アニメーション・エージェントとの感覚共有を想像することが人間－エージェント間のインタラクションに及ぼす影響

The Effects on the Human-Agent Interaction of Users' Imagination of Sensations Experienced by the Animated On-Screen Agent

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Keywords
アニメーション・エージェント，ヒューマンエージェントインタラクション，感覚共有の演出
animated agent, Human-agent interaction, conjuring the image of feeling information

ABSTRACT

今井（2006）は，ロボットの発話を自分自身の感覚と結びつけることが，人間にロボットが自身と同じ感覚を有していることを想像させ，その結果，人間がロボットの意図や状況を推測するというかたちでインタラクションに没入することを示唆している．本研究では，大学生を対象に画面上のアニメーション・エージェントと感覚を共有する演出の効果が検討された．今井（2006）の手続きに基づき，感覚を共有する演出は実験のために準備されたお菓子を参加者が食べると同時にエージェントが「おいしいでしょ」と発話することで行われ，またインタラクションへの没入はエージェントの指示に参加者が従うかどうかを確認することで行われた．感覚共有の演出がある実験群は，演出のない対照群に比べて，エージェントの「髪に何かついていますよ」という単純な指示には従う傾向が示されたものの，「お土産をもって帰ってね」という複雑な指示に対しては群間で特定の傾向は示されなかった．この結果は，参加者がエージェントの備えているであろう機能的な側面をどのように評価していたのかという観点から検討された．

Based on Imai (2006) study that conjuring the image of that Robot has same feeling with participants induces the attitude of looking from the Robot's standpoint, the present study examined the effect in the interaction with an animated agent in the computer screen. In the experiment, participants simply observed that the animated agent simultaneously expressed their taste ("It tastes good!") when they eat a prepared cookie for the experiment and later whether they follow the instruction by the animated agent was checked. The results showed that the tendency of following agent's simple instruction ("Have something in your hair?") was higher for those participants who observed the animated agent simultaneously expressed their taste than those who observed animated agent do not expressed their taste, although this tendency is not shown in case that agent's instruction is intricate ("Please bring this souvenirs"). That is, the participants who had an opportunity that they imaged the agent had same sensory experience with themselves often followed the agent's simple instruction. Discussion on this finding is developed in term of how participants perceived the functional competence of animated agent.

Introduction

Recently, the science of learning is receiving increasing attention as a means of establishing effective multimedia designs based on theories of learning and evidence-based principles of learning and instructional practice (Ayres & Paas, 2007; Mayer, 2009). Interface agents, which often appear in an animated human or animal form on a computer screen, are now receiving special attention. These on-screen animated agents, known as Embodied Conversational Agents, Intelligent Agents, or Animated Pedagogical Agents (APAs), etc. depending on their intended purpose, and the impact of communication with these agents have been receiving researchers' attention of late (Isbister & Doyle, 2004).

One aspect of agent-based systems that may have an effect on the effectiveness of learning is the role they are assumed to play as users interact with them. The potential power of an animated agent that can mimic face-to-face communication such as a learner might have with a human tutor, instructor, mentor, or peer, offers great promise for ever more effective multimedia learning environments in the future (Grasser, Chipman & King, 2008). The impact of communication with such agents on users' learning has been studied by a number of researchers in several disciplinary areas, including psychology (e.g., Atkinson, 2002; Choi & Clark, 2006; Craig, Gholson & Driscoll, 2002; Dunsworth & Atkinson, 2007; Louwerse, Graesser, Lu & Mitchell, 2005; Moreno, Mayer, Spires & Lester, 2001; Moundridou & Virvou, 2002; Nakajima, Morishima, Yamada, Brave, Maldonado, Nass & Kawaji, 2004; Veletsianos, 2009; for a review see Moreno, 2005). While many previous studies have consistently reported high subjective evaluations of the effectiveness of incorporating such agents into multimedia environments, learning outcomes as indicated by such measures as retention and transfer tests do not always confirm the presumed effectiveness of incorporating such agents into multimedia environments. Therefore, the positive evaluation of such agents depends on the ways in which they are utilized and efforts continue to develop the efficacy of animated agents for students' learning in multimedia contexts.

