Interface Agents as Social Models: The Impact of Appearance on Females' Attitude Toward Engineering

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Abstract
This experimental study investigated the impact of interface agent appearance (age, gender, "coolness") on enhancing undergraduate females' attitudes toward engineering. Results revealed that participants reported more positive stereotypes of engineers after interacting with a female agent. In contrast, participants interacting with a male agent reported that engineering was more useful and engaging. An interaction of "coolness" and age indicated that agents who were young and "cool" (i.e., peer-like; similar to participants) and agents who were old and

"uncool" (stereotypical engineers) were both most effective on enhancing self-efficacy toward engineering.

Keywords

Interface agents, persuasion, attitude change, anthropomorphic interfaces, agent appearance, computer-based social modeling

ACM Classification Keywords

H.5.1 Multimedia Information Systems: Evaluation/methodology; H.5.2 User Interfaces: Evaluation/methodology; H.5 Information interfaces and presentation (e.g., HCI): Miscellaneous; J.4 Social and Behavioral Sciences: Psychology

Introduction

Recent empirical evidence has shown that a particularly valuable feature of animated interface agents is their potential to serve as human-like social models to influence student attitude and motivation [e.g., 5, 10]. In this experimental study, we investigate the role of agent appearance in influencing female beliefs and attitudes toward engineering.

Interface Agents as Social Models

According to Bandura, (1997) much of our learning derives from vicarious experience. Social modeling of behaviors enables us to learn new behaviors, strengthens or diminishes previously learned behaviors, and reminds us to perform behaviors about which we had forgotten. Social models can also influence people's attitudes [9]. Observing a social model perform a behavior provides us with information relevant to self-efficacy through a process of social comparison [3]. Therefore, social models may be particularly helpful in affecting attitudes and self-efficacy of women with respect to engineering.

Interface agents can potentially serve as simulated social models to impact students' beliefs and attitudes. Recent empirical evidence indicates that interface agents can positively influence users' interest and motivation [e.g., 4, 5, 11]. Extensive research has demonstrated that people tend to apply human social rules to computer technologies. Further, young women are particularly influenced by the communication and relational aspect of interface agents and may be more influenced by them than males [e.g., 5].

Purpose of study

The purpose of this study was to investigate the impact of interface agent appearance on female students' stereotypes and beliefs about engineering. Research in social psychology suggests that several appearance features are critical in determining how persuasive a social model would be in influencing young women's' beliefs: age, gender, attractiveness, and "coolness"[2]. In general, people are more persuaded by models that are similar to them or similar to how they would like to be [e.g., 2, 12, 13]. Therefore, agents who are young, female, and "cool" may serve as viable peer models and influence young women's attitudes. However, users are also persuaded by those they perceive as experts [e.g., 8]. Thus, agents who are older and seem more like the typical or stereotypical engineer (i.e., male and uncool) may also be particularly influential.

This apparent contradiction is reconciled by evidence that different types of influence are exerted by peers and experts [9]. When an attitudinal, value-related issue (e.g., self-efficacy) is the object of influence, people are more likely to be affected by a similar other. Conversely, when the issue involves potentially verifiable facts, an expert is more influential. Thus, in the present research, we hypothesized that interacting with a young, cool, female agent (i.e., peer-model) would positively affect stereotypic beliefs and self-efficacy regarding engineering. Conversely, we anticipated that interacting with an agent perceived as an expert engineer (e.g., male, uncool, old) would positively affect participants' perception of engineering as useful, worthwhile, and interesting.

Method

Participants

Participants included 109 female undergraduate students enrolled in an introductory technology course who consented to participate (age *M = 19.72,* SD = 1.96). Of the participants, 80.7% were Caucasian, 3.7% were African-American, 0% were Asian/Asian American, .9% were Native American, 11.9% were Hispanic/Latino, and 2.7% were multiracial.

Research Design and Independent Variables

The study employed a 2 (gender: male vs. female) x 2 (age: old vs. young) x 2 (coolness: cool vs. uncool) between subjects factorial design. Participants were randomly assigned to one of the eight agent conditions.

The agents were designed and previously validated to represent three different factors (gender: male or female; age: older (~45 years) or younger (~25 years); and "cool-ness:" cool or uncool). Coolness was operationalized to include the agent's clothing and hairstyle. For example, both of the young female agents have identical faces, but differ in "coolness" by their dress and hairstyle. In previous related work, we found that attractive agents were more influential as agent models for engineering [7]. Consequently, only agents that had been previous validated as attractive (operationalized by facial features) were employed in this study. The agents (see Figure 1) were created in Poser. One male and one female voice were recorded for all the agents using the same script and similar inflection and tone. The audio files were synchronized with the agents using Mimic2Pro to create lip-synching and emotional expressions. Several deictic gestures, identical for all agents, were also included. A fully integrated environment was created using Flash MX Professional 2004.

