SMALL GROUP DECISION MAKING IN TELECONFERENCING SETTINGS: AN EXPLICATION AND TEST OF THE INTERPERSONAL CLOSENESS-DISTANCE MODEL

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Abstract

This study describes an initial structure for and test of a model of interpersonal closeness-distance with the objective of gaining a better understanding of small group decision making in different teleconferencing settings. 256 subjects randomly assigned to 64 small decision making groups were asked to reach a group consensus on an information exchange task with a criterion solution. These groups were randomly assigned to one of four conference format conditions: communication via face-to-face, audio, video, or computer channels. Conferencing format was found to be related to perceptions of group consensus and satisfaction and to decision making efficiency when the four types of conferencing formats were compared. No significant difference was found between the four formats in terms of the quality of the decision made.

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Introduction

The rapid proliferation and use of teleconferencing technologies in organizational settings, and their potential to reduce economic, environmental, and psychological costs (Grayson, 1983; Hiltz, 1988; Pye & Williams, 1977), has made the comparison of mediated and face-to-face group communication an increasingly important research problem (Hiltz, Johnson, & Turoff, 1986). Yet in the rush to develop, adopt, and test such technologies, the effects of, and implications for, group decision making have not been fully explored (Benbasat and Lim, 1993; Huber, 1990; Steinfield and Fulk, 1990). Research to date has not given full consideration to the point that the characteristics of teleconferenced meetings may be different from face-to-face meetings. These hypothesized differences provide the basis for a new line of study with the objective of understanding and possibly improving small group decision making in the teleconferencing setting.

Since the 1970's, research into the effects of teleconferencing formats on measures of small group decision making has focused primarily on comparing a single format to the face-to-face situation. This follows from views of face-to-face communication, such as that expressed by Goffman (1969), that sees this particular setting as having "a special place because whenever an individual can be observed directly a multitude of good sources of expressed information become available" (p. 5). The "direct" face-to-face conference has become the "base line of optimum communication conditions" (Ochsman & Chapanis, 1974, p.581) against which to compare and contrast the indirect, and possibly inferior, nature of mediated conferences. Computer, audio, and video conferencing formats have all been evaluated by comparing them to the face-to-face format (see Chapanis, 1978; Hiltz & Johnson, 1987; Hiltz, Johnson, & Turoff, 1986; Lea, 1991; Olaniran, 1994; Olaniran, Friedrich, & VanGundy, 1992; Piturro, 1989; Walther & Burgoon, 1992). However, little research has been reported which compares small group decision making across all

four conferencing formats where they can be evaluated relative to each other as well as the benchmark face-to-face condition. To this end, this paper describes a predictive theoretical model, the Interpersonal Closeness-Distance Model, intended to account for the behaviors, perceptions, and outcomes of decision making groups along the whole spectrum of teleconferencing settings. It also reports the results of a laboratory experiment which moves beyond the traditional single format comparison to face-to-face and tests the model through a comparison of four conferencing formats on measures of consensus, satisfaction, efficiency, and decision quality.

The Interpersonal Closeness-Distance Model

The concept of interpersonal closeness-distance has important similarities to other interpersonal models utilized in teleconferencing research. A common factor underlying these models is the proposition that teleconferencing formats decrease the number of channels of interpersonal information available to the participants. For example, Chapanis (1978) Chapanis, Ochsman, Parrish, and Weeks (1972), and Chapanis and Overby (1974) established the concept of "communication richness" with the purpose of identifying the effects of communication technology on natural human communication behaviors. Other researchers use the term "social presence" to describe the number of information channels available across different conferencing formats (Edinger & Patterson, 1983; Hiltz, Johnson, & Turoff, 1986; Hiltz & Turoff, 1978; Pye & Williams, 1977; Short, Williams, & Christie, 1976; Walther & Burgoon, 1992; Williams & Rice, 1983; Zmud, Lind, & Young, 1990). Walther and Burgoon (1992) and Rice (1987) describe interpersonal information capacity in terms of "bandwidth." Rosetti and Surynt (1984) posit that a medium is considered to be "warm" or "cold" depending on its ability to transmit nonverbal cues. Korzenny's (1978; Korzenny & Bauer, 1981) theory of "electronic propinquity" proposes that electronic conferencing formats alter the dynamics of small group interactions because they decrease the proximity between the participants.

