Does the presence of image and animation enhance pedagogical agent persona?

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Abstract

The purpose of this experimental study was to test the role of image and animation on learners' perceptions of agent persona characteristics (person-like, engaging, credible, instructor-like), agent value, and performance. The primary analysis consisted of two contrast comparisons: 1) comparing the presence/absence of agent image, and 2) comparing static versus animated agent images. In the study, seventy-five pre-service teachers developed an instructional plan for a case study within the MIMIC (Multiple Intelligent Mentors Instructing Collaboratively) agent-based environment. Overall, animation was found to be beneficial for all four persona characteristics, but not always as the single best implementation. For the agent to be perceived as instructor-like a strong effect was found for the presence of agent animation. Agent credibility was facilitated by either a static or animated image, with the presence of an image being critical. Perceptions of the agent as engaging and person-like were also improved by animation, although person-like was just as improved by no image. Results are discussed in terms of implementing anthropomorphic pedagogical agents to support computer-based instruction.

Does the presence of image and animation enhance pedagogical agent persona?

Several years ago researchers speculated that anthropomorphic agents (also referred to here as agents with a persona) could be beneficial for human-computer interaction (e.g., Laurel, 1997) while others had concerns that the use of personified agents may not be worth the effort (e.g., Erickson, 1997). For instance, Laurel (1997) argued three points in support of agents with a persona: 1) a personified agent optimally uses our ability to make accurate inferences about how it is likely to think, decide, and act on the basis of its external traits; 2) the agent as a character invites conversational interaction; and, 3) the metaphor of character successfully draws our attention to those qualities that form the essential nature of an agent: responsiveness, competence, accessibility, and the capacity to perform actions on our behalf. On the other hand, Erickson (1997) proposed that adaptive functionality is frequently sufficient for performing the same tasks without the need for the "trouble" of a personified agent. As he stated, "what is gained by having a character appear on the screen, whether it be a bow-tied human visage, an animated animal character, or just a provocatively named dialog box? … When designers decide to invoke the agent metaphor, what benefits and costs does it bring with it?" (p. 87).

More recently, computer scientists have been conducting interesting investigations to develop more anthropomorphic human-computer interaction with agents. Rousseau and Hayes-Roth (1998) developed an extensive social-psychological model that considers agent personality, emotions, and attitudes so that the agent can select appropriate behavior to enhance its believability. Gratch (2000) created a "personality GUI" that contains the agent's goals, social status, etiquette, (in)dependence and attitudes towards the user and other agents. Importantly, there is significant empirical evidence that by rendering systems more human-like, users can rely

on standard interaction skills (such as interpreting agents' facial expressions or taking into account eye contact), making the interaction with the computer much smoother (Dehn & van Mulken, 2000).

Such anthropomorphic agents may be valuable for learning, as empirical evidence is beginning to suggest (Atkinson, in press; Baylor, 1999, 2001b, in press-a, in press-b; Marakas, 2000; Moreno, Mayer, & Lester, 2000; Moreno, Mayer, Spires, & Lester, 2001). As Johnson, Rickel, and Lester (2000) explain:

> …these lifelike autonomous characters cohabit learning environments with students to create rich, face-to-face learning interactions. This opens up exciting new possibilities; for example, agents can demonstrate complex tasks, employ locomotion and gesture to focus students' attention on the most salient aspect of the task at hand, and convey emotional responses to the tutorial situation. (p. 47)

Similarly, Moreno and colleagues (2001) suggest that likable animated pedagogical agents may personalize the learning task and help students feel an emotional connection with the agent, thereby leading them to enjoy the learning situation and want to understand the material.

In particular, the learner's development of a social relationship with a pedagogical agent is a key mechanism to foster interaction and promote learning within a computer-based learning system (Baylor, 2001b). The nature of this agent-learner relationship dictates that the learner be familiar with the agent to better understand and predict its actions and intentions. Along this line, Baylor (2000) provides evidence that the existence of a persona is one of two necessary requirements for agents to be effective mentors in an educational environment.

The key characteristics that constitute a pedagogical agent persona include its propensity to be engaging, person-like, credible, and instructor-like. First, it is necessary for the agent to be engaging in order to facilitate the learner-agent relationship and to motivate the learner to be involved in the learning task. It is understood that agents which express emotion facilitate more enjoyable and compelling interactions (e.g., Lester, Towns, & FitzGerald, 1999). Second, together with engaging the learner, the agent must also be perceived as person-like in order to form a viable relationship with the learner. Person-like features that are critical for believability including expressing emotion and demonstrating a personality (Prendinger & Ishizuka, 2001b). Third, concomitant with the need for the agent to be a pedagogical expert, it must be perceived as credible. Along this line, the learner must have confidence in the agent and perceive it as trustworthy (Baylor, 2001b), competent (e.g., Maes, 1997), and consistent in its behavior (Rousseau & Hayes-Roth, 1998). Fourth, to serve as a pedagogical mentor, the agent persona must be characterized as instructor-like in order to effectively represent the content and pedagogy (Baylor, 2000). As Prendinger and Ishizuka (2001a; 2001b) argue, what is most critical for the agent persona is that the agent is "socially robust" within the context of its predefined role; in the case of a pedagogical agent, it is thereby key that it seem anthropomorphic and believable as an instructor or mentor, and behave accordingly.

