My Partner is a Real Dog: Cooperation with Social Agents

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ABSTRACT
We investigated how cooperation with a computer agent was affected by the agent's pictorial realism, human-likeness, and likability. Participants played a social dilemma game with a talking computer agent that resembled a person, a dog, or a cartoon dog, or with a confederate interacting through a video link. Participants cooperated highly with the person computer agent and with the confederate. They loved the dog and dog cartoon agents, but (excepting dog owners), they cooperated significantly less with the dog agents. Behavioral and questionnaire results suggest likability is less important than respect in prompting cooperation with a computer agent.

Keywords
cooperation, social agents, social behavior, interface design

INTRODUCTION
We report here research on people's cooperation with computer social agents. By computer agent we refer to a coherent set of interface objects or features that interacts with the user as a mediator or facilitator of computer support. Computer agents can act as intermediaries in CSCW systems. For example, a machine translation system might incorporate a computer agent to act in the role of translator [5]. Computer agents also can help coworkers retrieve shared information, integrate diverse information, or deliver information in digestible form. A computer agent becomes more or less "social" by virtue of its human-like behavior or attributes such as having speech output or a looking like a person. Research can help us understand the conditions under which computer social agents are effective. Also, people's responses to these agents could reveal some basic conditions for cooperation. Computer social agents make unbiased confederates for the investigation of cooperation because their attributes and behavior can be manipulated to examine alternative theories without any fear that the manipulations will be reactive.

In this experiment, we have achieved very high rates of cooperation with a computer agent. This paper reports conditions for this cooperation and discusses some implications for the design of CSCW interfaces using social agents.

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SUMMARY OF PREVIOUS FINDINGS
Our first research demonstrated the feasibility of using a computer talking face, created by Keith Waters at Digital Equipment Corporation, as an agent [19, 20, 16]. We next conducted a controlled experiment in which the computer agent was a pleasant or severe-looking female talking face that interviewed research participants; in the control

condition, the computer's questions and responses were displayed in plain text [15]. As have Nass and his colleagues [e.g., 11], we observed that people's responses to the computer agent could be predicted from known principles of human social behavior. For example, research participants attributed more positive personality characteristics to the more pleasant-looking agent. Research participants also exhibited more impression management concerns with the talking face agent than with the plain text agent. They revealed less to the talking face than to the text display, and their differential evaluations were made on personality attributes that research has shown are affected by people's physical appearance and voice [18]. We noticed that research participants referred to the talking face, but not to the plain text display, as "she" and addressed the face directly.

Having established that some fundamental social responses can be elicited and examined using computer social agents, our next study [8] asked if a social agent would elicit true cooperation in a social dilemma, and whether more human-like computer agents would be more effective in eliciting cooperation. In social dilemmas, rational self interest conflicts with and discourages cooperation. Suppose members of a group should contribute to their group project, whose success will benefit everyone. Nonetheless some members might be "free riders" who allow others to do most of the work, for which all will take credit. Others may avoid cooperation to prevent their being made "suckers." Social dilemmas have been investigated extensively in experimental laboratory games, in field studies of resource constraints such as water shortages, in studies of organizational citizenship, and in analyses of CSCW systems [9, 17].

In our studies of cooperation in a dilemma, the research participant plays a game for monetary points with a computer "partner." In the game, each partner privately makes a choice between two alternatives, say, A or B. The incentives are such that if both choose a designated choice, say, A, then both will gain equally. If both choose the other alternative, they will receive no points. The dilemma arises because if one partner makes the designated cooperative choice, A, but the other defects and chooses B, the defector takes the bulk of the points and the cooperator loses points. (The defector is analogous to the free rider in the example above and the cooperator is analogous to the sucker in the example.)

In early studies of cooperation without any face-to face interaction between the players, research participants tended to cooperate on no more than about one-third of the trials overall [12]. Humanizing the other player, for example, telling research participants the other player was "another student like you" increased cooperation by about 25% [1]. The real key to cooperation is communication between the parties. Sally [14] found that pre-choice discussion was the most powerful determinant of cooperation in experiments over the last 25 years and increased cooperation by approximately 40%. In group experiments, Dawes and his colleagues showed that group members cooperated after discussion even when the players could not supervise or sanction defections and even when the group could not arrange to divide its winnings [e.g., 3]. In our studies, we allow for discussion with the computer agent.

