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Group and Computer-Mediated Discussion Effects in Risk Decision Making

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In this study, we examine hypotheses, based on theories of group decision making and an extension of prospect theory to a social context, about the influence of group communication and group decision processes on group decisions. Managers individually and in 3-person groups made multiattribute risk choices (two investment alternatives, each with multiple outcomes). Two group decisions were reached during face-to-face discussion, and two were reached during (real-time) computer-mediated discussion. In comparison with prediscussion individual preferences, groups' multiattribute risk choices and attitudes after face-to-face discussion were risk averse for gains and risk seeking for losses, a tendency predicted by prospect theory and consistent with choice shift and other group extremitization research. By contrast, group decisions during computer-mediated discussion did not shift in the direction of prospect theory predictions. The results are consistent with persuasive-arguments theory, in that computer-mediated discussion contained less argumentation than face-to-face discussion. Social decision schemes were used to evaluate alternative assumptions about the group process. A "(prospect-theory) norm-wins" decision scheme described group choice well in the face-to-face discussion condition, but not in the computer-mediated discussion condition. Another decision scheme, first-advocate wins, which described choices well in both face-to-face and computer-mediated discussions, was explored in a discussion of the role of communication in group decision making.

Risk decision making is important in both prescriptive and empirical analyses of group and organizational behavior. In this research, we draw from research on prospect theory (e.g., Kahneman & Tversky, 1979), multiattribute risk choice (e.g., Payne, Laughhunn, & Crum, 1984), group decision making (e.g., Davis, 1973; Vinokur & Burnstein, 1974), and group computer communication (e.g., Kiesler, Siegel, & McGuire, 1984) to investigate how people make multiattribute risk choices in groups. Multiattribute risk choices are decisions that have multiple uncertain, or risky, consequences, such as when a finance committee has to consider short-term objectives as well as long-term goals. Organizations frequently delegate multiattribute risk choices to groups because these choices require expertise and perspectives from different parts of the organization. Thus far, however, multiattribute risk choice has been investigated as an individual decision process. One purpose of this research was to extend the generality of prior work by examining how people reach multiattribute risk decisions in groups. By studying decision problems in which individuals' responses have been found to exhibit tendencies toward risk aversion and risk seeking, we hoped to examine whether such tendencies are present, exacerbated, or reduced in group responses. Another purpose of this research was to examine the impact of computer communication technology on group decision making. By comparing face-to-face with computer-mediated group discussion, we examined systematically the impact of these communication processes on risk decision making in groups. This question has theoretical relevance to models of group extremitization as well as practical relevance to our society, where computer networks will soon be pervasive.

Individual Risk Choice

Most analyses of risk choice consider three aspects: (a) the alternatives, (b) the prospective outcomes attached to these alternatives along with their attractiveness, and (c) the uncertainty (risk) attached to outcomes. Two theoretical approaches for evaluating how these components will enter into decisions are expected-utility theory (Arrow, 1971; von Neumann & Morgenstern, 1953) and prospect theory (Kahneman & Tversky, 1979). Considerable research describes how people make choices when uncertain outcomes are defined on only a single attribute, usually money. This research indicates that individuals make single-attribute risk choices not only on the basis of net expected utilities but also according to their perceptions of gains or losses against a reference point or the status quo (Kahneman & Tversky, 1979; Payne, Laughhunn, & Crum, 1980, 1981; Tversky & Kahneman, 1981). People tend to be risk averse in situations of gain—hypothetically, they would choose an investment yielding a sure or nearly sure return of

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$20,000 over an investment yielding equal chances of a $40,000 return and of a zero return. But individuals tend to be risk seeking in situations of loss—they would choose an investment yielding equal chances of a loss of $40,000 and a zero return over an investment yielding a sure or nearly sure loss of $20,000.

Tversky and Kahneman (1981) and others have discussed choices whose outcomes consist of multiple but linked attributes, such as benefits and losses over 2 or more years. An extension of prospect theory, which assumes that joint multiattribute outcomes are experienced as a single "psychological account," is that such situations will produce risk aversion for gains and risk seeking for losses. In one experiment, subjects whose prospective outcomes were nonmonetary gains consisting of the attributes gallons of gasoline and pounds of ground beef were strongly risk averse (von Winterfeldt, 1980). Payne et al. (1984) asked managers to make hypothetical choices of capital investments where the multiple attributes were cash flow in Year 1 and cash flow in Year 2. The managers were risk averse for pure gains and risk seeking for pure losses, which supports the extension of prospect theory. Fischer, Kamlet, Fienberg, and Schkade (1986), in a partial replication of the Payne et al. (1984) study, found that the subjects (business students) were risk averse for pure gains and slightly, but insignificantly, risk seeking for pure losses. Their second experiment involved job attributes, such as salary and location, rather than cash; the subjects tended to be risk averse in gain situations and even more risk averse in loss situations. In sum, the evidence strongly supports prospect theory for single-attribute choices and for some, but not all, multiattribute choices. One purpose of this study was to examine whether, in the group situation, discussing the multiattribute decision problems might reinforce their gain and loss implications and strengthen the prospect theory effect. In the next section, we present some theoretical reasons for why groups might exacerbate these tendencies.

Relevant Group Research

Over the last 40 years, a considerable literature has developed concerning the small group as a vehicle for decision making. Group decision making in this research has four components: (a) prediscussion individual preferences, (b) group discussion, (c) group choice, and (d) postdiscussion individual preferences. Group decisions are often evaluated by comparing prediscussion preferences with group choice. Attitude change is evaluated by comparing prediscussion preferences with postdiscussion preferences.

Choice Shift

One general phenomenon of group decision making that has implications for multiattribute risk choice is that groups tend to make decisions that are more extreme than, but in the same direction as, the initial tendencies manifested in the population from which the groups are drawn (e.g., Kaplan, 1977). A special case of this phenomenon is exemplified by so-called *choice shifts.* When asked to decide a level of risk that a hypothetical person should accept in order to pursue a more attractive but riskier career or life style alternative, groups typically choose a level of risk that is more extreme but in the same direction as the members' average prediscussion positions (Kogan & Wallach, 1967; Stoner, 1961). Private attitudes often polarize in the same extreme direction but to a lesser extent than the group choices do (e.g., Moscovici & Zavalloni, 1969; Myers & Lamm, 1976). One example of group choice shifts on types of decisions within the domain of prospect theory is contained in a study by Davis, Kerr, Sussmann, and Rissman (1974). They asked individuals and 4-person groups to rate the attractiveness of duplex gambling bets, which are equivalent to single-attribute risk choices. The average attractiveness rating by groups was higher than that by individuals when the bets' expected values were positive, was lower for bets with negative expected values, and was not different for bets with zero expected values. In other words, group evaluations of bets were more extreme than individual choices were, but they were in the same direction as the initial individual preferences. This study suggests that for risk choices predicted by prospect theory, groups might become more extreme than individuals in the same direction generally preferred by individuals: risk aversion for gains and risk preference for losses. Extending this idea to multiattribute choice, we hypothesized that multiattribute risk choices in groups will be more risk averse for gains and more risk seeking for losses than will the same choices made by the individuals in the group prior to discussion. On the basis of past research, we predicted that the attitudes of individual group members would also shift in the same direction as the group choice, but not as extremely.

