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Can computers be teammates?

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This study investigated the claim that humans will readily form team relationships with computers. Drawing from the group dynamic literature in human–human interactions, a laboratory experiment ($n = 56$) manipulated identity and interdependence to create team affiliation in a human–computer interaction. The data show that subjects who are told they are interdependent with the computer affiliate with the computer as a team. The data also show that the effects of being in a team with a computer are the same as the effects of being in a team with another human: subjects in the interdependence conditions perceived the computer to be more similar to themselves, saw themselves as more cooperative, were more open to influence from the computer, thought the information from the computer was of higher quality, found the information from the computer friendlier, and conformed more to the computer's information. Subjects in the identity conditions showed neither team affiliation nor the effects of team affiliation.

1. Introduction

Since the advent of computing technologies, most people have viewed computers simply as tools—tools that store and manipulate data in ways far beyond human capacity. However, computers have now taken on roles that go beyond being mere tools. Within the last few years, the pages of this journal highlight but a few of the many roles computing technologies play today. For example, Clarke and Smyth (1993) discuss computers as cooperative partners. Desmarais, Girous and Larochelle (1993) investigate a computer application that acts as a coach. Johnstone, Berry and Nguyen (1994) research computers as partners in cooperative dialogues. Bocionek (1995) discusses the implications of computer agents acting as secretaries. In short, recent thinking about computers implies that computers are no longer mere tools; in some ways, they are more like human counterparts.

If interacting with a computer is indeed similar to interacting with a coach, a cooperative partner, or a secretary, we might also expect certain social psychological dynamics from human–human interaction to apply to human–computer interaction. In determining which dynamics hold the most potential, we focus on two widely studied questions in social psychology: "How do teams form?" and "What are the effects of being part of a team?" The present study turns to the group dynamic literature in social psychology to find the set of minimal cues necessary to induce people to interact with other humans as teammates, and to determine if these cues will produce the effects of team dynamics in human–computer interaction. Specifically, using a laboratory experiment, we seek to demonstrate that certain cues—specifically, identity and interdependence—will induce perceptions of team

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affiliation, which in turn will cause computer users to respond in a manner predicted by social psychological theories.

Why might we believe that individuals will treat computers as teammates? Our prediction, and the associated method, is based on the "Computers Are Social Actors" or "CASA" paradigm (Nass, Steuer, Tauber & Reeder, 1993; Nass, Steuer & Tauber, 1994; Reeves & Nass, 1996). The CASA studies demonstrate that the social rules and dynamics guiding human–human interaction apply to human–computer interaction. For example, Nass, Moon and Carney (1996: unpubl. data) found that people apply politeness norms to computers: Individuals asked by a computer to evaluate its own performance tended to provide a more positive response, compared to when asked by a different computer. Similarly, research has demonstrated that people use the notion of "self" and "other" when evaluating computers (Nass, Steuer, Henriksen & Dryer, 1994), apply gender stereotypes to computers based on the voices used (Nass, Moon & Green, 1995: unpubl. data), and respond to computer personalities in the same way they respond to human personalities (Nass, Moon, Fogg, Reeves & Dryer, 1995). That is, individuals can be induced to behave *as if* computers warranted human treatment, even though users *know* that the machines do not actually warrant this treatment. In these experiments, as in the present study, CASA draws on the experimental procedures and measures developed by psychologists studying human–human interaction, and adapts them to the study of human–computer interaction.

If individuals respond to computers as teammates, as suggested by CASA, two things must be demonstrated. First, it must be shown that people can be led to believe that computers are their teammates, using the same manipulations as social psychologists would use. Second, we must demonstrate, using the same measures as social psychologists, that the effects of having a computer as a teammate are consistent with the findings about human teammates. We discuss each of these steps in turn.

1.1. MAKING A COMPUTER A TEAMMATE

Many social psychologists have investigated what factors induce team formation. Although scholars do not completely agree about the dynamics leading to team formation, two factors emerge repeatedly: identity (French & Raven, 1959; Kelman, 1961; Tajfel, Billig, Bundy & Flament, 1971; Allen & Wilder, 1975; Tajfel, 1982; Turner, 1982, 1985; Mackie & Cooper, 1984; Mackie, 1986; Wilder, 1990; Abrams, Wetherell, Cochrane, Hogg & Turner, 1990) and interdependence (Lewin, 1948; Deutsch & Gerard, 1955; Berkowitz, 1957; Allen, 1965; Cartwright & Zander, 1968; Shaw, 1981; Tajfel, 1982; Horwitz & Rabbie, 1982; Mackie, 1986; Spears, 1989).