The concept of interpersonal closeness-distance is derived from the immediacy metaphor developed by Mehrabian (1967, 1981). Immediacy is grounded in two propositions: (a) that "people approach liked and avoid disliked things" (Mehrabian, 1981, p. 13) and (b) that nonverbal immediacy behaviors can be identified which express approach or avoidance, level of involvement, and positive and negative feelings in a given interaction. Burgoon, Buller, and Woodall (1989, pp. 100-101) employ the term "closeness-distance dimension" to refer to this cluster of behaviors and its implications.

The closeness-distance dimension of interpersonal interaction is related to its communication setting to the extent the setting "facilitates mutual sensory stimulation among persons within it" (Mehrabian, 1981, p. 112). "Mutual sensory stimulation" is operationalized by Mehrabian (1981, p. 112) as "the spatio-temporal proximity or by the number of 'communication channels' available to the individuals in that setting." "Communication channels" refers to the verbal and nonverbal means by which messages are sent and received and include "words, facial expressions, tone of voice, movements, and so on" (Mehrabian, 1981, p. 112). Following Mehrabian, it is possible to say that different settings allow different levels of mutual sensory stimulation. From this, one may also posit that this will result in different communication outcomes. Mehrabian's work suggests that settings which include more channels are associated with greater approach and tend to "result in greater affiliation, pleasantness, and rewarding relationships" (Mehrabian, 1981, p.113).

The Interpersonal Closeness-Distance Model defines the interpersonal closeness of any small group decision making format in terms of the number of communication channels (verbal and nonverbal) available to the participants. This allows the conceptualization and description of small group teleconferencing formats in terms of their relative interpersonal closeness-distance. Face-to-face settings are considered to be the interpersonally closest of the four formats considered here. Video conferencing, which utilizes two-way full motion video and audio, closely simulates a

face-to-face meeting (Rosetti & Surynt, 1984) but decreases interpersonal closeness in at least five ways:(a) it places geographic distance between participants, (b) it does not allow for the effects of the environment or setting, (c) status differences do not exist to the same extent, (d) it does not transmit olfactory information, and (e) it does not allow for transmission of haptic information. Audio conferences admit paralinguistic modes of information into the group communication process such as tone, volume, and rate. However, interpersonal closeness is further reduced by the filtering out of visual nonverbal communication channels such as posture, appearance, eye gaze, and facial expression. Computer conference formats are the most interpersonally distant of the four formats. These generally fall into one of two main types: synchronous and asynchronous. Synchronous computer conferencing involves small group members communicating in real time using the computer keyboard to enter and send messages and a screen and/or printer to read the messages of others. Asynchronous computer conferencing, exemplified by e-mail systems, involves a message produced by one person being stored in the system which others can then retrieve and respond to at a different time. In both synchronous and asynchronous formats, participants do not share a physical setting, are not visible to one another, and have no access to the nonverbal signals that are available in face-to-face (all channels), video (facial expression, paralanguage), and audio (paralanguage) formats.

It can be seen that teleconferencing technologies systematically alter the number and nature of interpersonal communication channels available to participants and hence the amount of mutual sensory stimulation that can take place. As a result, different interpersonal and group outcomes may be expected. Following Culnan and Markus (1987, p. 423), the model can be summarized in terms of three basic propositions:

(1) Communication mediated by technology filters out communicative cues found in face-to-face interaction

(2) Different media filter out or transmit different cues

(3) Substituting technology-mediated for face-to-face communication will result in predictable changes in interpersonal variables

The following literature review addresses whether or not differences in interpersonal closeness will lead to changes in interpersonal variables (consensus and satisfaction) and outcome variables (efficiency and decision quality).

Literature Review

Group Consensus

A pertinent test of the Interpersonal Closeness-Distance Model is the examination of small group decision making in face-to-face and teleconferencing formats on measures of group consensus. DeStephen and Hirokawa (1988) point out that the operationalization of consensus has been "confusing and even contradictory across a number of studies" (p. 227). Typically, consensus has been conceptualized as an end result of group discussion in terms of the amount of members' agreement with the group decision and the commitment to the group and its decision (DeStephen and Hirokawa, 1988, p. 228). Member satisfaction with the group or the group's decision is also an important component of consensus.