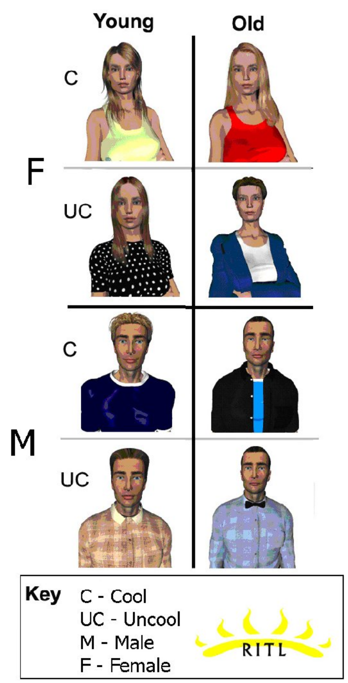

figure 1. Validated Agents, differing by Age, Gender, and "Coolness".

Dependent variables
There were three dependent variables in this study: a) participants' endorsement of the traditional engineering stereotype; 2) motivation (interest, utility, and engagement) towards engineering; and 3) self-efficacy regarding engineering. Students rated their level of agreement with each statement on a scale, ranging from strongly disagree (1) to strongly agree (7).

The *stereotype* inventory consisted of four items to assess female students' stereotype concerning engineering-related fields. For example, "People would make fun of me, if I were a math major." (α = .86).

Students' motivation to pursue engineering was measured according to three dimensions. First, interest in taking engineering related classes was measured using four items (α = .83). For example, "I will take a math course as an elective." Second, utility of engineering was measured with eight items (α = .84). For example, "Hard science courses are very useful for me." Third, the degree to which they found engineering engaging was measured with six items (α = .82). For example, "I am really interested in math." The self-efficacy inventory included 10 items to assess students' self-efficacy in engineering related fields (α = .89). For example, "I am confident that I could do well in math classes."

Research Environment
One of the eight agents was randomly presented to each student. The assigned agent (set in a coffee shop location) introduced itself and provided a twenty-minute narrative about four female engineers, followed by five benefits of engineering careers. This script was validated as effective in Baylor & Plant (2005). Periodically, the participants interacted with the agent to continue the presentation.

Procedure
The experiment was conducted in a regularly-scheduled classroom lab session where students accessed the online module through a web-browser (see Figure 2 for screen-shot). Following completion, participants answered the online post-survey questions.

figure 2. Sample Screenshot.

Results

Impact on endorsement of engineering stereotype

To determine the effects of agent appearance on student endorsement of the traditional engineering stereotype, a 2 (female vs. male) x 2 (young vs. old) x 2 (cool vs. uncool) between-groups ANOVA was performed. The analysis revealed a significant main effect for agent gender, $F(1,103)=4.44$, $p < .05$. Participants who interacted with a female agent were significantly less likely to endorse the traditional stereotype of engineers (e.g., geeky, less social, etc.) ($M = 2.66$, $SD = 1.36$) than those who interacted with a male agent ($M = 3.16$, $SD = 1.62$), $d = .34$, a small-moderate effect.

Impact on motivation toward engineering

Student motivation was analyzed through a factorial MANOVA, with interest, utility, and engagement as the three dependent measures. The MANOVA indicated that there was statistically significant main effect of agent gender on students' overall motivation, Wilks' Lambda=.920 $F(3,101)=2.943$, $p < .05$, =.08. Follow-up univariate ANOVAs indicated no significant differences in any of dependent measures. Given that the univariate results revealed no significant differences, a discriminant analysis was conducted to investigate the nature of the relationship among the dependent variables. The results of the discriminant analysis indicated that utility, and to a somewhat lesser extent, interest, most differentiated the male agent as more influential than the female agent.

Impact on self-efficacy

A 2 (female vs. male) x 2 (young vs. old) x 2 (cool vs. uncool) between-groups ANOVA on student self-efficacy revealed a significant interaction between agent age and agent coolness, $F(1,103)=4.43$, $p < .05$. Results indicated that if the agent were young, it had a more positive effect on self-efficacy if it were cool compared to un-cool ($M = 3.97$, $SD = 1.16$ vs. $M=3.14$, $SD=1.31$, respectively, $d=.67$, a moderate-large effect); however if the agent were old, it was more beneficial for self-efficacy if it were uncool compared to cool ($M = 3.48$, $SD = 1.39$ vs. $M=3.26$, $SD=1.27$, respectively, $d=.17$, a small effect).