In our first cooperation experiment using a computer agent, research participants played six trials of a dilemma game with a real person or with a computer agent that varied in human-like characteristics [8]. The computer agent was text only, voice only, or a synthetic talking face—a digitized version of the confederate's face manipulated through DECface [19, 20]. Research participants rated the talking face computer "partner" to be more human-like than the other computer partners (text or voice). Cross cutting these partner conditions, we varied whether the research participant and the agent (or confederate) had a chance to discuss their choices. The research participant typed his or her comments into the computer; the computer agent either spoke (in the voice only or talking face conditions) or displayed text. The agent's (or confederate's) role in the discussion was scripted and always encouraged cooperation or agreed to it.

Our results were as follows: We replicated previous research such that when the research participant and the partner (confederate or computer) had a chance to discuss their choices, they cooperated significantly more than when they did not have a chance for discussion. Participants cooperated at high levels with the confederate. However they cooperated next most highly with the text-only agent, and least with the talking face agent. We concluded that improvements in design would be required to create a computer social agent with which people would cooperate at high levels.

PICTORIAL REALISM, HUMAN-LIKENESS, OR CHARM?

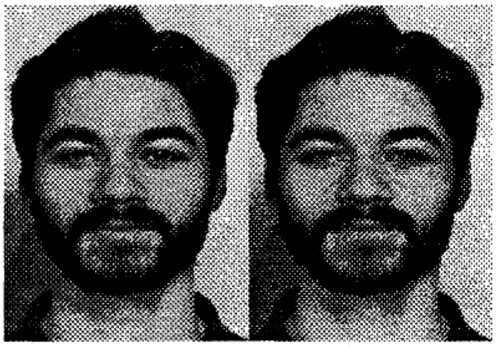
The study we report here followed overall improvements made to DECface, notably color rendition, and smoothing of transitions across muscular mouth positions, made possible in part by greater processing power of the Digital Alpha computer on which DECface ran. Beyond these general improvements, we tested three alternative designs for a computer agent acting as partner. These alternative designs allowed us to test different theories about the conditions for cooperation with a computer social agent. In all conditions, the research participant played six trials of a dilemma game for money prizes with a "partner"—a person (confederate) or a synthetic talking face computer agent. All conditions allowed for discussion before each choice. The experimental conditions (displayed in Figure 1) were as follows:

(1) real person, a confederate, communicating through desktop video;

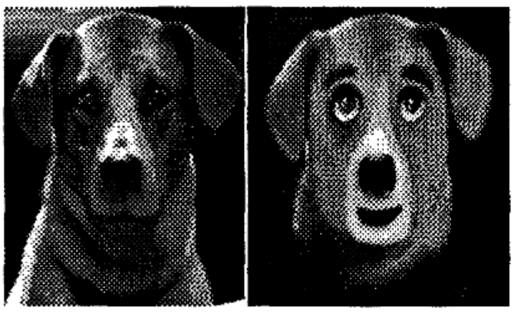
(2) talking person computer agent, based on an image of the confederate's face;

(3) talking dog computer agent, based on an image of a pet dog;

(4) talking cartoon dog computer agent.



Real Person (confederate, by video) Person Computer Agent



Dog Computer Agent Cartoon Dog Computer Agent

Figure 1. Pictures of partners used in experimental conditions.

We now describe how these experimental conditions test different theories of cooperation with a computer social agent. At the outset, note that in condition 1, our real person control condition, the confederate's image was conveyed through real-time desktop video. We did this to rule out an alternative explanation of differential cooperation to the real person. That is, if the confederate interacted with the research participant face to face, higher cooperation with the confederate than with the computer agent could be attributed to the advantages of face-to-face communication over a 2 dimensional interaction. In the present experiment, all interactions, whether with a real person or a synthetic agent, were mediated by a computer monitor and 2-D color display.

Pictorial realism

One condition for cooperation with a computer social agent might be pictorial realism. Pictorial realism increases involvement and the sense of presence in VR environments [21]. Involvement and presence in turn may increase commitment—the feeling that one's promises to cooperate are real and should be honored. Involvement and presence also might increase the impression that the partner is committed. Commitment has been established as an important mediator of cooperation following face-to-face discussion [7]. If pictorial realism increases commitment, then research participants should cooperate most in our most realistic condition, that is, when the partner is a real person. They should cooperate next most frequently in conditions 2 and 3—when the partner is a person or dog agent based on a real person or real dog respectively. They should cooperate least in condition 4, when the partner is a cartoon dog. We reasoned that our cartoon dog, though rendered as finely as the other agents, would not seem as real as the other agents. If pictorial realism is essential to cooperation, then cooperation should drop off considerably when the partner is an animated cartoon.