Communication and the Dynamics of Group Decision Making

How do group members resolve initial differences and reach consensus? Deutsch and Gerard (1955) defined two general processes of social influence in groups: normative and informational. Normative influence reflects conformity with the expectations of others, whereas informational influence reflects acceptance of others' evidence about reality. The identification and relative contribution of these two types of influence to group consensus and extremitization has been debated for 2 decades. Some researchers have emphasized the role of normative influences, drawing especially on social comparison theory (e.g., Goethals & Zanna, 1979; Jellison & Arkin, 1977; Jellison & Riskind, 1970; Sanders & Baron, 1977) and extensions of social identification theory (e.g., Mackie, 1986; Turner, 1982). Within social comparison theory, the dominant explanation of choice shift is that group members are motivated to equal or exceed the average group member on valued attributes. Group discussion reveals the true distribution on the value-laden dimensions, which demonstrates to a minority of the group members that they need to change in the valued direction in order to attain this standard. This version of social comparison theory implies that choice shift can occur without any discussion at all. As long as group members are made aware of one another's positions, they will change in the direction of what they believe to be the socially desirable position, typically conveyed through the positions taken by the majority. However, normative pressures are likely to be strongest when there is a large rather than slim majority, when consensus is required, when judgments are made publicly, when the desire for social acceptance or group identity exists, and when an objectively correct answer cannot be demonstrated (e.g., Kaplan & Miller, 1983; Laughlin, 1980).

An alternative approach to explaining group extremitization effects focuses on informational influence. The dominant explanation of choice shift is persuasive-arguments theory (Vinokur & Burnstein, 1974, 1978). This theory assumes that a pool of arguments of varying persuasiveness is associated with the alternatives to a decision and that prior to discussion these arguments are only partially shared among the group members. During group discussion, the arguments are aired and, to the extent they are perceived as valid, will cause a change in the choices of group members who had not previously considered these arguments. A choice shift will occur to the extent that group members are newly exposed to good arguments against the nonpreferred alternatives and in favor of the preferred alternative. This informational influence will be strongest when fact finding or identifying a correct answer is emphasized and when discussion facilitates the full exchange and elaboration of valid and novel arguments (e.g., Kaplan & Miller, 1983; Laughlin, 1980). We believe persuasive-arguments theory is particularly applicable to decisions predicted by prospect theory. These decisions fall into a domain commonly associated with rational choice (indeed, theories of rational choice have been applied to these decisions), which leads people to assume alternatives exist whose correctness is demonstrable. Second, the alternatives predicted by prospect theory can be supported with arguments that have intuitive appeal: People can justify risk aversion when they have assets to protect, as in the saying "A bird in hand is worth two in the bush." On the other hand, to do nothing to prevent losses is to be a quitter, as in the saying "Winners never quit and quitters never win." If risk aversion for gains and risk seeking for losses are defensible—socially desirable actions if they reflect "social truth"—then arguments favoring alternatives predicted by prospect theory should emerge in group discussion to produce informational influence. We tested this idea by manipulating the communication context in which group discussion took place.

Social influence in group discussion is communicated through verbal, paralinguistic, and social context cues (such as seating position; e.g., Patterson, 1983, pp. 2–3). In a series of experiments, we (Kiesler & Sproull, 1986; Kiesler, Zubrow, & Moses, 1985; Siegel, Dubrovsky, Kiesler, & McGuire, 1986; Sproull & Kiesler, 1986) have studied the group effects of computer-mediated communication, which consists of exchanging text information with the use of interconnected computers and computer software, such as computer mail. Because it allows for an astonishingly fast and paperless exchange of words, computer-mediated communication is becoming increasingly popular. But the speed, amorphousness, and text form of interaction using computers reduces paralinguistic and social context cues and prevents the full exchange of views and feedback possible in face-to-face interaction. When the time for discussion is held equal or nearly equal, the number, length, complexity, and novelty of arguments is less in computer-mediated discussions than in face-to-face discussions. These findings suggest that we might use computer-mediated communication to examine the impact of restricted discussion on multiattribute risk choice. By comparing face-to-face discussion with computer-mediated communication within the same groups, we might observe what occurs when these groups can exchange their positions, but not communicate fully. One interpretation of social comparison theory is that varying the fullness of discussion should not affect choice shift and attitude polarization so long as the group members and their preferred alternatives are known (Baron & Roper, 1976). These latter requirements can be fulfilled in both computer-mediated and face-to-face conditions.[1] In contrast, persuasive-arguments theory assumes that choice shift and attitude polarization depend on discussion and argumentation. Because discussion and argumentation are greater in face-to-face than in computer-mediated discussion, the theory predicts choice shift and attitude polarization will be greater in face-to-face discussions than in computer-mediated discussions. We tested this prediction from persuasive-arguments theory by hypothesizing that exacerbation of risk-averse choice for multiattribute gains and risk-seeking choice for losses will occur in face-to-face discussion to a greater extent than in computer-mediated discussion.

Social Decision Schemes

Some mathematical models of group decision making predict group choice shifts from the initial prediscussion preferences of members of the group (see Penrod & Hastie, 1979). Davis's (1973) social decision schemes analysis is one example of this approach in which various implicit decision rules are tested against empirical data on groups (often, mock juries). Applications of the theory have shown that a simple or large majority social decision scheme frequently describes the distribution of group decisions in choice shift (Stasser & Davis, 1981). That is, groups reach consensus on the position initially preferred by the majority of group members more frequently than they take the positions held by smaller factions. This pattern was evaluated explicitly in the Davis et al. (1974) study of 4-person groups evaluating gambling bets. When a prediscussion majority was obtained, a majority social decision scheme described the data; when there was no initial majority, groups favored alternatives either in proportion to their frequency or equally. In larger groups, the largest factions have the most influence (Hastie, Penrod, & Pennington, 1983, p. 27). For example, Davis, Kerr, Atkin, Holt, and Meek (1975) found that a two-thirds majority scheme best characterized decisions of the mock juries they studied. Extending this analysis to the 3-person groups making risk choices in the current study, we hypothesized that a majority social decision scheme describes the distributions of group choice shift in multiattribute risk decision making. (In groups of 3, the majority-wins scheme is indistinguishable from a *minimal-support-wins* scheme; that is, 2 members in agreement predict the group choice. We refer to majority wins to

[1] In deriving our predictions from social comparison theory, we constructed groups so that members would be similar on dimensions that typically produce differential normative influence, such as high status and expertise. If socially desirable attributes differ within the group, then normative social influence might be greater in face-to-face interaction than in computer-mediated interaction. This would arise from the greater communication of social status information in face-to-face interaction.

simplify the presentation and because previous research supports the generality of the majority-wins decision scheme.)

In addition to those based on faction size, there are social decision schemes that reflect the independent influence of social truths, that is, of alternatives people perceive to be inherently appropriate or true. A social norm can influence groups (Nagao, 1983). For instance, the mock juries in the Davis et al. (1975) study considered a rape case that had a strong defense bias in the case materials. In the absence of a two-thirds majority, group behavior was described by a defendant protection subscheme, which embodies the norm "Better to set 10 guilty men free than to convict 1 innocent man." Cvetkovich and Baumgardner (1973) and Wallach and Mabli (1970) also reported reversals of the initial majority in the direction of the normatively "correct" position. Another example of a decision scheme reflecting social truth is found when the task has, or seems to have, a demonstrably correct answer (Laughlin, 1980). In disjunctive problem-solving groups, groups working on eureka problems, whose solutions are compelling, reflect a truth-wins scheme (e.g., Davis, 1973). Laughlin and Earley (1982) studied choice-shift problems (which have no objectively correct answer), comparing problems whose solutions typically reflect shifts biased either toward risk or toward conservatism with problems that have not elicited any clear bias. They found that a truth-supported-wins scheme (i.e., two or more prediscussion preferences for the correct answer) described group decisions for the problems that typically exhibit bias. However, for the problems that typically exhibit no bias, majority wins was the most descriptive decision scheme.

