



The appearance effect: Influences of virtual agent features on performance and motivation [☆]



Youssef Shiban ^{a,*}, Iris Schelhorn ^b, Verena Jobst ^d, Alexander Hörnlein ^c, Frank Puppe ^c, Paul Pauli ^d, Andreas Mühlberger ^a

^a Department of Clinical Psychology and Psychotherapy, University of Regensburg, Germany

^b Department of Educational Psychology, University of Regensburg, Germany

^c Department of Informatics, University of Würzburg, Germany

^d Department of Clinical Psychology and Psychotherapy, University of Würzburg, Germany

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ABSTRACT

Background: Anthropomorphic (human-like) agents are commonly applied in e-learning as tutors for students, but we still do not know which particular features of an agent contribute to an enhancement of learning and motivation. **Method:** In this study a sample of university students was offered online learning cases as exam preparation aid and students were randomly assigned to one of three groups. The first group was tutored by a virtual male agent, the second by a virtual female agent. The cases of the third group were not assigned with an agent. We investigated if and under which circumstances a virtual tutor influences the students' exam performance, interest in the course material and their enjoyment during learning. **Results:** While the female agent (rated as young and attractive) had a positive impact on the interest in the course material, the male agent (rated as old and less attractive) had no positive influence at all on motivation or performance of the students on the exam. **Conclusions:** Appearance features of tutoring agents in e-learning independently influence the student's motivation and performance. Thus, interest can be manipulated by different aspects of the agent dependent on the primary goal while the agents have no effect on performance. We therefore suggest implementing personalized tutors in e-learning tutorials; however, we recommend more research examining the underlying mechanisms behind the positive effects on interest and look for ways to transfer them to performance.

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1. Introduction

For years, researchers have been examining the “persona effect” assuming a general positive affective impact of animated agents on the learner which is able to boost both motivation and, as a consequence, performance (Lester et al., 1997). This effect however has not yet been convincingly proven (Heidig & Clarebout, 2011). Only those studies that focus on specific features of agents yield some promising results. Baylor (2011) states in her literature review that motivation for learning can be enhanced by a “genuine” social interaction between agent and learner. A genuine

interaction according to the author is characterized by three factors: the appearance of the agents, advanced communication features like gestures and emotional expression, and the dialogue itself including motivational messages. In our study we focus on the appearance of the agents, but as our agents also provide feedback and therefore interact with the user, a few important findings related to those two characteristics will also be addressed.

In terms of *dialogue design*, elaborative feedback (Lin, Atkinson, Christopherson, Joseph, & Harrison, 2013) and polite conversation (Wang et al., 2008) have been shown to have a positive influence on performance. Furthermore, compliments for correct answers can encourage intrinsic motivation by positively influencing feelings of competence, self-control, self-efficacy, and curiosity (Johnson et al., 2004). *Advanced communication features* of social agents, such as nonverbal cues, seem to be crucial in maintaining learning motivation in virtual learning environments (Allmendinger, 2010), probably because they inform the observer about states, involvement, responsiveness, and understanding (Bavelas, Black, Lemery, & Mullett, 1986; Fridlund, Ekman, &

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* Corresponding author.

E-mail address: Youssef.Shiban@psychologie.uni-regensburg.de (Y. Shiban).

Oster, 1987). Emotional expressions displayed by virtual characters should therefore be recognizable which is sufficiently guaranteed when posture and facial expression convey the same message simultaneously (Visschedijk, Lazonder, van der Hulst, Vink, & Leemkuil, 2012). Deictic gestures have no effect on retention (Craig, Gholson, & Driscoll, 2002), but have been shown to guide attention (Atkinson, 2002), especially when the agent is static (Baylor & Ryu, 2003b).

