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BEYOND BRAINSTORMING: THE EFFECTIVENESS OF GROUP SUPPORT SYSTEMS FOR CONVERGENCE AND NEGOTIATION TASKS

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Beyond Brainstorming: The Effectiveness of Group Support Systems for Convergence and Negotiation Tasks

ABSTRACT

Various forms of commercially available group support systems (GSS) have been in use for a number of years to support group work in accounting settings. While a considerable body of research in information systems has established that GSS are beneficial for brainstorming (idea-generation) tasks, less is known about the effectiveness of these technologies for more complex tasks. This paper reports the results of two experiments comparing the performance of face-to-face and GSS teams in tasks that move beyond brainstorming. In the first experiment, the performance of face-to-face and computer-mediated teams was compared in a task requiring participants to engage in convergent thinking. For comparability with prior studies and to enhance experimental control, participants in experiment one also completed a brainstorming (idea-generation) task requiring divergent thinking. Consistent with predictions derived from McGrath's task circumplex model, the results of experiment one reveal that participants using computer-mediated communication perform significantly better than those interacting face-to-face on the divergent (brainstorming) task. On the convergent task, computer-mediated and face-to-face teams performed equally well; i.e., there was not a significant difference in their performance. In the second experiment, the performance of face-to-face and computer-mediated teams was compared in an integrative negotiation task. As in the first experiment, participants also completed an idea-generation task requiring no coordination or cooperation among team members. The results of the second experiment were similar to those of experiment one, as computer-mediated teams significantly outperformed face-to-face teams in the idea-generation task, while computer-mediated teams and face-to-face teams performed equally well on the integrative negotiation task. These experiments contribute to the literature by shedding additional light on the conditions under which computer-mediated communication is as effective as, and in some cases more effective than, face-to-face interaction.

Keywords: Computer-mediated communication (CMC), group support systems (GSS), convergent processes, group brainstorming, negotiation, task-technology fit theory.

I. INTRODUCTION

Increasingly, organizational team work is being facilitated by computer-mediated communication (CMC) and its variants—group support systems, decision support systems, negotiation support systems (NSS), and other electronic meeting systems. These systems enable teams of knowledge workers to collaborate outside the boundaries of time and distance to identify, discuss, and resolve problems. There has been much ongoing research on the subject of CMC and the conditions under which these systems result in superior outcomes relative to traditional face-to-face group work. Over the last decade, research in information systems has documented that groups meeting and working together electronically can outperform groups meeting face-to-face along several qualitative and quantitative dimensions (Valacich et al. 1993, Valacich et al. 1994, Dennis et al. 1997/98). A few studies have explored the effects of CMC

on various aspects of decision-making behavior in accounting and auditing (Kerr and Murthy 1994; Bamber et al. 1996; Karan et al. 1996; Arnold et al. 2000; Murthy and Kerr 2004).

Although a substantial number of studies have investigated the efficacy of CMC for idea-generation (brainstorming) tasks that involve divergent thinking, relatively few studies have explored the utility of such systems for tasks involving convergent thinking, conflict resolution, or negotiation. In the context of brainstorming tasks, the general finding is that groups brainstorming electronically generate a greater number of unique ideas than groups brainstorming face-to-face (Connolly et al. 1990; Gallupe et al. 1991; Gallupe et al. 1992; Valacich et al. 1993; Valacich et al. 1994). It should be noted that virtually all of this electronic brainstorming research follows Osborn's (1963) rules that encourage divergent thinking. In essence, participants are told "the wilder the idea, the better" based on the assumption that such divergent thinking fosters more creative ideas. It is also noteworthy that the tasks employed in the prior electronic brainstorming research tended to be generic tasks that did not require any specialized knowledge.[1] Although some group tasks in accounting settings require divergent thinking, there are a host of group decision-making settings in accounting where participants must engage in *convergent* thinking aimed at finding a consensus solution to a problem. Additionally, in negotiation tasks the interacting parties often have opposing goals requiring them to engage in conflict resolution. Negotiation support systems (NSS) are becoming more common with the widespread use of web-based systems in business (Foroughi 1998, Kersten and Noronha 1999). The InterNeg Group offers web-based NSS for both training purposes and live negotiations (see http://interneg.carleton.ca). Relative to face-to-face negotiations, NSS represent a viable lower-cost alternative when negotiators are geographically separated. Moving beyond simply proving that NSS can work, however, there is a great need for research into how and under what circumstances negotiation processes can be enhanced by NSS support (Foroughi 1998).

Relative to face-to-face communication, CMC has certain process gains, most notably the ability for each team member to input his/her ideas immediately in parallel with other team members. This

[1] Examples of tasks employed include generating ideas for how the parking problem on campus could be resolved, how tourism could be improved in the participants' city of residence, uses for an extra thumb, etc.

parallel communication feature has the potential to enhance performance on divergent-thinking tasks such as brainstorming. However, chat-based CMC also has several process losses relative to face-to-face interaction, such as lack of real-time feedback from others in the team, and the possible lack of sufficient attention paid to each team member's ideas as members become preoccupied entering their own comments. While these process losses are not likely to hinder teams performing divergent tasks, they are more likely to hinder teams performing convergent and negotiation tasks that benefit from immediate feedback and call for each team member's comments to be carefully attended to and considered by the other members.

McGrath (1984) proposes a "task circumplex" comprised of a series of tasks arranged in increasing order of the "information richness" requirements for successful task completion, where information richness is a communication medium's capacity to convey information (both verbal and nonverbal information) and improve understanding. At the lower end of the circumplex are tasks such as planning and idea generation that have minimal information richness requirements, whereas higher order tasks such as problem-solving, decision making, and mixed-motive (conflict-resolution/negotiation) tasks have high information richness requirements. The most common form of CMC is a "chat tool" (aka "instant messaging") that allows the instantaneous exchange of text messages and a common message log accessible to all participants. However, such a tool lacks information richness, as non-verbal cues normally associated with a face-to-face meeting are absent. Thus, according to McGrath's task circumplex model, a CMC chat tool could result in superior performance in the context of brainstorming (divergent thinking) tasks, but it would be too lean of a medium to allow CMC teams to outperform face-to-face teams in convergent thinking and negotiation tasks.