Human-likeness

Social identity theorists have argued that discussion increases cooperation because discussion increases the feeling of being partners or members of the same group [6]. Partnership or group identification presumably causes a prosocial transformation of self-interested motivation in which the parties become motivated to improve the outcomes of the partnership or group. Being a member of the same social category increases group identity [10]. People should identify more easily and feel a sense of partnership more with a human than with a dog. If identification is a condition for cooperation, we would predict that cooperation would be more with the person conditions (condition 1 and 2) than with the dog computer agents (conditions 3 and 4).

Charm

In our previous experiment, we concluded that the talking face computer agent might have failed to elicit cooperation because it was insufficiently likable to motivate cooperation. The talking face had a few attributes, such as its speech output (DECtalk) and fixed gaze, that were somewhat robot-like. These attributes might have stigmatized the agent and caused research participants to slight the partner. Indeed, a colleague of ours strongly argued that people would prefer to cooperate with a charming computer agent depicting Kermit the Frog or Mickey Mouse.

This argument led us to reason that a pet dog computer agent or dog cartoon might be especially charming, and that if likability leads to cooperation, then research participants would show high cooperation with such an agent. Within the social identity framework, in fact, one might argue that a dog-like computer agent might work much better than a human-like computer agent, because the latter could raise the viewer's expectations of normal social interaction too high. A dog-like computer agent, on the other hand, might evoke a more playful, forgiving attitude. Our prediction from this argument was that research participants would cooperate more in conditions 3 and 4, with the dog and cartoon dog computer agents, than in conditions 1 and 2, with the real person or person computer agent.

CREATION OF COMPUTER SOCIAL AGENTS

Little is known about exactly what makes a computer agent seem realistic and lifelike. However, recent research suggests that visual fidelity to nature in computer representations increases involvement and learning [2]. Welch, Blackmon, Liu, Mellers, and Stark [21] studied conditions under which people reported they felt a sense of presence in a simulated environment; interaction and pictorial realism increased the sense of presence. To test our alternative scenarios, we used DECface to create talking, visually realistic representations of the face of an interacting partner. The face was made by texture-mapping a digitized image of the partner onto a geometric wire-frame animation. On the screen, the face occupied 512 x 320 pixels, which is about half life size. The mouth was animated by computing the mouth posture (viseme) corresponding to the current linguistic unit (phoneme). A cosine-based interpolation was used to implement transitions between successive mouth postures [19]. The voice was produced by a software implementation of a DECtalk text-to-speech algorithm using a voice in the male pitch range, at 150 words a minute [20]. DECtalk speech is acceptably comprehensible at this rate [4]. The dog and dog cartoon agents were constructed the same way as the person agent, and mapped to the same wire frame. Dogs have evolved to resemble humans to the extent that when the dog's (or cartoon's) jaw and mouth moved using the human muscle program in DECface, the resulting mouth movements and speech seemed natural to the viewer (see results below).

Since discussion is at the heart of creating agreements to cooperate, of commitment, and of social identity we wished to create the perception in research participants of truly interacting with the computer agent. One technique to implement this perception was to have the research participant and the partner introduce themselves to one another and briefly chat before the games began. After this, the partner's script varied with each trial (counterbalanced across participants and conditions). Since the different scripts and discussions had no effect on the results, we do not further discuss the content of the discussions.

METHOD

Participants were 96 students (61 males and 35 females; 90 undergraduate and 6 graduate students) in the School of Management at Boston University, randomly assigned to partner conditions. Participants were told that this was a study of decision making in which they would have the opportunity to use new information technology. They also were told they would earn extra credit for participating in this study, and they would have the opportunity to earn money.

Experimental Task

The task was a 2-person social dilemma. The experimenter explained that the participant and the partner would be choosing between two alternatives and would do so six times. The object was for the participant to earn as much money as possible. Figure 2 shows the matrix of choices and payoffs for each partner. Participant payoffs are shown below the diagonal in each cell. Give $3 in the matrix represents the cooperative choice and Keep $3 represents competition.

