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The Case for Caring Colearners: The Effects of a Computer-Mediated Colearner Agent on Trust and Learning

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This research examines the effects of a computer-mediated colearner agent that manifests caring orientations toward human learners. Just as caring orientations have positive effects on trust and learning in human–human interaction, caring orientations manifested by a computer-mediated colearner agent resulted in positive consequences. We conducted an experiment using a computer application designed to test the effects of colearner agents that manifest caring orientations in the English idiom–learning context. The findings demonstrate that a caring colearner agent led to greater trust and learning measured by recall memory when compared with a noncaring colearner agent; recognition memory, which was another measure of learning, did not show a significant difference. Two intervening variables, namely, feelings of social support and perceived intelligence of the colearner agent, were tested for mediation; the results showed that the effects of caring orientations of the colearner agent on trust were mediated both by feelings of social support and by perceived intelligence of the agent, whereas the effects of caring orientations on recall memory were mediated by feelings of social support only. The authors discuss implications for incorporating positive social virtues, such as caring orientations, into interactive media to enhance communication and learning.

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Although learning is often considered a cognitive process, particularly when the focus is placed on how cognitive skills are acquired and developed, its *social and communicative* aspects should not be dismissed (Vygotsky, 1978). In classroom-based learning, for example, communicative activities such as exchanging information and providing feedback critically influence the way learners view their own performance as well as their peers' or classmates' (Goodenow, 1993; Green, Weade, & Graham, 1988).

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Communication among members of a learning community also affects how learners set particular goals and make efforts to achieve them (Ames, 1992).

When one moves from face-to-face communication to computer-based interactions, the social and communicative dimensions of learning are no less important. Fortunately, advances in artificial intelligence are putting new life into the development of highly interactive and human-like computer-mediated characters or agents (Bailenson & Blascovich, 2004; Cassell, Sullivan, Prevost, & Churchill, 2000; Johnson, Rickel, & Lester, 2000; Parise, Kiesler, Sproull, & Waters, 1996). These advances in technology have allowed computer interfaces to become more social and interactive, thus increasing their potential to become a key medium for learning (Baylor & Kim, 2005; Bracken & Lombard, 2004).

The most common computer-mediated learning applications with enhanced social interactions have involved the computer as teacher or tutor. Consistent with the pervasiveness of these applications, a great amount of research has explored the design and implications of computer applications featuring computer agents—preprogrammed digital representations controlled by computer algorithms (Bailenson & Blascovich, 2004)—that teach people (Graesser, Wiemer-Hastings, Wiemer-Hastings, Kreuz, & Tutoring Research Group, 1999; Moreno, Mayer, Spires, & Lester, 2001). Another line of research, leveraging the model of learning in which people can learn deeply by teaching others, has investigated and demonstrated the effectiveness of computerized teachable agents that can be taught by human learners (Biswas, Leelawong, Schwartz, & Vye, 2005; Brophy, Biswas, Katzlberger, Bransford, & Schwartz, 1999). Both approaches—that is, human learners interacting with *teaching* agents and with *teachable* agents—are crucial to promoting learning in computer-mediated learning systems. However, the intrinsically social nature of learning suggests that it is also important to examine the effects of computer agents that *learn along with* human learners, which we call *computer-mediated colearner agents*.

The presence of colearner characters in the media has its origins in the more traditional forms of educational media. In popular children's educational television programming such as *Sesame Street*, *Barney and Friends*, and *Blue's Clues*, one not only finds characters playing the role of instructor delivering information relevant to the material to be learned but also sees other characters presented as *colearners* whose presence is beneficial for the viewers' learning. For example, in *Barney and Friends*, Barney the dinosaur is featured as a teacher and guide along with four to six children who regularly appear as colearners (Wan, 1999). *Blue's Clues* also features animated characters that present problems to be solved, actively engaging child viewers in problem-solving activities. The show also uses child voice-overs that encourage viewers to participate in the problem-solving process and to learn answers to the problems (Crawley et al., 2002). Similarly, in adult educational television programming or videos, one often sees individuals ostensibly experiencing and/or demonstrating the material to be learned (e.g., cooking, woodworking, yoga) in the same way that the viewer does.

Colearner characters in traditional media may not only encourage viewers to learn but also keep the learners aware that others are learning with them, possibly preventing boredom and reducing the passivity of learning associated with a one-way, noninteractive medium. The mediated colearners in noninteractive media, however, are "merely present" in the content of the educational material. Although they may help viewers learn the given material via observational or vicarious learning (Welch & Watt, 1982), these mediated colearners in noninteractive media lack the important social and communicative features that an effective colearner should have, such as the ability to monitor the performance of the learner and to provide evaluative responses (Karabenick, 1996). Therefore, the psychological distance between the mediated colearner and a human learner may be considerable, and the extent to which the learner can be motivated for learning may be limited.

Such limitations can be overcome in a computer-based learning environment with enhanced interactivity based on increased responsiveness (Downes & McMillan, 2000; Heeter, 1989; Kiousis, 2002) and features that simulate interpersonal communication (DeFleur & Ball-Rokeach, 1989; Leary, 1990). Compared with traditional media, interactive media can provide better tools and environments for learning because they are more effective in terms of attracting and sustaining learners' attention. Users tend to devote more cognitive efforts to processing information when they attend to an interactive medium as compared to a noninteractive, one-way medium (Heeter); it has also been demonstrated that increased interactivity of media tends to enhance users' recall of the content (Schaffer & Hannafin, 1986).

Interactive media can also be effective for learning because they have the potential to process and provide appropriate evaluative reaction for users' performance as *feedback* to the user's input (Shannon & Weaver, 1949). Moreover, computer-based learning interfaces can integrate social and communicative characteristics beneficial for human learners into the feedback system (Baylor, 2002), which may effectively be tied to the creation of interactive colearner characters.

One of the key social and communicative characteristics that calls for empirical investigation is the manifestation of *caring*, which has demonstrated positive effects on social relationships and learning in human–human communication (Belvel & Jordan, 2003; Cabello & Terrell, 1994; Goodenow, 1993; Wentzel, 1997). No empirical research, however, has been conducted on the effects of computer-mediated colearner agents that show caring for human learners.

The present study attempts to explore the effects of a computer-mediated colearner agent with caring orientations toward a human learner. Our prediction is that a caring colearner agent will not only demonstrate the potential to enhance learning but also be viewed as a trustworthy learning partner by human learners. Trust may not directly or immediately enhance learning; however, trust is one of the key determinants of commitment, loyalty, and relationship management (Harris & Goode, 2004; Toth, 2000). Given the positive effects of trust on the maintenance of relationships, we can infer that trustworthiness of colearner agents will be crucial to

designing computer-mediated learning environments that can build and maintain a positive user interface relationship. Therefore, we will take both trust and learning into consideration as our outcome variables.