Laughlin (1980) has proposed a group-task continuum anchored by intellective tasks, which have a demonstrably correct answer, and judgmental tasks, which do not. According to Laughlin, the basic social combination process for tasks on the intellective side of the continuum is truth-supported wins, whereas the basic social combination process for judgmental tasks is majority wins. We propose, and there is evidence to suggest, that social decision schemes like truth wins or truth-supported wins may hold for group decision tasks that offer defensible or compelling, but not necessarily true, alternatives (as in the defendant-protection bias). The kinds of choices predicted by prospect theory would seem to be of this type. The popular choice alternatives—risk aversion for gains and risk seeking for losses—are pervasive among people in the population (60–85%). Moreover, as noted earlier, arguments with common appeal can be generated to support the predicted alternatives. If risk aversion for gains and risk seeking for losses is both normative and socially desirable, then, we argue, the group social combination process will reflect a prospect-theory bias. The strongest bias would be reflected in the norm-wins decision scheme.

In groups of randomly selected members, a prospect theory norm ordinarily would act in concert with the prediscussion majority, further exacerbating risk aversion for gains and risk seeking for losses in group risk choices and postdiscussion attitudes (see Zaleska, 1978). But where the prediscussion majority does not favor the alternatives favored by prospect theory, one might examine whether the basic social combination process for decisions predicted by prospect theory is based on faction size or on the social norm. In 3-person groups where none or 1 of the group members prefers the prospect theory alternative prior to discussion, we can compare whether the decision scheme for group choices is majority wins (or norm-supported wins, which makes the same prediction) or norm (alone) wins. On the basis of the idea that risk choices examined in prospect theory research fall cleanly within Laughlin's "intellective task" domain and are amenable to arguments favoring the social norm, we hypothesized that risk aversion for gains and risk seeking for losses will occur in group choice even when group members prior to discussion fail to show such tendencies. We predicted that a norm-wins scheme rather than majority/norm-supported-wins scheme will best describe group choices in these cases.[2] (See Kerr, Stasser, & Davis, 1979, for a discussion of this model-testing approach.)

Method

Subjects

The subjects were senior- and middle-level corporate managers and university administrators. There were 48 managers (37 men and 11 women; 19 corporate managers and 29 university administrators). All of the subjects participated in the experiment at Carnegie-Mellon University as unpaid volunteers. We scheduled the managers in 16 groups of 3 persons. One group was omitted from the analyses because one of the members would not agree to a group choice.

We attempted to form groups of managers from the same organization so as to establish social comparison and group-identification pressures that would operate even when group members were separated in the computer-mediated conditions. We reasoned that if group members were in the same organization they would be more likely to visualize one another and be concerned with others' acceptance than if they shared no organizational identity. We created six groups with members from the same organization and eight groups with two members from the same organization.

Design and Procedure

At the start of each session, we randomly assigned each of the groups (without replacement) to experimental conditions. Each group made *gain* and *loss* choices in both face-to-face and computer-mediated discussion conditions. The design was a 2 × 2 × 3 × 2 (Gain/Loss Problem Type × Problem × Prediscussion/Group/Postdiscussion Choice × Discussion Condition) repeated measures Latin square, with order of problem type, problems, and discussion balanced separately, but not jointly (Winer, 1971, Model 7). At the beginning of the experimental sessions, each group met with the experimenters. One experimenter explained:

> The objective of today's exercise is to learn more about how people make decisions between two alternatives with uncertain consequences and the impact these decisions have on capital budget proposals. . . . Here is a problem similar to those you will be given shortly. To keep things simple, you can assume that the only differences between the two capital projects are the annual cash flows.

[2] The most severe test of the norm-wins scheme arises when none of the group members prefer the prospect theory alternative prior to discussion. However, this possibility is not considered in major expositions of truth-wins schemes, which actually reflect a unanimity-wins scheme with a truth-wins subscheme (e.g., Laughlin & Earley, 1982, Table 3, p. 277). Our data show, however, that two of eight unanimous prediscussion groups reversed themselves. This led us to test a strict norm-wins model that assumes reversals of unanimous groups in favor of the norm.

In this situation, you are a manager of a firm. Decide which of the two capital budget proposals you would choose to implement. In the parentheses are the probabilities that each outcome would occur if the respective project is chosen.

After explaining the task, the experimenter asked the subjects to complete a questionnaire that asked them to indicate privately which investment they would choose for each of four problems, each a hypothetical choice between investment alternatives described by lotteries over the attributes *cash flow in Year 1* and *cash flow in Year 2* (see Figure 1). We searched Payne et al. (1984) for pure gain and loss problems that elicited risk-averse behavior (for gains) and risk-seeking behavior (for losses) in individual managers. We found one pure gain problem and two pure loss problems that were structurally similar; we constructed one pure gain problem for this study.

In the next stage of the experiment, the groups had to reach consensus and indicate their confidence on four investment problems, two (one gain, one loss) during face-to-face discussion and two (one gain, one loss) during computer-mediated discussion. They were given 10 min for each problem in both conditions. During the face-to-face discussions, the group members were seated around a circular table in a regular meeting room. During the computer-mediated discussions, each subject was seated in a separate office and communicated with others by using a computer terminal (with keyboard and screen) connected to a DEC 20 mainframe computer. These discussions were performed using an interactive software program for on-line, synchronous communication. The program (Converse) splits the computer screen into three windows, one for each person, so that each person can read his or her name and the message he or she is composing and sending as well as the other group members' names and messages. Once the program has begun, each window scrolls independently so that group members need not wait to see others' responses before entering their own. The messages are sent automatically the instant they are typed. Although the managers in this study had not used this program before, most had familiarity with electronic mail. We also spent about 10 min before the experimental session training novices.

In the fourth part of the experiment, the subjects were asked again to indicate their private choices on the investment problems as well as their confidence in the decisions and to complete another questionnaire. This questionnaire consisted of open-ended items about how the group made its decision and closed-ended items about the subjects' sex, age, organizational position, acquaintanceship with other group members, and computing experience. Then, one of the experimenters debriefed the subjects.

The raw data for preferences at the four stages are contained in the Appendix.

Dependent Measures

The raw data from this experiment consisted of the choices between two investment alternatives by individuals and groups along with Likert ratings of their confidence in each choice, all of which they marked after each stage of decision making on the same sheets of paper containing the problems. Following the procedure used in four previous experiments on face-to-face and computer-mediated communication in groups (Kiesler et al., 1985; Siegel et al., 1986), we tape-recorded the face-to-face sessions and made automatic records of all computer-mediated discussion along with the time of each remark. In the previous experiments, we developed a content-coding scheme for group discussions that reliably differentiates between face-to-face and computer-mediated discussion. In the present study, we used this content-coding scheme to evaluate the influence of face-to-face and computer-mediated communication on discussions and to examine some premises of persuasive-arguments theory.

