

The design of motivational agents and avatars

Amy L. Baylor

© Association for Educational Communications and Technology 2011

Abstract While the addition of an anthropomorphic interface agent to a learning system generally has little direct impact on learning, it potentially has a huge impact on learner motivation. As such agents become increasingly ubiquitous on the Internet, in virtual worlds, and as interfaces for learning and gaming systems, it is important to design them to optimally impact motivation. The focus of this paper is on the design of agents and avatars (one's self-representation as a visual agent) for enhancing motivational and affective outcomes, such as improving self-efficacy, engagement and satisfaction, moderating frustration, and/or improving stereotypes. Together with motivational messages and dialogue (which are not discussed here), the agent's appearance is the most important design feature as it dictates the learner's perception of the agent as a virtual social model, in the Bandurian sense. The message delivery, through a human-like voice with appropriate and relevant emotional expressions, is also a key motivational design feature. More research is needed to determine the specifics with respect to the ideal agent voice and the role of other nonverbal communication (e.g., deictic gestures) that may contribute to the agent's role as an embodied motivator, particularly in the long-term.

Keywords Interface agents · Pedagogical agents · Avatars · Motivation · Persuasion · Attitudes · Self-efficacy

Introduction

This paper focuses on the design of anthropomorphic agents and avatars that positively impact motivational (e.g., self-efficacy, attitude, interest) and affective (e.g., feelings of

A. L. Baylor (✉)
Amy Baylor Consulting, LLC, Reston, VA 20195, USA
e-mail: amy.baylor@gmail.com
URL: <http://amybaylor.com>

connection, relief of frustration) outcomes. Building upon the paradigm of Computers as Social Actors (CASA) (e.g., Reeves and Nass 1996), there is significant evidence that the social influence of anthropomorphic agents is comparable to that of humans (Baylor 2007; Ebbers 2007; Kim and Baylor 2007; Lee et al. 2007; Nass and Steuer 1993).

As a social influencer, or virtual “social model,” there are several advantages of implementing an anthropomorphic agent, as described in Baylor (2009). Importantly, an agent can be available when it is most convenient or timely for a learner. As described in Baylor (2009), the availability of an always-live agent as social model is advantageous given the difficulties in arranging for a human mentor to coach another to lose weight; or for a teenage idol to persuade youth against joining gangs.

Perhaps more valuable than availability is the possibility of customizing an agent-based social model to represent an *ideal social model* for a particular user or group of users. For example, an agent social model designed to positively influence inner-city youth to stay in school could be designed to appear as an older “cool” peer, with respect to dress, age, race, gender and socio-economic status, with a persona that represents someone with whom they can identify as part of their in-group (from Baylor 2009).

The potential for accessing such agents in real-time and customizing them to individual learners is noteworthy, but less so if it requires considerable time and resources to design and build them. Interestingly, while an agent with greater computational functionality may be perceived as more believable and human-like, research indicates that learners perceive, interact socially with, and are influenced by anthropomorphic agents *even when* their functionality and adaptability are limited (e.g., Baylor and Kim 2005, 2009; Guadagno et al. 2007; Kim et al. 2007; Rosenberg-Kima et al. 2007, 2008; Ryu and Baylor 2005). Consequently, designing motivational agents is within the reach of educators, trainers, and all who wish to promote new attitudes, change behaviors, or positively influence others.

Appearance and message delivery (e.g., voice, non-verbal communication) together with the motivational message and dialogue are key design considerations for a motivational agent. First, perhaps the most important aspect of designing a motivational agent is its *appearance*, as that plays a major role in its effectiveness as a virtual social model in the Bandurian sense (Baylor 2009). Second, the agent’s *delivery* of the message involves its voice and nonverbal communication, including deictic gestures (e.g., pointing, head-nodding) and emotional expression, the latter being of special importance for a motivational agent. Third, the design of the message or human-agent dialogue is also very important, yet there are fewer agent-specific guidelines; consequently, this aspect will not be covered here. There are also special considerations where it may be advantageous to employ multiple agents simultaneously with a separate and distinct motivational agent. In the sections that follow, each of these aspects will be described in greater detail as they impact agent design.