Research comparing participants' responses of the extreme ends of the interpersonal closeness-distance continuum, the face-to-face and computer conferencing formats, suggests that degree of interpersonal closeness is related to the amount of and the ability to achieve group consensus (Hiltz & Johnson, 1990; Lea, 1991; Matheson and Zana, 1990). Participants have an increased likelihood of achieving consensus in the face-to-face mode (Adrianson & Hjelmquist, 1991; Hiltz and Johnson, 1987) and they prefer the face-to-face groups for building consensus (Hiltz et al, 1986; Lea, 1991). Consistency in findings also exists when comparing computer and face-to-face conferencing formats in terms of group satisfaction. Participants' satisfaction levels are significantly higher in the face-to-face conference (Olaniran, et al., 1992; Walther and

Burgoon, 1992). Saunders, Robey, and Vaverek (1994) suggest that the absence of visual and other nontextual cues signifying status leads to an equalization effect such that subjects participate more equally in the computer conference than they do when participating face-to-face. As a result, communication is more "open." However, the link to consensus and satisfaction is not clear because, as Saunders et al (1994) point out, equal participation in computer conferencing is frequently accompanied by inappropriate socioemotional behaviors (flaming) such as swearing and self-absorption. Flaming is typically viewed as a negative outcome of the computer medium in task-oriented groups and signifies lower levels of consensus and satisfaction (see Dubrovsky, Kiesler, and Sethna, 1991).

Little research has been reported which examines group consensus in formats which lie in the middle of the interpersonal closeness-distance continuum, audio and video conferencing. More research is needed which takes into account these two modes.

Group Outcomes: Efficiency and Decision Quality

Group outcomes are measures of the end result of the group decision making process and include such variables as quality of decision, degree of agreement on a decision, and group efficiency. The study reported here builds on Hiltz, Johnson, and Turoff's (1986) claim that differential group process produced as a result of different conferencing formats will lead to differential group outcomes. The specific outcome measures considered here are: (a) group decision making efficiency, or time taken to reach consensus on a final decision, and (b) the quality of the decision made by the group, defined as "how close a group came to the solution provided by recognized...experts" (Finn, 1988, p. 179).

Since the present study compares face-to-face, audio, and video formats in a laboratory (experimental) setting, only the synchronous computer conferencing literature is appropriate here, as per a conclusion drawn by Hiltz, Turoff, & Johnson (1989) which states: "a `controlled'

experiment, in which asynchronous conferencing is used, is...a contradiction in terms" (p. 224). In other words, there is no sense of control in the asynchronous situation; users may sign on at any time it is convenient for them and may spend a total of five minutes on the discussion, whereas others might spend five hours or more (Hiltz, Turoff, & Johnson, 1989, p. 224). Thus, it is impossible to usefully compare the efficiency of computer conferencing with other formats in a laboratory design using the asynchronous mode.

Decision efficiency research in synchronous computer conferencing is characterized by several conflicting findings. In some cases, computer conferencing was found to be a less efficient medium for group decision making than the face-to-face interaction (Hiltz, 1986; Hiltz, Johnson, & Turoff, 1986; Olaniran, 1994; Olaniran, Friedrich, & VanGundy, 1992; Phillips, 1983). This finding was based on results indicating that typing is slower than speaking, which thereby decreases the relative efficiency of the computer conference. Yet, in computer conferencing studies employing no time limitations there were no differences between the computer and face-to-face formats (Walther & Burgoon, 1992). Lea (1991) states that computer conferencing can be viewed as an efficient channel of communication. Adrianson and Hjelmquist (1991) suggest that there are no differences in problem solving efficiency across face-to-face and computer conferencing formats. According to Dennis, George, Jessup, Nunamaker, & Vogel (1988), perhaps the only generalization possible for synchronous computer conferencing studies of decision efficiency is that of inconsistent findings.

The literature which examines decision quality in computer conferencing appears to be reasonably consistent. While perfect agreement does not exist (Kerr & Hiltz, 1982), the data available clearly suggests that group decisions are equally good in both face-to-face and computer conferencing formats (Archer, 1990; Hiltz, Johnson, & Turoff, 1986). Findings such as these lead Adrianson and Hjelmquist (1991) to question whether group process differences, as an effect of mode, have a direct effect on final outcomes, as is claimed by Hiltz, Johnson, and Turoff (1986).

Adrianson and Hjelmquist (1991) qualify this when they note that "only a few studies have been conducted, implying a restricted range of problems used, and a limited number of methods for analysis of the outcome" (p. 282).