The virtue of caring: Effects on trust and learning

> We like people who agree with us more than people who disagree with us; we like people who like us more than people who dislike us; we like people who cooperate with us more than people who compete with us; we like people who praise us more than people who criticize us. (Aronson, 1972, p. 205)

Elliott Aronson's statement in *The Social Animal* epitomizes one of the basic human needs: the need for belonging, affiliation, and support. Simply put, humans want to be *cared for* by others. The sense of being cared for is crucial to fostering positive social relationships and enhancing achievement in various social contexts (Battaglia, Finley, & Liebschutz, 2003; Belvel & Jordan, 2003; Cabello & Terrell, 1994; Johnson, Makinen, & Millikin, 2001; Jones, 2004b; Semmes, 1991; Solnit & Nordhaus, 2005; Thom & Stanford Trust Study Physicians, 2001).

With respect to the positive effects of caring orientations on social relationships, expressions of care and concern foster a trusting relationship between communicators, as demonstrated in social support research (Burleson & Goldsmith, 1998). Clinical settings are a frequent locus for the examination of the trust-building effects of caring orientations. Patients' trust in health practitioners is positively affected by health practitioners' demonstration of caring through emotional commitment and sensitivity to patients' psychological states (Semmes, 1991). Similarly, research has demonstrated that patients tend to show greater trust in health care providers who express caring orientations through compassionate gestures and empowering statements (Battaglia et al., 2003).

The positive effects of caring on building interpersonal trust have also been found in the context of intimate relationships, underscoring the vital role played by caring orientations in trust building. The sense of being cared for has been found to be a key determinant of trust in romantic partners among both male and female late adolescents (Lock, Ferguson, & Wise, 1998). In adult romantic relationships, violation of the expectation that one's partner would offer caring in times of distress tends to erode trust (Johnson et al., 2001).

Studies of teacher–student communication have also demonstrated that caring orientations foster trust. In a series of experiments that used written scenarios and video recordings of teacher behaviors during a classroom lecture as stimuli, teachers who displayed caring behaviors to a greater degree, verbally and/or nonverbally, were rated more credible by students (Teven & Hanson, 2004).

In addition to its contribution to fostering trust in various social relationships, communication of caring has also been found to promote learning in educational settings. Research has stressed the important role of a caring pedagogical environment in increasing the motivation for learning (Noblit, 1993; Noddings, 1992).

Studies have demonstrated that students' academic motivation and achievement in learning can be enhanced when the students are cared for by their teachers (Wentzel, 1997) and by their peers (Goodenow, 1993). Particularly in the face of difficulties, as research with children demonstrates, people who are aware that someone is there to support them can respond to the challenge with "more vigor, flexibility, and constructive actions" (Furrer & Skinner, 2003, p. 148). In a similar vein, learners tend to better engage themselves in learning and show higher achievement in the presence of caring peers or colearners (Jennings, 2003; Wentzel & Watkins, 2002).

Drawing on empirical findings about the positive effects of caring orientations on trust building and learning in human–human communication, we may ask whether a computer-mediated colearner agent that manifests caring orientations can promote a trusting relationship with human learners and enhance their learning. We address the question based on the *Computers Are Social Actors* (CASA) paradigm, which has demonstrated that (a) computer personalities can easily be manifested with a minimal set of social cues (Nass, Moon, Fogg, Reeves, & Dryer, 1995) and that (b) interactions and relationships between a computer and a human interactant tend to be fundamentally *social*; that is, people respond to computers in the same manner as they would toward other people (Nass & Brave, 2005; Nass & Moon, 2000; Reeves & Nass, 1996). More specifically, studies based on the CASA paradigm have shown that various social rules and principles in human–human interaction, including the effects of similarity attraction, flattery, reciprocity, and expertise, along with the dynamics of social identification and teamwork, can be applied to human–computer interaction (Nass & Brave, 2005; Nass & Moon, 2000; Reeves & Nass, 1996). Therefore, the CASA paradigm may provide theoretical underpinnings for investigating whether caring orientations communicated by a computer-mediated colearner agent may have effects similar to those found in the context of human–human interaction.

The effects of computer agents with caring orientations

For the past decade, research based on the CASA paradigm has aimed at a better understanding of the effects of computer-manifested personas on people's attitudes, perceptions, and behaviors in the context of human–computer interaction. The CASA paradigm has made important contributions to redefining communication between humans and interactive media as a construct that should be explored "not only as mediated communication but also as a new type of interpersonal interaction" (Bracken & Lombard, 2004, p. 23).

Although possible effects of caring colearner agents on human learners have yet to be explored empirically, a number of studies have taken important steps toward addressing topics relevant to our current research question. For example, in Bickmore and Picard (2004), participants in the study were involved in daily interactions with an embodied computer agent named Laura, an exercise advisor, and received feedback on their exercise patterns for 1 month. There were two

versions of Laura: One version of the agent did not show any caring orientations (labeled *a nonrelational agent*), and the other version of the agent (*a relational agent*) exhibited caring orientations both verbally and nonverbally. The findings of the study suggest that the participants in the relational agent condition, compared to those in the nonrelational agent condition, experienced emotional attachment to and showed greater trust in the agent.

Brave, Nass, and Hutchinson (2005) examined the effects of a computer agent manifesting caring orientations through empathy expressed toward computer users in a game-playing context, in which the experiment participants paired up with a computer agent and played casino-style blackjack. Their findings showed that user-oriented, empathic emotion expressed by the computer agent had positive effects on users' liking of and trust in the agent.

Along similar lines, but with a greater focus on learning, Bracken and Lombard (2004) investigated the effects of a "praising" computer on children's learning. In their study, child participants ranging from 8 to 10 years old were assigned to work with a computer that provided either praising or neutral feedback. First, the participants read a story with illustrations presented on the computer screen; they subsequently interacted with the computer by responding to a series of multiple-choice questions. If the participant answered correctly, the praising computer would respond with a text-based compliment ("Wow, you are doing a fine job"), whereas the neutral-feedback computer would neutrally respond with "OK" (Bracken & Lombard, 2004, p. 28). If the children answered incorrectly, regardless of the conditions to which they were assigned, they were told by the computer to try again. The study concluded that interacting with a praising computer had positive effects on children's perceived self-competence and learning. Because praising is considered a crucial component of caring orientations (Bartol, 1983), the findings of Bracken and Lombard provide important insight into understanding the possible beneficial effects that the caring orientations of a colearner agent might have on learning.

Based on the literature on the effects of caring orientations in human–human interaction contexts and on the prior research about the effects of computers that manifest caring orientations, we make the following predictions:

H1: Individuals who learn with a caring colearner agent will show a greater degree of trust in the colearner agent than individuals who learn with a noncaring colearner agent.

H2: Individuals who learn with a caring colearner agent will show better performance in learning-related tasks than those who learn with a noncaring colearner agent.

In addition to examining whether the effects of caring orientations on trust and learning are significant, the present study attempts to explore potential mechanisms behind these effects by identifying mediating variables. Specifically, we focus on

feelings of social support and perceived intelligence of the colearner agent as possible mediators for trust and learning.