This paper reports the results of two experiments aimed at comparing the performance of CMC and face-to-face (FTF) teams in the context of tasks requiring convergent thinking and negotiation. For the purpose of comparison with prior studies and to provide a control group in each experiment, participants also performed a brainstorming task. In the first experiment, student participants worked on two tasks, communicating either face-to-face or via a CMC chat tool. The first task in experiment one was

akin to prior brainstorming tasks, requiring participants to make recommendations regarding how a company's operations could be improved. In the second task, participants were provided with a list of recommendations and were asked to indicate whether each recommendation would or would not improve the company's operations. Thus, the first task involved divergent thinking while the second task involved convergent thinking. The results of experiment one reveal that while participants using the CMC chat tool performed significantly better than those interacting face-to-face on the divergent task, there was no significant difference in performance between CMC and FTF teams on the convergent task. In the second experiment, a separate set of participants also worked on two tasks—one involving brainstorming and one involving negotiation. The CMC tool used in the brainstorming task resembled a chat-based system, while the computer-based negotiation tool was designed specifically for the purpose of the experiment. The results of the second experiment are consistent with those of experiment one. Computer-mediated groups again outperformed face-to-face groups in the brainstorming task while performing on par with face-to-face groups in a negotiation task. This study thus contributes to the literature by shedding additional light on the conditions under which CMC does, and does not, outperform face-to-face interaction.

The remainder of the paper is organized as follows. The next section provides background on prior research related to the current study and discusses McGrath's task circumplex model. The research hypotheses are then presented, stating the expected effects of face-to-face interaction and the use of a CMC for divergent, convergent, and negotiation tasks. For each of the two experiments, the research method is discussed, followed by the presentation of the experiment's results. The concluding section discusses the results of both experiments and their implications, summarizes the paper, and provides some directions for future research.

II. BACKGROUND AND DEVELOPMENT OF HYPOTHESES

Computer-mediated communication offers a number of advantages relative to face-to-face communication in the context of group work. The primary advantages are parallel communication, the

potential for anonymous input, and the group memory feature of CMC systems. Since CMC overcomes the process losses inherent in FTF interaction, it is logical to expect that team brainstorming via CMC should be superior to FTF brainstorming, a notion that is supported by a considerable body of research in information systems (Gallupe et al. 1991; Gallupe et al. 1992; Valacich et al. 1993; Dennis and Valacich 1999; Pinsonneault et al. 1999; Satzinger et al. 1999). What is noteworthy, however, is that prior studies on brainstorming using CMC have invariably employed the following four rules for brainstorming: (1) Criticism is ruled out. Adverse judgment of ideas must be withheld; (2) "Free-wheeling" is welcomed. The wilder the idea, the better; it is easier to tame down than to think up; (3) Quantity is wanted. The greater the number of ideas, the greater the likelihood of useful ideas; and (4) Combination and improvement are sought (Osborn 1963). Thus, the emphasis in these studies on "electronic brainstorming" has been on divergent thinking—how CMC tools can facilitate performance in tasks requiring participants to freely generate as many ideas as possible without regard to the quality or practicality of the ideas. And, not surprisingly, the majority of these studies have found that CMC teams outperform FTF teams in brainstorming proficiency. Whether CMC is more effective than FTF communication for tasks other than brainstorming, especially tasks involving convergent thinking and negotiation, is less clear and is the subject of the current study.

Theoretical Framework and Hypotheses

There is increasing recognition in the group support systems body of research that task-type has a significant effect on the effectiveness of computer-mediated communication relative to face-to-face communication. As stated by McGrath and Hollingshead (1993, p. 90),

> "The crucial question … is not whether or not electronic support systems improve group performance in general. Rather, the crucial question is this: What are the circumstances under which various support systems improve, hinder, or do not affect various aspects of group performance, on various kinds of tasks … ?"

McGrath (1984; see also McGrath and Hollingshead 1993) presents a "task circumplex" which identifies eight distinct types of basic group task processes. These eight group task processes, ordered in

terms of increasing "information richness" requirements, are: (1) planning tasks (generating plans), (2) creativity tasks (generating ideas), (3) intellective tasks (solving problems with correct answers), (4) decision-making tasks (deciding issues without right answers), (5) cognitive conflict tasks (resolving conflicts of viewpoints), (6) mixed-motive tasks (resolving conflicts of interest), (7) contests/competitive tasks (resolving conflicts of power), and (8) performances/psychomotor tasks (executing performance tasks).

Per McGrath's (1984) task circumplex model, idea-generation (brainstorming) tasks require only the exchange of messages containing ideas, whereas tasks which involve resolving conflicts of interest or power are facilitated by the exchange of information-rich messages that convey emotions, attitudes, values, expectations, and other information (McGrath and Hollingshead 1993). The implication is that CMC involving the use of a relatively simple chat tool may be very effective when used by groups to perform tasks which do not require information-rich communication, such as planning tasks and creativity tasks involving generating ideas. However, for higher order tasks such as intellective, decision-making, cognitive conflict, and mixed-motive tasks, CMC may not provide a sufficiently rich communication environment, implying that FTF communication should be more effective (Ibid.). While McGrath and Hollingshead (1993) do not indicate any alternative to FTF communication for tasks with the highest "information richness" requirements (e.g., competitive tasks), there is limited evidence that CMC can be effective for certain types of intellective and problem-solving tasks (Murthy and Kerr 2004).

Beyond Brainstorming: Performance in Convergence

Kerr and Murthy (2004) compared the performance of CMC groups and FTF groups in divergent thinking, measured by the number of unique ideas generated, and in convergent thinking, measured by how well the groups perform at weeding out irrelevant ideas. An experiment was performed employing two cases, each requiring participants to make recommendations regarding how a company's operations could be improved. Each case required participants to engage in divergent thinking to convey alternative ideas and recommendations and convergent thinking to filter out irrelevant recommendations. Performance in both the divergent and the convergent aspects of the tasks was compared between

computer-mediated teams and face-to-face teams. Kerr and Murthy found that participants who worked in computer-mediated collaborative teams performed better than face-to-face teams at the divergent aspect of the tasks, but performed worse than face-to-face teams at the convergent aspect of the tasks, as their recommendations included a higher percentage of irrelevant suggestions than those of participants who interacted face-to-face.