Designing agents as virtual social models

There is much evidence citing the effectiveness of human social models to influence change in others’ behaviors, beliefs, or attitudes (e.g., Bandura 1997; Schunk 1981). An agent serving as a virtual social model can similarly be highly effective. One can acquire the behaviors or expertise mediated through a social model using processes such as observation, vicarious experience (experience gained by observing another) and social interaction. Research indicates that the most effective social model is similar to the observer while representing someone whom the observer aspires to be like. Consequently,

one of the most important attributes for a social model is *appearance*; how s/he looks with respect to age, status, attractiveness, and credibility. Indeed, research indicates that for motivational outcomes it is critical that the agent be *visibly* present, and not just represented as a voice or text box (e.g., Baylor 2009; Baylor et al. 2003; Rosenberg-Kima et al. 2007). For an agent social model, the potential to customize its anthropomorphic qualities provides unlimited possibilities for optimization.

As reviewed in Baylor (2009), learners tend to be more influenced by an agent of the same gender and ethnicity/race, similar to human–human interactions where we are more persuaded by members of our in-group. Yet, both the learning/motivational context, age of learners, and topic play a significant role. For example, research has shown that sometimes surprising learners with an agent that does not match their expectations or providing a female agent (instead of a male agent) to both male and female younger students may be optimal (e.g., Baylor and Kim 2004; Plant et al. 2009).

In a series of experimental studies, Baylor and colleagues (Baylor and Plant 2005; Plant et al. 2009; Rosenberg-Kima et al. 2008, 2010) have manipulated other appearance features such as agent attractiveness, “coolness” (operationalized by clothing and hairstyle), and age to investigate the impact on student motivation toward engineering as a possible career. See Fig. 1 for a subset of validated virtual engineers.

For undergraduate females, experimental results revealed that the most effective agent social model was the young, attractive, cool, female agent (see top left agent in Fig. 1); this

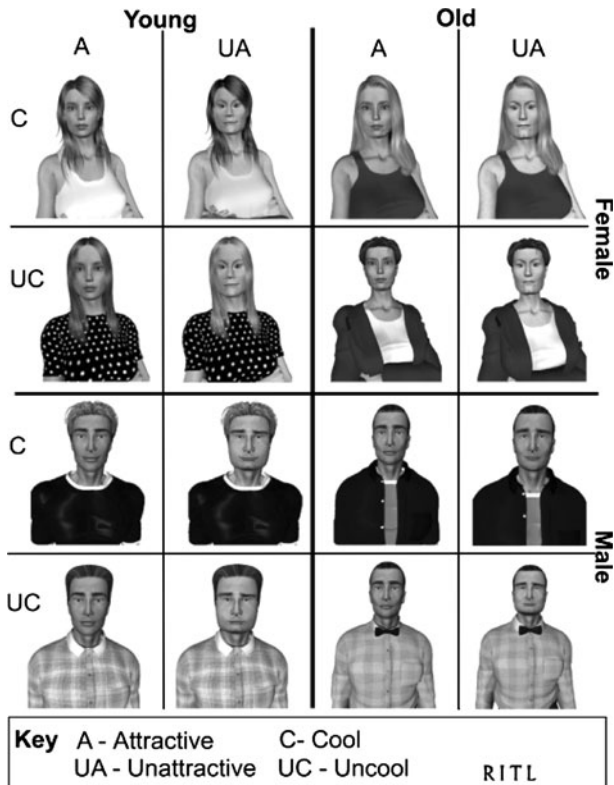


Fig. 1 Virtual engineers, differing by attractiveness, gender, age, and “coolness”

agent enhanced students' self-efficacy towards being successful as an engineer as well as positively influenced their stereotypes toward engineering (Rosenberg-Kima et al. 2008). Implementing a similar set of agents to middle-school students (both male and female) resulted in a slightly different outcome where the female agents (either young or old) were more effective than any of the male agents (Plant et al. 2009). This suggests that for this age group, female authority figures (e.g., teachers, mothers) may be more persuasive and motivational. A third target audience included African-American undergraduate women at a historically-Black institution who received one of four validated peer-aged agents (each equivalent with respect to coolness and attractiveness), differing by race (Black, White) and gender (male, female). As hypothesized, results indicated that the Black female agent was optimal for enhancing the motivational outcomes (Rosenberg-Kima et al. 2010).