Both the Bickmore and Picard (2004) and the Brave et al. (2005) studies suggest that people tend to feel more socially supported in the presence of a computer agent that cares for them. As noted before, in Bickmore and Picard, the participants who interacted with the relational agent felt more supported than those who interacted with the nonrelational agent; the relational agent was also perceived to be more concerned with the participants' welfare. Similarly, Brave et al. demonstrate that participants who played blackjack with the caring agent felt greater support. These findings may be extended to a context in which people learn with a computer-mediated colearner agent that shows caring orientations.

There are also reasons to believe that a colearner agent with caring orientations may be perceived as more "intelligent." Emotional and behavioral expressions of caring often involve social skills and expressivity (Squier, 1990). In human–human interactions, individuals who display good social skills and expressivity tend to be evaluated positively (DePaulo & Friedman, 1998; Riggio, 1986), whereas shy individuals who lack social expressivity tend to be perceived as less intellectually competent (Gough & Thorne, 1986; Paulhus & Morgan, 1997) or less talented (Jones, Cavert, & Indart, 1983). In addition, socially sensitive individuals tend to be highly attentive to others and aware of norms and rules concerning what is socially appropriate, that is, "being good watchers and listeners" (Riggio, 1986, p. 651). Accordingly, this awareness may be associated with perceived intelligence.

Human learners' feelings of social support and perception of the colearner agent as intelligent may in turn influence the learners' trust in the agent. Trust, which is "an expectancy that others can be relied upon" (Rotter, 1978, p. 651), has both affective and cognitive roots (Lewis & Weigert, 1985; McAllister, 1995). People are more likely to trust others who make them feel socially supported because feelings of social support may engender emotional attachment and bonding, which constitute the affective foundations of trust (Lewis & Weigert; McAllister). On the other hand, trust is also grounded in a cognitive process that allows one to discern what is trustworthy or not (Lewis & Weigert); information such as perceived intelligence of a target may constitute a key criterion for people to make such a judgment. Particularly in the context of human–computer interaction, perceived intelligence of computer interfaces/agents can be considered a key determinant of their trustworthiness (King & Ohya, 1996).

We also posit that feelings of social support and perceived intelligence of the agent will mediate the effects of a caring colearner agent on learning. For learners, social support can serve both as a reward for good performance (Bracken & Lombard, 2004; Hancock, 2002; Nielson & Bryant, 2005) and as a psychological buffer against possible frustration (Bryant, 1998); therefore, feelings of social support induced by a caring colearner agent may keep learners motivated for learning. Perceived intelligence of a colearner agent may also be a significant mediator, as a seemingly intelligent colearner agent will better attract the attention of human

learners and help them stay engaged in the learning process.[1] To test our mediation models, we propose the following hypotheses:

H3: Individuals who learn with a caring colearner agent are likely to feel a greater degree of social support than those who learn with a noncaring colearner agent.

H4: A caring colearner agent will be perceived as more intelligent than a noncaring colearner agent.

H5: Feelings of social support and perceived intelligence of a colearner agent will mediate the effect of caring orientations of the agent on trust.

H6: Feelings of social support and perceived intelligence of a colearner agent will mediate the effect of caring orientations of the agent on learning.

Method

To test the proposed hypotheses, we chose the context of language learning, in particular, learning idiomatic expressions. Using a computer application developed for English idiom learning for nonnative English speakers, we conducted the following experiment with Japanese participants.

Participants

Seventy-six undergraduate students at a private university in Japan were recruited for the experiment for course credit (25 men and 51 women). The participants, recruited from a group of students enrolled in a beginner-level English language course, were relatively homogeneous with respect to their English proficiency. There were individuals who did not complete the postexperiment questionnaires or those who had technical problems with using the computer application, and their data were not included. As a result, the final sample consisted of 60 participants (17 men and 43 women).

Design and stimuli

The experiment was based on a between-participants design with three conditions, and participants were randomly assigned to one of the three conditions, with gender balanced: (a) caring colearner condition, (b) noncaring colearner condition, and (c) control condition. In the *caring colearner* (n = 20) and the *noncaring colearner* conditions (n = 20), the participant, represented by an avatar, learned English idioms with a teacher agent and a colearner agent (Figure 1).[2] The colearner agent in the caring colearner condition manifested a caring personality by expressing empathic emotion and by giving supportive and encouraging verbal feedback to participants. Conversely, the noncaring colearner agent did not manifest caring orientations toward the participants, although all the other behavioral features were identical

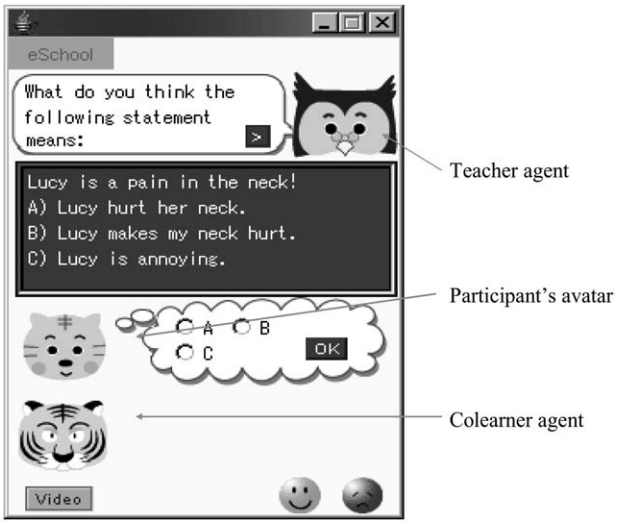

Figure 1 The idiom-learning application: teacher agent, colearner agent, and participant's avatar.

to those of the caring colearner agent. The control condition (n = 20) featured the same teacher agent and participant's avatar but no colearner agent.

The computer application employed cartoon-like animal characters for representing participants, the teacher agent, and the colearner agent; human characters were not used so that biases associated with race or gender could be prevented.

Measures

Feelings of social support was an index composed of five items: "not alone," "praised," "attended," "appreciated," and "supported." The participant rated how well each adjective described their feelings during their use of the learning application on scales ranging from 1 (describes *very poorly*) to 10 (describes *very well*). The index was reliable (Cronbach's α = .75).

Perceived intelligence of the colearner agent was an index composed of five items: "smart," "intelligent," "capable," "successful," and "confident." The participant rated how well each adjective described the colearner agent on scales anchored with 1 (describes very poorly) and 10 (describes very well). The index was reliable (α = .75).

Trust in the colearner agent was an index based on five items that described the agent: "attentive," "sincere," "useful," "trustworthy," and "honest." The participant rated how well each adjective described the colearner agent on scales of 1 (describes very poorly) to 10 (describes very well). The index was very reliable (α = .89).