Although the Kerr and Murthy study (2004) sheds light on the effectiveness of CMC for divergent thinking relative to convergent thinking, a cleaner test of the implications of McGrath's task circumplex model would use two separate tasks, one requiring divergent thinking and one requiring convergent thinking. For tasks requiring divergent thinking, team members simply need to generate ideas and communicate them to their team members, for which a relatively simple CMC chat tool should allow computer-mediated groups to outperform groups meeting face-to-face. In contrast to divergent thinking tasks, tasks requiring convergent thinking require team members to reach a shared understanding of the problem and arrive at a mutually acceptable solution. Whether the lean environment of a CMC chat tool allows computer-mediated teams to outperform face-to-face teams in a task involving convergent thinking is one question addressed in the current study. Unless provided with specific tools in the CMC environment that might enable groups to overcome the lack of "information richness," groups using CMC are not likely to outperform groups interacting face-to-face in convergent tasks. For groups meeting face-to-face, given that only one person can be speaking at a time, solutions proposed can be instantly evaluated and processed such that the optimal solution, as deemed by the group via interaction, can be reached. This discussion leads to the following hypothesis:

HYPOTHESIS 1: Relative to face-to-face communication, computer-mediated communication will enhance performance to a greater extent in divergent brainstorming tasks than in convergent solution-identification tasks.

Similarities in the design of the divergent and convergent tasks used in this study permit joint analysis in a single statistical model. Thus, hypothesis 1 is a prediction of an interaction between communication mode (face-to-face vs. computer-mediated) and task (brainstorming vs. solution

identification) and can be tested as such. Specifically, communication mode and task are predicted to interact such that computer-mediated communication is more effective when used to facilitate brainstorming (divergent) tasks than when used in solution-identification (convergent) tasks.

Beyond Brainstorming: Performance in Negotiations

Related to information richness is the concept of "social presence richness" proposed by Bazerman et al. (2000). Bazerman et al. suggest that the level of social presence richness inherent in a communication medium can be critical to the process and outcome of negotiations. As described by Bazerman et al. (2000), face-to-face communication has the richest level of social presence, while computer-mediated communication has a relatively low level of social presence (see also Fulk et al. 1990; Rutter and Robinson 1981). Prior research has demonstrated that relative to negotiators communicating using audio only, face-to-face negotiators are more likely to develop rapport and therefore more likely to conclude the negotiation with favorable outcomes for the negotiators (Drolet and Morris 2000). Along similar lines, Valley et al. (1998) found a greater incidence of truth-telling among negotiators interacting face-to-face relative to negotiators interacting via telephone or through the exchange of written messages. These prior studies suggest that face-to-face negotiations are likely to achieve higher joint benefits than negotiations conducted through communication media less rich in social presence.

An earlier study by Wichman (1970) underscores the importance of face-to-face contact and verbal communication in the context of prisoner's dilemma games, which require negotiation and cooperation to achieve the optimal joint outcome for participants. Wichman (1970) found that 87% of participants in prisoner's dilemma games cooperated when they could see and hear one another, 72% cooperated when they could only hear one another, 48% cooperated when they could only see one another, and only 41% cooperated when they could neither hear nor see one another. Thus, in the context of the current study, the relatively rich level of social presence in face-to-face interaction may lead to more favourable outcomes in face-to-face negotiations relative to computer-mediated negotiations.

However, there is some evidence from prior research suggesting that face-to-face communication in bargaining situations may be undesirable. For example, Lewis and Fry (1977) found that when

negotiators communicated across a barrier that prevented them from seeing each other, they used fewer pressure tactics, were less likely to be deadlocked in impasse, and obtained higher joint profits. The notion that face-to-face negotiations can sometimes lead to tension between the negotiators is consistent with Zajonc's (1965) theory that human presence itself is arousal-inducing. It follows then that the arousal-inducing aspect of face-to-face negotiations could lead to dominating behavior on the part of one or more negotiating parties, with adverse consequences on negotiation outcomes. Indeed, as Selye (1976) suggests, dominant behavioral responses induced by arousal in face-to-face contexts are manifested in either attack or retreat by negotiators. Thus, under conditions of high arousal, face-to-face negotiations may lead to less favourable negotiation outcomes relative to computer-mediated negotiations (Bazerman et al. 2000).

As the above discussion indicates, the effect of communication mode in the context of integrative negotiation tasks is less than clear-cut. Integrative bargaining requires negotiators to consider outcomes that are favorable for all parties. However, it is possible and indeed likely given human nature that individual negotiators could undercut the welfare of others and simply look out for their own best interest. Thus, it is unclear which medium—face-to-face or computer-mediated—will result in the most mutually beneficial outcomes in the context of integrative negotiation tasks. The above discussion leads to the following research question:

RQ: Is there a significant difference in the outcomes of integrative negotiations conducted face-to-face and those conducted via a computer-based negotiation support system?

III. METHOD

Participants and Design: Experiment 1

The first experiment was designed to test the hypothesis relating to performance on a convergent task. One hundred thirty-three students enrolled in a master's degree program in accounting participated in the experiment. The students were attending a corporate auditing course and were organized into teams of three or four at the beginning of the course. Students were assigned to teams such that teams were as

homogeneous as possible along four dimensions: (1) employment history (students' prior or current employment in an accounting- or auditing-related job, including internships), (2) aptitude (measured by students' overall grade point average at the beginning of the course), (3) membership in student organizations, and (4) gender (no all-male or all-female teams). Prior to the experiment, participants had completed several course projects in their teams. Thus, the teams used in this experiment were "established" teams, having a history of prior interactions working together. Participants received 10 points (out of 440 possible for the course) toward their final grade for participating in the experiment. All participants took the tasks seriously, as indicated by a review of logs of teams' discussions.

The research design includes two tasks: a brainstorming task involving divergent-thinking, and a solution-identification case involving convergent thinking. The independent variables in the design are task type (divergent vs. convergent) and participants' communication mode while completing the two tasks. Communication mode was varied at two levels: (1) face-to-face communication, and (2) computer-mediated communication. Teams were assigned randomly to one of the two communication modes. Twenty-one teams completed the two tasks in the computer-mediated environment, and 15 teams completed the tasks while working face-to-face. All teams completed the brainstorming task prior to working on the solution-identification task.