Research comparing video and face-to-face conferencing in terms of efficiency and decision quality is extremely limited and suggests little or no difference between the two formats (Champness, 1972; Chapanis, Ochsman, Parrish, & Weeks, 1972; Williams & Holloway, 1974). The dearth of research may be explained by the equipment demands of video conferencing technology, or the fact that video conferencing is significantly more expensive than computer conferencing or audio conferencing (Rice, 1984) - although these costs are now rapidly falling (Francis, 1993; Hutsko, 1993; Kirvan, 1993). Recent trends strongly suggest that video may be the teleconferencing format of choice in the near future (Fish, Kraut, Root, and Rice, 1993; Kupfer, 1992). Clearly, more systematic research is needed in this area.

The available literature generally suggests that no significant differences exist between audio and face-to-face conferencing on measures of efficiency and quality (Champness, 1975; Chapanis, 1975; Fowler & Wackerbath, 1980; Short, 1971). Fielding & Hartley (1987) suggest a possible explanation for these findings. They argue that decision making is a task in which social relationships are relatively unimportant. Nonverbal research, such as that of Argyle (1983), suggests that visual, nonverbal cues function primarily to transmit socioemotional information and therefore nonverbal cues are of less importance in determining the outcome of task-oriented encounters. Again, systematic investigation of claims like these are needed.

Hypotheses

The extant literature discussing the relative performance that should be expected from small decision making groups in four conferencing formats on measures of consensus, satisfaction, efficiency, and decision quality is scarce and inconclusive. The literature and the Interpersonal Closeness-Distance Model both suggest that a difference should be found between small decision making groups in face-to-face and computer conferencing formats on measures of consensus and satisfaction. However, the impact of the video and audio formats is far from clear. The model suggests that, as a trend, face-to-face groups should report the greatest amounts of consensus and satisfaction, followed by groups in the video, audio, and computer conditions, in that order.

In terms of efficiency and decision quality, the literature shows little difference between face-to-face, video, and audio formats and mixed and inconclusive results comparing face-to-face and computer formats. The Interpersonal Closeness-Distance Model predicts that the differing levels of interpersonal closeness inherent in the four formats will be reflected in measures of efficiency and decision quality, with face-to-face groups performing more quickly and with higher quality decisions than their counterparts in the computer format. Groups in the video and audio conditions are expected to fall somewhere in between, although whether they will perform significantly differently from the face-to-face groups is difficult to predict. In light of the uncertainty inherent in the literature review, the Interpersonal Closeness-Distance Model is tested against the following hypotheses:

H1: Conference format is related to an individual's feelings of group consensus. Decision making groups in interpersonally closer formats will display more consensus than groups in more interpersonally distant formats.

H2: Conference format is related to an individual's satisfaction with the group decision. Decision making groups in interpersonally closer formats will display more satisfaction with the group decision than groups in more interpersonally distant formats.

H3 Conference format is related to the efficiency of the group decision making process. Decision making groups in interpersonally closer formats will reach a decision faster than groups in more interpersonally distant formats.

H4: Conference format is related to the quality of the group decision. Decision making groups in interpersonally closer formats will produce higher quality decisions than groups in more interpersonally distant formats.

Method

Sample

Subjects in this study were 256 undergraduate students enrolled at a Northeastern 4 year State College. 47% were male, 53% were female, and the average age was 22.6 years. Subjects were enrolled in a wide cross section of majors, although the majority (145) of subjects was currently matriculated in the communication degree. Subjects were recruited through announcements made in their classes. All subjects who took part in this study were volunteers and did not receive extra credit for their participation.

Task and Procedure

The study used the NASA Moon Survival Problem (Hall & Watson, 1970), an information exchange task resulting in a rank-ordering of 15 items required for survival on the moon. The task had a criterion solution plus a measure of how "correct" a group's answer was. This task was selected because (a) it resulted in a group product that can be objectively and quantitatively evaluated, and (b) its successful completion required an identifiable and finite body of task-relevant information.

Each subject was given a problem answer sheet which contained a subject number, a group number, and a code number specifying the conference format through which the group would conduct its discussion. These sheets were shuffled and distributed in random order assuring that each subject was randomly assigned to both group and conference format condition. Any subjects who had knowledge of this task previous to the experiment, as determined by a pre-test interview, were excluded from the study. Subjects completed the rank ordering of the 15 items individually and in silence. This was done under the supervision of the experimenter to ensure no interaction among the subjects. The individual solution to the problem was recorded on the problem sheet in a column called, "Individual Ranking." No verbal instructions were given to subjects other than that of telling the subjects to read the instructions on the problem sheet, to carry them out, and to work in silence. From this point, the experimenter did not answer any questions regarding the task.