Learning was assessed via an online test administered after the idiom-learning session. The test included 10 correct–incorrect questions and 6 fill-in-the-blank questions. The correct–incorrect test, which was designed to assess recognition memory performance, asked the participants to indicate whether idiom usage in

a given sentence was correct or incorrect; a correct answer for each of the correct–incorrect questions was worth 1 point.

The fill-in-the-blank test, which was designed to assess recall memory performance, asked the participants: "Please fill in the blanks using the idioms you learned so that the sentences make sense" (e.g., "How could you believe what he said? He was just _____"; for this question, the correct answer was "pulling your leg"). The answers to the fill-in-the-blank questions were given 0–5 points: A perfect answer was worth 5 points; partial credit was assessed depending upon the grammatical or spelling mistakes made by the participants; and participants received 0 points if they gave totally irrelevant answers or left the blanks unfilled. Scoring was conducted by two coders who were blind to the experimental conditions. To obtain a chance-corrected measure of intercoder reliability, we employed intraclass correlation coefficient (ICC). The reliability was very high for all the six fill-in-the-blank items, with ICC ranging from 0.92 to 0.98.

Recognition and recall involve different cognitive processes (Cariana & Lee, 2001; Jones, 2004a; Lang, 1995; Raaijmakers & Shiffrin, 1992; Singer, 1980). Thus, it is not surprising that the correlation between the correct–incorrect and the fill-in-the-blank tests was not very high, though positive and significant ($r = .54$, $p < .001$). Therefore, our analysis treated raw scores of the correct–incorrect and the fill-in-the-blank tests separately, following previous research that examined recall and recognition as separate dependent variables for assessing memory (Lang, 1995; Lang, Borse, Wise, & David, 2002).

Procedure

Each participant was randomly assigned to a desktop computer on which the idiom-learning application designed for the experiment was installed. The experiment session consisted of four parts: (a) instructions, (b) a brief video skit, which presented a dialogue between two individuals, (c) an idiom lesson, and (d) a posttest questionnaire.

At the beginning of the experiment, participants received instruction on how to use the software application. The participants were then asked to watch a brief video skit presented on the computer screen. In the video, two individuals carried out a conversation using idioms that were to be explained in detail in the idiom lesson that followed.

When the participants finished watching the video, they were asked to click on the "Continue" button, which initiated the idiom lesson. First, the teacher agent asked a question regarding a given idiom (e.g., "What do you think the following statement means?") and offered a statement that included the idiom in question (e.g., "Lucy is a pain in the neck!"). Three answer choices, for example, (a) Lucy hurt her neck, (b) Lucy makes my neck hurt, and (c) Lucy is annoying, were displayed. When the participant selected one of the three answer choices, he/she received feedback from the teacher agent concerning whether the chosen answer was correct or incorrect. The teacher agent then provided a detailed explanation about the correct answer and the specific usage of the given idiomatic expression. When the

idiom lesson ended, the participants were given a set of questionnaires to assess the participants' experience with the learning application and learning process.

Although this general structure was shared by all the three conditions, the specific features of the idiom lesson varied across conditions. In the control condition, which did not have a colearner agent, the teacher agent called on the participant to select an answer choice for the given question. When the participant finished responding, the teacher agent informed the participant whether his or her answer was correct or incorrect and provided an explanation. In both the experiment conditions (caring colearner vs. noncaring colearner), however, the teacher agent asked either the participant or the colearner agent to give an answer to the question, alternating between the two. The teacher agent then indicated whether the answer choice was correct or incorrect.

The caring colearner and noncaring colearner conditions varied with respect to the colearner agent's behavior. In the caring colearner condition, the agent showed empathic emotional expressions and made highly person-centered comforting remarks, that is, "messages that acknowledge, elaborate, legitimize, and contextualize the feelings of the other" (Jones & Burleson, 1997, p. 530). More specifically, when the participant gave a correct answer to the teacher agent, the caring colearner agent showed positive emotional expressions and provided complimentary feedback such as: "Good job"; "That was hard, and you got it!"; "You're good at this"; "I'm impressed"; "I knew you'd get it right"; and "You are doing very well!" When the participant provided an incorrect answer, the caring colearner agent gave empathic feedback such as: "That was a hard one"; "I didn't know that one, either"; "Don't worry—you are really good at these"; "I would have given the same answer; this is hard"; and "Good try." In contrast, in the noncaring colearner condition, the colearner agent did not say anything to the participant.

When the idiom-learning session was completed, participants filled out a questionnaire, which included items regarding their experience with the idiom-learning application; the items that asked specifically about the colearner agent were not included in the questionnaire for the participants in the control condition. Upon completion of the questionnaire, participants took correct–incorrect and fill-in-the-blank tests on the idiomatic expressions they learned during the lesson.

It took approximately 1 hour for the participants to complete the entire experiment. When the session was over, the participants were debriefed and thanked by the experimenter.

Results

To examine whether the intended manipulation was successful, that is, the caring colearner agent was actually perceived as expressing caring orientations, we composed an index for a manipulation check: Participants rated how well each of the four adjectives ("caring," "friendly," "helpful," and "warm") described the colearner agent on 10-point Likert scales ranging from 1 (describes very poorly) to 10 (describes very

well); the index was reliable ($\alpha = .80$). We then compared participants' ratings of the colearner agents based on the manipulation check index. Although the mean score of the caring colearner agent ($M = 6.04$, $SD = 1.76$) was only slightly higher than the midpoint value (i.e., a 5.5 midpoint on the 10-point scale), a one-tailed t test revealed that the caring colearner agent received significantly higher ratings than the noncaring colearner agent ($M = 4.18$, $SD = 1.66$), $t(37) = 3.38$, $p < .01$.

In testing our first hypothesis (i.e., the caring colearner agent will be perceived as more trustworthy than the noncaring colearner agent), we conducted a one-tailed t test. The analysis showed that the caring colearner ($M = 5.44$, $SD = 1.73$) received higher trustworthiness ratings than the noncaring colearner agent ($M = 3.66$, $SD = 1.52$), $t(38) = 3.45$, $p < .01$, which was consistent with the hypothesis.

To test Hypothesis 2, which posited that caring colearner agent would have a positive effect on learning, we compared recall and recognition scores on the idiom tests across the three conditions based on a one-way analysis of variance (ANOVA). The one-way ANOVA for the recall memory test given in the fill-in-the-blank question format was statistically significant, $F(2, 50) = 5.85$, $p < .01$. A post hoc test (Student–Newman–Keuls test) demonstrated that the participants in the caring colearner condition ($M = 21.38$, $SD = 5.96$) did significantly better on the recall memory test compared to those who were in the noncaring colearner condition ($M = 14.53$, $SD = 7.35$) and the control condition ($M = 15.18$, $SD = 5.77$); the latter two conditions did not differ significantly from each other. Therefore, Hypothesis 2 was supported for the recall memory task.