The present study focused on the difficulty of natural interaction between an artificial entity and a human being and considered ways to smoothly enhance the human-agent interaction. Whereas most previous studies have discussed the usefulness of an agent in the context of learning based on

performance on retention and transfer tests, not many studies have focused on the nature of the interaction itself although some researchers have pointed to the importance of considering what it means to interact with a digital entity (e.g. Veletsianos, 2008). It is not unreasonable to imagine that the presence in a multimedia environment of a highly visible human-like cartoon character that is intended to emphasize social presence might lead to the enhancement of learning. This basic idea is captured in the "Media Equation" as suggested by Reeves & Nass (1996). Even subtle social cues are known to induce an automatic response from people in accordance with social rules of communication. In a study by Nakajima et al. (2004), participants completed a multiple-choice test based on what was to have been learned. Each multiple-choice item consisted of four choices with "I don't know" as the fourth choice, implying "No response". Participants who received empathic words from an animated agent showed a tendency not to select the choice of "I don't know", suggesting that they did not maintain a passive attitude toward the test, possibly as a result of human-agent interaction related to learning activity. Therefore, exploring whether learning activity can be enhanced by emphasizing an agent's social cues as a way of inducing human-agent interaction is an issue worth exploring.

The present study relates to the results of an experiment by Imai (2006) who considered the effects of having participants interact with a robot operated by the experimenter in an engaging and socially appropriate manner. Imai was concerned with whether reactions emitted by a robot to a sensory event such as taste experienced by a participant might induce the participant to infer what the robot intends to do, thereby triggering the participant to become immersed in his/her interaction with the robot. In like manner in an educational context, a program designer might be able to adjust a learner's attitude to infer what an animated agent, as the "teacher", intends to do in a way that might prove effective in allowing the learner to gain insight into the "teacher's" viewpoint regarding the learning that should occur in a given situation.

The present study examined the potential for immersion in a human-agent interaction in reference to the experimental procedures developed by Imai (2006). Participants were encouraged to perceive an on-screen animated agent's behavior as indicating that the agent had experienced a taste sensation similar to that actually experienced by the participant. As participants experienced eating a sweet cookie, the agent commented concurrently on the cookie's taste ("It tastes good!"), the idea being to encourage the participants to imagine that the sensory experience of the animated agent's was similar to what they had experienced themselves. In the present experiment, an on-screen animated agent played the role of a horticulturist who lectured to the participants on the features of several plants. The process of encouraging a "relationship" between the participants and the agent was embedded during a pause in the lecture. Although an on-screen animated agent was used in the present study instead of a robot as used by Imai (2006), similar results were expected. In particular, it was hypothesized that participants who imagined that the animated agent had experienced a taste sensation similar to their own would be more inclined to follow the agent's instructions compared to those participants who did not imagine a shared sensory experience. The effects of two different kinds of instructions (simple vs. intricate) from the animated agent on the human-agent interaction were also examined.

Method

Participants: A total of 38 participants (8 male and 30 female) served in this experiment. All were undergraduate students attending the International Christian University located in Mitaka, Tokyo,

Japan.

Design: Participants were assigned to one of two groups which differed in terms of the experimental procedure to which they were subjected. In the feeling information group (FI group), an attempt was made to have participants "connect" with the agent by having the agent make a comment on taste as the participant was eating a cookie. In the no image of feeling group (NFI), the animated agent provided factual information not related to the taste sensation experienced by the participants as they were eating a cookie.

Apparatus & Material: The animated agent appeared as a female cartoon like character wearing clothes appropriate to a horticulturist. The appearance of the agent was created by using "Sashie Studio" clip art (Shusaku Co., Ltd). A 17 inch CRT display monitor (Nanao, Flex Scan 53T) and Microsoft PowerPoint deployed on a Windows-based personal computer (Dell, Latitude X200) were used to present the visual information to participants, including pictures of several plants. The narration was recorded by a female volunteer who spoke with a standard Japanese accent. Figures 1 and 2 show the on-screen interface with which the participants engaged. In addition, a questionnaire and five cookies placed in a basket were located on the right side of the CRT monitor to make it easier for participants to pick them up.

Procedure: Figure 3 shows the flowchart of the experiment. After exchanging courtesies and obtaining informed consent, the experimenter informed participants as they sat in front of the computer screen that all stages of the experiment would be presented by the animated agent on the computer screen from beginning to end. In the first stage, the pre-programmed animated agent asked participants to take the questionnaire located on the right side of the monitor and to complete it by providing basic demographic information such as age, gender, major, etc. Upon completion of the questionnaire, the animated agent then proceeded to give a lecture on several plants (e.g. the place of origin, the condition of growth, etc.). Participants were instructed to take one break during the lecture and were encouraged to eat one of the cookies in the basket located by the side of the monitor. While eating the cookie, participants in the FI group heard the agent make a comment on the taste of the cookie ("It tastes good!") while participants in the NFI group and the other heard the agent

Figure 1. A screen shot of instructions being issued by the agent.