The 256 subjects were randomly assigned to 64 groups of four. Subjects were told that they would be asked to compare and contrast their individual responses with those of three other subjects to derive a group ranking of the fifteen items. No instructions regarding decision making strategies such as consensus decision making (see Hall & Watson, 1970) or voting were given. All of the groups were considered unstructured (i.e., with no pre-established patterns of leadership or role structure) and with zero-history at the time they began the group interaction. Subjects consulted the problem sheet and located their assigned group number and the three other people

with the same number. The experimenter then consulted the condition number assigned to that group, and took them to the appropriate experimental setting (face-to-face, audio, video, or computer conferencing). Once in the assigned condition, subjects were instructed to complete the problem as a group by sharing and discussing the rankings generated individually. Sixteen groups (64 subjects) participated in each of the four conditions. Once the task was completed, all subjects completed the 21 Likert scales which comprise DeStephen and Hirokawa's (1988) consensus instrument. Code numbers were used so that groups could be identified and individual identities protected.

Independent Variable

The independent variable, interpersonal closeness-distance, is operationalized according to the channel through which small group communication takes place and has four levels: face-to-face (highest interpersonal closeness), audio, video, and computer conferencing (lowest interpersonal closeness). These are described below.

Face-to-face Condition

In the face-to-face condition, groups of four communicated around a small table with full access to the nonverbal information of the other participants. The discussion was recorded by a video camera which was concealed behind a screen. Subjects were notified, however, that the recording was taking place.

Video Condition

In the video condition, groups of four were assigned to stations in four separate rooms. Each subject was seated before a video screen on which other subjects in the group could be seen simultaneously. Each group member appeared in one quadrant of the screen. Group members could freely speak to one another through the audio-conferencing devices on a single shared line.

Audio Condition

As in the video condition, groups of four were individually seated before the isolated teleconferencing stations. However, in this condition, video screens were turned-off, allowing intragroup communication by voice only.

Computer Condition

In the computer condition, groups of four were individually seated before computer terminals in separate rooms so that subjects were unable to see or hear each other. Communication was mediated solely through the computer terminals in "real time," or synchronously. Subjects entered their messages in the lower portion of the computer screen. After the depressing the "Enter" key, these messages would then be sent to the conference, and would appear in the upper portion of the screen so that subjects could read the group's transcript as the discussion transpired. Transcripts were saved and printed.

Technical Specifications

To meet the unique demands of the experiment, a special conferencing system was created. The video portion consisted of a four node network, laid out in a "star" topology with a Panasonic WJ450 video multiplexor at the center. Placed at each subject position (node), was a Panasonic WV-D5110 remotely controllable, low light camera and a color monitor. The multiplexor allowed

all four subjects to appear simultaneously in separate quadrants of each screen, and a VHS videorecorder was used to record the multiplexed output.

The audio for both the video and audio conditions was provided by NEC "VoicePoint," echo-cancelling, audio-conferencing devices placed at each subject position. Each unit has a self-contained speaker and microphone. To accomplish communication across all four nodes, each was connected to an AT&T System 75 PBX, and a "party line" was created by means of a conference call. The computer portion of the experiment was conducted on an AT&T "Starlan" through UNIX-based "Xchange" conferencing software.

Dependent Variables

Consensus and Satisfaction

The variables of consensus and satisfaction were operationalized using a 21 (4-point) Likert scale instrument developed and tested by DeStephen and Hirokawa (1988). This original instrument yielded five dimensions intrinsic to group consensus which measured participants' feelings regarding: (a) the group decision, (b) the decision process, (c) group member relationships, (d) individual effectiveness, and (e) individual opportunity to participate (see DeStephen and Hirokawa, 1988, p. 230, for complete instrument). Replicating DeStephen and Hirokawa's analysis, a factor analysis with a varimax rotation was performed on the instrument data. All 21 items were included in the factor analysis (see Appendix A). The results of the analysis indicated a three factor solution. Items nested within each index were selected on the basis of their "factor purity" (Salazar, Hirokawa, Propp, Julian, & Leatham, 1994, p. 545); that is, an item had to load above .70 on the factor and below .45 on any other factor. 10 of the original items in DeStephen and Hirokawa's (1988) instrument were dropped from further analysis because they had insufficient factor purity. The three factors which emerged were as follows:

Factor 1 - Feelings Regarding Group Member Relationships

Factor 1 was defined by the responses to scales 10, 11, 12, & 19 (see Appendix B). This factor matches, with the exception of the addition of scale 19, DeStephen and Hirokawa's (1988) factor called "Feelings Regarding Group Member Relationships" and has a validity, as measured by Cronbach's Coefficient Alpha, of .88.

