ness was seen between self-adaptor conditions for the HSS group, this suggests that the LSS group had an oversensitive response to the agent's performance of self-adaptors.

Regarding the question, "Was it easy to listen to the agent's voice?" the HSS group rated the agents' voice as significantly easy to listen to compared with the LSS group. The agent's voice was the exactly the same for the HSS group and LSS group. The results suggest the possibility that in general, the HSS group had positive view of the agent, whereas the LSS group had a negative view of the agent.

5.4 Limitations and Future Work

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. For example, we need to conduct close observations on the form and movements of self-adaptors with larger samples. In this research we had only four pairs of conversations.

Secondly, on the implementation of self-adaptors to the agent, our next work should include both relaxed and stressful self-adaptors. While we used a female figure of an agent in this experiment, implementing a male agent and evaluation by both genders are also needed.

Thirdly, we cannot exclude the effects of the conversational content when evaluating perceived impression on the agent. Although self-adaptors are indirectly related to what is being said, and we carefully designed the conversation scenarios so as not to leave any particular impression on the topic, it

is hard to evaluate self-adaptors completely isolated from the content of the conversation.

Future work should also consider cultural differences in expressing and perceiving self-adaptors, since 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.

6 CONCLUSIONS

Our results suggest the importance of changing the level of displaying self-adaptors of IVAs according to the users' social skills. The dichotomy between the use's social skills suggests that it is possible to continually improve users' sense of friendliness toward IVAs by combining the presence of self-adaptors with the user's level of social skills during continued interactions with agents. We believe that it is possible to efficiently elicit users' sense of agent's friendliness for both people with high social skills and with low social skills by finely adjusting the appropriate timing of the agent's performances of self-adaptors and their frequency depending the user's level of social skills. Because users with high social skills frequently make nonverbal movements such as gestures and nods, and users with low social skills have a low frequency of these nonverbal movements, it is possible to use tools such as Kinect sensors to detect users' movements and frequency during conversations and estimate their level of social skills. If we can develop agents that use the estimation results to automatically control the number and frequency of self-adaptors and draw out a sense of friendliness from users, we can sustain high-quality agent interactions. The results of this research could be applied to the development of IVAs with which users require long-term interaction, such as counselling agents.

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