The mean scores of the recognition memory test given in the correct–incorrect question format were also subjected to a one-way ANOVA; this time, statistically significant differences were not found, $F(2, 50) = 1.55$, *ns*. The recognition test mean scores, however, revealed a pattern similar to that of the recall test scores: Participants in the caring colearner condition ($M = 7.43$, $SD = 1.71$) had the highest mean score, followed by those in the control condition ($M = 7.05$, $SD = 1.43$) and in the noncaring colearner condition ($M = 6.47$, $SD = 1.66$).

With Hypotheses 1 and 2 supported for recall memory, the next step was to test the proposed mediating variables. A significant mediator should satisfy three key conditions. First, it should demonstrate a significant relationship with the independent variable of the model. Second, it should have a significant relationship with the dependent variable of the model. Finally, the originally significant relationship between the independent and the dependent variables of the model should no longer be significant when controlling for the mediating variable (Baron & Kenny, 1986).

Given these conditions, a path analysis based on multiple regressions was conducted to test the hypotheses involving mediation (see Figure 2). For regression analyses, the experiment conditions were dummy coded (caring colearner = 1, noncaring colearner = 0). Consistent with Hypotheses 3 and 4, simple regression analyses confirmed that caring orientations manifested by the colearner agent had a significant positive association with feelings of social support ($\beta = .42$, $p < .01$) and with perceived intelligence ($\beta = .39$, $p < .05$). A multiple regression analysis was then

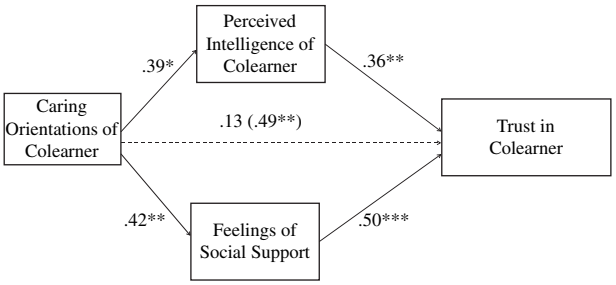

Figure 2 A path model of trust: feelings of social support and agent's perceived intelligence as mediating variables.

Note: The dashed line indicates that the coefficient became nonsignificant after mediators; the coefficient before the mediators is shown in the parentheses. The paths from the mediators (perceived intelligence of the colearner agent and feelings of social support) to the outcome measure (trust in the colearner agent) control for one another as well as for the independent variable, caring orientations of the colearner agent. $^{***}p < .001$. $^{**}p < .01$. $^{*}p < .05$.

conducted for testing the mediation model of trust in the colearner agent. Both of the proposed mediators, feelings of social support ($\beta = .50$, $p < .001$) and perceived intelligence of the agent ($\beta = .36$, $p < .01$), showed significant relationships with trust, the dependent variable. However, the effect of the caring orientations of the colearner agent on trust, which had been significant before controlling for the two proposed mediators ($\beta = .49$, $p < .01$), was no longer significant after controlling for the mediators ($\beta = .13$, *ns*). Thus, all parts of Hypothesis 5 were supported.

The mediation model posited by Hypothesis 6 was tested only with the recall memory test scores because recognition memory scores did not show a significant difference initially (see Figure 3). In the first round of the path analysis, feelings of social support showed a significant relationship with the recall memory performance ($\beta = .42$, $p < .01$). Perceived intelligence of the agent, however, did not show a statistically significant relationship with learning ($\beta = .22$, *ns*) and was thus disqualified as a mediating variable. Therefore, the final test of the path model for learning included only feelings of social support as a mediator. As the results, the path from the caring orientations of the colearner agent to learning, which had been significant ($\beta = .47$, $p < .01$), was no longer significant ($\beta = .31$, *ns*), whereas feelings of social support remained significant ($\beta = .36$, $p < .05$). The data thus suggest that Hypothesis 6 was supported for feelings of social support.[3]

Discussion

The results of the present paper demonstrate that a computer-mediated colearner agent manifesting caring orientations benefits human learners, just as caring orientations can bring about positive consequences in the contexts of human communication and learning.

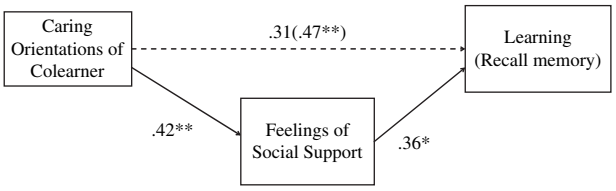

Figure 3 A path model of learning: feelings of social support as a mediating variable.

Note: The dashed line indicates that the coefficient became nonsignificant after inclusion of the mediator (feelings of social support); the coefficient before the mediator is shown in the parentheses. $^{**}p < .01$. $^{*}p < .05$.

We predicted that a caring colearner agent would enhance learning as well as trust in the colearner agent. The predicted relationship between caring orientations of the colearner agent and trust was supported by the data. This is important to note, given that trustworthiness and reliability of media are pivotal factors that positively contribute to a stable and sustainable user–media relationship (Menon, Deshpande, Perri, & Zinkhan, 2002).

The effect of caring orientations on learning was significant only for recall memory, although the mean scores of the recognition memory test across the three conditions showed a pattern similar to that of the recall memory test. Our data reveal that the mean values of the recognition memory test were relatively high across groups (i.e., mean scores ranging between 6.47 and 7.43 out of the possible perfect score of 10.00) with low variances (i.e., standard deviations ranging between 1.43 and 1.71). Given that recall memory tasks tend to be more difficult than recognition memory tasks (Rimmer, 2004), it is likely that the recall memory test was a more sensitive and effective measure for assessing learning in our study when compared with the recognition memory test that may have showed a ceiling effect (Haist, Shimamura, & Squire, 1992; Norris & Colman, 1992).

In order to understand mechanisms underlying the positive effects of caring orientations of the colearner agent on trust and learning, we proposed and tested two mediators: perceived intelligence of the colearner agent and feelings of social support. All parts of the mediation model for trust were supported by the data, suggesting that feelings of social support induced by interaction with the caring colearner agent as well as perceived intelligence of the agent may foster learners' confidence that their interaction with the colearner agent is reliable and valuable.

The mediation model for learning revealed a different pattern. The effect of caring orientations on recall memory was mediated only by feelings of social support. It is possible that feelings of social support elicited by the caring colearner agent may effectively motivate and engage the human learner. For those who learn, praise for good performance constitutes an intrinsic reward that can increase the level of motivation in the course of learning (Bracken & Lombard, 2004; Hancock, 2002; Nielson & Bryant, 2005). On the other hand, when learners make mistakes or show

poor performance, feelings of social support may function for them as a psychological buffer against frustration (Bryant, 1998), preventing them from losing interest in or motivation for learning. At the broadest level, the present research confirms that a computer-mediated colearner agent can be a source of psychological buffering by manifesting caring orientations, just as a human colearner could (Nass & Moon, 2000; Reeves & Nass, 1996).

