

The Effect of the Visual Gender of an Embodied Agent: A Cross-Cultural Comparison

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ABSTRACT

This study explored if the visual gender representations (androgynous, male, or female) of an embodied agent would influence students' perceptions of their agent and their attitudes toward the agent as their conversational partner. The study also explored if students' gender and cultural background would interact with the agent's visual gender to influence their perceptions and attitudes. Participants were 208 early-teen students sampled from US and South Korea. The results revealed that student gender was a significant factor for influencing students' perceptions and attitudes and that the students showed positive attitudes toward an androgynous agent more than toward a gendered agent (either male or female).

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Purpose of Study

Embodied conversational agents (ECAs) are animated digital characters that interact with a user in natural language via text or voice. ECAs enrich users' social interactions with computers and are becoming increasingly popular in a variety of contexts, where they play various roles like coaches, peers, tutors, or tutees. This study explored if the visual gender representations (androgynous, male, or female) of an ECA would influence US and Korean students' perceptions of their agent and their attitudes toward the agent as their conversational partner. The study also explored if students' gender and cultural background would interact with the agent's visual gender to influence their perceptions and attitudes.

Theoretical Background

When people encounter someone, they first determine the person's gender. This gender categorization in turn colors subsequent responses and evaluations (Brave, Nass, & Hutchinson, 2005). People tend to evaluate an identical proposal, narrative, or message delivered by a man versus by a woman differently in accordance with gender stereotypes (Adelswärd, 1999; Bem 1993). A study by Voelker (1994) shows how the gendered evaluative patterns known from social psychology are manifested consistently in computing, such as computer-mediated communications and users' interactions with a computer system itself (Reeves & Nass, 1996). Users' reactions are clearly differentiated when female voices are electronically altered to be feminine-sounding or when altered to be masculine-sounding. Just as an identification of the other person's gender plays an important role in human-to-human relations, it is also very likely in human-agent relations. It might be warranted to investigate the impact of an agent's visual gender in educational applications and the relationship between a learner's identification of the agent's gender and his/her willingness to work with the agent.

Until now, research on the social interactions between learners and ECAs has usually highlighted their potential benefits: i.e., promoting learner motivation and, thereby, increasing learning. However, an early call to equally consider "a darker side" of these interactions was made as well (Angeli & Brahnham, 2008). That is, social biases and stereotypes in the real world are consistently applied to learner-agent interaction. The increasing use of embodied agents in digital learning environments renders agents' external representations too significant to ignore. Veletsianos and colleagues (2010) bring up that user reactions are influenced by the visual representation of virtual agents. Previous studies in agents have examined the impact of male and female agents, but not gender-neutral agents (i.e., androgyny). If a

gender-neutral agent would work just as well as a gendered agent, we can provide agent-based learning that is free from gender-related stereotypes.

Research Questions

This study investigated how an agent's visual gender, students' gender, and students' cultural background would influence learners' experiences in working with the agent. The research questions (RQs) were, 1) Will student gender and cultural background affect students' perception of their agent? 2) Will student gender and cultural background affect students' attitudes toward the agent as a conversational partner? 3) Will an agent's visual gender, students' gender, and students' cultural background interact to influence students' perception? 4) Will an agent's visual gender, students' gender, and students' cultural background interact to influence students' attitudes?

Method

Participant

Participants were 207 students (84 male and 123 female) sampled both from the United States and South Korea. Eighty-six students (37 male and 49 female) were obtained from a middle school in a medium-size city in a mountain-west state in the United States. One hundred and twenty-one students (47 male and 74 female) were obtained from an elementary school in a large city in South Korea. In both countries, sampling was done by participants' age that ranged from 12 to 15 (an average of 12.96); consequently, the grade levels turned out to be different.

Material

The intervention was a math game, integrated with an ECA playing as a teachable agent (i.e., a tutee), meaning that the student taught the agent. The game

aimed at training the base-10 system (such as carry-overs and borrowings). The game employs a board-game design, including playing cards and a common game board, with several game modes and levels of difficulty. All arithmetic operations are visualized, using the graphical metaphor of squares and boxes that can be “packed” or “unpacked” in numbers of 10. The goal is to consistently pick the cards that, in combination with what is represented on the game board, maximize the number of carry-overs (in the addition games) or borrowings (in the subtraction games). See the screenshots in Figure 1.

Three variations of agent gender were designed: female, androgynous, and male. Both US students and Koreans played the math game in English during two subsequent classes. For the first time, all students played the game with androgynous *Chris*; for the second time, they were randomly assigned either to female *Jude* or male *Jude*. *Chris* and *Jude* were different only in their visual genders and identical in everything else, such as questions, behaviors, conversational style, etc. The visual design of the three agents used a common basic set of graphical elements and exploited a number of visual strategies. To ensure the validity of the visual representations, we asked the students to indicate if the agent looked male-like or female-like on a five-level Likert scale at the end of the game. There was no significant difference in students’ identification of androgynous *Chris*’ gender, but the students identified male *Jude* significantly as male-like and female *Jude* significantly as female-like.

The agent offered two conversational modes in the game. One was a guided conversation with multiple-choice options, where the agent asked questions about mathematical concepts, and the students answered by choosing one out of several alternatives. The other mode was social conversation (i.e., chatting), where the

learners typed in freely on any topic. The two modes adopted the metaphor of breaks between regular classes in school, switching between playing the game with on-task dialogue and off-task social conversation.