Figure 2. A screen shot of the lecture about plants given by the agent.

make a factual comment ("There are five cookies in the basket."). Synchronizing these comments by the agent with the eating of the cookie by the participants was accomplished by asking participants to click a computer mouse when they put a cookie in their mouth. Before restarting the lecture on plants, the animated agent talked to the participant saying "Do you have something in your hair?" and the experimenter, who was out of sight of the participant, observed whether the participant touched his/her hair in response to the agent's comment. After this, the lecture restarted and participants received an explanation about two different types of plant. The time between the agent's comment and the restarting of the lecture was three seconds. Finally, the animated agent informed the participant that the experiment had been completed successfully and asked the participant to move to an adjacent room (The agent said "Please take a souvenir and move to the next room with your belongings."). The experimenter conducted a debriefing session in the adjacent room and recorded whether the participant had taken a wrapped cookie from the experimental room as instructed by the agent. The experimental session from beginning to end lasted approximately 15 minutes for each participant.

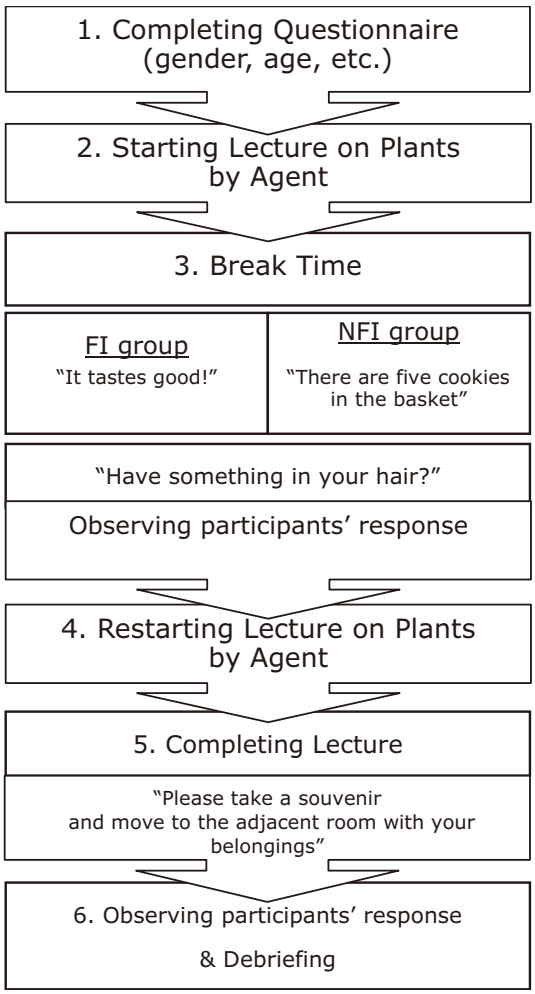

Figure 3. A flowchart of the experimental procedure.

Results

Figure 4 indicates whether participants responded to the agent's more intricate instructions while Figure 5 indicates whether participants responded to the agent's simpler instructions. While participants assigned to the no imagination of the agent's feeling condition (NIF group) showed a tendency not to touch their hair following the agent's instruction, participants in the imagination of the agent's feeling condition (FI group) were inclined to touch their hair somewhat more frequently following the agent's instruction. In addition, regardless of experimental condition, participants were not inclined to take a wrapped cookie as they departed from the experimental room. A Chi-square test of independence suggested no relationship between a tendency towards imagining the agent's experience and participants' response to the agent's instruction to take a cookie, $\chi^2(1, N = 38) = .00$, *n.s*). On the other hand, there was a relationship between a tendency towards imagining the agent's experience and participant's response to the agent's instruction about the participant's hair, $\chi^2(1, N = 38) = 3.97$, $p < .05$.