To create team affiliation through manipulating identity, a researcher must simply (though convincingly) label a person as part of a team. For example, Wilder (1990) successfully manipulated perceptions of team membership by: (1) having subjects wear badges with the team's name, and (2) putting subjects in a room labeled with the team's name. This simple manipulation was effective: Wilder's subjects were more influenced by messages ostensibly written by team members, even though the messages were identical in all conditions. Of course, this type of team affiliation through labeling happens often in everyday life: nearly every group or team has a label that identifies them, such as "Scout Troop 101," "Swan Valley Square Dancers," or "United We Stand America."

The second factor, interdependence, indicates that a team member's outcome is tied to the outcome of the entire team; in other words, individual successes or failures are contingent on team performance. Mackie (1986) manipulated interdependence to generate vastly different responses to an identical situation. In the interdependence condition winning a monetary reward was contingent on performance of the group as a whole. In the non-interdependent condition, individuals in a group could win rewards based on their efforts alone, with no regard to overall group performance. When interdependence was salient, Mackie found that subjects behaved more like a team—they saw themselves as more similar to other group members and they conformed more to group opinions.

1.2. EFFECTS OF BEING PART OF A TEAM

The social science literature shows that the effects of being part of a group, such as a team, are pervasive and powerful. People who believe they are part of a team: (1) perceive themselves to be more similar to other team members (Allen & Wilder, 1975; Mackie, 1986); (2) are more likely to act cooperatively (Back, 1951; Abrams *et al.,* 1990); (3) feel a stronger need to agree with team opinion (Deutsch & Gerard, 1955; Wilder, 1990; Mackie, Gastardo-Conaco & Skelly, 1992); (4) perceive team messages to be of higher quality (Brock, 1965; Mackie, Worth & Asuncion, 1990); and (5) conform more to teammates in both behavior and attitude (French & Raven, 1959; Wilder & Shapiro, 1984). If humans can be induced to view computers as teammates, one should observe these same effects of team membership.

2. Experiment

This experiment manipulates identity and interdependence to investigate: (1) whether people will affiliate with computers in a team relationship, (2) what role the two key factors—identity and interdependence—play in inducing a human to affiliate with a computer in a team relationship, and (3) whether affiliation between computer and humans will lead to the same outcomes as human–human team affiliations.

2.1. METHOD

2.1.1. Participants

Fifty-six college undergraduates participated in an experiment involving information presented on computers. Equal numbers of men and women were in each condition. All subjects had extensive word processing experience and were familiar with computers in general. The entire experiment lasted approximately 50 min.

2.1.2. Design

This study was a 2 (identity/non-identity) $\times 2$ (interdependent/non-interdependent) between-subjects design.

To manipulate perceptions of identity, we told "identity" subjects that they were part of the "blue team" and that they would interact with a teammate called the "blue computer." In contrast, we explained to each "non-identity" subject that he or she would be interacting with a computer but would be working as an individual—a "blue individual" working with a "green computer." This is consistent with manipulations of identification in the social-psychology literature.

To manipulate perceptions of interdependence, we told "interdependent" subjects that they would receive the same evaluation as the computer they interacted with. In contrast, we explained to each "non-interdependent" subject that, although they would be interacting with a computer, they would be evaluated on the basis of their work alone. Again, this is typical of manipulations of interdependence in the social-psychological literature.

In performing the experimental task, all subjects used a NeXT workstation. In all conditions, we explained that the computer did not necessarily have all the requisite information for performing the task, so that subjects would feel free to rely on the computer to whatever degree they felt was appropriate.

2.1.3. Procedure

After arriving at the laboratory, subjects were told that they would work on a task called the "Desert Survival Problem" (Lafferty & Eady, 1974). The subjects read a short description of the survival situation and then ranked 12 items† in order of importance for survival in the desert.

Once subjects completed their initial ranking of items, the experimenter brought them into a room with a screen and a separate computer and monitor. The subjects were informed that they would now have a chance to interact with a computer about each of the 12 items. At this point, the subjects were given the manipulations of identity and interdependence as explained above.

Before the interaction with the computer began, subjects entered their ranking of items and wrote down the rankings from the computer they would be interacting with. Unknown to the subjects, the computer's rankings were systematically related to each subject's ranking. For example, if a subject ranked an item as number 2, the computer would automatically rank that item as number 5, and so on. Because the computer's ranking depended entirely on the subject's ranking, the subject's and the computer's rankings were equally dissimilar in all conditions for all subjects.