Whereas feelings of social support did mediate the effect of caring orientations of the colearner agent on recall memory, perceived intelligence of the agent was disqualified as a mediator because the relationship between perceived intelligence of the agent and recall memory was not statistically significant. We may infer that learners' perception of the agent as intelligent may not have been sufficient enough to affect their attention or motivation in the learning process. Rather, the data suggest that what possibly mediated the positive effect of the caring colearner agent on learning was the social and emotional support communicated to the learners by the caring colearner's feedback in the course of learning. The mediation model thus points to the importance of social and communicative aspects of learning and how they should be reflected in the design of interactive media effective for learning.

The present research provides strong confirmation for the CASA paradigm. The findings of the current research do not simply suggest that learning with a colearner is an important social model for mediated learning environment. Even more importantly, this research suggests that *communication of caring*, which addresses the basic human need for affiliation and support, is the key to positive consequences such as fostering trust and enhancing learning in human–media interaction.

On the other hand, it is intriguing to find that the social facilitation effects (Zajonc, 1965) were not found. As illustrated by the learning effects, it was caring that truly made the difference; the noncaring colearner agent did not improve performance relative to no agent at all. Although the social facilitation literature has posited that the mere presence of other individuals, either as audience or as coactors, influences one's performance or learning (Zajonc, 1965), our data suggest that as far as mediated colearner agents are concerned, mere presence may not be sufficient. This may be because the applications used in the present study featured nonhuman characters to avoid race- or gender-related biases; at the same time, the contrast between the absence of social facilitation effects and the presence of significant effects of caring orientations emphasizes that imbuing positive social characteristics into computer interfaces and computer-mediated agents, regardless of whether human or nonhuman representations are used, can be critical to enhancing learning.

In this light, the present research also has important practical implications for developers and designers of interactive media for learning. As computers and agent-based technologies become more prominent as educational tools for both children and adults (Bracken & Lombard, 2004), the present findings suggest that the casting of computer-mediated colearner or teacher agents' characteristics and personalities may be as critical a consideration as the selection of course content.

Limitations

This research certainly has limitations. First, the experiment only examined language learning, specifically, English idioms for nonnative speakers. It will be important to explore whether caring colearner agents can foster learning in other domains.

Second, the participants in the current study were college students; it is important that learners in other age groups are also studied. In particular, caring colearner agents may considerably benefit children. Recent research illustrates that praising computers have positive effects on children's learning (Bracken & Lombard, 2004); future research should examine the effects of supportive and encouraging feedback when children make mistakes or perform poorly.

Third, the current experiment measured learning effects on the basis of recognition and recall memory tests. Although both recognition and recall memory tests constitute key measures of learning effects, learning also includes the learner's ability to extend or apply what is learned in one context to other contexts, a process known as knowledge transfer (Byrnes, 1996). Future research should examine whether caring colearner agents can have positive effects on transfer as well as memory.

Fourth, researchers should consider the role of culture. The present research was conducted with Japanese college students. Japan has a collectivist culture in which the self is viewed as interdependent (Markus & Kitayama, 1992); one of the most important social goals in such a cultural atmosphere is "to adjust and restrain self" and to "maintain harmony with [the] social context" (Markus & Kitayama, 1992, p. 230). The strong effects of caring colearner agents in the current study may have been influenced by the collectivist nature of Japanese culture, in which people tend to value the social context and could thereby be relatively more susceptible to the effects of caring orientations manifested by computer-mediated colearner agents. It will be important, therefore, to examine the effects of caring colearner agents in individualistic cultures such as the United States and Germany.

Last, research on the effects of mediated agents manifesting social characteristics will benefit from comparisons of people's responses to real people, mediated representations, and computer agents. The CASA approach, including the current experiment, has largely been devoted to investigating people's social responses to computers to test whether and how social rules and virtues can be applied to human–media communication. The CASA paradigm should extend its theoretical and empirical scope by examining subtle differences, beyond similarities, that might exist between human–human and human–media communication. For example, future research could improve the present study by exploring whether and how people's perception of and responses to computer agents' caring behaviors, both verbal and nonverbal, differ from the way they perceive and react to real people's expression of caring orientations.

Conclusion

The current study demonstrates the importance of computer-mediated colearner agents, showing that caring orientations simulated by computer agents can result in

positive consequences for human learners. Although concerns have been raised that the "artificial caring" of technology could be abused for the purpose of masking deceptive and manipulative intents (Bickmore & Picard, 2004; Picard & Klein, 2002), the findings of the present study point toward an avenue for establishing a relationship between new media technology and human users that could be beneficial. Future research should make continued efforts to pursue such opportunities so that positive social characteristics such as caring orientations can be better integrated into computer systems and interactive media interfaces to advance human–media communication.

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Notes

1 We had hypothesized that both perceived intelligence of the colearner agent and feelings of social support would mediate the effects of caring orientations on trust as well as on learning; however, we did not hypothesize that trust would have significant effects on learning. Although long-term use of the learning application may tell a different story, a significant relationship between the two variables may not be found, particularly in a short-term setting as in the present experiment. The proposed mediating variables (i.e., feelings of social support and perceived intelligence of the colearner) can be more immediate sources of motivation and drivers of attention in the process of learning; however, trust, as more of a relationship-level variable, may only be able to affect learning as the learner establishes a positive relationship with the colearner agent (and ultimately with the learning application) via long-term use.

2 Avatars and agents are conceptually distinct. Whereas an avatar refers to a form of digital representation controlled by a human being, an agent is a digital representation controlled by computer algorithm (Bailenson & Blascovich, 2004). In the computer application used in the current study, the participants could control the behaviors of their digital representations (e.g., answering questions); therefore, we may call the digital representation of the human learner "an avatar." In contrast, the behaviors of the teacher and the colearner characters in the interface were controlled entirely by preprogrammed computer algorithm; therefore, the term "agent" is used for the digital representations of the teacher and the colearner characters.

3 As noted earlier, we did not expect that there would be a significant relationship between trust and learning. The statistical analysis does not show any significant associations between trust and recognition ($r = .27$, $p > .13$) or between trust and recall ($r = .32$, $p > .07$).

References

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology*, **84**, 261–271.

Aronson, E. (1972). *The social animal*. New York: Viking.

Bailenson, J., & Blascovich, J. (2004). Avatars. In W. S. Bainbridge (Ed.), *Encyclopedia of human-computer interaction* (pp. 64–68). Great Barrington, MA: Berkshire Publishing Group.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, **51**, 1173–1182.

Bartol, M. A. (1983). Reaching the patient. *Geriatric Nursing*, **4**, 234–236.

Battaglia, T. A., Finley, E., & Liebschutz, J. M. (2003). Survivors of intimate partner violence speak out: Trust in the patient-provider relationship. *Journal of General Internal Medicine*, **18**, 617–623.

Baylor, A. L. (2002). Agent-based learning environments for investigating teaching and learning. *Journal of Educational Computing Research*, **26**, 249–270.