Tasks and Administration

All teams completed both tasks in a single session. For the brainstorming task, each participant received a written narrative description of a museum's operations and related internal control system over admissions and cash collections. Participants were instructed to study the narrative description and then brainstorm with their team to generate a list of recommendations regarding how the museum's management could improve operations related to admissions and cash collection procedures. Participants were urged to develop as many recommendations as possible and to include on their list all recommendations mentioned by every team member, avoiding criticism of any participant's suggestions. The use of reference materials was not allowed. Teams were told they would have 20 minutes to complete this task. As each face-to-face team finished, the experiment's facilitators collected the task materials,

including the team's list of recommendations. Computer-mediated teams' lists of recommendations were automatically captured and saved by the system.

Following completion of the brainstorming task, participants worked on the solution-identification task. To begin, participants received the same narrative description of the museum's operations and internal control system, but were now also given a list of 12 possible recommendations to improve the museum's operations. Participants' instructions were as follows: "Independent of your answers to Part 1 [the brainstorming task], a list of 12 possible management recommendations is shown on the next page. Not all of the recommendations, if implemented, would necessarily improve the client's operations, however. The partner in charge of this engagement has asked your team to narrow this list down to include only those recommendations that you believe would improve the client's operations related to admissions and cash collection procedures. Discuss with your team the list [of recommendations] and decide which of the 12 recommendations would improve the client's operations and should be presented to management." As in the brainstorming task, teams were given 20 minutes to complete this task.

In the face-to-face condition, teams met in separate conference rooms to complete the tasks. Each room contained a conference table, several chairs, a large artist's sketchpad and marker, and a closed-circuit camera used to monitor the team's interactions. Teams used the sketchpad to write any notes they wanted to make and to list their recommendations.

Participants assigned to the computer-mediated condition used a chat system (*Visual IRC*) to communicate with their team members. Participants completed the tasks in a large computer lab, with each participant seated at a separate computer terminal. Team members were dispersed throughout the lab to prevent verbal communication, which simulated a same time/different place communication environment. Prior to the experiment, each participant received written instructions on the use of *Visual IRC*, and a facilitator was available during the experiment to answer participants' questions and provide help on the use of the system. *Visual IRC* allows team members to enter comments simultaneously. As

comments are entered, they are displayed sequentially, in real time, on each participant's screen and are automatically saved to a computer log.

Dependent Measures

To assess teams' performance in the brainstorming task, we determined the total number of recommendations proposed by each team, omitting duplicates. This served as a dependent variable in subsequent tests of hypothesis one.

To assess teams' performance in the solution-identification task, we determined the number of recommendations correctly identified by each team as either improving or not improving the client's existing operations. Twelve recommendations were provided in the materials; six of these recommendations were of high quality and would improve the client's operations, while the others would not improve operations. Recommendations correctly identified by each team as improving the client's operations were awarded one point, and recommendations correctly identified as not improving operations were also awarded one point. Thus, the maximum score possible on this task was 12. If a team were to assign all 12 recommendations to only the "would improve operations" category (or to the "would not improve operations" category), their score would be 6. Likewise, if a team were to assign each recommendation randomly or haphazardly to one of the two categories, the expected score would also be 6, on average.

Participants and Design: Experiment 2

The second experiment was designed to investigate the extent to which the outcomes of computer-mediated negotiations differ from those of face-to-face negotiations. This experiment was conducted using 176 master's level accounting students enrolled in a corporate auditing course. Participants received 5 points (out of 450 possible for the semester) toward their final grade for participating in the experiment. Review of logs of groups' discussions indicated that the participants took the experiment seriously.

Tasks and Administration

For purposes of the experiment, participants were randomly assigned to four-person groups. Twenty groups completed an integrative negotiation task using a computer-based negotiation support system (NSS), and 24 groups completed this task face to face[2]. All groups were given 50 minutes to complete the negotiation task.

The task was modelled after the *Prisoner's Dilemma* scenario and is described in detail in the Appendix. The task consisted of seven rounds. During each round, participants either won or loss hypothetical "points," depending on their choices and the choices of the other participants in their negotiation group. The hypothetical points were redeemable at the conclusion of the experiment for $0.25 per point. In rounds 4, 6, and 7, participants were allowed to communicate verbally for three minutes in order to negotiate with the other participants in their group; no negotiation was allowed in rounds 1, 2, 3, or 5.

Participants in the NSS environment completed the task in a computer lab with the other participants in their negotiation group spread throughout the room; no verbal communication was allowed. Written instructions about the NSS software was provided to each participant, and assistance from a facilitator was available. Participants made their choices, and their choices were communicated to the other participants in their group, using the NSS. As each participant clicked on either "X" or "Y" to make a selection, he/she was asked to confirm the selection before it was submitted in the event that the participant had inadvertently clicked on the wrong button. In rounds 4, 6, and 7, participants were able to communicate with their team members using a synchronous chat system built into the NSS in order to negotiate. The NSS system was programmed such that the chat system was not available in rounds 1, 2, 3, or 5. A "Results" window showed the round-by-round selections made by each group member, the payoff earned by the group member in each round, and the cumulative payoff. The outcome for each round was

[2] In experiment two, participants also completed an idea-generation task similar to that used in experiment one. The results mirror those from experiment one, with computer-mediated teams outperforming face-to-face teams.

not revealed until all four members of the negotiation group had input their selections for the round (i.e., either an X or a Y). An example of the NSS screen at the beginning of round 1 is shown in Figure 1.

[INSERT FIGURE 1 HERE]

All negotiation groups in the face-to-face environment met in a large conference room. Participants made their choices via paper and pencil and communicated their choices to the other participants in their group face-to-face. In rounds 4, 6, and 7, participants negotiated face-to-face. A facilitator in the conference room provided verbal directions throughout the session, and other facilitators present in the conference room ensured that all participants followed those directions.

The research design is a 2x2 factorial, with communication mode and negotiation level as the two factors in the design. The two levels of communication mode are: (1) face-to-face communication, and (2) computer-mediated communication via a negotiation support system. The negotiation factor was also manipulated at two levels as: (1) no negotiations allowed, and (2) negotiations permitted. The dependent variable is the total "points" payout for each group at the end of a series of rounds. As shown in the payoff schedule provided in the appendix, each round's payout is based on the combination of choices made by the four individuals in the negotiation group. In each round, possible payouts ranged from -4 to +4 points, with payouts doubled in rounds 4 and 6 and tripled in round 7.