Such studies suggest that learners are more influenced by agents that are similar to themselves with respect to appearance-related characteristics (e.g., Bailenson et al. 2008). However, prior stereotypes and expectations can sometimes be used to a positive advantage depending on the desired outcome. For example, in the context of influencing young women's motivation toward engineering, it was found that the male agents were more influential than the female agents in promoting the *usefulness* of engineering as a career field. This is likely due to learners' existing stereotypes which led them to perceive a message from a male engineer as more credible than the same message from a female engineer. As a result, the context of the persuasion (e.g., participants' prior knowledge, domain area) as well as the desired motivational outcomes (e.g., interest, attitude change) must be at the forefront when designing an agent's appearance.

Designing avatars as ideal virtual selves

Within virtual environments such as web-based chat rooms or gaming environments learners can easily create an avatar to represent their virtual "selves." If this is within an environment designed to promote motivation, how the learner creates his/her avatar can have a profound influence on the motivational outcome. In a series of studies, Bailenson and colleagues have found that the way people represent themselves in virtual environments can substantially change their verbal, nonverbal, and task-related behavior. In one line of research, the potential effect of an avatar representing one's "possible" self is investigated. For example if learners watch an avatar that looks like themselves exercising and losing weight in a virtual environment, they subsequently exercise more and eat healthier in the real world as compared to a control group (Fox and Bailenson 2009). In another study, participants were exposed to either an avatar running on a treadmill that looked like them, another avatar (agent) running, or an avatar loitering that looked like them. Within 24 h after the experiment, participants who were exposed to the running avatar that looked like them exercised significantly more than those in other conditions. Along the same line, undergraduates who observed their avatar aging in a virtual mirror, were more likely to form a psychological connection to their "future selves" and decided to invest more money in a retirement account as compared to a control group (Ersner-Hershfield et al. 2008). These studies extend prior work on self perception theory (Bem 1967), showing that changes in aspects of one's virtually-represented self can lead to changes in one's real physical self.

In a different line of research, these researchers find that people tend to conform to how their avatar appears, regardless of how it is perceived by others—a process they refer to as the Proteus effect (Yee and Bailenson 2007). In one study, they manipulated the

attractiveness of the avatars and observed participants' behaviors. Participants with more attractive avatars demonstrated increased self-disclosure, friendliness and extroversion and were more willing to approach opposite-gendered strangers after less than 1 min. In contrast, participants with an unattractive avatar kept a significantly farther distance away from strangers (5 vs. 3.5 feet) and shared significantly less personal details. As indicated by the authors, these studies "show the dramatic and almost instantaneous effect that avatars have on behavior in digital environments" (p. 285). More recently, the authors have extended this work beyond the more controlled laboratory setting to an actual online community (Yee et al. 2009). In this more ecologically valid context they found that both the height and attractiveness of an avatar in an online game were significant predictors of the player's performance. Further, behavioral changes originating within the virtual environment tended to transfer to subsequent face-to-face interactions.

It is clear that appearance plays a large role for both agents and avatars. Further, in the case of avatars, designing the avatar appearance is likely to be the only learner-controlled feature. The next section will discuss the delivery of a motivational agent's message with respect to voice and nonverbal communication.

The motivational impact of agent message delivery

Social presence theory helps explain why anthropomorphic agents can be effective messengers. According to Short et al. (1976), social presence is a function of both verbal cues (e.g., tone of voice, prosody) and nonverbal cues (e.g. facial expression, direction of gaze, posture, and deictic gestures). In this sense, the social presence of an agent is quite similar to that of a human.

The facility for the agent to communicate through voice is highly beneficial as the voice modality has been found to be superior to visual information (e.g., text) for computer-based communication (Mayer and Moreno 1998; Moreno and Mayer 1999). Research conclusively indicates that having a human (as opposed to a computer-generated) voice is preferable to enhance social presence. Further, a human voice can lead to increased interest and facilitate learners' interacting with the technology in a social manner (Atkinson et al. 2005; Baylor et al. 2003; Nass and Brave 2005; Reeves and Nass 1996). In particular, Nass and Brave (2005) suggest that key dimensions of voice include *volume* (e.g., the booming voice of a person who loves socializing to the soft voice of someone who prefers to read books), *pitch* (e.g., the enthusiastic friend with the high voice versus the deeper tones of a subdued person), *pitch range* (e.g., the rich ups-and-downs of an animated story teller and the monotone delivery of a technical presenter), and *speech rate* (e.g., the exuberant fast talker vs. the calm articulator).