But how should these persona characteristics be translated into the actual technological instantiation of the agent? Recent experimental investigations that have indicated a positive effect of anthropomorphized pedagogical agents greatly differ in terms of how they operationalize “anthropomorphic agent” (Atkinson, in press; Baylor, 1999, 2001b, in press-a, in press-b; Moreno et al., 2000; Moreno et al., 2001). Specifically, these studies each used different agent modalities (e.g., with/without text, with/without voice, with/without image, and

with/without animation), making inferences regarding the technological constitution of the agent not possible. What does related research indicate regarding the technology features of voice, image and animation as they contribute to an anthropomorphic pedagogical agent?

The inclusion of voice has consistently been found to be a key element for agent-based learning environments. Nass and Steuer (1993) found that simply having the computer use a human voice is enough to cause people to apply social rules to the computer. The presence of voice has a motivational advantage because it strongly indicates a social presence (Reeves & Nass, 1996), which can lead to increased learner interest and agent interaction. It has been found that learners who study from visual presentations with narration outperform learners with the same visual presentation with text (Mayer & Moreno, 1998; Moreno & Mayer, 1999). In this way the presence of narration can serve as redundancy to help the learner focus on the desirable information to increase understanding (Bishop & Cates, 2001) and also to indicate social presence (Reeves & Nass, 1996). Moreno and colleagues's (2001) fourth experiment with a pedagogical agent indicated a main effect where the presence of voice (as compared to text) significantly improved the learners' retention, transfer, and interest. Likewise, Atkinson (in press) also found a main effect for voice (as compared to text) with pedagogical agents, indicating that the presence of voice facilitated learners' performance in near and far transfer. The optimal combination is for voice narration to be presented together with the corresponding text as a way to reduce cognitive load and improve learning (Moreno & Mayer, 2000; Mousavi, Low, & Sweller, 1995).

While there are consistent results that voice (particularly in conjunction with text) is a key aspect for enhancing agent persona, the role of agent image and animation is not clear. As Moreno and colleagues (2001) stated, more research is needed to investigate the role of agents' visual presence in multimedia learning environments. Given that visual appearance of an agent

can vary from no image (text-based or voice only) to a fully animated agent with 3-dimensional graphics and gestures, the role of image and animation need to be better clarified.

In terms of the potential role of agent image, the Guides project investigated the issue of believability for agent-like computer programs (Oren, Salomon, Kreitman, & Don, 1990). The project involved the design of an interface to a CD ROM encyclopedia (focusing on early American history) with a set of travel guides, each of which was biased towards a particular type of information (settler woman, Indian, inventor). They found that students tended to assume that the guides, which were presented as stock characters, embodied particular characters. Some of the students got emotionally engaged with the guides; one student getting angry that the guide had betrayed her; in another case the guide inadvertently disappeared and the student interpreted this as "...the guide got mad, he disappeared." While no controlled experiment was involved in these findings, it is hard to believe that the learner would have made such an inference if the suggested articles had been presented in a floating window that had vanished. Thus, the presence of the agent character images led to a human-like interaction with the system.

More recently the focus has been on implementing animated agents rather than static images, particularly given the potential importance of the agent's non-verbal behavior as it contributes to agent believability (Cassell & Thorisson, 1999). Walker, Sproull, and Subramani (1994) performed a controlled study of human response to a synthesized talking face. They found that those who answered the questions delivered by the two synthesized faces spent more time, wrote more comments, made fewer errors, and were more engaged by the experience, as compared to the people who simply filled out a questionnaire. Given the importance of emotional expression by the agent (e.g., Lester et al., 1999), animation seems to be necessary for the agent to demonstrate facial expressions (e.g., related to fear, anger, sadness, happiness, and

disgust (as described by (Ekman, 1992)) and related speech and body movements. Thus, it seems that emotional expressiveness would be facilitated by animation.

While it seems that agent image and especially agent animation may enhance agent persona, there are potential drawbacks, particularly when considering the agent's pedagogical role. Harp and Mayer (1998) reported that adding entertaining illustrations and text to a scientific explanation actually hurts students' retention and transfer of the core material. Likewise, the addition of agent animation could be seen as extraneous and distracting to the learner (e.g., what Moreno and colleagues (2001) referred to as an interference hypothesis). Further, evidence suggests that agents with a more realistic visual appearance can hamper learning by suggesting misleading behaviors (Dehn & van Mulken, 2000), as earlier warned by Norman (1997).

Overall, it is inconclusive as to whether agent image and/or animation is required to create a viable pedagogical agent persona. While two recent sets of controlled experimental studies found positive results for pedagogical agents on learning, they did not isolate the variables of image and animation (Atkinson, in press; Moreno et al., 2001), making it impossible to tease out which technology features may have contributed to the significant results. Consequently, these variables must be isolated to answer questions such as the following: Is it essential for the agent persona for the agent to be visually apparent or is voice (and text) sufficient? Does animation further enhance the persona or does it serve as a negative distraction?