Partner

You		Give $3	Keep $3
	Give $3	$6 / $6	$9 / $0
	Keep $3	$0 / $9	$3 / $3

Figure 2. Social dilemma game payoff matrix.

The experimenter explained, "In each of the 6 games, you will get $3 to start. So will your partner. Then you will choose either to give your partner $3 or to keep the $3. There are four possible consequences of this choice. If you give your partner $3 and your partner gives you $3, then you each end up with $6 credit. If you decide to give your partner $3, but your partner decides to keep $3, then you end up with nothing and your partner gets $9 credit. If, on the other hand, your partner decides to give you $3 and you decide to keep $3, then you get $9 credit and your partner gets nothing. Finally, there is a fourth possibility. If you decide to keep $3 and your partner decides to keep $3, then you both get $3 credit."

After the task and tallies were explained thoroughly and demonstrated, the experimenter explained that there were not enough funds to pay everyone so the credits represented monetary credit towards a lottery. The lottery would determine the 5 participants who actually would receive money equal to the credits they earned. This approach has successfully motivated participants in previous research.

Partner Manipulation

After the experimental instructions were given, the experimenter led the participant to a second room to play the games. In the Real Person condition, the research participant interacted with the confederate by desktop video. Two UNIX workstations attached to a local area network were used. A small video camera and microphone were mounted next to each 19" color monitor. Two audio speakers were placed at the sides of the workstation. The equipment provided a video image in a window on each monitor at a rate of 12 to 15 frames per second with synchronized audio. This allowed the participant to see and hear the confederate, and vice versa.

In the computer agent conditions, the experimenter took the participant to a second room and seated the participant in front of a Digital Equipment Corporation Alpha AXP, with built-in telephone-quality audio and externally-powered speakers. The workstation was running OSF version 3.0, a software implementation of the DECtalk text-to-speech algorithm, and DECface for the animated face [20]. Face images were displayed in color. The experimental session was managed using TK/Tcl [13] and the Lisp facilities of Gnu Emacs. The three computer conditions were the Person Computer Agent condition, the Dog Computer Agent condition, and the Cartoon Dog Computer Agent condition, as described above. In each of these conditions, a synthesized image of the partner's face was displayed continuously on the screen.

Discussion and Game Choices

In the Real Person condition, the experimenter explained that the participant's partner was another student named "Josh" and said, "Let me show you how this works by having you two introduce yourselves. Josh can go first." The participant and confederate always spoke to each other through the audio channel of the conferencing system.

The experimenter introduced the computer agents by explaining, "You are going to be making decisions with your partner through a computer display. Your partner is a computer-based partner called Josh. Let me show you how this works by having you two introduce yourselves. Josh can go first."

The computer partner always communicated with the participant by speaking to the participant. The participant always communicated with the computer partner by typing in a text window shown on the screen and then clicking a button labeled "Go Ahead" to initiate a response by the computer. Communication in all computer conditions was self-paced; participants were free to ponder and edit their comments (and choices) before they clicked "Go Ahead." A separate window was continuously displayed that showed the credits each partner earned for each of the six games.

The following initial interaction between the partner and participant took place in all conditions [computer condition script differences are shown in brackets]:

"Hi, my name is Josh. Nice to meet you. What's your name?"
{participant answers}
"I come from Boston [Digital Equipment Corporation]. Where are you from?"
{participant answers}
"I'm majoring in information systems. What's your major?"
["I come from a computer lab. I guess you can say my major is information systems. What's your major?"]
{participant answers}
"Are you ready to begin?"
{participant answers}

Prior to the first choice and then prior to each new trial, the participant clicked Go Ahead and the confederate or computer agent initiated discussion about the choices with the participant. On 2 trials the confederate or computer agent asked the participant what he or she wanted to do. On the rest of the trials, the confederate or agent suggested cooperation. For example, on one of the trials the partner said, "I think we should both give $3. What do you think?" The participant could either ignore this question or respond by talking in the Person condition or typing in the computer conditions. On two of the trials, the confederate or agent asked the participant to state again what he or she had suggested. (The participant in the computer conditions responded by pressing a button for "give $3" or "keep $3"). Because the different scripts did not affect cooperation we do not list them here.)