IV. RESULTS

Experiment 1: Divergent versus Convergent Tasks

The first research hypothesis predicts that computer-mediated communication will improve teams' performance to a greater extent when used to facilitate divergent brainstorming tasks than convergent solution-identification tasks. Teams' brainstorming performance was measured as the total number of recommendations generated by the team, excluding duplicates. For the convergent task, performance was measured as the number of recommendations correctly categorized by each team as either improving or not improving the client's existing operations. A hypothesis-blind, independent research assistant

performed the grading for both tasks. Given the objective nature of the grading (e.g., teams either correctly categorized each recommendation or they did not), only one grader was used.

As shown in table 1, computer-mediated teams generated a mean of 22.5 recommendations while brainstorming, whereas face-to-face teams generated a mean of only 13.7 recommendations. In contrast, computer-mediated teams and face-to-face teams performed nearly equally on the solution-identification task, correctly categorizing a mean of 9.4 and 9.7 recommendations, respectively.

[INSERT TABLE 1 HERE]

Hypothesis 1 predicts an interaction between communication mode (computer mediated or face to face) and task (brainstorming or solution identification). ANOVA was used to test this prediction. Consistent with hypothesis 1, the ANOVA results reveal a significant interaction between communication mode and task ($F=16.5$; $p<0.001$; see Table 2); the interaction's pattern is illustrated in Figure 2. As predicted, the advantages of computer-mediated communication relative to face-to-face communication were greatest when the task required divergent thinking (brainstorming), rather than convergent thinking (solution-identification).

[INSERT TABLE 2 HERE]

[INSERT FIGURE 2 HERE]

To further examine the interactive effects of communication mode and task on teams' brainstorming performance, the simple effects of communication mode in each task were examined. As expected, computer-mediated communication is associated with significantly increased brainstorming performance relative to face-to-face communication ($F=16.0$; $p<0.001$). In contrast, there is no significant difference between computer-mediated and face-to-face teams' performance on the solution-identification task ($F=0.5$; $p=0.480$).[3]

[3] To assess the extent to which these results might have been driven by instances of extreme values, SPSS's *Explore* procedure was used to identify any outliers in the data. No outliers were identified.

Experiment 2: Negotiation

The objective of experiment two was to investigate the extent to which integrative negotiations conducted via a negotiation support system differ from those conducted face to face. The negotiation task used in Experiment 2 was designed to provide a net negative or zero payoff to participants unless they could successfully negotiate an agreement with the other participants in their negotiation group to jointly choose a course of action that would result in a positive payoff (i.e., choice of "Y" instead of "X;" see the payoff chart in the Appendix). In each round, higher payoffs were evidence of cooperative behavior ("win-win"), while lower or negative payoffs were evidence of competitive behavior ("win-lose").

To assess the effects of the NSS relative to face-to-face negotiations in terms of cooperative or competitive behavior, payoffs were calculated for rounds 1 thru 3 (in which negotiation was not allowed) and for rounds 4 thru 7 (negotiation was allowed in rounds 4, 6, and 7). Descriptive statistics for payoffs are shown in Table 3.

[INSERT TABLE 3 HERE]

Panel A of Table 3 reveals that at the end of the first three rounds in which negotiations were not allowed, payoffs were negative for both NSS and FTF groups. However, for rounds 4 through 7, as shown in Panel B of Table 3, payoffs were positive in both communication modes, with average payoffs of 5.8 and 7.4 points for NSS groups and FTF groups, respectively. As indicated by the relatively high standard deviations shown in Table 3, there was considerable variation in team payoffs in both the NSS and FTF communication modes. The range of payoffs was -16 to 36 in the FTF mode and -16 to 32 in the NSS mode.

A plot of the payoffs (see Figure 3) reveals a disordinal interaction between communication mode and negotiation level. The pattern of this interaction suggests negotiations are more effective when conducted face-to-face than when using the negotiation support system. However, this interaction is not statistically significant, as indicated in the ANOVA results presented in Table 4. Although the effect of negotiation was significant ($F=16.8$, $p=.000$), neither the communication mode nor the interaction

between communication mode and negotiation level were statistically significant (F=0.04, p=0.85 and F=0.9, p=0.35, respectively).

[INSERT FIGURE 3 HERE]

[INSERT TABLE 4 HERE]

In addition to the ANOVA results presented above, Pearson's chi-square test was also performed to assess whether the use of NSS had a significant effect on negotiation outcomes relative to face-to-face negotiation. As indicated in the cross-tabulation matrix shown in Table 5, the distribution of NSS groups receiving, and not receiving, a net positive payoff at the end of seven rounds was similar to that of face-to-face groups, with 40% of NSS groups and 46% of face-to-face groups receiving a positive payoff. Pearson's chi-square test revealed the association between communication mode and positive payoffs is not statistically significant (chi-square=0.15, P=0.70). Thus, neither the non-parametric chi-square test nor the parametric ANOVA test reveals any significant differences in team negotiation payoffs between groups negotiating face to face and groups negotiating via the NSS at the conclusion of all seven rounds.

[INSERT TABLE 5 HERE]

V. DISCUSSION AND CONCLUSION

This study extends the recent line of research on computer-mediated communication in the context of both problem-solving and negotiations. While the majority of prior research on the effectiveness of computer-mediated communication has focused on brainstorming tasks requiring *divergent* thinking, it is important to investigate whether computer-mediated communication is effective relative to face-to-face communication for tasks that move beyond brainstorming, i.e., tasks requiring *convergent* thinking and tasks involving conflict-resolution and negotiation. Recently, Kerr and Murthy (2004) compared the performance of computer-mediated and face-to-face teams on a task requiring both divergent and convergent processes. Participants in the Kerr and Murthy (2004) study were required to generate a list of possible internal controls for a hypothetical company, which was then evaluated on the basis of quality. Divergent thinking was measured in terms of the number of unique ideas generated by

CMC and face-to-face teams, while convergent thinking was measured in terms of the percentage of irrelevant ideas generated within each communication mode.

In the first experiment reported in this paper, we extend the Kerr and Murthy (2004) work by using two distinct tasks—one involving divergent thinking and one requiring participants to engage in convergent thinking. As hypothesized, the results revealed that while CMC-mediated teams outperformed face-to-face teams on the divergent task, there was no significant difference in performance between face-to-face and computer-mediated teams on the convergent task. It is interesting to note that in the Kerr and Murthy (2004) study, where convergence was measured as the percentage of irrelevant ideas generated in each communication mode, teams interacting face-to-face outperformed teams interacting via CMC. In the present study, where convergence is defined in terms of categorizing possible solutions into groups (effective and ineffective), there was no significant difference between face-to-face teams and CMC teams.