In the content coding of group discussion, the main unit of analysis was each separable thought or remark group members uttered during the group discussion (see Siegel et al., 1986). Coders divided subjects' statements into remarks and counted them. To measure exchange of positions versus argumentation, which is important in evaluating the persuasive-arguments theory, we counted remarks that stated or advocated one alternative ("Pick number 2!" or "I prefer the sure bet on \$20,000") and calculated the proportion of the discussion consisting only of these statements of position. To measure sociability, which bears on group-identification effects, we counted remarks containing uninhibited (deviant) social behavior, such as impoliteness or name-calling. Finally, we specifically developed for this study several content codes that might reflect how group members were thinking about the multiattribute risk problems. We counted remarks about risk aversion, risk seeking, gains, losses, and cliches that might function as heuristics for risk-averse choice (e.g., "Play it safe") and for risk-seeking choice (e.g., "Go for it!"). We also counted statements of confusion about the problem, references to cash flow (and the content of those statements), and statements about the impact of the choice outside of the group, such as how top management might react. Two coders used transcripts from pilot experiments to develop the coding guide. They practiced until they differed in no more than one phrase (remark) per transcript. Then, in cases where the coders disagreed, they discussed and resolved differences together.

Results

Preliminary Analyses

As described earlier, half of the groups participated in the computer-mediated discussion before they met face-to-face, and half participated in the computer-mediated discussion after they met face-to-face. We evaluated order effects on group choice and individual postdiscussion choice for gain and loss problems and found no significant effects.[3] Organizationally homogeneous groups did not differ from heterogeneous groups with respect to group outcomes or processes. In the analyses that follow, we evaluate the effects of face-to-face group discussion without regard to whether a computer-mediated discussion took place before or after it and without regard to whether groups came from the same organization. We also evaluated the effects of managers' individual characteristics, such as age, sex, acquaintanceship with other group members, organization, organizational position, and computing experience. None of these characteristics significantly affected group outcomes or process.

Individual Prediscussion Preferences

We analyzed all individual prediscussion responses to the problems (including those problems later used in the computer conditions) to check (a) whether our two gain-situation problems were comparable and our two loss-situation problems

[3] Except where otherwise noted, all preliminary and general effects were estimated with analyses of variance using BMDP3V software for mixed models, Latin square repeated measures designs. The results are maximum likelihood statistics that have asymptotic chi-square distributions. In some cases, we have ignored possible individual-specific effects (which we have not observed empirically) and have been forced to appeal to asymptotic properties for significance levels. In such cases, test statistics reported in the form "$t = \ldots$" are not really t statistics; however, they are analogous to t statistics and are reported as such to aid the reader's intuition.

Instructions: You are the manager of a firm. You are to decide which of two capital projects your company will choose. (Dollars in thousands.)

Gain Problem 1

Choose one project:

Capital Project 1		
Probability of each outcome	.5	.5
Cash Flow, Year 1	$20	$0
Cash Flow, Year 2	$0	$20
Capital Project 2		
Probability of each outcome	.5	.5
Cash Flow, Year 1	$0	$20
Cash Flow, Year 2	$0	$20

Gain Problem 2

Choose one project:

Capital Project 1		
Probability of each outcome	.75	.25
Cash Flow, Year 1	$60	$0
Cash Flow, Year 2	$100	$100
Capital Project 2		
Probability of each outcome	.75	.25
Cash Flow, Year 1	$0	$180
Cash Flow, Year 2	$100	$100

Loss Problem 1

Choose one project:

Capital Project 1		
Probability of each outcome	.5	.5
Cash Flow, Year 1	–$75	$0
Cash Flow, Year 2	$0	–$200
Capital Project 2		
Probability of each outcome	.5	.5
Cash Flow, Year 1	–$75	$0
Cash Flow, Year 2	–$200	$0

Loss Problem 2

Choose one project:

Capital Project 1			
Probability of each outcome	.6	.1	.3
Cash Flow, Year 1	–$10	$0	–$5
Cash Flow, Year 2	$0	–$40	–$5
Capital Project 2			
Probability of each outcome	.5	.2	.3
Cash Flow, Year 1	$0	–$30	–$5
Cash Flow, Year 2	$0	–$20	–$5

Figure 1. Investment problems used in the experiment. (Gain Problem 1 and Loss Problems 1 and 2 are from Payne, Laughhunn, and Crum, 1984. We constructed Gain Problem 2 to match Loss Problem 2 structurally. The extra element in Loss Problem 2 is equal for both alternatives and easily discounted.)

were comparable and (b) whether our subjects differed significantly in their responses from those in the experiments of Payne et al. (1984) and Payne and Laughhunn (1982), three of whose problems we used. There were no significant differences between the two problems of each problem type. By using the asymptotic approximations to the variances and covariances of the sample proportions, the differences between the two problems of the same problem type were as follows: $t = 0.39$ for the gain problems and $t = 0.38$ for the loss problems. Similarly, the differences between individual confidence scores on the two gain problems and two loss problems for the prediscussion choices were as follows: $t = 0.38$ and $t = 0.21$. Also, the null hypotheses of independence for the two gain problems and the two loss problems were not rejected (on the basis of the asymptotic likelihood ratio test), implying no individual-specific effects.

Our subjects' average responses differed from those of Payne and Laughhunn (1982) on the three common problems. For the two loss problems (their Problems 4 and 34), 63% and 68% of their subjects chose the risk-seeking alternative, whereas only 44% and 49% of our subjects made that choice (large sample, approximate p levels of .05 and .1), respectively. For the common-gain problem, 74% of their subjects and only 58% of our subjects selected the risk-averse alternative ($p = .1$). Our results are not consistent with prospect theory. Because both of our subject pools consisted of practicing managers, we have no ready explanation for the remaining differences. We deliberately selected problems from Payne and Laughhunn (1982) that had produced substantial prospect theory effects. Our results conform more closely with those of Fischer et al. (1986). We examined the discussion transcripts and interviewed subjects to try to reconstruct what had occurred prior to group discussion. It is evident from the transcripts that 5 subjects were confused by the problems (not realizing they had to stay with their investment over both years), and these subjects tended to make random prediscussion choices. Also, from postexperiment interviews, some of the managers reported that they treated the prediscussion choices as an arithmetic problem rather than as a gain or loss investment situation, which caused them to see the outcomes as equal. We believe these and other undiscovered phenomena prevented some subjects from framing the situation as one of gain and loss. (Aggregation seems not to have been a problem.) Although an unexpected finding, this result does not rule out tests of our hypotheses. If the prospect theory effect, which has been elicited regularly in research, is a population tendency and normative (as we have argued), then group discussion, especially face-to-face discussion where persuasive arguments can be elaborated, ought to bring the gain/loss nature of the multiattribute choice to light and facilitate expression of prospect theory choices.

Group Decisions and Prediscussion Preferences

Table 1 shows that in the face-to-face conditions, where individual prediscussion preferences were not correlated with problem type, all but 3 of the 15 groups chose the risk-averse option in gain situations, and all but 4 chose the risk-seeking option in loss situations, which is consistent with prospect theory. In contrast, in the computer-mediated condition, where again individual prediscussion preferences were uncorrelated with problem type, only 14 of the 30 group decisions were consistent with prospect theory ($p = .02$ for the contrast between face-to-face and computer-mediated conditions). On the basis of persuasive-arguments theory, we hypothesized that risk-averse choice for gains and risk seeking for losses would occur in face-to-face discussion to a greater extent than in computer-mediated discussion. In that the prospect theory norm seems not to have emerged in the computer-mediated discussion, this finding supports persuasive-arguments theory.