Researchers have speculated that facial expressions (eye, eyebrow, and mouth movements) and deictic gestures (e.g., pointing with arms and hands, head-nodding) are important for pedagogical agents to promote learning-related outcomes (Atkinson 2002; Johnson et al. 2000; Lester et al. 2000). Based on research in human-to-human communication, gestures can reduce ambiguity by focusing learner attention, and facial expressions can reflect and emphasize agent message, emotion, personality, and other behavioral variables. Some evidence now indicates that agent nonverbal communication (specifically, the use of gaze and gesture) may enhance the learning experience by guiding attention, particularly for procedural learning (Baylor and Kim 2009; Johnson et al. 2000). For motivational outcomes, preliminary evidence suggests the value of emotional expression,

but *without* other nonverbal communication that could distract the learner from the message (Baylor and Kim 2009).

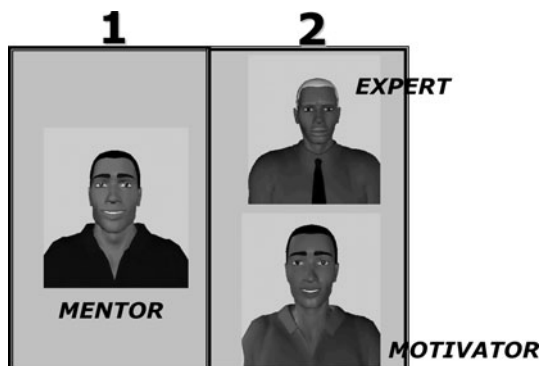
Specifically, in a large-scale experimental study Baylor and Kim (2009) employed a $2 \times 2 \times 2$ factorial design to investigate the effects of type of instruction (procedural, attitudinal), deictic gesture (presence, absence) and facial expression (presence, absence) on motivation and learning. A total of 236 college students learned from an agent that varied by two factors: deictic gestures and facial expression within one of two instructional environments: one training them to perform tasks within a software program (procedural learning outcome); the other focusing on changing their beliefs regarding intellectual property (attitudinal learning outcome). Of particular interest was the interaction effect between type of instruction and agent nonverbal behavior (deictic gestures and facial expression). Results indicated that for enhancing learner attitude, it was best when the agent's facial expression was present but its deictic gestures were *absent*, thereby allowing the learner to fully focus on the motivational message.

With the increasing interest in embodied cognition and emotion (Niedenthal 2007), future research should explore the impact of the agent's full-body presence on motivation. In the past, some researchers have employed agents with large faces and small bodies, so as to highlight the facial emotional expressions while still providing the agent with a physical body to "move around the screen" and implement gestures such as pointing to focus learners' attention.

Employing multiple agents with distinct functionality

Regardless of the level of agent embodiment, one way to provide learners with both motivational and learning support is to employ multiple agents where each representing distinct agent personas. This unique affordance of multiple anthropomorphic agents is termed the "split-persona effect," indicating that splitting agent roles/functionality into two distinct agent personas (see Fig. 2) is preferable to combining those roles/functionality into one agent persona (Baylor and Ebbers 2003). This can be explained by the fact that it is easier for students to compartmentalize the agent information when it is delivered by two distinct sources. With respect to motivational design, this effect suggests that having an affective or motivational coach implemented as a distinct agent may be preferable to having its functionality figuratively "rolled up" into a more inclusive help or training agent.

Fig. 2 *Split-persona effect*: separating agent functionality (2 Expert, Motivator) is preferable to combining it (1 Mentor)



Alternatively, instead of interacting with multiple anthropomorphic agents, affective support might be enhanced when a student's avatar (i.e., his/her self-representation within the program) *co-learns* with a computer-driven agent. In an experimental study with 76 Japanese college students, Lee and colleagues (2007) employed three conditions: a caring co-learner agent (expressed empathic emotion and provided supportive and encouraging verbal feedback); a non-caring co-learner agent (did not manifest caring orientations toward the participants, although all the other behavioral features were identical), and a control (no co-learner agent). As compared to students in the other two conditions, results indicated that students who worked with the caring co-learner agent had significantly greater feelings of social support (an index comprised of five items: "not alone," "praised," "attended," "appreciated," and "supported"), trust, as well as enhanced recall.