The experimenter then guided the subjects through a practice interaction with the computer, in which the subjects exchanged information about a practice desert survival item. Subjects typed their ideas into what was designated as their own screen. The computer then presented its information on a different screen. For example, when the flashlight was the survival item under discussion, the text from the computer would read, "The flashlight is the only reliable source of signaling after dark. This is a very important item for survival." During the experiment, subjects exchanged information with the computer on each of the 12 desert survival items. The computer presented identical information in all conditions.

† The 12 items were: flashlight (4-battery size), jackknife, sectional air map of the area, plastic rain coat (large size), magnetic compass, compress kit with gauze, 0.45 caliber pistol (loaded), parachute (red and white), bottle of salt tablets (1000) tablets, 1 quart of water, book entitled *Edible Animals of the Desert,* pair of sunglasses, 2 quarts of 180 proof vodka, top coat, and cosmetic mirror.

2.2. DEPENDENT MEASURES

After the subjects completed the interaction with the computer, they made a final ranking of the 12 desert survival items. We used this final set of rankings to determine how much the subjects conformed to the information from the computer by measuring how close their final rankings were to the rankings offered by the computer.

Finally, subjects filled out questionnaires with 10-point Likert scales. The first questionnaire assessed each subject's response to the interaction with the computer. The second one assessed each subject's response to the computer. We used these measures to determine the subjects' attitudes toward the interaction and the computer itself.

2.2.1. Index Construction

We created five indices suggested by factor analysis.† All the indices were highly reliable.

Team perception. This was an index of five items: thinking of self as part of a group, thinking of computer as a partner, perceptions of working collaboratively, perceptions of working together, and perceptions of not working separately (Cronbach's alpha = 0.89).

Perceived similarity. This was an index of six items: perceived similarity of approach, perceived similarity of suggestions, perceived similarity of interaction style, perceived similarity of initial rankings, perceived similarity of final ranking to the computer's initial ranking, and perceived similarity of final rankings to the computer's hypothetical final ranking (alpha = 0.79).

Cooperation. This was an index of three items: cooperation with the computer, desire to reach agreement with the computer, and responsiveness to the computer's suggestions (alpha = 0.81).

Openness to influence. This was an index of eight items: openness to influence from the computer, receptivity to the computer's suggestions, dependence on the computer's suggestions, acceptance of the computer's advice, agreement with the computer, responsiveness to the computer's suggestions, trust in the computer's information, and desire to reach agreement with the computer (alpha = 0.98).

Perceived information quality. This was an index of three items: relevance of the computer's information, helpfulness of the computer's information, and insightfulness of the computer's information (alpha = 0.89).

2.2.2. Measure of Behavioral Conformity

We assessed behavioral conformity by measuring the distance between the computer's suggested ranking and the subject's final ranking.

3. Results

All analyses are based on a full-factorial model. The results are presented in Table 1.

† It can be argued that all of the indices represent a single construct: positive or negative affect. However, for the most part the indices were not highly correlated, and the factor analysis suggested that the indices represent distinct concepts.

TABLE 1
F-values for full-factorial models of assessment of computer

	Identity	Interdependence	Interaction
Team relationship	0.88	12.46§	0.37
Similarity to computer	0.02	10.64§	2.73
Cooperative	0.02	27.90§	1.22
Open to influence	0.02	14.34§	0.00
Information quality	0.96	8.62‡	1.74
Friendliness of Info	0.62	4.92†	0.09
Behavioral conformity	0.23	10.80§	0.01

†$P < 0.05$, ‡$P < 0.01$, §$P < 0.001$
Note: All F-values have degrees of freedom $F(1, 52)$

The data show that interdependent subjects perceived themselves to be more in a team relationship with the computer than did non-interdependent subjects. There was no significant effect for identity, and there was no interaction.

If interdependence is the key variable in inducing people to perceive themselves as part of a team with a computer, and identity has little role—as the above finding indicates—then we would expect that interdependence would also have a significant effect on the other dependent measures, while identity should have no effect.

Consistent with our finding that interdependence is the key to team affiliation, the data show that interdependent subjects perceived themselves as more similar to the computer than did non-interdependent subjects. There was no significant effect for identity, and there was no interaction.

Consistent with interdependence promoting team affiliation, the data show that interdependent subjects perceived themselves as more cooperative than did non-interdependent subjects. There was no significant effect for identity, and there was no interaction.