Attitude Polarization

We hypothesized that individual attitudes would change in the direction of prospect theory more in the face-to-face than in the computer-mediated condition. We also expected individual attitudes to change in the direction of group choice. Persuasive-arguments theory makes this latter prediction on the basis of the assumption that group members internalize the arguments they have heard about the "correct" choice. Current versions of social comparison theory also predict attitude change, assuming that group members are motivated to reduce dissonance (Festinger, 1957) and identify themselves with the group (Turner, 1982). However, if group choice is mere compliance with the majority, as may be found in many Asch-type judgmental situations, then no attitude change would be expected (Kiesler & Kiesler, 1969). Table 2 contains the results of cross-classifying prediscussion and postdiscussion individual preferences. Entries along the main diagonal are instances for which no attitude change occurred. There were 56 such cases in the face-to-face discussion condition and 59 in the computer-mediated discussion condition. Of the off-diagonal entries in the face-to-face discussion condition, 15 of the 19 ($p = .02$) individuals in the gain situation indicate attitude change in line with the prospect theory norm, whereas 11 of 15 ($p = .12$) such changes in the loss situation are consistent with the norm; overall, 26 of the 34 ($p = .001$) attitude changes are in the prospect theory direction. In contrast, there is no evidence of a prospect theory norm in the computer-mediated discussion condition, in which only 7 of 16 individuals in the gain situation and 8 of 15 in the loss situation changed their attitudes in the direction predicted by prospect theory.

Table 1
Percentage of Risk-Seeking Choices and Mean Confidence Ratings of Individuals and Groups

Measure	Gain problems: % risk-seeking choices	Gain problems: Confidence *M*	Gain problems: Confidence *SD*	Loss problems: % risk-seeking choices	Loss problems: Confidence *M*	Loss problems: Confidence *SD*
Face-to-face discussion						
Individuals (prediscussion)	49	2.7	.81	47	2.4	.88
Group choice	20	3.1	.78	73	2.3	.86
Individuals (postdiscussion)	24	3.0	.69	62	2.7	.82
Computer-mediated discussion						
Individuals (prediscussion)	40	2.8	.88	47	2.4	.83
Group choice	60	3.3	.80	53	2.6	.72
Individuals (postdiscussion)	44	3.4	.61	49	2.9	.69

Note. Prospect theory predicts that the percentage of risk-seeking choices is small when the problems involve gains and large when the problems involve losses. Confidence was measured on a 4-point Likert scale where 1 = *low confidence* and 4 = *high confidence.*

For each problem type in each condition, group members' postdiscussion attitudes changed in the direction of the group choice, but their postdiscussion attitudes did not differ from their prediscussion attitudes as much as group choice did. Hence, much, but not all, of the group choice seems to have been internalized. That substantial private attitude change occurred is supported by the confidence data. That is, group members' confidence in their decisions increased, equally so in the two discussion conditions (Table 1). Apparently, group members were not merely complying with the group, and they were not complying differentially in the two discussion conditions.

Social Decision Schemes

Table 3 permits inferences about observed social decision schemes. As a general outcome, we expected a majority/norm-supported-wins social decision scheme to describe the distributions of group choice, assuming the prediscussion choices would tend to favor prospect theory. (To simplify presentation, we shall speak of majority wins.) We begin by considering unanimous and nonunanimous prediscussion groups separately because groups with no initial dissent may be less likely to change than groups with nonunanimous majorities. Where the prediscussion preferences were unanimous, the majority-wins decision scheme predicts well but not perfectly, with 1 reversal of a unanimous initial preference in 7 cases in the face-to-face discussion condition and 2 reversals in 12 cases in the computer-mediated discussion condition. Where the prediscussion preferences were nonunanimous, the majority-wins social decision scheme has no predictive power. It correctly predicts only 10 of 23 outcomes in the face-to-face discussion condition and 8 of 18 in the computer-mediated discussion condition.

We next compared the prospect theory norm-wins scheme with the majority-wins scheme, where the prediscussion majorities did not happen to favor alternatives predicted by prospect theory. A striking result in the face-to-face discussion condition was that the predictions of prospect theory were dramatically better than those of prediscussion majority rule. Of the 17 cases (including unanimous and nonunanimous prediscussion preferences) where the data discriminated between these alternative decision schemes, 12 choices supported the prospect theory norm, whereas only (the remaining) 5 supported majority rule. This difference was significant at the .14 level by a two-tailed test (the probability of 12 or more, or 5 or fewer, successes in 17 Bernoulli trials with a population mean of .5 is .1434). For the 14 discriminating nonunanimous cases, 11 of the outcomes were predicted by a prospect theory norm and only 3 by majority rule (p = .06). In contrast, only 2 of the 13 cases for which the prediscussion majority favored the prospect theory choice (2 of the 9 nonunanimous cases) were reversed. This difference in nonunanimous conditional preference-reversal probabilities was highly significant (p = .0001). In the computer-mediated discussion condition, the prospect theory norm described the data less well than did majority rule. Of the 14 cases (including nonunanimous and unanimous prediscussion preferences) where the data discriminated between these alternative social decision schemes, majority rule correctly predicted 9 of the outcomes, whereas the prospect theory norm predicted only 5. For the nonunanimous subset, the two social decision schemes performed about equally (prospect theory predicted 4 of the 9 cases, whereas the prediscussion majority predicted 5 of the 9 cases). Where the prediscussion majority was consistent with prospect theory, 7 of the 16 cases (6 of 9 nonunanimous cases) were reversed. Hence, in the computer-mediated condition, neither the prediscussion majority nor prospect theory predicted significantly better than a coin toss.[4]

Table 2
Transition Matrices Reflecting Number of Individuals Who Changed Their Attitudes in Face-to-Face and Computer-Mediated Discussion

Prediscussion preferences	Gain problems: Postdiscussion preferences		Loss problems: Postdiscussion preferences	
	Averse	Seeking	Averse	Seeking
Face-to-face discussion				
Averse	19	4	13	11
Seeking	15	7	4	17
Total	34	11	17	28
Proportion	.76	.24	.38	.62
Computer-mediated discussion				
Averse	18	9	16	8
Seeking	7	11	7	14
Total	25	20	23	22
Proportion	.56	.44	.51	.49

Note. Opinion change differences (off diagonal entries) for the gain versus loss problems were as follows: for face-to-face, $\chi^2(1, N = 34) = 9.29$, $p < .01$; for computer mediated, $\chi^2(1, N = 31) = 0.03$, *ns;* and combined, $\chi^2(1, N = 65) = 4.43, p < .05$. Opinion change differences for the face-to-face versus computer-mediated discussion were as follows: for gain problems, $\chi^2(1, N = 35) = 4.61, p < .05$; for loss problems, $\chi^2(1, N = 30) = 1.29$, *ns;* and combined, $\chi^2(1, N = 65) = 0.75$, *ns.*

Table 3
Observed Social Decision Schemes: Group Choice as a Function of the Distribution of Prediscussion Preferences

Group prediscussion preference distribution: Averse, seeking	Gain problems: No. groups choosing each alternative		Loss problems: No. groups choosing each alternative	
	Averse	Seeking	Averse	Seeking
Face-to-face discussion				
3, 0	1	0	2	0
2, 1	5	2	2	6
1, 2	5	1	0	2
0, 3	1	0	0	3
Total	12	3	4	11
Proportion	.80	.20	.27	.73
Computer-mediated discussion				
3, 0	4	1	3	0
2, 1	0	4	2	3
1, 2	1	3	2	3
0, 3	1	1	0	2
Total	6	9	7	8
Proportion	.40	.60	.47	.53

Note. Group decision outcome differences for the gain versus loss problems were as follows: for face-to-face, $\chi^2(1, N = 30) = 8.57, p < .01$; for computer-mediated, $\chi^2(1, N = 30) = 0.14$, *ns;* and combined, $\chi^2(1, N = 60) = 3.27, p < .10$. Group decision outcome differences for the face-to-face versus computer-mediated discussion were as follows: for gain problems, $\chi^2(1, N = 30) = 5.0, p < .05$; for loss problems, $\chi^2(1, N = 30) = 1.29$, *ns;* and combined, $\chi^2(1, N = 60) = 0.6$, *ns.*

[4] A reviewer noted that the computer-mediated group decisions might best be described by a prediscussion unanimity-wins scheme with a risk-seeking-wins subscheme, which correctly describes 23 of the 30 outcomes (of which the subscheme alone describes 13 of 18; p = .1). We are apprehensive about the risk-seeking subscheme because the bulk of our evidence for it comes from four computer-mediated gain-problem choices in which a nonunanimous prediscussion majority favored the risk-averse alternative, but all four groups chose the risk-seeking alternative; also, no theory exists to explain risk seeking in such situations.