The primary purpose of this study was to test the role of static image and animation on how agents are perceived in terms of personal characteristics (person-like, engaging, credible, and instructor-like). It is predicted that the presence of an agent image and particularly animation will lead the learner will perceive the agent as more person-like, engaging, credible, and

instructor-like. The effects of agent image and animation on learner performance will also be tested. It will also be evaluated whether image and animation differentially affect the perceived value of the agent. Building on prior research, two key features of this study's design are that voice is used simultaneously with text in all agent conditions, and the presence/absence of agent image and the presence/absence of agent animation are each explicitly compared.

Methods

Sample

The sample consisted of 75 pre-service teachers, in four sections of an "Introduction to Educational Technology" course in a public Southeast university. As part of this required course, the participants had already been taught a traditional systematic model of instructional planning (Reiser & Dick, 1996) and a constructivist approach to instructional planning (Grabe & Grabe, 2001) with identical course material (e.g., lectures, Powerpoint slides, assignments, exams) across the four sections. Participation in this study was a required activity for class participants, and they received course credit for participating. The average age of the sample was 20.75 years (SD=2.01). Of those reporting ethnicity, 84% were Caucasian, 4% were Hispanic, 10% were African American, and 2% were of other groups. Of those reporting gender, 23% of the sample were male and 77% were female. Sixty percent (the majority) of the participants were sophomores, 27% were juniors with 7% freshman and 6% seniors. In terms of prior experience with instructional planning, participants' mean score was 2.23, (SD=.97), where 1=no experience and 5=very much experience, indicating that overall they had little prior experience.

Multiple Intelligent Mentors Instructing Collaboratively (MIMIC) Environment

From the learner's perspective, the MIMIC (Multiple Intelligent Mentors Instructing Collaboratively) computer-based learning environment consists of an introduction, a case study, blueprints phase, plan phase, and assessment phase. The introduction begins with the statement

that “We are pleased that you have decided to join our educational consulting firm, ‘Instruction Inc.’ Given your new skills in instructional planning, we have a project for which we really need your help,” and briefly describes the case study situation with thirteen-year-old Anna and her teacher Mr. Lange. Next participants are told that their task is to design a plan for Anna and her peers to learn this material and that they may use any method they would like to solve the problem. Following this, participants are instructed how to move throughout the environment. Following this, the personal Advisor "Chris" (see "Agent Format" section) introduces itself and its role, and it is suggested to the participant that s/he “request information from the Advisor when possible as he has good ideas and much experience in instructional planning."

The MIMIC environment organized the participant’s instructional planning processes into four main phases which will be described below, each indicated through large icon-buttons: case study, blueprints, planning, and assessment. At any time it is possible for the participant to move from one phase to the other although it is not possible for the participant to return to the introductory screens. Once the participant enters the assessment stage, an additional button labeled “Finished” is provided. After selecting “Finished” the participant is asked “Are you ready to exit the application and go to the exit survey?” Upon selecting “OK” the participant answers post-questions.

Case study. The case study was developed for the purposes of MIMIC given that it is difficult to find existing case studies that are appropriate (Ertmer & Russell, 1995). It consisted of a description of Anna and her problems learning supply and demand, her teacher Mr. Lange, and her school in Texas. The concept of supply and demand was chosen as it is relatively domain-independent of specialty areas for instruction and requires less specific prior knowledge. Links were provided so that participants could access Anna's homework that contained

comments from Mr. Lange, and his personal planning notes which included text and graphics. In this way, participants could review the necessary content for themselves as well as evaluate Anna's situation.

Blueprints. The purpose of this phase was listed on-screen as follows: "… for you to decide what you want Anna to learn. What have you determined to be the learning goals? List them clearly in the workspace below. For reference you may want to see the stated Texas standards and benchmarks regarding supply/demand for eighth graders, with links below." A text-box field was provided within which the participant could list the instructional goals or objectives. Two links provided additional information regarding Texas standards and benchmarks for supply/demand.

Planning. The purpose of this phase was listed on-screen as "... to develop a detailed instructional plan for Anna. " A text-box field was provided within which the participant could enter the instructional plan.

Assessment. The purpose of this phase was listed on-screen as follows: "...to develop ways to determine if Anna learned what you initially defined in the blueprints phase. Please describe this assessment in detail in the space below." A text-box field was provided within which the participant could type in the assessment.

The MIMIC web application was developed in terms of functionality according to factors regarding learner and agent control (Baylor, 2001b). Technically, it is comprised of a series of HTML forms within which the user interacts with the Microsoft Agent character, Merlin, programmed in Visual Basic Script. Microsoft Agent was chosen because the agents are three-dimensional and animated with built-in functionality. The core of the application's processing is done with server-side scripting, implemented with ColdFusion. CFML (ColdFusion Markup

Language) is used to process all submitted forms, provide database interactivity, and allow the MIMIC environment to be set to variable configurations. Data are recorded to a Microsoft Access database.