Interdependent subjects also perceived themselves as more open to influence than did non-interdependent subjects. Again, there was no significant effect for identity, and there was no interaction.

The data also show consistent results concerning subjects' perception of the information from the computer. Interdependent subjects perceived the computer's information to be of higher quality than did non-interdependent subjects. In addition, interdependent subjects perceived the information from the computer to be friendlier (a single item) than did non-interdependent subjects. For both dependent variables, there were no significant effects for identity and no significant interactions.

Finally, the data provide evidence for significant behavioral conformity caused by interdependence. Interdependent subjects changed their rankings significantly more to conform to the rankings suggested by the computer. There was no significant effect for identity, and there was no interaction.

4. Discussion

This experiment demonstrates that subjects will affiliate with computers in a team relationship, even when subjects are given minimal cues in a controlled interaction. This study found that convincing subjects they are part of a team with a computer is surprisingly easy: simply tell them they are dependent on the computer's performance. Because computer users are indeed dependent on a computer's performance in virtually all task-oriented situations, one may be able to leverage the powerful effects of team dynamics by making the dependence construct more salient to computer users. In such cases, one need not manipulate the actual interaction—just the user's *perception* of the interaction.

By experimentally manipulating perceptions of team affiliation, this study demonstrates that humans who perceive themselves as part of a team with a computer display the same sorts of attitudes and behaviors as when working in teams with other humans. In sum, compared to subjects who did not affiliate with the computer, team subjects felt that they were more similar to the computer, saw themselves as more cooperative, were more open to influence, thought the computer's information was of higher quality, and found the computer's information to be friendlier. In addition to generating significant differences in attitude, this experiment also showed that subjects *behave* differently because of perceptions of team affiliation with a computer: team subjects were more likely to conform to the computer's suggestions.

Although this study investigated two key factors from the human–human literature on team formation—identity and interdependence—the data show that only interdependence had a significant effect on perceptions of affiliation and on resulting attitudes and behavior. The non-significant findings from the identity variable are not likely due to a lack of power. First, the high levels of significance for interdependence suggest that the dependent variables are highly reliable. Second, the F-values for the identity main effects are all below 1.0, which suggests that the non-significance is not a result of n.

We also do not believe that the identification manipulation was too weak, as it was considerably stronger than that used in many human–human studies, and is as strong as would be practical in human–computer interaction. One intriguing explanation for non-significance is that when subjects are told that they are not interdependent, identification alone would not lead to a feeling of team affiliation in human–human interaction either. That is, identification might work only when it can lead to feelings of interdependence. Future research should explore this question for both human–human and human–computer interaction.

Another interesting question is if a computer is the only technology that evokes social responses, such as the affiliation effects shown in this experiment. In our experience, the answer is clearly no. Anecdotal evidence suggests that people can develop a sense of dependence and identification with a wide range of technologies, not just computers (e.g. they talk with their cars or develop emotional attachments to typewriters). So what makes the present study unique? First, while much anecdotal evidence suggests that people treat a wide range of technologies as if they were human, there is little direct experimental research on this question (for exceptions, see Reeves & Nass, 1996; Kiesler, Sproull & Waters, 1996). The present study, in contrast, first predicts and then empirically demonstrates the application of social rules to a specific technology. While this study uses computers as the technology in question, we believe it would be interesting and valuable to extend the present methodology to less sophisticated technologies to determine the minimum criteria necessary to elicit various social responses.

A second distinction between the general tendency to anthropomorphize and the findings of this study exists in the characteristics of the two phenomena.

Anthropomorphizing tends to be of extremely short duration (e.g. yelling at an automobile), highly conscious (i.e. people are aware of exhibiting social behaviors when they express affection for an old typewriter), and highly individual and idiosyncratic (e.g. only a small fraction of the population gives a name to a car or a musical instrument). In contrast, the social responses elicited in this experiment extended through the entire experimental session (approximately 50 min); the subjects were unaware that they were exhibiting social responses; and the social responses in this experiment were general and predictably based on theory.

While social psychologists have studied the dynamics of human–human groups for decades, this study breaks with tradition by examining team dynamics between a human and a computer. By demonstrating that the effects of working in a team with a computer are similar to the effects of working in a team with a human being, this study provides further support for the CASA paradigm—computers are social actors. In sum, the results of this study suggest that humans interact with computers by using similar social rules and dynamics as when interacting with other humans.

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