Figure 1. Screenshots.

Variables and Measures

There were three independent variables. First, student gender had two levels of female vs. male. Second, students' cultural background was operationalized by their nationality and had two levels of US vs. Korean. Third, agent visual gender had three levels of female vs. androgynous vs. male as shown in Figure 2.



Figure 2. Female, androgynous, and male agents.

Dependent measures included students' perceptions of their agent and their attitudes toward their agent as a conversational partner. Students' perceptions were measured by a questionnaire with 5 items scaled from 1 (Strongly disagree) to 5 (Strongly agree), e.g., "Chris (or Jude) feels like someone who can be trusted" and "Chris (or Jude) feels similar to me." Students' attitudes were measured by a questionnaire with 5 items scaled from 1 (Strongly disagree) to 5 (Strongly agree), e.g., "I got glad when I chatted with Chris (or Jude)" and "I made an effort to ask and answer in a good way to Chris (or Jude)."

Procedure

The math game was implemented twice a week apart from each other, with each session lasting about 45 minutes. All students first played with a visually androgynous agent, Chris; then, were randomly assigned to either female Jude or male Jude. In each session, they played the game and also socially chatted with the agent. In the first session, the researchers introduced them to the game activity and gave login instructions. The students first watched an introduction video, played the game three or four rounds individually with androgynous Chris. At the end of each round, they were asked to chat with Chris for about three minutes. This session concluded with the students' filling out the questionnaires. The second session took place one week after the first session. This time the students were randomly assigned either to male Jude or female Jude and taught Jude to play the game. They first played themselves, thereafter taught Jude, and finally let Jude play against the computer. They also chatted with Jude in a similar manner. Finally the students filled out the questionnaires.

Data Collection and Analysis

Data on the students' perceptions their attitudes were collected with paper-based questionnaires without agent presence. Information on students' prior online chatting experiences were collected and used as a covariate in the subsequent analyses. To analyze RQ1 and RQ2, a two-way ANCOVA was conducted, in which student gender and cultural background had two levels each. To analyze RQ3 and RQ4, a three-way repeated ANCOVA was conducted.

Results

Perceptions of the Agent

For RQ1 about the effect of student gender and cultural background on perceptions, a two-way ANCOVA conducted with the data collected after they worked with androgynous Chris revealed a significant main effect of student gender, $F(1, 175) = 5.65, p = .019, \text{Partial } \eta^2 = .031$. Regardless of their cultural backgrounds, girls perceived androgynous Chris significantly more positively than did boys. Also, a two-way ANCOVA conducted with the data collected after they worked with gendered Jude (either male or female) revealed a significant main effect of student gender, $F(1, 171) = 6.28, p = .013, \text{Partial } \eta^2 = .035$. Girls perceived gendered Jude significantly more positively than did boys.

For RQ3 about the effect of student gender, cultural background, and agent visual gender, a three-way repeated ANCOVA revealed a significant main effect of agent visual gender, $F(1, 149) = 10.424, p = .002, \text{Partial } \eta^2 = .065$. Regardless of student gender and cultural background, students perceived androgynous Chris most favorably and male Jude least favorably.

Attitudes toward the Agent as a Conversational Partner

For RQ2 about the effect of student gender and student cultural background on students' attitudes, a two-way ANCOVA twice: one with the data collected after they worked with androgynous Chris revealed a significant main effect of student gender, $F(1, 180) = 5.65, p = .019, \text{Partial } \eta^2 = .031$. Regardless of their cultural backgrounds, girls showed positive attitudes toward androgynous Chris significantly more than did boys. Also, a two-way ANCOVA conducted with the data collected after they worked with gendered Jude (either male or female) revealed significant main effects of student gender and cultural background. Girls showed positive attitudes toward gendered Jude significantly more than did boys, $F(1, 174) = 9.07, p = .003, \text{Partial } \eta^2$

= .05. Korean students showed positive attitudes toward gendered Jude significantly more than did US students, $F(1, 174) = 5.76, p = .017$, Partial $\eta^2 = .032$.

For RQ4 about the effect of student gender, cultural background, and agent visual gender, a three-way repeated ANCOVA revealed a significant interaction effect of agent visual gender and student cultural background, $F(1, 148) = 6.505, p = .012$, Partial $\eta^2 = .042$. US students showed most positive attitudes toward androgynous Chris and least positive attitudes toward male Jude; whereas, Korean students showed most positive attitudes toward androgynous Chris and least positive attitudes toward female Jude.

Discussion

As research in human-computer interaction indicates the social nature of the interaction, design of online learning environments is trending to integrating embodied agents in order to render social and affective richness to online learning experience. Especially, the social presence of an agent has been used as a motivational strategy to invite females and ethnic minority students to learning challenging domains (Kim & Wei, 2011; Kim, Wei, Xu, & Ko, 2007). Unexpectedly, however, social biases and gender-related stereotypes are replicated in learner-agent interactions (Haake & Gulz, 2008). This has challenged designers to contrive ways to prevent the replication of the biases and stereotypes.

On the whole, the finding of this study is in line with the current literature in embodied agents, in that girls reacted more positively to their tutee agent than did boys, regardless of students' cultural background and agent visual gender. What is unique from the study is students' positive reactions to the androgynous agent more than to the gendered agent. This implies that androgynous agents could play a role in addressing the challenge. The use of an androgynous agent could make design efforts

efficient and also help create a learning environment that is free from gender-related biases.

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