Agent Format

In this study, one Microsoft Agent character (Merlin the Wizard) was implemented as "Chris," an advisor to the participants. It was found in previous research (Baylor, in press-b) that participants respond similarly to both Merlin and Peedy (the two Microsoft Agent characters with the most functionality); consequently, Merlin was arbitrarily chosen for this investigation. In terms of pedagogy, the agent reflected a constructivist perspective toward instructional planning, and represented a learner-centered approach, focusing on the importance of the context of learning, stressing that learning involves active interaction, and emphasizing the process rather than the product of learning (Driscoll, 2000).

Depending on experimental condition, the pedagogical agent "Chris" appeared in one of three formats as illustrated in Figure 1. In the animated condition, the agent was fully animated using the functionality of Microsoft Agent, with animated gestures corresponding to the spoken words and to direct attention on the screen. In the static condition, only the static image of the agent was present. In the no-image condition, a box with the words "Ask Chris" was present at all times.

In order to select an advisement, the learner would click on the image of the agent in the animated and static conditions, or would click on the box in the no-image condition. In all three of the conditions, several features of "Chris" were identical: 1) advisements; 2) voice; and, 3) the speaking-bubble which displayed text that corresponded with the spoken advisements.

The instructional purpose of the agent within MIMIC was to serve as a mentor (Baylor, 2000) and to operationalize the constructivist approach to instructional planning. In all three agent conditions, the following events resulted within MIMIC: 1) the agent provided an initial observation upon entering each of the four MIMIC planning phases; 2) the agent provided reflection questions to encourage self-evaluation consisting of statements "Make sure you are not just talking about how you would do it; actually create the instruction for Mr. Lange (Anna's teacher).", "Actually develop the content-related activities", or "Apply the plan specifically to the topic of supply and demand" every five minutes upon entering a phase; 3) the agent provided an example of his instructional plan following the participant's development of an instructional plan; and, 4) the agent provided additional advisements when selected by the participant. Agent advisements were specific to the case study and were developed and validated by experts in instructional planning together with the consultation of an economics professor. The available advisements (specific to each planning phase) would appear in a pop-up box for the participant to select. For example, in the plan phase, one available advisement was "What is my role in the learning process?" If this advisement were selected from the agent, it replied "Anna should be at the center of the learning process. This will encourage Anna's initiative, get Anna to think and to reflect, and make the information real for Anna." Within MIMIC, there are a total of thirteen agent advisements, including the advisement presented automatically as the participant entered each stage. By stage, the number of agent advisements were as follows: case study (2) ; blueprints stage (3); plan stage (6); and, assessment stage (2). See a related study (Baylor, in press-a) for a complete listing and description of all agent advisements.

Measures

Perceived agent persona characteristics. Participants rated the agent according to four sets of agent characteristics: the extent to which the agent was engaging, person-like, credible, and instructor-like.

Engaging. Two items were used to determine the level to which the agent was perceived as engaging. Both items were in a 1-5 Likert scale format and required participants to rate how engaging they found the agent to be and their enjoyment in working with the agent. Inter-item reliability was assessed as alpha=.68.

Person-like. Four items were used to determine the level to which the agent was perceived as person-like. All items were in a 1-5 Likert scale format and required participants to rate how much the agent seemed like a person, his believability, expression of emotion, and motivational impact. Inter-item reliability was assessed as alpha=.74.

Credibility. Three items were used to determine the level to which the agent was perceived as credible. All items were in a 1-5 Likert scale format and required participants to assess their agreement with and usefulness of his advisements, and the overall impact of the agent. Additionally, as an indirect measure of the learner's perceived credibility of the agent, the program recorded the number of advisements selected by the participant in each of the four phases of MIMIC which was summated into a total. Inter-item reliability was assessed as alpha=.71.

Instructor-like. Participants were asked the open-ended question “Please describe how you think Chris would be like as an instructor.” Answers were coded according to whether participants cited that he represented a constructivist pedagogical approach, including statements that the agent would focus on the students and guide and scaffold the students with authentic

learning experiences; e.g., “he focused adequately on the role of the student”, “he would allow the students to be involved”, “he would be concerned with teaching through real-life experiences and scaffolding.” If the participant indicated that the agent represented a constructivist pedagogy, s/he was assigned a "1"; if not, s/he was assigned a "0."

Agent Value. An open-ended question was asked, “What did you like about Chris?” and answers were coded on two dimensions. The first dimension referred to persona, as to whether the participant cited reasons for liking the agent regarding his character or personality, e.g., “his cute character;” “he was there when I needed him;” “he is straightforward;” “provided me with the comfort of knowing that he was there whenever I needed him.” The second dimension referred to the information provided, as to whether the participant cited liking the agent because of the quality of the information, e.g., “he was very informative;” “he gave tips and hints on how to develop ideas;” “I liked his suggestions and guidelines.” In terms of scoring, if the participant indicated that s/he liked the agent because of his persona, s/he was assigned a "1"; if not, s/he was assigned a "0." If the participant indicated s/he liked the agent because of the information provided, s/he was assigned a "1"; if not, s/he was assigned a "0."