Factor 2 - Satisfaction with the Group Decision

Factor 2 was defined by the responses to scales 1, 2, 3, 4, & 5 (see Appendix C). This factor matches DeStephen and Hirokawa's (1988) factor labeled, "Feelings Regarding the Group Decision," and has a Cronbach's alpha coefficient of .91.

Factor 3 - Perceptions of Individual Effectiveness

Factor 3 was defined by responses given to scales 15 & 16 (see Appendix D). This factor matches, with the exception of the omission of scale 16, DeStephen and Hirokawa's (1988) factor called, "Feelings Regarding Individual Effectiveness" and has a Cronbach's alpha coefficient of .83.

Efficiency

The efficiency of the group was operationalized as the time taken for the group to complete the task, measured in minutes. In all four conditions, groups were allowed as much time as needed to reach a group decision.

Decision Quality

The NASA Moon Survival Problem used in this study has a correct solution, or criterion, obtained from the Crew Equipment Research Section of the NASA Manned Spacecraft Center at

Houston, Texas (see Hall & Watson, 1970, p. 303). Decision quality was operationalized in terms of the group's summed deviations from the criterion rank order. This score represents a measure of error, thus, magnitude is inversely related to decision quality. The score is free to vary from 0 to 112 points from absolute accuracy. A score of zero indicates total agreement (i.e. no difference) with the NASA ranking. Rank order estimates of quality of decision have been used in other studies, including Finn (1988), Hall & Watson (1970), Hiltz, Johnson, & Turoff (1986), and Hirokawa (1987).

Statistical Analysis

A single factor analysis of variance (ANOVA) was conducted to examine the influence of the four communication channels on the measures of group consensus, satisfaction, individual effectiveness, efficiency, and decision quality. Tukey's studentized range test, controlling for type I experiment wise error rate, alpha=.05, was conducted to compare, post hoc, the mean of each condition relative to the means of all other conditions.

Results

A significant result was found for the effect of conference format on the mean score for factor 1 (perception of group consensus), F (3,247) = 3.72, $p<.012$. The mean scores for the four conditions are presented in Table 1. The Tukey Studentized Range Test ($p<.05$) shows a significant difference in perception of group consensus between the face-to-face condition and the audio condition. Face-to-face, video, and computer conditions were not significantly different from each other. Computer, audio, and video conditions were not significantly different from each other.

Table 1

Mean Score for Factor 1: Perception of Group Consensus

Face-to-Face (N=61)	Video (N=64)	Computer (N=60)	Audio (N=63)
3.58	3.47	3.25	3.21

Note: Any conditions with a common underscore are not significantly different ($p<.05$). Higher mean scores reflect more positive perceptions of group consensus (Scale=1-4).

A significant result was found for the effect of conference format on the mean score for factor 2 (satisfaction with the group decision), $\underline{F}$ (3,230) = 5.55, $p<.0011$. The mean scores for the four conditions are shown in Table 2. The Tukey studentized range test ($p<.05$) shows a significant difference in perception of satisfaction with the group decision between the face-to-face and video conditions with the computer condition. No other significant differences were found.

Table 2

Mean Score for Factor 2: Satisfaction with the Group Decision

Face-to-Face (N=63)	Video (N=57)	Audio (N=58)	Computer (N=53)
3.60	3.54	3.43	3.15

Note: Any conditions with a common underscore are not significantly different ($p<.05$). Higher mean scores reflect more positive reports of individual satisfaction with the group decision (Scale=1-4).

No significant result was found for the effect of conferencing condition on the mean score of factor 3 (feelings regarding individual effectiveness), F (3,249) = 0.55, p<.65.

A significant result was found for the effect of conference format on decision efficiency (time taken to complete the task), F (3,63) = 48.71, p<.0001. The mean scores for the four conditions are presented in Table 3. The Tukey studentized range test (p<.05) showed that the computer condition was significantly less efficient than all other conditions. The face-to-face, audio, and video conditions were not significantly different from each other.

Table 3: Decision Efficiency

Mean Time Taken to Complete Task (in Minutes) by Conferencing Condition

Face-to-Face (N=16)	Audio (N=16)	Video (N=16)	Computer (N=16)
10.56	12.44	15.38	36.38

Note: Any conditions with a common underscore are not significantly different (p<.05). Lower mean scores reflect lower times to group decision.

No significant result was found for the effect of conference format on group decision quality, F (3,63) = 2.70, p<.0535. The mean scores for the four conditions are presented in Table 4.