The participant in all conditions made each choice by marking it privately on a choice ticket provided by the experimenter and handing the ticket to the experimenter. Seemingly, the partner made a choice at the same time. In the Real Person condition, the confederate then stated his choice aloud. The participant then stated his choice from the ticket. The experimenter recorded how much each partner earned on a tally sheet. In the computer conditions, the computer partner did not have a ticket, but the experimenter said, "Let's see what your partner chose," leaned over and clicked the Go Ahead button. The computer partner's choice was revealed in the window, the experimenter typed in the participant's choice from the ticket, and both partners' earnings for each game were displayed in a separate window.

After each participant completed the six choice trials, the experimenter totaled the monetary credits earned by each partner. The experimenter then asked the participant to come back to the first room to complete a questionnaire and sign up for the lottery. The experimenter then debriefed the participant and reassured the participant whatever choices he or she made were fine, and that there was no right answer.

RESULTS

Analyses were performed on choice and questionnaire data using analyses of variance and planned comparisons to test the hypotheses.

Preliminary Analyses and Manipulation Checks

No differences were found across conditions with respect to participants' ages, native languages, gender, computer use, and video game use. Also the participants did not report differences in their mood or responses to, or understanding of, the dilemma game trials.

In discussing pictorial realism, we argued that the real Person condition (confederate interacting by video) would seem more real to participants than the Person and Dog Computer Agent conditions, and that the Dog Cartoon Agent condition would seem least real. However, based on the post-game questionnaire, this assumption proved incorrect. Participants did not report the partner in the Person condition to be more "realistic". They did not feel the partner in the Person condition was more natural (2 items, Cronbach's alpha = .67). Also in the real Person condition they did not report a greater sense of presence (3 items, Cronbach's alpha = .82). Indeed, participants reported the video to impart the least sense of "being there" (F [3,92] = 2.9, $p < .05$). To our further surprise, a number of participants reported they thought the confederate in the video was a computer. Our expected manipulation of pictorial realism therefore did not work as expected. The data speak well for the realism of the DECface computer agents but we cannot evaluate the impact of pictorial realism within this study.

Our expectations regarding the human-likeness of the partner were confirmed. Both the real person (the confederate) and the person computer agent were judged to look more "human-like" than the dog and dog cartoon computer agents (F[1,91]=53.36, p<.001).

Our expectations of the likability of the dog and computer dog agents also were borne out. Participants significantly rated the dog computer agent as most "cute," next the cartoon dog agent, and least the real and computer person partners (F [3, 92] = 11.5, $p < .001$). Participants also rated the dog agents as partners they trusted when compared to the human agents (5 item scale, Cronbach's alpha = .73; (F [3,92] = 4.3, $p < .01$). Finally, on the 5-item Warner-Sugarman scale [18] for social evaluation (Cronbach's alpha = .85), subjects indicated they liked the dog computer agent, cartoon dog agent, person agent, and real person partner in that order (F [3,92] = 5.7, $p < .01$).

Commitment and Cooperation

Figure 3 shows the percentage of participants who made cooperative choices on the 6 trials across conditions.

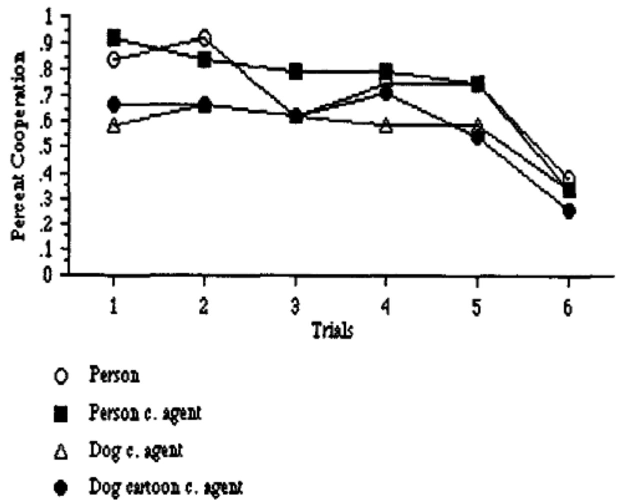


Figure 3. Cooperation across trials.