Participants were also asked the open-ended question “What did you dislike about Chris?” These answers were coded on three dimensions according to whether the characteristic was present or absent within the answer. The first dimension was persona, as to whether the participant cited reasons for disliking the agent regarding his character or personality, e.g., “I did not like his voice”; “his appearance”; “he was a little snotty.” The second dimension was information provided, as to whether the participant disliked the agent because of the quality of the information, e.g., “he wasn’t helpful in completing the assignment. He didn’t suggest anything”; “he gave obvious information”; “some of his suggestions were irrelevant or

confusing." The third dimension was nothing-disliked which assessed whether the participant cited "nothing" when asked what they disliked about the agent. In terms of scoring, if the participant indicated that s/he disliked the agent because of his persona, s/he was assigned a "1"; if not, s/he was assigned a "0." If the participant indicated s/he disliked the agent because of the information provided, s/he was assigned a "1"; if not, s/he was assigned a "0." If the participant answered "nothing" when queried what s/he disliked about the agent, s/he was assigned a "1"; if not, s/he was assigned a "0."

Performance. Within MIMIC, all participants developed an instructional plan to teach the concepts of supply and demand to Anna, the girl described within the case study. Each instructional plan was scored according to a rubric that consisted of four sub-areas. The four sub-areas of the rubric were goals/objectives, procedure, assessment, and holistic, the first three being aligned with the major components of instructional planning (goals/objectives, procedure, and assessment).

For the goals/objectives sub-score, the plans were rated according to how clearly the goals/objectives were stated and how specifically the purpose of instruction was described. For the procedure sub-score, the plans were rated according to the meaningfulness and effectiveness of the instructional activities, whether they were in a logical sequence, and whether they addressed the goals stated in the blueprints phase. For the assessment sub-score, the plans were rated according to whether the assessment matched the goals/objectives, and whether it was logical. For the holistic sub-score, the plans were rated according to whether the plan was overall reasonable and effective. The overall performance score was the compilation of these four sub-scores (each rated from 1 to 5), with a potential range of 4-20.

Two of the researchers met and together discussed what characterized a score of 1 through 5 (where 1=poor and 5=excellent) for each of the four sub-areas for five sample instructional plans. Following that, each researcher independently scored 15 instructional plans. Inter-rater reliability between the two researchers was determined to be $r > .9$ for the fifteen instructional plans. One of the researchers then scored the remainder of the instructional plans using the same rubric. Both researchers were blind as to the conditions of the participants throughout the rating process.

Procedure

There were no significant differences in age and GPA among the participants in the three conditions. In terms of ethnicity, gender, and year in school, chi-square analyses revealed no significant differences among the groups. All participants logged into the MIMIC computer environment and answered computer-based questions regarding gender, age, class section number, and prior experience with instructional planning. Following these initial measures, the participant entered the introduction to the MIMIC environment (see the MIMIC section). Next, the participants worked through the case study, blueprints phase, planning phase, and assessment phase, developing an instructional plan. The agent "Chris," in one of three forms (see the Agent Format section), was present within the environment as a constructivist pedagogical advisor. All participants worked independently within the environment at their own pace. Following completion of the instructional plan within the environment, all participants answered computer-based questions regarding perceived agent persona characteristics. The entire procedure took approximately 90 minutes.

Design and Data Analysis

To analyze the perceived agent persona characteristics (engaging, person-like, credible, and instructor-like), agent value, and performance, a one-way Analysis of Variance (ANOVA) was conducted with the three agent conditions as treatment levels with the primary analysis consisting of two planned orthogonal contrast comparisons, see Figure 2. The first planned contrast comparison tested the effect of presence/absence of image by comparing the no-image versus image (including static image and animation) conditions. The second planned contrast comparison tested the effect of animation by comparing just the static and the animated image conditions. If the first contrast indicated a non-significant difference but the second contrast indicated a significant difference, a posthoc pairwise comparison was conducted to compare the animated versus no-image conditions. For all analyses, the significance level was set to $p < .05$.

Results

Perceived agent persona characteristics

Regarding the four perceived agent persona characteristics, an initial screening for all dependent measures showed no violation of the assumption of homogeneity of variance as assessed by Levene's statistic. Sample sizes for the three agent conditions were 22, 21, and 26 for no-image, static, and animated conditions. For a listing of means and standard deviations by contrast, refer to Table 1 for the first contrast and to Table 2 for the second contrast. Note that the number of participants in the first contrast comparison groups are unbalanced given that it includes the no-image condition versus the combined static and animated conditions.

Engaging. The first contrast indicated no significant difference for the presence/absence of agent image. The second contrast showed a significant difference where those in the animated condition found the agent to be more engaging (M= 3.27, SD= 0.65) than those in the static

condition (M= 2.83, SD= 0.93), t(66)= - 1.76, p< 0.05. The effect size estimate was calculated as d=.55, corresponding to a medium effect. A post-hoc pairwise comparison of the animated and no-image conditions revealed that those in the animated condition found the agent to be significantly more engaging (M=3.27, SD=.65) than those in the no-image condition (M=2.89, SD=.96), t(46) =1.63, p<.05, with an effect size estimate of d=.46.