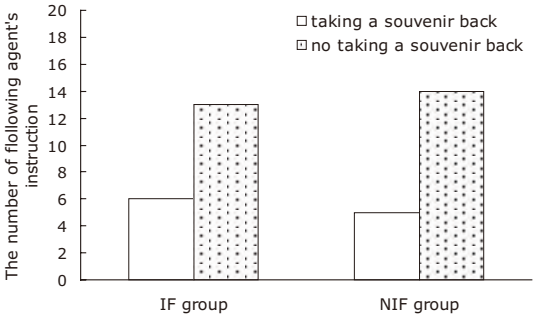

Figure 4. Number of participants following the agent's instruction to "take a souvenir cookie" following the more intricate instruction by the agent.

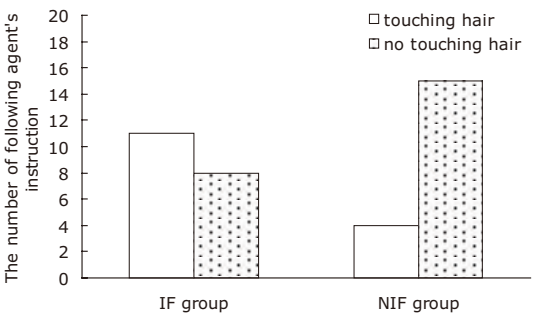

Figure 5. Number of participants responding by touching their hair following the agent's simple comment regarding whether there was something in their hair.

Discussion

The present study sought to experimentally induce in participants a sense of a shared taste experience with an animated agent to observe what effects, if any, such an experience might have on the subsequent behavior of participants. Most participants who imagined that the animated agent had a sense of taste did not show a tendency to comply with the agent's instruction take a wrapped cookie upon leaving the experimental room although they were encouraged to touch their hair following the agent's comment on the possibility of something being in their hair. That is, a tendency to follow a robot's instruction as reported by Imai (2006) was observed only partially in the present experimenter in which an on-screen animated agent was employed. Therefore, the intricacy versus simple instruction situations used in the present study might require re-examination. In the debriefing, several participants mentioned that they did not pay attention to the agent's instructions because they thought the agent could not interact with them and was therefore probably not related to the purpose of the experiment. Therefore, if the animated agent had been equipped with a sensor that implied that the agent could monitor the participant, then it is possible that participants would have been more likely to follow the agent's instructions. The difference between the present findings and those of (Imai, 2006) might relate to the possibility that people tend to recognize a robot as a functional with a kind of autonomy and intelligence which an on-screen animated agent such as that used in the present study lacks such characteristics. The tendency for participants to touch their hair following a comment by the agent that something might be in their hair brings to mind the Media Equation of Reeves & Nass (1996) and the idea that even subtle social cues may induce an automatic response from humans in accordance with the social conventions of communication. In the present experiment it is possible that the intricacy instruction related to identifying what a souvenir means and taking it back may have given participants time to recognize the animated agent as a virtual entity which might have interfered with a tendency to immerse themselves in an interaction with the on-screen animated agent. If so, educational designers need to emphasize that an animated agent should be convey to some degree an aura of competence and autonomy in order to attract people into interacting with such agents. In that regard, the observation in the present study that participants who imagined sharing feelings with the animated agent showed a tendency to follow the agent's simple instruction is noteworthy. Whether

such a tendency indicates an attitude to infer another's intention such as Imai (2006) suggested is equivocal based on the data from the present experiment, but further attention should be directed to this issue as a possible way of encouraging people to cooperate actively with an animated agent.

It is recommended that future studies should focus on the following aspects to confirm and extend the results of the present study. The effect of endowing an animated agent with functional characteristics on subsequent human-agent interactions requires further investigation. As most participants in the present study were likely to have been aware that the function of software utilized in the experiment was limited to a one-way presentation, participants may not have anticipated any possibility of interacting with the animated agent. Therefore, subsequent experiments should utilize software that gives rise in participants to the possibility of interacting with the animated agent.

In addition, the effects of imagining sharing sensory information with an animated agent on subsequent participant's response should be observed on a continuous basis. For example, the results of the present experiment may relate to having placed greater emphasis on sharing a sensory experience with the animated agent than on mutual activity with the agent. If greater emphasis had been placed on sharing activity with the agent in the present study, it is possible that participants would have been more likely to engage subsequently in activity with the agent. To clarify these points, it is necessary to include different ways of relating with an animated agent as an experimental variable. Overall, the results of this study point to the importance of further experimentation to identify the circumstances under which smooth, natural, engaging, and socially appropriate interactions with on-screen animated agents may be encouraged, thereby enhancing the prospect that effective learning outcomes can be achieved using this medium of instruction.

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