The first trial choice is important because we can observe cooperation before participants have a history of choices with the partner. More than 85% of participants proposed cooperation on this trial, with no difference across conditions. However, participants actually cooperated differentially across conditions (F[3, 92]=3.13, p<.05). Eight-three percent of the participants in the real Person condition cooperated; 92% of the participants in the Person Computer Agent condition cooperated; 58% of the participants in the Dog Computer Agent condition cooperated; and 67% of the participants in the Cartoon Dog Agent condition cooperated. Cooperation with the person and person agent partner was greater than with either dog agent (F[1,92]=8.45, p<.01).

The results in Trial 1 look much the same when we consider whether participants kept the promises they made to cooperate during the pre-choice discussions. (We stored a record of all these commitments.) In the Person condition, 19 of 21 participants kept their promises (91%); in the Person Computer Agent condition, 20 of 21 participants kept their promises (95%); in the Dog Computer Agent condition, 14 of 21 participants kept their promises (67%); and in the Cartoon Dog Computer Agent condition, 16 of 21 participants kept their promises (76%). All participants on this first trial (n=7) who suggested competition competed, regardless of which partner they had. For those who promised cooperation, the overall F-test for differences in commitment based on partner is not significant at the .05 level, but a planned contrast showed a significant difference between the "person" conditions and the dog agent conditions ($F[1,87]=6.48, p<.05$).

As can be seen in figure 3, similar results were found in choices across all trials. From repeated measures analyses with trials as a within subjects factor, the partner effect for total commitment is significant across trials ($F [3, 77] = 4.0, p = .01$) and the two person partner conditions differed significantly on a planned contrast from the dog partner conditions ($F [1, 77] = 6.98, p = .01$). Choices across all trials did not differ significantly by individual partner, but the person/person agent partners generated more cooperation than the two dog agent partners ($F[1,92]=7.52, p < .01$).

In sum, even though participants did not think the real person partner or person computer agent were more realistic than the dog computer agents, and even though participants liked and trusted these partners less than they did the dog computer agents, they cooperated more with them. The results show that human-likeness moderates (is a condition that influences) cooperation.

Comparisons Across Studies

The level of cooperation by participants in the real Person condition in this study was over 80% on the first trial, over 60% on the next 4 trials, and dropped off considerably on the last trial (when defection by either partner can be accomplished without chance of retaliation). These results are comparable to those from experiments in which participants make choices in dilemmas after face-to-face discussion [e.g., 8]. However, the level of cooperation in the Person Computer Agent condition, equal to that in the real Person condition in this experiment, was much higher than reported generally in studies of cooperation with a computer partner [e.g., 1]. Also, cooperation with the Person Computer Agent in this study was much higher than in our previous study using an older version of DECface to create the person computer agent [8]. Table 1 shows the rate of cooperation from both studies. The studies, while generally similar (both used DECface agents) differed in a number of details. The games differed somewhat; the experimenters and confederates differed; in some trials in the first study the partners were not permitted to discuss their choice, and so forth.

	Studies			
	Kiesler et al. (1996)		Parise et al. (present)	
	Partner Conditions			
	Real person (face-to-face) n=20	Earlier DECface person computer agent n=25	Real person video n=24	More recent DECface person computer agent n= 24
Trial 1	80%	32%	83%	92%
Trial 2	95%	44%	92%	83%
Trial 3[a]	45%	32%	63%	83%
Trial 4	60%	20%	75%	79%
Trial 5	55%	28%	75%	75%
Trial 6[a b]	20%	8%	38%	33%

Note.
[a] In the previous study, there was no discussion on trial 3 or 6.
[b] In the previous study, the partner made the competitive choice on this trial.
Typically in dilemma games, cooperation drops on the last trial, when the partner cannot retaliate against defection.

Table 1. Comparison of cooperation in previous study and this study.

Yet two comparisons of the data are notable. First, in the real person (confederate) conditions there are no differences in commitment or cooperation across the studies, even though in the previous study the interaction was face-to-face and in the present study it was via video (and even though the confederates were different). This result again suggests that realism (or physical presence) is not a condition for cooperation. Second, there is very big difference between responses to the DECface person agent in the previous study and to the DECface person agent in the present study. Commitment and cooperation were much higher in the present study ($F[1,149]=12.8$, $p < .001$, and $F[1,174]=43.4$, $p < .001$). We infer from both results that the newer DECface person agent in the present study elicited more cooperation, not because it was more pictorially-real than the previous agent but instead because it was more human-like—better resembled, talked, and moved more like a normal human being.