Baylor, A. L., & Kim, Y. (2005). Simulating instructional roles through pedagogical agents. *International Journal of Artificial Intelligence in Education*, **15**, 95–115.

Belvel, P. S., & Jordan, M. M. (2003). *Rethinking classroom management: Strategies for prevention, intervention, and problem solving*. Thousand Oaks, CA: Corwin Press.

Bickmore, T. W., & Picard, R. W. (2004). Towards caring machines. In E. Dykstra-Erickson and M. Tscheligi (Eds.). *Extended abstracts of CHI 2004 conference on human factors in computing systems* (pp. 1489–1492). New York: ACM Press.

Biswas, G., Leelawong, K., Schwartz, D., & Vye, N. (2005). Learning by teaching: A new agent paradigm for educational software. *Applied Artificial Intelligence*, **19**, 363–392.

Bracken, C. C., & Lombard, M. (2004). Social presence and children: Praise, intrinsic motivation, and learning with computers. *Journal of Communication*, **54**, 22–37.

Brave, S., Nass, C., & Hutchinson, K. (2005). Computers that care: Investigating the effects of orientation of emotion exhibited by an embodied computer agent. *International Journal of Human-Computer Studies*, **62**, 161–178.

Brophy, S., Biswas, G., Katzlberger, T., Bransford, J., & Schwartz, D. (1999). Teachable agents: Combining insights from learning theory and computer science. In S. P. Lajoie & M. Vivet (Eds.), *Artificial intelligence in education* (Vol. 50, pp. 21–28). Amsterdam: IOS Press.

Bryant, B. K. (1998). Children's coping at school: The relevance of "failure" and cooperative learning for enduring peer and academic success. In L. H. Meyer, S. H., Park, M. Grenot-Scheyer, I. S. Schwartz, & B. Harry (Eds.), *Making friends: The influences of culture and development. Children, youth and change: Sociocultural perspectives* (Vol. 3, pp. 353–367). Baltimore, MD: Paul H. Brookes.

Burleson, B. R., & Goldsmith, D. J. (1998). How the comforting process works: Alleviating emotional distress through conversationally induced reappraisals. In P. A. Andersen & L. K. Guerrero (Eds.), *Handbook of communication and emotion: Research, theory, applications, and contexts* (pp. 245–279). San Diego, CA: Academic Press.

Byrnes, J. P. (1996). *Cognitive development and learning in instructional contexts*. Boston: Allyn and Bacon.

Cabello, B. T., & Terrell, R. (1994). Making students feel like family: How teachers create warm and caring classroom climates. *Journal of Classroom Interaction*, **29**, 17–23.

Cariana, R. B., & Lee, D. (2001). The effects of recognition and recall study tasks with feedback in a computer-based vocabulary lesson. *Educational Technology Research and Development*, **49**, 23–36.

Cassell, J., Sullivan, J., Prevost, S., & Churchill, E. (2000). *Embodied conversational agents*. Cambridge, MA: MIT Press.

Crawley, A. M., Anderson, D. R., Santomero, A., Wilder, A., Williams, M., Evans, M. K, et al. (2002). Do children learn how to watch television? *Journal of Communication*, **52**, 264–280.

DeFleur, M. L., & Ball-Rokeach, S. J. (1989). *Theories of mass communication*. New York: Longman.

DePaulo, B. M., & Friedman, H. S. (1998). Nonverbal communication. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology* (pp. 3–40). New York: McGraw-Hill.

Downes, E. J., & McMillan, S. J. (2000). Defining interactivity: A qualitative identification of key dimensions. *New Media and Society*, **2**, 157–179.

Furrer, C., & Skinner, E. (2003). Sense of relatedness as a factor in children's academic engagement and performance. *Journal of Educational Psychology*, **95**, 148–162.

Goodenow, C. (1993). Classroom belonging among early adolescent students: Relationships to motivation and achievement. *Journal of Early Adolescence*, **13**, 21–43.

Gough, H. G., & Thorne, A. (1986). Positive, negative, and balanced shyness. In W. H. Jones, J. M. Cheek, & S. R. Briggs (Eds.), *Shyness: Perspectives on research and treatment* (pp. 205–225). New York: Plenum Press.

Graesser, A. C., Wiemer-Hastings, K., Wiemer-Hastings, P., Kreuz, R.,& Tutoring Research Group. (1999). AutoTutor: A simulation of a human tutor. *Journal of Cognitive Systems Research*, **1**, 35–51.

Green, J. L., Weade, R., & Graham, K. (1988). Lesson construction and student participation: A sociolinguistic analysis. In J. L. Green & J. O. Parker (Eds.), *Multiple perspectives analyses of classroom discourse: Vol. 28: Advances in discourse processes* (pp. 11–47). Norwood, NJ: Ablex Publishing.

Haist, F., Shimamura, A. P., & Squire, L. R. (1992). On the relationship between recall and recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **18**, 691–702.

Hancock, D. R. (2002). Influencing graduate students' classroom achievement, homework habits and motivation to learn with verbal praise. *Educational Research*, **44**, 83–95.

Harris, L. C., & Goode, M. M. H. (2004). The four levels of loyalty and the pivotal role of trust: A study of online service dynamics. *Journal of Retailing*, **80**, 139–158.

Heeter, C. (1989). Implications of new interactive technologies for conceptualizing communication. In J. L. Salvaggio & J. Bryant (Eds.), *Media use in the information age: Emerging patterns of adoption and computer use* (pp. 217–235). Hillsdale, NJ: Erlbaum.

Jennings, G. (2003). An exploration of meaningful participation and caring relationships as contexts for school engagement. *California School Psychologist*, **8**, 43–52.

Johnson, S. M., Makinen, J. A., & Millikin, J. W. (2001). Attachment injuries in couple relationships: A new perspective on impasses in couples therapy. *Journal of Marital and Family Therapy*, **27**, 145–155.

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.

Jones, L. (2004a). Testing L2 vocabulary recognition and recall using pictorial and written test items. *Language Learning & Technology*, **8**, 122–143.

Jones, S. M. (2004b). Putting the person into person-centered and immediate emotional support: Emotional change and perceived helper competence as outcomes of comforting in helping situations. *Communication Research*, **31**, 338–360.

Jones, S. M., & Burleson, B. R. (1997). The impact of situational variables on helpers' perception of comforting messages: An attributional analysis. *Communication Research*, **24**, 530–555.

Jones, W. H., Cavert, C., & Indart, M. (1983, August). Impressions of Shyness. Paper presented at the 91st Annual meeting of the American Psychological Association, Anaheim, CA.

Karabenick, S. A. (1996). Social influences on metacognition: Effects of colearner questioning on comprehension monitoring. *Journal of Educational Psychology*, **88**, 689–703.

King, W. J., & Ohya, J. (1996). The representation of agents: Anthropomorphism, agency, and intelligence. In M. J. Tauber (Ed.), *Proceedings of the ACM conference on human factors in computing systems* (pp. 289–290). New York: ACM Press.