In the second experiment reported in this paper, we compared the performance of CMC and FTF teams in the context of an integrative negotiation task based on the *Prisoner's Dilemma* scenario. The task required cooperation among group members in order to obtain mutually beneficial outcomes for all individuals involved. Results reveal no statistically significant differences in the average total payoffs to NSS and face-to-face groups at the conclusion of negotiations.

The findings of the current study have important implications for entities, including CPA firms, contemplating the use of CMC technology to provide electronic support for the teamwork of their professionals. For tasks requiring teams to generate alternative solutions—that is, to engage in divergent thinking—the findings echo prior research suggesting that the use of CMC would lead to superior performance relative to meeting face-to-face. However, for tasks requiring convergent thinking, as the results of Experiment 1 revealed, the use of simple chat-type CMC cannot be expected to produce a performance enhancement over face-to-face interaction. Additionally, the results of Experiment 2 revealed that NSS use did not produce superior negotiation outcomes relative to face-to-face negotiations. However, it is noteworthy that NSS was not significantly inferior to face-to-face negotiation. Thus,

despite theoretical arguments both for and against the use of NSS for integrative bargaining tasks, such as the *Prisoner's Dilemma* task used in this study, the findings provide no basis for arguing against the use of NSS for such tasks. It is also important to keep in mind that CMC facilitates "anytime-anywhere" interaction, thereby lowering meeting costs. Thus, the finding that CMC was *not inferior* to face-to-face interaction for both the convergent task and the negotiation task is encouraging.

In addition to the limitations normally associated with experiments, the generalizability of this study is limited by the use of student participants. Although the use of teams of professional practitioners would have been desirable in this study, there is no reason to believe that audit experience would have a differential effect on teams' performance across the tasks employed in the two experiments. Furthermore, empirical support for the use of graduate-level business students as surrogates for business professionals is provided by Remus (1986) and Briggs et al. (1996). Nevertheless, caution should be used when generalizing these results to real-world settings and experienced audit practitioners. The negotiation task employed in the second experiment was a stylized mixed-motive task designed to foster cooperation to yield the highest payoff. The extent to which this task (the *Prisoner's Dilemma* scenario) can be extrapolated to real-world business negotiation situations is limited.

There are several potential extensions to this study. Future research should examine whether the use of CMC tools, including various information-processing-support tools and agenda-structuring tools, enhance the performance of teams performing convergent-type tasks. In addition, given the hierarchical nature of audit teams, future research should examine whether the findings of prior studies, which have primarily been based on teams of peers, hold in the context of hierarchical teams. Regarding negotiation tasks, future research could examine whether there is an interactive effect between the extent of subjects' negotiation experience and the impact of NSS on negotiation outcomes. Finally, future research could also explore whether the use of NSS significantly alters the dynamics of the negotiation process between negotiators with varying levels of negotiation experience, cultural background, age, and gender.

APPENDIX
Negotiation Task Used in Experiment Two

Win As Much As You Can: An Intergroup Competition

Introduction:

- The title of this assignment is "**Win as Much as You Can**." Be sure to keep that goal in mind throughout this activity, since you will receive a cash award based on how much you win in this activity.

- There are seven rounds to this activity. During each round, you will either win or lose hypothetical "points." You will receive $0.25 for each point you end up with at the conclusion of all seven rounds.

- In this assignment, you will not be working with your teammates; rather, you will be interacting with three other students, each of whom comes from a different team.

- There are two rules:

  1. You are **not** to confer with the other three students with whom you are interacting unless you are given specific permission to do so. This rule applies to nonverbal as well as verbal communication.

  2. You are to ensure that the other three students do not know your choice until you are instructed to reveal it.

- During each of the seven rounds, you will have 30 seconds to mark your choice for the round. In rounds 4, 6, and 7, you will be allowed to *confer for three minutes* with the other three students before making your decision. The payoff is *doubled* in rounds 4 and 6. The payoff is *tripled* in round 7.

WIN AS MUCH AS YOU CAN:
TALLY SHEET

Instructions: For seven successive rounds you will choose either an X or a Y, and each of the other three students with whom you are interacting will also make a choice. Each round's payoff depends on the pattern of choices made:

PAYOFF SCHEDULE

4 X's:	Lose 1 point each
3 X's: 1 Y:	Win 1 point each Lose 3 points
2 X's: 2 Y's:	Win 2 points each Lose 2 points each
1 X: 3 Y's:	Win 3 points Lose 1 point each
4 Y's:	Win 1 point each

In rounds 4, 6, and 7, you will be allowed to *confer for three minutes* with the other three students before making your decision. The payoff for rounds 4 and 6 will be *doubled*; the payoff for round 7 will be *tripled*.

SCORE CARD (use a pen!!)

	Round	Your Choice (circle one)	Outcome: Pattern of Choices	Payoff for Round	Cumulative Payoff
	1	X Y	____X ___Y		
	2	X Y	____X ___Y		
	3	X Y	____X ___Y		
Consultation round Payoff x 2	4	X Y	____X ___Y		
	5	X Y	____X ___Y		
Consultation round Payoff x 2	6	X Y	____X ___Y		
Consultation round Payoff x 3	7	X Y	____X ___Y		

REFERENCES

Arnold, V., Sutton, S.G., Hayne, S.C., Smith, C.A.P (2000). Group decision making: The impact of opportunity-cost time pressure and group support systems. *Behavioral Research in Accounting*, 12:69-96.

Bamber, E.M., Watson, R.T., and Hill, M.C. (1996). The effects of group support system technology on audit group decision making. *Auditing: A Journal of Practice & Theory.* 15(1): 122-134.

Bazerman, M.H., Curhan, J.R., Moore, D.A., Valley, K.L. (2000) Negotiation. *Annual Review of Psychology* 51, 279-314.

Briggs, R.O., Balthazard, P.A., and Dennis, A.R. (1996). Graduate business students as surrogates for executives in the evaluation of technology. *Journal of End User Computing* 8(4): 11-17.

Connolly, T., Jessup, L.M., and Valacich, J.S. (1990). Effects of anonymity and evaluative tone on idea generation in computer-mediated groups. *Management Science*, 36(6): 689-703.