Considering the agent as a potential motivator suggests that the agent could serve as a "mastery model," demonstrating positive attitudes towards the task and/or the desired levels of performance so that a learner can learn vicariously, or as a "coping model," modeling for the learners how to cope with a situation as a novice (e.g., Schunk et al. 1987). In an experimental study with 103 undergraduate students, Ebbers (2007) manipulated type of anthropomorphic interface agent model (coping vs. mastery) and interaction type (direct vs. vicarious) and found a main effect where the agent as a coping model significantly enhanced motivational outcomes as compared to the agent as a mastery model. Similarly Kim and Baylor (2006) experimentally found that agents with *similar* competency to learners were more influential than highly competent agents in enhancing student self-efficacy beliefs. These results suggest that a peer model agent with similar level of competence to the learner is advantageous.

Conclusion

From a macro-level, research suggests that a motivational agent (e.g., a coach or persuader) should be employed as a separate and distinct agent persona. Additionally, if the agent is caring and/or acts as a "coping model," motivational and affective outcomes may be enhanced. With respect to message delivery, the presence and appropriate instantiation of the agent's emotional expressions are paramount. Other nonverbal communication such as deictic gestures could actually be detrimental and thus should be designed carefully (Baylor and Kim 2009). More research needs to be conducted regarding an optimal agent voice, but it should be as human-like as possible (if not actually human) with human-like tone and prosody (see Nass and Brave 2005).

Perhaps the most critical design feature for a motivational agent is its appearance. Interestingly, it is not necessarily in the best interest of the learners for them to choose the appearance of their agent or avatar. In comparing learner-choice versus experimental studies, research has shown that learners do not always choose the agent that actually is "best" for them (see Baylor and Kim 2003; Baylor et al. 2003; Moreno and Flowerday 2006). Instead of providing learners with a choice of agent, it would be preferable to provide them instead with an attractive agent that resembles them with respect to gender, ethnicity/race, age, and perceived competency in the domain. Not only should the agent or avatar's figurative "demographics" match those of the learner, but also it should represent (appearance-wise) what the learner aspires to be. For example, in a system designed to promote more positive attitudes toward mathematics for young adults, the agent should reflect what the target learners perceives as a "pro-math" peer, similar in age, gender, ethnicity/race and perceived competency. Similarly, in a fitness program, the most

motivational avatar (self-representation) would reflect the *ideal* version of a person with respect to body shape. Yet in the case of Wii Fit[®], for example, the avatar is designed to reflect one's *actual* weight and respective body shape. In general, the potential for learners to visualize idealized versions of themselves through their avatars or to work with a motivational coach that reflects an optimal appearance as a social model is particularly powerful. In our human-based lives such possibilities to customize appearance are not an option.

Future research should determine the most important aspects of agent nonverbal communication as well as the nature of the agent messaging. For example, in what ways should an agent's motivational messages match that of a human motivator? How and in what ways should it differ? Along this line, more research is needed to define the qualities of voice that are most motivationally appropriate as delivered through an agent or avatar.

The future also holds great promise to optimize the human-agent motivational "relationship." The use of affective sensors can provide real-time adaptive interactions based on the learner's affective or motivational state (see Arroyo et al. 2009). Along this line, implementing a motivational agent over the long-term suggests the importance of establishing and maintaining rapport with the learner (Gratch et al. 2007) and including an autobiographical story for the agent (Bickmore et al. 2009).

In summary, developing interface agents on the Internet for gaming or learning systems brings exciting possibilities to promote health, positive attitudes, self-efficacy, and more productive stereotypes. The potential for motivational agents and avatars is here. Realizing the potential through thoughtful design is the next step.