Kiousis, S. (2002). Interactivity: A concept explication. *New Media & Society*, **4**, 355–383.

Lang, A. (1995). Defining audio/video redundancy from a limited-capacity information processing perspective. *Communication Research*, **22**, 86–115.

Lang, A., Borse, J., Wise, K., & David, P. (2002). Captured by the World Wide Web: Orienting to structural and content features of computer-presented information. *Communication Research*, **29**, 215–245.

Leary, T. (1990). The interpersonal, interactive, interdimensional interface. In B. Laurel (Ed.), *The art of human-computer interface design* (pp. 229–234). Menlo Park, CA: Addison-Wesley.

Lewis, J. D., & Weigert, A. (1985). Trust as a social reality. *Social Forces*, **63**, 967–985.

Lock, S. E., Ferguson, S. L., & Wise, C. (1998). Communication of sexual risk behavior among late adolescents. *Western Journal of Nursing Research*, **20**, 273–294.

Markus, H. R., & Kitayama, S. (1992). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, **98**, 224–253.

McAllister, D. J. (1995). Affect- and cognition-based trust as foundations for interpersonal cooperation in organization. *The Academy of Management Journal*, **38**, 24–59.

Menon, A. M., Deshpande, A. D., Perri, M., & Zinkhan, G. M. (2002). Trust in online prescription drug information among internet users: The impact on information search behavior after exposure to direct-to-consumer advertising. *Health Marketing Quarterly*, **20**, 17–35.

Moreno, R., Mayer, R., Spires, H. A., & Lester, J. C. (2001). The case for social agency in computer-based teaching: Do students learn more deeply when they interact with animated pedagogical agents. *Cognition and Instruction*, **79**, 177–213.

Nass, C., & Brave, S. (2005). *Wired for speech: How voice activates and advances the human-computer relationship*. Cambridge, MA: MIT Press.

Nass, C., & Moon, Y. (2000). Machines and mindlessness: Social responses to computers. *Journal of Social Issues*, **56**, 81–103.

Nass, C., Moon, Y., Fogg, B. J., Reeves, B., & Dryer, D. C. (1995). Can computer personalities be human personalities? *International Journal of Human-Computer Studies*, **43**, 223–239.

Nielson, K. A., & Bryant, T. (2005). The effects of non-contingent extrinsic and intrinsic rewards on memory consolidation. *Neurobiology of Learning and Memory*, **84**, 42–48.

Noblit, G. W. (1993). Power and caring. *American Educational Research Journal*, **30**, 23–38.

Noddings, N. (1992). *The challenge to care in schools: An alternative approach to education*. New York: Teachers College Press.

Norris, C. E., & Colman, A. M. (1992). Context effects on recall and recognition of magazine advertisements. *Journal of Advertising*, **21**, 37–46.

Parise, S., Kiesler, S., Sproull, L., & Waters, K. (1996). My partner is a real dog: Cooperation with social agents. In G. M. Olson, J. S. Olson, & M. Ackerman (Eds.), *Proceedings of the 1996 ACM conference on computer-supported cooperative work* (pp. 399–408). New York: ACM Press.

Paulhus, D. L., & Morgan, K. L. (1997). Perceptions of intelligence in leaderless groups: The dynamic effects of shyness and acquaintance. *Journal of Personality and Social Psychology*, **72**, 581–591.

Picard, R., & Klein, J. (2002). Computers that recognize and respond to user emotion: Theoretical and practical implications. *Interacting with Computers*, **14**, 141–169.

Raaijmakers, J. G., & Shiffrin, R. M. (1992). Models for recall and recognition. *Annual Review of Psychology*, **43**, 205–234.

Reeves, B., & Nass, C. (1996). *The media equation: How people treat computers, television, and new media like real people and places*. Cambridge, UK: Cambridge University Press.

Riggio, R. E. (1986). Assessment of basic social skills. *Journal of Personality and Social Psychology*, **51**, 649–660.

Rimmer, J. (2004). Improving software environments through usability and interaction design. *Journal of Audiovisual Media in Medicine*, **27**, 6–10.

Rotter, J. B. (1978). A new scale for the measurement of interpersonal trust. *Journal of Personality*, **35**, 651–665.

Schaffer, L. C. & Hannafin, M. J. (1986). The effects of progressive interactivity on learning from interactive video. *Educational Communication and Technology Journal*, **34(2)**, 89–96.

Semmes, C. E. (1991). Developing trust: Patient-practitioner encounters in natural health care. *Journal of Contemporary Ethnography*, **19**, 450–470.

Shannon, C., & Weaver, W. (1949). *The mathematical theory of communication*. Urbana, IL: University of Illinois Press.

Singer, J. L. (1980). The power and limitations of television: A cognitive-affective analysis. In P. H. Tannebaum & R. Abeles (Eds.), *The entertainment functions of television* (pp. 31–65). Hillsdale, NJ: Erlbaum.

Solnit, A. J., & Nordhaus, B. F. (2005). Divorce and custody in a changing society. In L. Gunsberg & P. Hymowitz (Eds.), *A handbook of divorce and custody: Forensic, developmental, and clinical perspectives* (pp. 139–142). Hillsdale, NJ: Analytic Press.

Squier, R. (1990). A model of empathic understanding and adherence to treatment regimens in practitioner-patient relationships. *Social Science and Medicine*, **30**, 325–339.

Teven, J. J., & Hanson, T. L. (2004). The impact of teacher immediacy and perceived caring on teacher competence and trustworthiness. *Communication Quarterly*, **52**, 39–53.

Thom, D. H., & Stanford Trust Study Physicians. (2001). Physician behaviors that predict patient trust. *Journal of Family Practice*, **50**, 323–328.

Toth, E. L. (2000). From personal influence to interpersonal influence: A model for relationship management. In J. A. Ledingham & S. D. Bruning (Eds.), *Public relations as relationship management: A relational approach to the study and practice of public relations* (pp. 205–219). Mahwah, NJ: Erlbaum.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wan, G. (1999, April). "Barney and Friends": *An Evaluation of the Literacy Learning Environment Created by the TV Series for Children* (ERIC Document Reproduction Service No. ED438900). Paper presented at the Annual Meeting of the American Educational Research Association. Montreal, Canada. Retrieved June 1, 2005, from ERIC E-Subscribe database.

Welch, A. J., & Watt, J. H., Jr. (1982). Visual complexity and young children's learning from television. *Human Communication Research*, **8**, 133–145.

Wentzel, K. R. (1997). Student motivation in middle school: The role of perceived pedagogical caring. *Journal of Educational Psychology*, **89**, 411–419.

Wentzel, K. R., & Watkins, D. E. (2002). Peer relationships and collaborative learning as contexts for academic enablers. *School Psychology Review*, **31**, 366–377.

Zajonc, R. B. (1965). Social facilitation. *Science*, **149**, 256–268.