Group Process

Our hypotheses, derived from the literature, assumed that individual prediscussion preferences would predict group choice. But we were unable to identify a statistically significant relation of prediscussion majorities with the group decision. One explanation consistent with persuasive-arguments theory and with our results is that a norm favoring prospect theory emerged in the face-to-face discussion and dominated the influence of prior preferences. However, when discussion was restricted, in the computer-mediated conditions, prospect theory did not predict group choices. Indeed, no clear decision scheme emerged from an examination of prediscussion preferences and prospect theory. These results suggested that we examine the content of the discussions to try to understand the processes underlying the group decision-making effects we observed. We wished to evaluate our hypothesis derived from persuasive-arguments theory that communication allowing for arguments to be shared in the discussion will foster the emergence of the social norm. If that is the case, then positions advocated by group members in the discussion should reflect the social norm when full discussion is allowed; otherwise, advocacy will be without reference to the norm. Hence, we asked, is discussion related to communication context and group members' advocacy of positions, and in turn, does advocacy predict group choice? To address these issues, we evaluated the content of the discussion and the effect of advocacy during discussion by group members.

In Table 4, we show that the quantity of discussion (remarks) in the face-to-face discussion condition was much greater than in the computer-mediated discussion condition even though it took longer for group members to reach consensus in the latter condition. Also, in the face-to-face condition as compared with the computer-mediated condition, there was more discussion before anyone took a position in the group. And there was more discussion of consequences of the choice in the face-to-face condition, including arguments about risk taking and novel arguments (not shown in Table 4). However, the face-to-face and computer-mediated discussions contained about the same number of statements advocating specific positions (e.g., "Let's go with 3 in 10") rather than pro and con arguments for positions. These findings support the persuasive-arguments theory because they show that face-to-face discussion produced more frequent, more full, and more novel arguments than computer-mediated communication did. Full discussion would have allowed a prospect theory norm to emerge, whereas computer-mediated communication would have restricted that possibility. The data are less supportive of social comparison theory, the main version of which predicts that mere knowledge of the positions of others will influence the group. We have evidence that in this study, the positions of group members were communicated in both face-to-face and computer-mediated discussions. Yet the groups made prospect theory choices significantly more in the face-to-face condition. Of course, we cannot reject social comparison theory from these data. Computer-mediated discussion differs in a number of ways from face-to-face discussion, and one or more of these factors might have reduced social comparison pressures. Our data, however, indicate no qualitative differences between conditions, only differences in frequency.

Table 4
How Group Discussion Varied With Problem and Communication Condition

	Face-to-face discussion		Computer-mediated discussion	
Measure	Gain problems	Loss problems	Gain problems	Loss problems
Time[a]				
M	6.0	6.5	9.6	11.7
SD	3.0	3.1	4.3	3.4
Remarks[b]				
M	91.1	92.6	27.5	33.7
SD	32.1	40.1	8.9	9.5
Advocated or stated position[c]				
M	4.3	4.5	3.7	3.9
As % of total remarks[c]	4.8	4.9	13.3	12.3
Remarks made before any position stated[d]				
M	7.5	8.0	0.7	1.7
As % of total remarks[c]	8.2	8.6	2.5	5.0

Note. t tests compare group discussion in a face-to-face versus computer-mediated context.
[a] Gain problems: $t(16) = 2.60, p < .05$.
Loss problems: $t(15) = 4.38, p < .01$.
[b] Gain problems: $t(16) = 7.38, p < .01$.
Loss problems: $t(15) = 5.53, p < .01$.
[c] *ns*.
[d] Gain problems: $t(15) = 4.02, p < .01$.
Loss problems: $t(14) = 4.64, p < .01$.

We turn now to the question of how advocacy is related to group choice. Does the very first statement of position reflect choices in the group? We evaluated the relation of the first advocate's first statement of preference for a choice alternative and the group choice. In the face-to-face discussion condition, the first position advocated accurately predicted about 72% of the group outcomes, with no apparent problem-type effects, whereas the prospect theory norm predicted 76%; there was no interaction effect (see Table 5). These results for the face-to-face condition do not provide insight into the relative importance of the prospect theory norm and the first advocated position. By contrast, in the computer-mediated condition, the first advocate predicted 79% of the group decisions, whereas the prospect theory norm predicted only 48%; again, there was no interaction effect. For the cases that discriminate, the first-advocate predicted 13 of the 17 choices (p = .05). In this case, where the norm was not confounded empirically with the first advocate's position, we see an unambiguously strong first-advocate effect. First-advocate wins was thus a good characterization of the decision process in both face-to-face and computer-mediated conditions.[5]

[5] We checked for evidence of an individual-specific first-advocate effect. Because each group discussed four problems, there are four possible outcomes for the distribution of first advocacy: (a) One individual

Table 5
Group Choice as a Function of Prospect Theory Norm and First Advocate's Position

First advocate's position	Group choice: No. consistent with first advocate	Group choice: No. inconsistent with first advocate	Total
Face-to-face discussion			
Consistent with prospect theory	16	6	22
Inconsistent with prospect theory	5	2	7
Total	21	8	29
Computer-mediated discussion			
Consistent with prospect theory	10	4	14
Inconsistent with prospect theory	13	2	15
Total	23	6	29

Our data suggest that argumentation and advocacy in the face-to-face discussion resulted in a strong shift in the direction predicted by prospect theory. Our experiment does not allow us to explain this effect, although we can offer some relevant observations. Of the 87 prediscussion choices for groups where there was a first-stated preference (in one group, nobody stated a preference during the discussion of the loss problem), 47% were consistent with prospect theory, which is not significantly different from chance. However, it turns out that there was a substantial and highly significant ($p = .005$) difference between the prediscussion choices of the first advocates and those of the others. Specifically, 69% of the prediscussion preferences of first advocates were in the prospect theory direction, whereas only 36% of the prediscussion choices of the others were in this direction. Hence, it is not the switching behavior of the first advocates (the net effect of their switching was to reduce the number of prospect theory preferences by two) but rather the self-selection process that explains the proportion of first-advocated positions in the prospect theory direction (62%) relative to the proportion of individual (47%) or majority-rule (41%) prediscussion preferences in this direction. The same pattern holds true for switches in the computer-mediated discussion condition. Self-selection exerts a strong effect, but the selection is not in line with prospect theory.

is the first advocate twice, each other individual is the first advocate once (2-1-1); (b) (2-2-0); (c) (3-1-0); (d) (4-0-0). The actual and expected outcomes (based on the naive zero-order model that each individual has a one-third probability of being the first advocate for each problem) for the 14 of our 15 groups for which there was a first advocate for each problem are as follows: (2-1-1)-4 (6.22 expected); (2-2-0)-4 (3.11 expected); (3-1-0)-5 (4.15 expected); and (4-0-0)-1 (0.52 expected). The chi-square goodness-of-fit statistic for testing for nonrandomness (combining the two last categories) with two degrees of freedom was 1.43, which is insignificant. Hence there is no evidence of an important individual-specific first advocacy effect.