Discussion

The current study examined the implications of agent appearance for influencing young women's stereotypes, motivation, and self-efficacy regarding engineering-related fields. Overall, female students who interacted with the female agent reported a more *positive stereotype* of engineering than those who interacted with the male agent. Thus, the agent who was similar to the participants in terms of gender (female) was more influential for changing their stereotypic beliefs. Given that previous work indicates that young women tend to view the typical engineer as male [7], the greater effectiveness of the female agents may have also been due to the female agents seeming less stereotypical as an engineer than the male agents. Thus, the very presence of the female agent who presented herself as an engineer may have been sufficient to influence stereotypic beliefs. Improving young women's perceptions of the stereotypical engineer could lead them to see engineers as the type of people with whom they would want to work, which may increase interest in pursuing engineering.

In contrast, the male agents were more effective than the female agents in influencing the young women's *motivation* to pursue engineering and, particularly, their perceptions regarding the *utility* of engineering-related fields. Because the male agents were likely perceived as more proto-typical engineers [as found in 7]and as having greater expertise, they may have been more influential in changing the young women's perceptions of the usefulness and value of engineering

Because women tend to have negative perceptions regarding their ability to pursue engineering related fields, assessing the impact on *self-efficacy* was a particularly important goal. Results indicated that if the agent were young, it was more effective if it was cool compared to uncool. In contrast, if the agent were old, the uncool agent was slightly more effective than the cool agent. Thus, the agents were more effective if they were either peer models who were similar to how the students viewed themselves (i.e., young and cool) or similar to the stereotypical engineer (i.e., old and uncool). For self-efficacy, it appears that either the perception of similarity or expertise in-creased the effectiveness of the agent.

The current work adds to the growing empirical evidence of the impact of agents on changing attitudes and beliefs and in particular the significance of agent appearance [5]. These findings highlight the importance of employing agents that are similar to the participants as well as agents who are perceived as experts. It may be that the most effective approach would be to use multiple agents (e.g., an expert and a peer model). Future research should also consider the additive effects of other important agent persona features (e.g., voice, message, non-verbal communication).

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References

[1] American Association of University Women. (2000). Tech savvy: Educating girls in the new computer age. Washington, DC: American Association of University Women Educational Foundation.

[2] Bandura, A. (1997). Self-efficacy: The exercise of control. New York: W.H. Freeman and Company.

[3] Bandura, A., & Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. Journal of Personality and Social Psychology, 41(3), 586-598.

[4] Baylor, A. L. (2002). Expanding preservice teachers' metacognitive awareness of instructional planning through pedagogical agents. Educational Technology, Research & Development, 50, 5-22.

[5] Baylor, A. L. (2005). The Impact of Pedagogical Agent Image on Affective Outcomes. Proceedings of Workshop "Affective Interactions: The Computer in the Affective Loop" at the International Conference on Intelligent User Interfaces, San Diego, CA.

[6] Baylor, A. L., & Kim, Y. (2005). Simulating instructional roles through pedagogical agents. International Journal of Artificial Intelligence in Education, 15(1).

[7] Baylor, A. L. & Plant, E.A. (2005). Pedagogical agents as social models for engineering: The influence of appearance on female choice. In C.K. Looi, G. McCalla, B. Bredeweg, & J. Breuker (Eds.), Artificial intelligence in education: Supporting Learning through intelligent and socially informed technology (Vol. 125, pp. 65-72). IOS Press.

[8] DeBono, K. G., & Harnish, R. J. (1988). Source expertise, source attractiveness, and the processing on persuasive information: A functional approach. Journal of Personality and Social Psychology, 55(4), 541-546.

[9] Goethals, G. R., & Nelson, R. E. (1973). Similarity in the influence process: The belief-value distinction. Journal of Personality and Social Psychology, 25(1), 117-122.

[10] Kim, Y., & Baylor, A. L. (in press). A social-cognitive framework for pedagogical agents as learning companions. Educational Technology Research & Development.

[11] Moreno, R., Mayer, R. E., Spires, H. A., & Lester, J. C. (2001). The case for social agency in computer-based teaching: Do students learn more deeply when they interact with animated pedagogical agents? Cognition and Instruction, 19(2), 177-213.

[12] Mussweiler, T. (2003). Comparison processes in social judgment: Mechanisms and consequences. Psychological Review, 110, 472-489.

[13] Schunk, D. H. (1987). Peer models and children's behavioral change. Review of Educational Research. 57, 149-174.