Person-like. The first contrast indicated no significant difference for presence/absence of agent image. The second contrast showed a significant difference where those in the animated condition found the agent to be more person-like (M= 2.73, SD= 0.52) than those in the static condition (M= 2.37, SD= 0.75), t(66)= - 1.84, p< 0.05. Cohen's d statistic yielded an effect size estimate of d=.56 which corresponds to a medium effect (Cohen, 1988). A post-hoc pairwise comparison of the animated and no-image conditions revealed that there was no significant difference between participants' perceptions of agent as person-like in those two conditions.

Credibility. For credibility, the first contrast revealed a significant difference where participants in the agent image conditions (static and animated) reported that the agent was more credible (M=3.55, SD= 0.72) than those in the no-image condition (M= 3.18, SD= 0.84), t(66)= -1.71, p< 0.05, with an effect size estimate of d=.47, indicating a medium effect. The second contrast indicated no significant difference for type of image.

Regarding the indirect measure of perceived agent credibility, the number of advisements selected by the learner, the first contrast revealed a statistically significant difference where the participants with the agent present selected more advisements (M=12.98, SD=7.02) than those in no-image condition (M=9.33, SD=6.24), t(71)= 2.13, p<0.05, with an effect size estimate of d=.55 indicating a medium effect. The second contrast for type of image revealed no statistically significant differences.

Instructor-like. When asked to describe how the agent would be like as an instructor, the percentage of participants who cited constructivist pedagogy are as follows, by condition: no-image (29%), static (23%) and animated (69%). The first contrast did not indicate a statistically significant difference for presence/absence of agent image. The second contrast revealed that the animated condition perceived the agent as more instructor-like (as indicated by citing his constructivist pedagogy) (M=.69, SD=.47) than the static condition (M=.23, SD=.43), $t(66)=3.53$, $p<.001$, with an effect size estimate of d=1.02, indicating a large effect. A post-hoc pairwise comparison of the animated and no-image conditions revealed that those in the animated condition found the agent to be more instructor-like (M=.69, SD=.47) than those in the no-image condition (M=.29, SD=.46), $t(45)= 2.97$, $p< .01$, with an effect size estimate of d=.86 indicating a large effect.

Agent value. In terms of what participants liked about the agent, neither contrast revealed a statistically significant difference for participants' citing agent persona, with 25-30% of participants in the three conditions mentioning persona.

For participants citing the information provided as something they liked, the first contrast revealed a significant difference where the participants with an agent image present (static and animated image) were more likely to cite the information provided as valuable (M= .74, SD=.44) than those in the no-image condition (M=.50, SD= .51), $t(70)=2.08$, $p<.05$, with an effect size estimate of d=.50, indicating a medium effect. The second contrast for type of image indicated no statistically significant differences. Percentages by condition for those citing information provided are as follows: no-image (50%), static (82%), and animated (67%).

In terms of what participants disliked about the agent, neither contrast revealed a statistically significant difference for participants' citing agent persona (24-35% of participants in the three conditions) or information provided (19-35% of participants in the three conditions).

However, in evaluating whether participants cited nothing-disliked about the agent, the first contrast revealed a significant difference where those in the no-image condition were more likely to cite that they disliked nothing about the agent (M=.52, SD=.51) than those in the image conditions (M=.24, SD=.43), $t(67)=2.30$, $p<.05$, with an effect size estimate of d=.59 indicating a medium effect. The second contrast for type of image showed no significant differences. The percentages of participants who cited that they disliked nothing about the agent are as follows, by condition: no-image (52%), static (30%), and animated (19%).

Performance

Neither contrast indicated a significant difference on the total performance score.

Discussion

Results from this study indicate that the presence of animation is either the most desirable or one of the most desirable instantiations of image and animation for agent persona perceptions in educational computer-based environments. Even so, as summarized in Table 3, there are differences among the agent persona features where image and animation differentially affect the perceptions of agent persona features. Note that because this study investigated pedagogical agents, the results may not be generalizable beyond educational agent-based environments. Further, these results are all based on the implementation of the Microsoft Agent character image of Merlin; future research should be conducted to replicate these findings with other types of agent characters.

Results indicated that animation provides the most positive impact for an agent to be perceived as engaging. The positive effect of animation could be explained based on the fact that it contributes to the agent's expression of a personality through non-verbal behaviors, leading to be more likable, and thus more enjoyable to learn with (Moreno et al., 2001) and also more emotionally expressive (Lester et al., 1999).

There was a positive effect of animation on the agent as person-like as compared to a static image of the agent, but there were no differences between the animated and no-image agent conditions. The positive effect of animation was predicted given that other research has suggested that animation enhances the agent's believability as an anthropomorphic character through more extensive expression of emotion (Lester et al., 1999), demonstration of a personality (Prendinger & Ishizuka, 2001b), and non-verbal behavior (Cassell & Thorisson, 1999). However, the fact that there was no difference between the animated and no-image conditions seems to emphasize the importance of voice as a key feature for engendering an agent as person-like (Atkinson, in press; Moreno et al., 2001; Nass & Steuer, 1993; Reeves & Nass, 1996). Another interpretation is that the presence of a static image (as compared to animated or no-image) actually <u>detracts</u> from the agent as seeming person-like because instead of the agent "acting" believable, emotional, and personable it instead appears motionless. This lack of action which may be less of an issue with the no-image condition because the expectation for action is not present given the lack of image. Further research needs to determine if these interpretations are valid.