Dennis, A.R., Hilmer, K.M., and Taylor, N.J. (1997/98). Information exchange and use in GSS and verbal group decision making: Effects of minority influence. *Journal of Management Information Systems* 14(3): 61-88.

Dennis, A.R. and Valacich, J.S. (1999). Research Note. Electronic brainstorming: Illusions and patterns of productivity. *Information Systems Research* 10(4): 375-377.

Drolet, A.L., & Morris, M.W. (2000). Rapport in conflict resolution: Accounting for how nonverbal exchange fosters coordination on mutually beneficial settlements to mixed motive conflicts. *Journal of Experimental Psychology* 36(1): 26-50.

Foroughi, A. (1998). Minimizing negotiation process losses with computerized negotiation support systems. *The Journal of Applied Business Research* 14, 15-26.

Fulk J., Schmitz J., & Steinfield C.W. (1990). A social influence model of technology use. In *Organizations and Communication Technology*, ed. J Fulk, CW Steinfield, 117-40. Newbury Park, CA: Sage.

Gallupe, R.B., Bastianutti, L.M., and Cooper, W.H. (1991). Unblocking brainstorms. *Journal of Applied Psychology* 76(1): 137-142.

Gallupe, R.B., Dennis, A.R., Cooper, W.H., Valacich, J.S., Bastianutti, L.M., and Nunamaker, J.F., Jr. (1992). Electronic brainstorming and group size. *Academy of Management Journal* 35(2): 350-369.

Karan, V., Kerr, D.S., Murthy, U.S. and Vinze, A.S. (1996). Information technology support for collaborative decision making in auditing: An experimental investigation. *Decision Support Systems* 16: 181-194.

Kerr, D.S. and Murthy, U.S. (1994). Group support systems and cooperative learning in auditing: An experimental investigation. *Journal of Information Systems* 8(2): 85-96.

Kerr, D.S. and Murthy, U.S. (2004). Divergent and Convergent Idea Generation in Teams: A Comparison of Computer-Mediated and Face-to-Face Communication, *Group Decision and Negotiation,* July, 13(4) 381-399.

Kersten, G.E. & Noronha, S.J. (1999). WWW-based negotiation support: design, implementation, and use. *Decision Support Systems*. 25, 135-54.

Lewis, S. A., & Fry, W. R. (1977). Effects of visual access and orientation on the discovery of integrative bargaining alternatives. *Organizational Behavior and Human Performance*, 20, 75-92.

McGrath, J.E. (1984). *Groups: Interaction and Performance.* Englewood Cliffs, NJ.: Prentice Hall.

McGrath, J.E. & Hollingshead, A.B. (1993). Putting the "group" back in group support systems: some theoretical issues about dynamic processes in groups with technological enhancements. In L.M. Jessup and J.S. Valacich (Eds.) *Group Support Systems: New Perspectives*:,78-96, New York: Macmillan.

Murthy, U.S. and Kerr, D.S. (2004). Comparing Audit Team Effectiveness via Alternative Modes of Computer-Mediated Communication, *Auditing: A Journal of Practice & Theory*, March, 23(1): 141-152.

Osborn, A.F. (1963). *Applied Imagination: Principles and Procedures of Creative Problem-Solving*. Charles Scribner's Sons, New York.

Pinsoneault, A., Barki, H., Gallupe, R.B., and Hoppen, N. (1999). Research Note. The illusion of electronic brainstorming productivity: Theoretical and empirical issues. *Information Systems Research* 10(4): 378-380.

Remus, W. 1986. Graduate students as surrogates for managers in experiments on business decision making. *Journal of Business Research* 14: 19-25.

Rutter, E.R, & Robinson, B. (1981). An experimental analysis of teaching by telephone: theretical and practical implications for social psychology. In *Progress in Applied Social Psychology*, ed. GM Stephenson, JH Davis, pp. 345-74. New York: Wiley

Satzinger, J.W., Garfield, M.J., and Nagasundaram, M. (1999). The creative process: The effects of group memory on individual idea generation. *Journal of Management Information Systems*. 15(4): 143-160.

Selye, H. (1976). *The stress of life*. New York: McGraw-Hill.

Valacich, J.S., Paranka, D., George, J.F., and Nunamaker, J.F., Jr. (1993). Communication concurrency and the new media: A new dimension for media richness. *Communication Research* 20(2): 249-276.

Valacich, J.S., Dennis, A.R., and Connolly, T. (1994). Idea generation in computer-based groups: A new ending to an old story. *Organizational Behavior and Human Decision Processes* 57(3): 448-467.

Valley, K.L, Moag J., & Bazerman, M.H. (1998). A matter of trust: effects of communication on the efficiency and distribution of outcomes. *Journal of Economic Behavior in Organizations*. 34, 211-38.

Wichman, H. (1970). Effects of isolation and communication on cooperation in a two person game. *Journal of Personality and Social Psychology* 16, 114-20.

Zajonc, R.B. (1965). Social facilitation. *Science* 149, 269-74.

Table 1
Descriptive Statistics for Experiment 1:
Performance of Computer-Mediated Teams and Face-to-Face Teams

Dependent Variables	CMC teams	Face-to-face teams
Number of recommendations proposed (divergence task—brainstorming)		
Mean	22.5	13.7
Median	21.0	13.0
Standard deviation	6.0	6.4
Minimum	11	8
Maximum	32	30
n	21	15
Number of recommendations categorized correctly (convergence task—solution-identification)		
Mean	9.4	9.7
Median	9.0	10.0
Standard deviation	1.0	1.2
Minimum	8	7
Maximum	11	11
n	21	15

Table 2
ANOVA Results for Experiment 1:
Interaction between Communication Mode and Task

	Sum of Squares	df	Mean Square	F	Sig.
Intercept	13381.4	1	13381.4	679.7	.000
Communication mode (face-to-face vs. computer-mediated)	316.4	1	316.4	16.1	.000
Task (brainstorming vs. solution-identification)	1281.4	1	1281.4	65.1	.000
Interaction (communication mode x task)	**352.9**	**1**	**352.9**	**17.9**	**.000**
Error	1338.6	68	19.9		
Total	18322.0	72			