Table 4: Decision Quality

Mean Summed Deviation from NASA Experts Criterion by Conferencing Condition

Face-to-face (N=16)	Audio (N=16)	Video (N=16)	Computer (N=16)
33.13	34.81	34.88	41.94

Note: Any conditions with a common underscore are not significantly different ($p<.05$). Lower mean scores reflect greater agreement with NASA ranking.

A related finding is that the group solution to the problem was of significantly higher quality ($p<.0001$) than the solution obtained from the mean individual score of the four group members prior to group interaction. Performing a t-test for related samples on the difference between the group score and the mean individual score, significant improvement in decision quality was found in the dataset as a whole (N=64, M=12.60, t=14.09, $p<.0001$) and in each of the four conditions: face-to-face (N=16, M=14.34, t=7.53, $p< .0001$), video (N=16, M=14.64, t=7.60, $p<.0001$), audio (N=16, M=11.92, t=7.00, $p<.0001$), and computer (N=16, M=9.50, t=6.66, $p<.0001$). Further, the amount of improvement was not significantly different between each of the four conditions ($F(3,63) = 1.89$, $p<.14$).

Discussion

This study tested a model of interpersonal closeness-distance by exploring the impact of four conferencing formats on the perceptions and outcomes of small decision making groups. Significant results were found for three of the four hypotheses tested in the one-way analysis of variance. However, when the Tukey Studentized Range Test ($p<.05$) was performed, post hoc, the differences between formats were generally non-significant and performance in the four conditions was very similar.

On the consensus measures, face-to-face groups reported significantly greater levels of consensus than audio only groups (but not video or computer) and greater levels of satisfaction than the computer condition (but not video or audio). In general, participants in these conditions felt that they were equally organized, that they worked well together, that they liked each other (consensus), that the solution reached was appropriate, that they supported the group, and that the goal of the group was accomplished (satisfaction). Despite the diminishment of communication channels that each condition progressively imposed, no significant accompanying loss of consensus or satisfaction was observed.

Similar results were found on the outcome measures of efficiency and decision quality. Conferencing format was found to be significantly related to efficiency when the four types were considered together in a one-way analysis of variance. However, when the post hoc Tukey studentized range test is considered, it becomes clear that the main effect is generated by the difference of the computer conferencing condition from all other conditions. No significant differences were found between the face-to-face, audio, and video conferencing conditions. On the measure of decision quality, all conditions performed equally.

The lack of significant differences again suggests that any diminishment in the number of communication channels had no significant effect on the groups' ability to reach a quality decision in a timely manner relative to the performance of the face-to-face condition. The finding that the

computer condition performed significantly slower can be explained, in this case, by the fact that the majority of subjects were unfamiliar with using the computer as a communication device in real time.

In general, groups did not let the presence of the mediated channels interfere with the task focus required to address the problem and reach a consensus. This may be a function of the highly structured nature of the task used in this study. The NASA task requires only that the group agree on a ranking, and it is possible that this can be done with little discussion if certain group members either dominate the group and/or if other members agree to conform to the wishes of others without significant input and discussion. However, this also suggests that communicating via the audio and video conferencing formats had no impact on the emergence of dominance or conformity behaviors as evidenced in the efficiency and quality measures.

This claim is supported when the decision quality indexes reported in this study are compared to Hall and Watson's (1970) original estimates of decision quality in small group decision making. Hall and Watson found a mean decision quality index of 34.19 (summed deviations from the criterion) for unstructured groups comparable to the groups used here. When compared with the mean decision quality indexes of 33.13, SD = 11.93 (face-to-face), 34.88, SD = 6.85 (video), 34.81, SD = 8.29 (audio), and 41.94, SD = 10.28 (computer) reported here, it can be claimed that the performance of the small groups in this experiment was not unusual, thus strengthening the validity of the finding that groups in mediated formats produced decisions equal in quality to those of face-to-face groups. This claim is further supported by the findings that (a) groups in all conditions produced decisions which were statistically significant ($p.<.05$) improvements over the scores of individuals working alone and (b) there was no difference ($p.<.05$) in the amount of that improvement between each of the four conditions.