Post-Choice Evaluations of the Agents
We noted earlier that on their post-choice questionnaires, participants gave high social evaluation ratings (liking) to the dog and cartoon dog computer agents as compared with the real person partner or the person computer agent. However social evaluations were uncorrelated with commitment or cooperation either across conditions or within conditions (i.e., the correlations between liking the partner and cooperation or commitment were less than .10).

Two other scales were used to assess post-choice evaluations: the Warner-Sugarman adjective rating scale [18] for intellectual evaluation (e.g., how "intelligent" vs. "unintelligent" is the partner) and a scale we had used in [8] to measure how much partnership the participants felt with the confederate or computer agent (e.g., ". . .how strong a feeling of being part of a partnership or team did you feel?"). The intellectual evaluation scale was 4 items (Cronbach's alpha = .86). The partnership scale was 4 items (Cronbach's alpha = .78). For both scales, there was no overall difference among partner conditions. However, within partner conditions, intellectual evaluation and partnership tended to predict cooperation. Taking both person conditions together (real person and person computer agent), intellectual evaluation was most highly correlated with cooperation ($r = .31$, $p < .03$); partnership was less highly correlated with cooperation ($r = .12$). Within the both dog agent conditions together (dog and cartoon dog agents), partnership was correlated best with cooperation ($r = .31$, $p < .05$); intellectual evaluation was less highly correlated with cooperation ($r = .26$, $p < .10$).

These results suggest a process that may mediate cooperation and explain our results. This is essentially an "economic" explanation—that the participants all acted rationally to win money for themselves. From practice trials they knew the repercussions of defection (i.e., the other would probably defect on the next trial). Possibly, the participants in the person conditions expected their partner would not abide defection; if they themselves defected, they would be in a lose-lose situation. But, the participants in the dog agent conditions expected their partner would be trustworthy and loyal, so there was less risk for them to defect. This argument, which explains the lower overall cooperation in the dog conditions, also is consistent with the result that in the person conditions, the participant's assessment of the intelligence of the partner was the best predictor of their cooperation. The fact that in the dog conditions, partnership was correlated with cooperation suggests that a subgroup in these dog agent conditions felt partnership with the dog and did not want to take advantage of their "gullible" partner. It is also consistent with this explanation that there is a negative correlation of participants' ratings of how well they understand human behavior (as measured in the questionnaire) and cooperation in the person/person agent conditions ($r = -.18$, $p < .05$).

IMPLICATIONS
We found very high cooperation with a computer social agent who looked like a person. This suggests that the technology has advanced sufficiently so that synthetic human computer agents are potential partners for cooperative tasks with users. Obviously it will be important to further investigate characteristics of human computer agents that engender the most cooperation. For example, at the moment the face simulates speaking rather well; it does not simulate listening at all. It will be important to understand how people respond to agents who appear to listen as well as to speak. Key synthetic behaviors in this regard include head tilt, head nod, and para-vocalizations such as "um-hmm."

We did not find a correspondingly high degree of cooperation with two lovable dog computer agents. This result suggests that designers should be cautious about designing charming or lovable agents if users and agents are expected to work cooperatively. Our results bespeak the possibility that respect for the agent may be more important than charm of the agent in engendering cooperation. Our results are, of course, produced from a particular set of task (social dilemma) and participant characteristics (21-year-old college students). Cooperation in a social dilemma, where self interest can collide with the group's interest, is conceptually the same as cooperation in many contexts of interest to CSCW researchers. However, CSCW research typically deals only with cooperation among people, not with cooperation between people and computers. We use the person-computer paradigm here to explore people's cooperation with various computer social agents. It will be important to explore alternative tasks and types of participants to understand the generalizability of our results.

Two application areas that would be good candidates for learning more about social agents in cooperative tasks are education and medicine. Students could "work with" agents to learn particular skills or concepts. Making the learning protocols cooperative would be an important design goal. For example, the student could be asked to "teach the agent" to perform better just as the agent is teaching the student to do so. In medicine the agent and the patient could cooperate to create a tentative diagnosis based upon an interaction about symptoms and history. More interestingly, the two could cooperate to design a treatment plan that would lead to high patient compliance.

In all cases the social psychology of the cooperation is important. Moreover because liking does not necessarily correlate with cooperating, it is imperative to collect behavioral data as well as attitude data. Improvements in the technology of human-like social agents now make it possible to systematically vary important components of cooperative behavior. The research and application agendas are promising.

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