Table 3
Descriptive Statistics for Experiment 2:
Negotiation Payoffs

		N	Mean	Std. Deviation
Panel A:				
Rounds 1 thru 3	NSS	20	-1.00	1.777
	FTF	24	-3.50	3.788
	Total	44	-2.36	3.264
Panel B:				
Rounds 4 thru 7	NSS	20	5.80	13.391
	FTF	24	7.42	15.283
	Total	44	6.68	14.312

Table 4
ANOVA Results for Experiment 2:
Negotiation Payoffs

	Sum of Squares	df	Mean Square	F	Sig.
Communication mode (face-to-face vs. computer-mediated)	4.3	1	4.3	0.04	.849
Negotiation level (no communication vs. negotiation allowed)	1712.1	1	1712.1	16.8	.000
Interaction (Negotiation level x communication mode)	92.4	1	92.4	0.9	.347

Table 5
Cross-tabulation Results:
Communication Mode by Payoff Received

		Positive Payoff Received?		
		No	Yes	Total
Communication mode	Face to face	13	11	24
	NSS	12	8	20
	Total	25	19	44

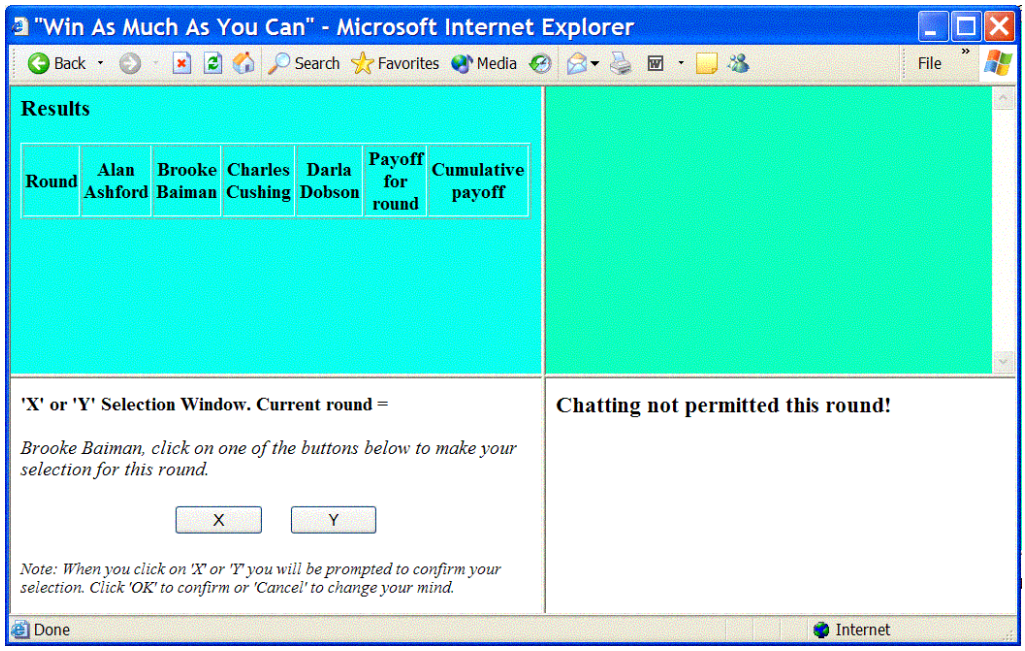

Figure 1: NSS screen

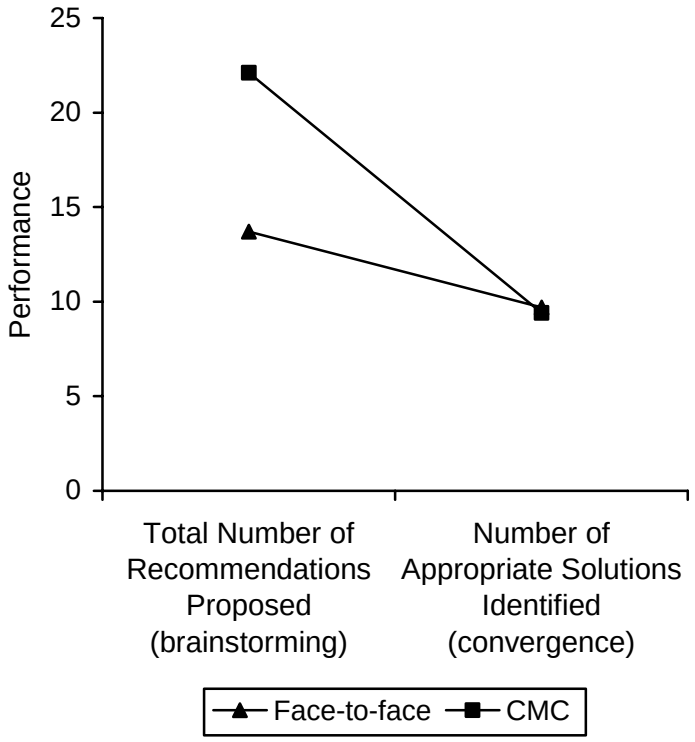

Figure 2: Interaction between Task Type and Communication Mode

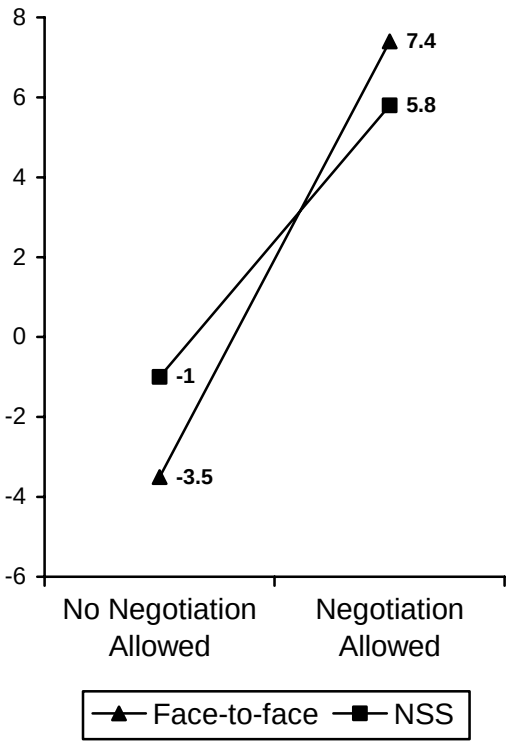

Figure 3: Negotiation Payoffs:
Interaction between Communication Mode and Negotiation Level