Limitations and Directions for Future Research

The findings from the consensus and satisfaction measures lend support for the validity of the DeStephen and Hirokawa (1988) consensus instrument. The original scale was developed using zero-history, leaderless discussion groups comprised of students enrolled in basic communication courses (DeStephen & Hirokawa, 1988, p. 229). This study used a similar sample but with the additional variable of the amount of interpersonal closeness-distance afforded to the participants by the four conferencing formats. Data from the new sample produced factors and validity coefficients very similar to those found by DeStephen and Hirokawa (1988) and suggest it may be a valid instrument to use when researching the nature of small group decision making in teleconferencing contexts.

However, following DeStephen and Hirokawa (1988), it is possible that these findings may be accounted for by the nature of the sample rather than diminishing interpersonal closeness. In all groups, and in all conference formats, reports of consensus and satisfaction were very high (3+ on a 4 point scale). It is possible that the groups in this study will naturally foster higher consensus due to being given the opportunity to participate in an informal setting with novel communication technologies. Participants may have experienced the group decision making process as a game and their enjoyment of the activity may have resulted in elevated levels of consensus. These results may not be representative of more realistic decision-group situations whereby the impact of the conferencing format may have been obscured. The study of groups with real charges, more formal structures, and controversial decisions may reflect stronger levels of variation in consensus and reveal differences due to the level of interpersonal closeness inherent in the conference format.

The impact of task type in the face-to-face and teleconferencing situations is another important consideration for further study. The task is a specific goal that the decision making group intends to achieve. Socioemotional tasks emphasize the more social interpersonal skills and outcomes, such as negotiations or getting new members to join, while a technical task involves

more factual or cognitive skills and outcomes, such as arriving at a decision based on information gathered and/or evaluated by the group (Rice, 1984). Studies using task type as an independent variable along with conferencing format suggest that different conferencing formats are better suited for different types of task (e.g., Hiltz, Johnson, & Turoff, 1986).

Another untreated variable is the presence or absence of some kind of pre-established structure in which the group discussion takes place. In this study, no instructions were given to subjects concerning specific discussion or decision making procedures. It would be useful to investigate whether or not the findings presented here can be generalized to small groups employing other group discussion formats, such as delphi or nominal group techniques (Delbecq, Van de Ven, & Gustafson, 1975; Van de Ven & Delbecq, 1974).

This paper has described an initial sketch and test of a model of interpersonal closeness-distance with the objective of gaining a better understanding of small group decision making in different teleconferencing settings. While the model displays a limited ability to predict differences between the extreme ends of the interpersonal closeness-distance continuum on measures of consensus and satisfaction, it is clear that more research is needed in this area before definitive conclusions can be reached.

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Appendix A

Rotated Factor Matrix:

DeStephen and Hirokawa (1988) Consensus Instrument

Rotated Factor Pattern

Scale	FACTOR1	FACTOR2	FACTOR3
1	0.28817	0.80475 *	0.18243
2	0.36681	0.77511 *	0.18234
3	0.31934	0.80831 *	0.22439
4	0.18493	0.79145 *	0.28319
5	0.29570	0.72770 *	0.25942
6	0.53076	0.63649	-0.06784
7	0.45838	0.66894	0.21268
8	0.65748	0.56066	0.09533
9	0.57221	0.48804	0.02510
10	0.75420 *	0.25986	0.06307
11	0.78961 *	0.35661	0.14001
12	0.78150 *	0.36310	0.15182
13	0.64568	0.22048	0.22006
14	0.44184	0.30177	0.62130
15	0.34048	0.23828	0.72735 *
16	0.39854	0.19084	0.72555 *
17	-0.12604	0.06443	0.65741
18	0.64486	0.31918	0.38226
19	0.72201 *	0.31874	0.23162
20	0.54273	0.40192	0.40132
21	0.66911	0.24444	0.42552

Variance explained by each factor

FACTOR1	FACTOR2	FACTOR3
6.077947	5.451174	2.834542

Note: * indicates scales defining a factor

Appendix B

Scales Which Comprise Factor 1:

Feelings Regarding Group Member Relationships

10. This group was a place where people could feel comfortable expressing themselves.
11. I like the members of my group.
12. I would like to work with members of my group on another similar project.
19. I believe that the other members of the group liked me

Appendix C

Scales Which Comprise Factor 2:

Feelings Regarding the Group Decision

1. The group reached the right decision
2. I believe that our group's decision/solution is appropriate
3. I support the final group decision.
4. I believe we selected the best alternative available.
5. I would be willing to put my best effort into carrying out the group's final decision.

Appendix D

Scales Which Comprise Factor 3:

Feelings Regarding Individual Effectiveness

15. I believe I had a lot of influence on the group's decision making

16. I contributed important information during the group's decision-making process.