Discussion

The purpose of this study was to evaluate an extension of prospect theory in a social context by using theories of group decision making to evaluate alternative hypotheses about how groups and group discussion might produce group decisions predicted by prospect theory. Our results provide some support for prospect theory. Although they did not do so as individuals, groups that met face-to-face made multiattribute investment choices that were risk averse for gains and risk seeking for losses, and these changes mostly persisted on a measure of private attitude made afterward. Together with the group choice shifts on single-attribute bets discovered by Davis et al. (1974), our data suggest that tendencies predicted by prospect theory may be exacerbated in groups. The face-to-face groups in our study were even more risk averse for gains and more risk seeking for losses than individuals have been in previous research.

The results also support the theory of persuasive arguments, which assumes that group choice shifts are produced by arguments shared in group discussion. We found that when groups met face-to-face, they exchanged more arguments, and they shifted toward prospect theory predictions more than when they met via computer. The face-to-face discussions contained more argumentation relative to simple statements of position than did the computer-mediated discussions. Also, more of the face-to-face discussions occurred prior to the first position taken in advocacy of an alternative. These differences reflect limitations of real-time computer-mediated discussion as compared with face-to-face discussion. These limitations include the restricted ability to exchange verbal and paralinguistic information, to provide dynamic feedback, to convey social context cues, and to coordinate turn taking. In addition to reducing the actual exchange of arguments, these limitations might have contributed to group members taking a hurried attitude toward sharing and elaborating arguments in the computer-mediated discussions.[6] An inability to read the group (figuratively, of course), to sense how strongly others felt as well as when the group might be ready to reach consensus, could have led group members to take sides early in the group process and to discourage argumentation. This possibility could be tested in the future by comparing real-time computer-mediated discussion with asynchronous computer-mediated discussion, which facilitates longer and more leisurely discussion; it is an important issue for those who design computer systems.

Any interpretation of our analyses of social decision schemes must be discounted at the outset because of the small number and group size. A major limitation is the inability to distinguish among theoretically interesting schemes such as norm-supported wins versus majority wins. Even so, the social decision scheme approach proved useful for evaluating the decision-making process of the groups in this study. We were able to compare alternative ideas about how the group process would lead to consensus. The idea that a prospect theory norm would emerge in discussion and influence group choice was captured in the prospect-theory-wins decision scheme, whereas the idea

[6] This hypothesis was proposed by an anonymous reviewer.

that prediscussion faction size would influence group choice was captured in the majority-wins or norm-supported-wins scheme. We were able to reject the notion of group process implied by the prediscussion-majority/norm-supported-wins scheme in the face-to-face condition (also this scheme failed to describe the computer-mediated condition very well). By contrast, the norm-wins decision scheme fit the data in the face-to-face condition and was consistent with the notion that norms can influence group decision making. Our data support and extend Laughlin's proposal that intellective tasks, that is, tasks with a demonstrably correct answer, are best described by a truth-supported-wins scheme rather than a majority-wins scheme (when group size permits such comparisons) and that persuasive arguments are most persuasive for these kinds of tasks (Laughlin, 1980; Laughlin & Earley, 1982, p. 278). We believe that choices within the domain of prospect theory are of the intellective type, in that the alternatives predicted by that theory can be legitimized in group discussion. Hence, group decisions will be described better by a norm-wins scheme than by a majority-wins scheme, especially when persuasive arguments can be exchanged.

Our internal analysis of the group process is also limited by small numbers, but we venture some suggestions nonetheless. Serendipitously, we discovered that the first group member to advocate or state a position during discussion determined the different directions taken by groups in face-to-face and computer-mediated discussions. We also found that the alternative favored by the first advocate predicted group choice very well in both communication contexts. In the face-to-face discussion, the first group member to state a position favored the choice predicted by prospect theory before and during the discussion. Once this "self-selection" occurred, the group tended to agree. By contrast, in the computer-mediated discussion, the first advocate's first-stated position did not differ from chance but, nonetheless, predicted other positions taken in the group and group choice. Two alternative processes could account for the first advocate effect we observed. One alternative is that the first advocate influences the group independent of other factors. A second alternative is that the first advocate reflects the "drift of the group" that emerges during group discussion. In this study, the emergence of the prospect theory norm early in face-to-face discussion might have encouraged the group member holding consistent views to state his or her position first. In the computer-mediated discussion, with emergence of the norm and even prediscussion majority preferences less evident, the drift of the group and the first advocate's position would have been determined more idiosyncratically. These alternative explanations might be tested in future research, for example, by comparing self-selected and randomly assigned first advocates.

Our analyses of group process also suggest some other ways that future research could proceed. For example, one could explore group convergence by tracing the observable states of the group system as it moves from the independent prediscussion choices of the individual group members through the first-stated preferences in the group to the group choice itself. To illustrate from our own study, in the face-to-face condition, the first advocate's first-stated preference in the group predicted substantially better than the prediscussion choice of either other advocate or the majority-rule prediction based on all three prediscussion choices (18 of the 26 cases for which all group members advocated some position, or 69.2%). Indeed, as soon as the first advocate's first-stated position was available, none of the prediscussion choices contributed to the predictions of group choices. The second advocate's first-stated position predicted even better (80.8%), whereas the third advocate's first-stated position correctly predicted all group choices. Majority rule based on all three advocates' first-stated positions predicted 96.2%—all but one of the cases. The computer-mediated discussion was similar to the face-to-face discussion in the predictability of the first two advocates' positions. The first advocate correctly predicted the group decision in 77.3% of the cases (17 of 22), whereas the second advocate predicted 86.4%. The third advocate, however, inexplicably predicted only 72.7% (16 of 22). Table 6 illustrates the shift in preferences of group members toward the prospect theory norm from their prediscussion positions to their advocated positions for the face-to-face group, where 16 of the 17 ($p = .0002$) changes in the distributions of group preferences were in the prospect theory norm direction. By contrast, for the computer-mediated discussions, only 5 of the 12 transitions were consistent with the prospect theory norm. The differences between these propositions was highly significant ($p < .01$).

A practical goal of this study was to extend our investigation of social aspects of new computer-mediated communication technologies. Once, computers were mostly the province of scientists and engineers. Today, as computers grow more powerful, more versatile, and less expensive, more people are using them. With computer networks, people are beginning to use computers as a general-purpose tool to gather and distribute information, to talk with others, and to perform long-distance group work. To some degree, all communication technologies (such as the telephone) reduce feedback and social cues in interaction, but computer mail and computer conferences do so more than these other technologies (Sproull & Kiesler, 1986). Although computer-mediated communication allows people to work in groups they would not have formed otherwise and to exchange information more quickly and easily, the dynamics of group interaction are changed, too. Our experimental results suggest that groups that use a computer to communicate might be less influenced by norms than they would be in face-to-face interaction, yet the group members are equally as convinced and confident of the choices they make in both cases. We conjecture that the fullness of verbal and nonverbal exchange is responsible for the obtained difference. This suggests that the design of technologies should take into account their effect on social behavior.