The third factor, the *appearance* of pedagogical agents has been widely ignored in research on pedagogical agents (Gulz & Haake, 2006). The authors argue that the appearance of the agent influences the student's interpretation of the role of the agent and more importantly, the perceived similarity between the student and the agent that in turn influences the pleasantness of the agent and the quality of the interaction with it. Appearance has also been shown to increase student's motivation. For example, in a study with undergraduates Baylor and Kim (2009) demonstrated that a visible and physically present agent leads to better motivational outcomes than a voice or simply a text box. Furthermore, it is important to design agents realistically, because e.g. cartoon figures have been shown to diminish the positive motivating effects in comparison to realistic figures (Baylor & Kim, 2004). However, it is also important not to fall into what is known as "The uncanny valley". The uncanny valley hypothesis states that when the humanness of an agent is increased, the valence reported by the students also increases, until a point beyond which the reaction is reversed. However, when the agent is designed to resemble a human until it is hardly distinguishable from a real person, the valence turns positive again (Mori, MacDorman, & Kageki, 2012). In addition, the similarity of an agent to the learner positively influences the learner's motivation (Bailenson, Blascovich, & Guadagno, 2008 in a study with undergraduates). For example, computer-based female agents yielded better motivational outcomes for undergraduate women if they matched the students with respect to race and gender (Rosenberg-Kima, Plant, Doerr, & Baylor, 2010). Another study, conducted with undergraduates by Rosenberg-Kima, Baylor, Plant, and Doerr (2008) revealed that a female agent rated as young, attractive and "cool" succeeded in enhancing young female students' self-efficacy, which is believed to be a driving force behind motivation (Bandura, 1997). All these findings are theoretically supported by Bandura's social cognitive learning theory which states that people often learn behavior and norms by imitating people whom they perceive as similar (or superior: higher in rank or status) to them and who are therefore rather accepted as social role models (Bandura, 1986). This finding is supported by another study of Gulz, Haake, and Tärning (2007) which demonstrated that participants prefer same-gender agents when they are asked to choose their preferred agent as presenter for a multimedia slideshow.

A study by Baylor and Kim (2005) demonstrated that manipulating the role of an agent by changing its appearance and text in a dialogue enhanced the learner's (in this case undergraduate literacy students and pre-service teachers) motivation and increased their performance depending on the role the agent is given. Interestingly, in this study motivation and performance were influenced independently. An expert agent was shown to enhance performance whereas a motivator agent enhanced motivation (self-efficacy).

Motivation was also boosted by agents that were used to tutor students learning mathematics in a sample of 7th to 10th graders in a recent article by Arroyo, Bursleson, Tai, Muldner, and Woolf (2013). In their 4 studies, virtual learning companions elicited more interest ("less boredom") for the subject. Importantly, they found clear gender influence on how students benefit from the tutoring.

The primary goal of the current study was to investigate the influence of virtual agents in a web-based tutoring program in a sample of undergraduate psychology students attending a

statistics' class. We expected to confirm the "similarity hypothesis" of Rosenberg-Kima et al. (2008): This hypothesis predicts that a young female agent has a more positive effect on the motivational outcome than an older male agent because of the similarity (young and female) or superiority (attractive) to the sample investigated (mostly female students). In order to test this hypothesis, we chose a young and female (therefore similar) agent and contrasted it against an older, male agent, expecting the young female agent to boost motivation and performance. Assuming both of the agents we used could act as motivators, we added a third group with no agent as control group and expected to replicate the finding of Arroyo et al. (2013) that any agent positively influences interest of the students in a mathematical subject.

2. Method

2.1. Participants

One hundred and eight psychology students in two successive terms participated in this study. They were between 18 and 28 years old ($M = 20.20$, $SD = 1.82$), 21 of them were male and 73 female. Fourteen students did not answer the age and gender question. Students who took the class were randomly assigned to one of three groups: female agent, male agent or no agent. Randomization was conducted online via computer as the students registered to the online course. Thirteen students (26%) who used less than 13 (out of 48) e-learning case training quizzes (cases) were excluded as they were not sufficiently exposed to the agents.

2.2. Stimulus material

The study was conducted in an obligatory statistic course for psychology students at the University of Würzburg in Germany. All cases (for an example see Fig. 1) were created by the lecturer of the class. Each case was accessible via a weblink which was displayed in the virtual course room of the class. As the cases are based on flash-player, the case can be used with almost any kind of browser. The cases could be accessed only via computer with internet connection. Several cases could be answered in either multiple choice (MC) or short answer (SA) format. Students always received immediate explanatory feedback including the correct solution after answering a question as immediate feedback has been shown to facilitate transfer performance (Moreno, 2004).

2.3. Agents

According to the results of a pilot study we conducted with 29 students that will not be presented here, two agents were selected for the actual study (see Fig. 2): From a pool of six agents, we chose "Minnie" as she was rated as the most feminine and as one of the most attractive agents. "Edgar" was the already established agent generally used in the case trainings and compared to Minnie, he was perceived as less feminine, older, and less attractive, (all p 's < .001). Minnie was not rated as "cooler" than Edgar, $t(28) = 1.49$, $p = .151$.

In order to ensure high performance and motivation of the learners, the agents were designed based on the above mentioned empirical findings concerning communication characteristics and dialogue design: Both agents automatically provided elaborative feedback after a question had been answered (including the correct answer) and reacted with changes of facial expression and gestures while giving feedback: They used deictic gestures as well as clapping hands and smiling for a correct answer and displayed a disappointed face and crossed their arms for a wrong answer (see Fig. 3).

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