Perhaps the most promising finding of this study from an educational perspective was the large positive effect where the agent was perceived as instructor-like when it was animated. This finding further substantiates other evidence that animated agents can effectively serve as

pedagogical mentors to represent an instructional approach (Baylor, 2000, 2001a, in press-a). An explanation for the finding that significantly more participants in the animated condition recognized and validated the agents' instructional pedagogy than those in both the static image and no-image conditions could be that the animated agent appeared to better embody the social role as a valid human-like instructional mentor (e.g., Prendinger & Ishizuka, 2001b), or that its increased expressiveness through non-verbal gesturing and demonstration of emotion led it to be perceived as communicating with greater clarity (Lester et al., 1997).

Agent image enhances agent credibility

In terms of the agent persona feature of credibility, it was found that the presence of an agent image led to the agent being perceived as significantly more credible than when it was absent. This finding was substantiated by both the self-report items and the greater number of agent advisements that were selected by the participants when the agent image was present. In the case of credibility, the presence of an image may be critical given that a "talking box" (i.e., the no-image condition) seems much less convincing without a picture to represent the voice/text advisements. The reason why animation may not have added to the credibility could be that it was perceived as a secondary characteristic—what was key was that the agent's information was perceived as coming from a valid source. Similarly, Burgoon and colleagues (2000) found that credibility was marginally greater in their text/voice condition as opposed to their richer and seemingly more anthropomorphized conditions, suggesting that features such as animation may not contribute to credibility. Since they did not control for agent image, that specific feature cannot be compared.

An additional indicator of the importance of agent image on credibility was the finding that participants in the agent image conditions (static and animated) were more likely to cite the

value of the information that the agent provided than those in the no-image condition. The information provided by the agent is a viable dimension of credibility in both communications theory (Burgoon, Pfau, & Birk, 1990) and agent features (Baylor, 2001b; Koda & Maes, 1996). Perhaps the participants cited valuing the agent's information more often in the image conditions because they believed that the agent had more personal ownership of the information (e.g., "Chris" was a visually recognizable being).

Also in line with the interpretations regarding credibility, participants were more likely to be critical of the agent when an agent image was present, suggesting that only if it was visually apparent was it "worthy" of being criticized. Significantly more participants in the no-image condition reported disliking "nothing" about the agent than those in the no-image condition where the agent was essentially a "talking box." Thus, the image-less agent may have been perceived as less credible and thus less appropriate to which to assign criticism.

Across all of these findings related to agent credibility, the contribution of image is evident. Further, the consistent lack of a significant difference between the effects of a static versus animated image indicates that an animated image is neither better or worse than a static image for enhancing agent credibility.

Performance

While there was evidence that the role of image and animation differentially affect participants' perceptions of the agent persona, no effects were found on performance, as assessed by the two contrast comparisons in this study. This finding is supported by a review of empirical research that found that the use of animated agents does not generally contribute to improved performance (Dehn & van Mulken, 2000). More recent research investigations have found positive effects on performance in educationally-based uses of animated pedagogical agents

(Atkinson, in press; Moreno et al., 2001), but as mentioned previously, they did not control for the role of image and animation. Given that the performance measures were based on the instructional plan created by participants while they were engaged within MIMIC, perhaps different post-test measures of near and far transfer of learning would be more appropriate and yield a greater probability of significant results.

Conclusion

In terms of presence/absence of image (static and animated), some preliminary guidelines for implementing pedagogical agents seem evident. Assuming that narration combined with text is already present, the instructional designer has several options: 1) include a static image of agent; 2) include an animated agent; or, 3) do not include any visual image (static or animated) of agent. As shown in Table 4, agent persona features are listed by the optimal use of image and animation as suggested by results of this study. Overall, in all aspects of the pedagogical agent persona, animation is listed as one of (if not the only) most effective technological implementation. Consequently, if cost of implementation is not an issue, animation could lead to optimal perceptions for these four pedagogical agent persona features. For an agent-based pedagogical system where credibility is the most important issue, either a static or animated image will lead to equally good results. Or in a system where it is critical that the agent is person-like, either an animated agent or even an agent with no image would lead to similar outcomes. For the features of engaging and instructor-like, the presence of animation was found to lead to significantly more positive perceptions than either no image or the presence of a static image.

Another key consideration for instructional designers implementing pedagogical agents is the desired learning outcome of the environment. Although this was not tested here, it seems that

the persona features of person-like and engaging may be more conducive to promoting affect-related outcomes such as motivation and enjoyment, whereas the persona features of instructor-like and credibility may be more relevant for learning. A promising line of future research would be to try to directly attribute agent features to specific learning and motivational outcomes.

Figure 1. Three agent conditions.