One design issue, for example, concerns decision making. Computer-mediated communication permits wide information searches, and it fosters more equal participation in groups (Siegel et al., 1986). Because it reduces social restraints and the impact of norms, group interactions via computer might also increase the influence of those who initially have minority or deviant views. This could lead either to greater innovation by groups or to silliness. In implementing a system, an organization needs to address such potential tradeoffs. Do we want to make important decisions on the computer? What kinds of decision processes is it simply inappropriate to leave to computer messages? Conventionally, we tend to think important decisions ought to be made face-to-face, but it is clear from our studies of organizathat prediscussion faction size would influence group choice was captured in the majority-wins or norm-supported-wins scheme. We were able to reject the notion of group process implied by the prediscussion-majority/norm-supported-wins scheme in the face-to-face condition (also this scheme failed to describe the computer-mediated condition very well). By contrast, the norm-wins decision scheme fit the data in the face-to-face condition and was consistent with the notion that norms can influence group decision making. Our data support and extend Laughlin's proposal that intellective tasks, that is, tasks with a demonstrably correct answer, are best described by a truth-supported-wins scheme rather than a majority-wins scheme (when group size permits such comparisons) and that persuasive arguments are most persuasive for these kinds of tasks (Laughlin, 1980; Laughlin & Earley, 1982, p. 278). We believe that choices within the domain of prospect theory are of the intellective type, in that the alternatives predicted by that theory can be legitimized in group discussion. Hence, group decisions will be described better by a norm-wins scheme than by a majority-wins scheme, especially when persuasive arguments can be exchanged.

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Payne, J. W., Laughhunn, D. J., & Crum, R. (1980). Translation of gambles and aspiration level effects in risky choice behavior. *Management Science, 26,* 1039–1060.

Payne, J. W., Laughhunn, D. J., & Crum, R. (1981). Further tests of aspiration level effects in risky choice behavior. *Management Science, 27,* 953–958.

Payne, J. W., Laughhunn, D. J., & Crum, R. (1984). Multiattribute risky choice behavior: The editing of complex prospects. *Management Science, 30,* 1350–1361.

Penrod, S., & Hastie, R. (1979). Models of jury decision making: A critical review. *Psychological Bulletin, 86,* 462–492.

Sanders, G. S., & Baron, R. S. (1977). Is social comparison irrelevant for producing choice shifts? *Journal of Experimental Social Psychology, 13,* 303–315.

Siegel, J., Dubrovsky, V., Kiesler, S., & McGuire, T. (1986). Group processes in computer-mediated communication. *Organizational Behavior & Human Decision Processes, 37*(2), 157–187.

Sproull, L. S., & Kiesler, S. (1986). Reducing social context cues: The case of electronic mail. *Management Science, 32,* 1492–1512.

Stasser, G., & Davis, J. H. (1981). Group decision making and social influence: A social interaction sequence model. *Psychological Review, 88,* 523–551.

Stoner, J. (1961). *A comparison of individual and group decisions including risk.* Unpublished master's thesis, School of Industrial Management, Massachusetts Institute of Technology, Cambridge.

Turner, J. C. (1982). Toward a cognitive redefinition of the social group. In H. Tajfel (Ed.), *Social identity and intergroup relations* (pp. 15–40). Cambridge: Cambridge University Press.

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science, 211,* 453–458.

Vinokur, A., & Burnstein, E. (1974). The effects of partially shared persuasive arguments in group-induced shifts: A group problem-solving approach. *Journal of Personality and Social Psychology, 29,* 305–315.

Vinokur, A., & Burnstein, E. (1978). Novel argumentation and attitude change: The case of polarization following group discussion. *European Journal of Social Psychology, 8,* 335–348.

von Neumann, J., & Morgenstern, O. (1953). *Theory of games and economic behavior* (3rd ed.). New York: Wiley.

von Winterfeldt, D. (1980). Additivity and expected utility in risky multiattribute preferences. *Journal of Mathematical Psychology, 21,* 66–82.

Wallach, M. A., & Mabli, J. (1970). Information versus conformity in the effects of group discussion on risk taking. *Journal of Personality and Social Psychology, 14,* 149–156.

Winer, B. J. (1971). *Statistical principles in experimental design* (2nd ed.). New York: McGraw-Hill.

Zaleska, M. (1978). Some experimental results: Majority influence on group decisions. In H. Brandstatter, J. H. Davis, & H. Schuler (Eds.), *Dynamics of group decisions* (pp. 67–74). Beverly Hills, CA: Sage.

(Appendix follows on next page)

Appendix

Pregroup Choices, First-Stated Preferences Advocated in the Group Discussion, Group Choices, and Postgroup Choices for Each Group

Group	Problem type: Gain	Problem type: Loss
	Group risk choice with face-to-face discussion	
1	ASS, SSA, A, AAA	AAS, SSS, S, SSS
2	ASS, AAA, A, AAA	SSA, ASS, S, SSS
3	SAS, AAA, A, AAA	SAS, ASS, S, SAS
4	SAS, SAS, S, AAS	SAA, SAA, A, SAA
5	SAA, SAA, A, SAA	SSS, SSS, S, SSS
6	ASA, AAA, A, AAA	SAA, SAS, S, SSS
7	ASA, AAA, A, AAA	SAA, SAS, S, SSS
8	SSS, SAA, A, AAS	SAA, SSS, S, SSS
9	ASA, SSS, S, SSS	SSS, xxx, S, SSS
10	ASA, AAA, A, AAA	AAS, ASA, A, ASA
11	SAS, AAA, A, AAS	SAA, SSS, S, SAA
12	AAS, AAA, A, ASA	SAA, ASS, S, ASA
13	AAA, AAA, A, ASA	AAA, AAx, A, AAA
14	ASA, SSx, S, ASA	SSS, SSx, S, AAS
15	ASS, AAA, A, ASA	AAA, SAA, A, AAA
	Computer-mediated group decisions	
1	SAS, SSA, S, SSS	SAS, ASS, S, SSS
2	ASS, SSx, S, AAA	ASA, AAA, A, AAA
3	SAS, SSS, S, SSS	AAS, AAS, A, AAA
4	AAA, AAx, A, AAA	SSS, SSS, S, SSS
5	AAA, AAx, A, AAA	AAS, SSS, S, SSS
6	AAA, AAA, A, AAA	ASS, AAA, A, AAS
7	AAA, SAA, S, SAS	AAA, AAA, A, AAA
8	ASA, ASS, S, SSS	SAS, SSA, S, SSS
9	SSS, xxx, S, SSA	AAA, SSx, A, AAA
10	SSS, SAA, A, SAA	ASA, ASS, S, SAA
11	SAS, AAS, A, ASA	SSA, ASS, S, SSS
12	AAS, SAS, S, AAS	AAA, AAS, A, AAA
13	ASA, SAS, S, SSA	ASS, AAx, A, AAA
14	ASA, SSS, S, SSA	SAA, Sxx, S, SSS
15	AAA, AAA, A, AAA	SSS, SSx, S, SAS

Note. Entries are of the form ($X_1X_2X_3$, $Y_1Y_2Y_3$, G, $Z_1Z_2Z_3$), where the subscript indicates the order in which the subject first stated his or her preferred choice in the group discussion. The *X*s are pregroup choices, the *Y*s are first-stated preferences in the group discussion, *G* is the group choice, and the *Z*s are postgroup choices. The Xs, Ys, Zs, and G can take values of A or S, which represent relatively risk-averse and risk-seeking choices, respectively. Lowercase *x* indicates that no preference was advocated.

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