References

- Arroyo, I., Cooper, D. G., Burleson, W., Woolf, B. P., Muldner, K., & Christopherson, R. (2009). Emotion sensors go to school. In V. Dimitrova, R. Mizoguchi, B. DuBoulay & A. Graesser (Eds.), *Artificial intelligence in education—Building learning systems that care: From knowledge representation to affective modelling* (Vol. 200, pp. 17–24). Amsterdam: IOS Press.
- Atkinson, R. K. (2002). Optimizing learning from examples using animated pedagogical agents. *Journal of Educational Psychology*, *94*, 416–427.
- Atkinson, R. K., Mayer, R. E., & Merrill, M. M. (2005). Fostering social agency in multimedia learning: Examining the impact of an animated agent's voice. *Contemporary Educational Psychology*, *30*, 117–139.
- Bailenson, J. N., Blascovich, J., & Guadagno, R. E. (2008). Self-representations in immersive virtual environments. *Journal of Applied Social Psychology*, *38*(11), 2673–2690.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman.
- Baylor, A. L. (2007). Pedagogical agents as a social interface. *Educational Technology*, *47*(1), 11–14.
- Baylor, A. L. (2009). Promoting motivation with virtual agents and avatars: Role of visual presence and appearance. *Philosophical Transactions of the Royal Society B—Biological Sciences*, *364*(1535), 3559–3565.
- Baylor, A. L., & Ebbers, S. J. (2003). Evidence that multiple agents facilitate greater learning. In U. Hoppe, M. F. Verdejo, & J. Kay (Eds.), *Artificial intelligence in education: Shaping the future of learning through intelligent technologies* (pp. 377–379). Amsterdam: IOS Press.
- Baylor, A. L., & Kim, Y. (2003). The role of gender and ethnicity in pedagogical agent perception. In G. Richards (Ed.), *Proceedings of world conference on E-learning in corporate, government, healthcare, & higher education 2003* (pp. 1503–1506). Chesapeake, VA: AACE.
- Baylor, A. L., & Kim, Y. (2004). Pedagogical agent design: The impact of agent realism, gender, ethnicity, and instructional role. In J. Lester et al. (Eds.), *Lecture notes in computer science: Intelligent tutoring systems* (Vol. 3220, pp. 592–603). Berlin/Heidelberg: Springer.
- Baylor, A. L., & Kim, Y. (2005). Simulating instructional roles through pedagogical agents. *International Journal of Artificial Intelligence in Education*, *15*(1), 95–115.

- Baylor, A. L., & Kim, S. (2009). Designing nonverbal communication for pedagogical agents: When less is more. *Computers in Human Behavior*, 25(2), 450–457.
- 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). Bristol: IOS Press.
- Baylor, A. L., Ryu, J., & Shen, E. (2003). The effects of pedagogical agent voice and animation on learning, motivation and perceived persona. *Proceedings of world conference on educational multimedia, hypermedia and telecommunications, Honolulu, Hawaii* (pp. 452–458). Norfolk, VA: AACE.
- Bem, D. J. (1967). Self-perception: An alternative interpretation of cognitive dissonance phenomena. *Psychological Review*, 74, 183–200.
- Bickmore, T., Schulman, D., & Yin, L. X. (2009). Engagement vs. deceit: Virtual humans with human autobiographies. In Z. Ruttkay, M. Kipp, A. Nijholt & H. H. Vilhjalmsson (Eds.), *Proceedings of intelligent virtual agents* (Vol. 5773, pp. 6–19). Amsterdam: Springer.
- Ebbers, S. J. (2007). *The impact of social model agent type (coping, mastery) and social interaction type (vicarious, direct) on learner motivation, attitudes, social comparisons, affect and learning performance* (Vol. Ph.D). Tallahassee, FL: Florida State University.
- Ersner-Hersfield, H., Bailenson, J., & Carstensen, L. L. (2008). *A vivid future self: Immersive virtual reality enhances retirement saving*. Paper presented at the Association for Psychological Science. Annual Convention. Chicago, IL.
- Fox, J., & Bailenson, J. N. (2009). Virtual self-modeling: The effects of vicarious reinforcement and identification on exercise behaviors. *Media Psychology*, 12(1), 1–25.
- Gratch, J., Wang, N., Gerten, J., Fast, E., & Duffy, R. (2007). Creating rapport with virtual agents. In *Lecture notes in artificial intelligence: Proceedings of international conference on intelligent virtual agents*. Paris: Springer.
- Guadagno, R. E., Blascovich, J., Bailenson, J. N., & McCall, C. (2007). Virtual humans and persuasion: The effects of agency and behavioral realism. *Media Psychology*, 10(1), 1–22.
- Johnson, W. L., Rickel, J. W., & Lester, J. C. (2000). Animated pedagogical agents: Face-to-face interaction in interactive learning environments. *International Journal of Artificial Intelligence in Education*, 11, 47–78.
- Kim, Y., & Baylor, A. L. (2006). Pedagogical agents as learning companions: The role of agent competency and type of interaction. *ETR&D—Educational Technology Research and Development*, 54(3), 223–243.
- Kim, Y., & Baylor, A. L. (2007). Pedagogical agents as social models to influence learner attitudes. *Educational Technology*, 47(1), 23–28.
- Kim, Y., Baylor, A. L., & Shen, E. (2007). Pedagogical agents as learning companions: The impact of agent emotion and gender. *Journal of Computer Assisted Learning*, 23(3), 220–234.
- Lee, J.-E. R., Nass, C., Brave, S., Morishima, Y., Nakajima, H., & Yamada, R. (2007). The case for caring co-learners: The effects of a computer-mediated co-learner agent on trust and learning. *Journal of Communication*, 57(2), 183–204.
- Lester, J. C., Towns, S. G., Callaway, C. B., Voerman, J. L., & FitzGerald, P. J. (2000). Deictic and emotive communication in animated pedagogical agents. In J. Sullivant (Ed.), *Embodied conversational agents*. Boston, MA: MIT Press.
- Mayer, R. E., & Moreno, R. (1998). A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory. *Journal of Educational Psychology*, 90, 312–320.
- Moreno, R., & Flowerday, T. (2006). Students' choice of animated pedagogical agents in science learning: A test of the similarity-attraction hypothesis on gender and ethnicity. *Contemporary Educational Psychology*, 31(2), 186–207.
- Moreno, R., & Mayer, R. E. (1999). Cognitive principles of multimedia learning: The role of modality and contiguity effects. *Journal of Educational Psychology*, 91, 358–368.
- Nass, C., & Brave, S. (2005). *Wired for speech: How voice activates and advances the human-computer relationship*. Cambridge, MA: MIT Press.
- Nass, C., & Steuer, J. (1993). Anthropomorphism, agency, and thopoeia: Computers as social actors. *Human Communication Research*, 19(4), 504–527.
- Niedenthal, P. M. (2007). Embodying emotion. *Science*, 316(5827), 1002–1005.
- Plant, E. A., Baylor, A. L., Doerr, C. E., & Rosenberg-Kima, R. B. (2009). Changing middle-school students' attitudes and performance regarding engineering with computer-based social models. *Computers and Education*, 53(2), 209–215.
- Reeves, B., & Nass, C. (1996). *The media equation*. Stanford, CA: CSLI Publications.