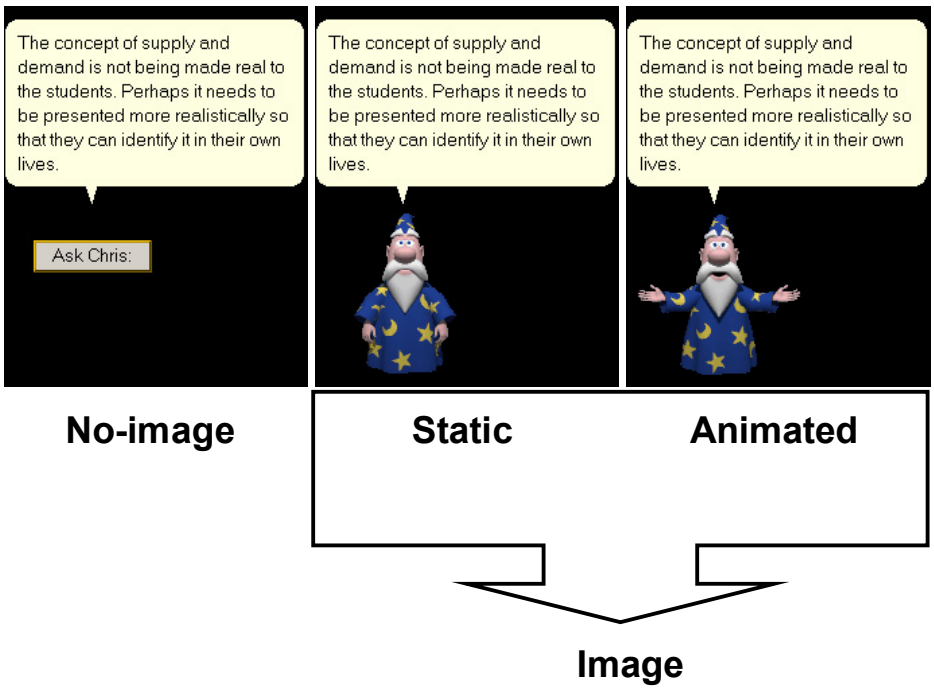

Figure 2. The two planned contrasts.

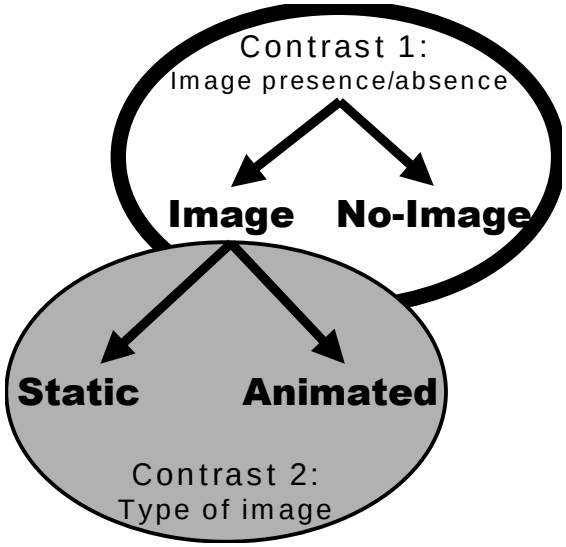

Table 1. Means and standard deviations of perceived agent persona characteristics for the first contrast

	Agent condition		
	No image	Image	Total
	(N=22)	(N=47)	(N=69)
	M (SD)	M (SD)	M (SD)
Person-like	2.63 (0.79)	2.57 (0.65)	2.59 (0.69)
Engaging	2.89 (0.96)	3.07 (0.81)	3.02 (0.86)
Credible	3.18 (0.84)	3.51 (0.71)	3.41 (0.77)
Instructor-like	.29 (.46)	.48 (.45)	.42 (.50)

Table 2. Means and standard deviations of perceived agent persona characteristics for the second contrast

	Agent condition		
	Static	Animated	Total
	(N=21)	(N=26)	(N=47)
	M (SD)	M (SD)	M (SD)
Person-like	2.37 (0.75)	2.73 (0.52)	2.57 (0.65)
Engaging	2.83 (0.93)	3.27 (0.65)	3.07 (0.81)
Credibility	3.55 (0.72)	3.49 (0.72)	3.51 (0.71)
Instructor-like	.23 (.43)	.69 (.47)	.48 (.45)

Table 3. Summary of results by contrast.

	First Contrast Image presence (I) vs. absence (NI)	Second Contrast Static (S) vs. Animated (A)
Person-like	-	S < A
Engaging	-	S < A
Credibility	NI < I	-
(Number of advisements selected)	NI < I	-
Instructor-like	-	S < A

Agent Value		First Contrast Image presence vs. absence	Second Contrast Static vs. Animated
Likes	Persona	-	-
	Information provided	NI < I	-
Dislikes	Persona	-	-
	Information provided	-	-
	Nothing-disliked	NI > I	-

Table 4. Summary of recommendations regarding implementation of image and animation for each persona feature.

Persona Feature	**Optimal use of image/animation**
Engaging	Animation
Person-like	Animation OR No-image (Voice/text only)
Instructor-like	Animation
Credibility	Animation OR Static image

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