- Rosenberg-Kima, R. B., Baylor, A. L., Plant, E. A., & Doerr, C. E. (2007). *The importance of interface agent visual presence: Voice alone is less effective in impacting young women's attitudes toward engineering*. Paper presented at the Persuasive 2007, Stanford, CA.
- Rosenberg-Kima, R. B., Baylor, A. L., Plant, E. A., & Doerr, C. E. (2008). Interface agents as social models for female students: The effects of agent visual presence and appearance on female students' attitudes and beliefs. *Computers in Human Behavior*, 24(6), 2741–2756.
- Rosenberg-Kima, R. B., Plant, E. A., Doerr, C. E., & Baylor, A. L. (2010). The influence of computer-based model's race and gender on female students' attitudes and beliefs towards engineering. *Journal of Engineering Education*, 99(1), 35–44.
- Ryu, J., & Baylor, A. L. (2005). The psychometric structure of pedagogical agent persona. *Technology, Instruction, Cognition and Learning (TICL)*, 2(4), 291–315.
- Schunk, D. H. (1981). Modeling and attributional effects on children's achievement: A self-efficacy analysis. *Journal of Educational Psychology*, 73, 93–105.
- Schunk, D. H., Hanson, A. R., & Cox, P. D. (1987). Peer model attributes and children's achievement behaviors. *Journal of Educational Psychology*, 79, 54–61.
- Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. London: Wiley.
- Yee, N., & Bailenson, J. N. (2007). The Proteus effect: The effect of transformed self-representation on behavior. *Human Communication Research*, 33(3), 271–290.
- Yee, N., Bailenson, J. N., & Ducheneaut, N. (2009). The Proteus effect implications of transformed digital self-representation on online and offline behavior. *Communication Research*, 36(2), 285–312.

Amy L. Baylor is the principal consultant at Amy Baylor Consulting, LLC, in the Washington DC area. She recently served on a 3-year assignment as Program Officer of Human-Centered Computing at the National Science Foundation. She has been referred to as the “Avatar Queen,” given her expertise in the design of anthropomorphic agents and avatars.