Exploring the Core Concepts of Media Richness Theory: The Impact of Cue Multiplicity and Feedback Immediacy on Decision Quality

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ABSTRACT: Employing media richness theory, a model is developed to open the black box surrounding the impact of computer-mediated communication systems on decision quality. The effects on decision quality of two important communication system factors, cue multiplicity and feedback immediacy, are examined in light of three important mediating constructs: social perceptions, message clarity, and ability to evaluate others. A laboratory experiment examining two tasks and employing face-to-face, electronic meeting, electronic conferencing, and electronic mail communication systems is used to assess the model's validity. Results provide consistent support for the research model as well as media richness theory.

Richer media facilitate social perceptions (total socio-emotional communication and positive socio-emotional climate) and perceived ability to evaluate others' deception

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and expertise. Leaner media (electronic mail and electronic conferencing) facilitate communication clarity when participants have less task-relevant knowledge. The impacts of these mediating constructs on decision quality were found to depend on the levels of participant expertise and deception. In general, it was found that richer media can have significantly positive impacts on decision quality when participants' task-relevant knowledge is high. Moreover, effects of participant deception can be mitigated by employing richer media.

KEY WORDS AND PHRASES: computer-mediated communication, feedback immediacy, group performance, group processes, media richness theory, nonverbal cues.

COMPUTER-MEDIATED COMMUNICATION SYSTEMS (CMCS) include computer conferencing systems, electronic and voice mail systems, group decision support systems, and text retrieval systems [7]. Since CMCS significantly alter communication processes and outcomes in organizations [7, 44], it is important to develop a better understanding of their effects in order to enable increased benefits from their use. Although many theories have been developed in this regard, media richness theory is one of the most widely known and used [21, 85]. Media richness theory proposes that media differ in the ability to facilitate changes in understanding among communicators [15]. For example, face-to-face communication is richer (can better facilitate changes in understanding) than written memos because it enables immediate feedback and the conveyance of cues such as facial expressions. Media richness theory suggests that managers will be more effective and efficient when richer media are used for equivocal tasks and leaner media are used for less equivocal tasks [15, 18, 45].

The popularity of media richness theory is interesting given its relatively poor empirical track record. Although it has performed reasonably well with traditional media (e.g., face-to-face, telephone, and written memos), there are many findings that it cannot explain when newer media (e.g., voice mail, e-mail, and videoconferencing) are included [10, 36, 72, 73]. For instance, Kraut et al. [58] found that, contrary to the prediction of media richness theory, the use of video telephony by managers with people management jobs was not more than the use by other managers.

Dennis and Kinney [21] suggest that a major reason for the anomalies found in media richness research is that with few exceptions (e.g., [70]), most studies have examined media choice rather than media use (e.g., [18, 20, 58, 72]). They therefore argue that the central proposition of the theory remains largely untested; that is, "does the use of richer rather than leaner media for equivocal tasks improve performance?" However, works examining this proposition have not provided better support for media richness theory. For example, examining both traditional and newer communication media, Dennis and Kinney [21] and Suh [85] found that the use of richer media did not lead to higher decision performance for more equivocal tasks. On the other hand, Rice [70] found mixed support and Kraut et al. [57] found substantial support for this relationship.

Although empirical tests of media richness theory are disappointing, the supportive findings "suggest a degree of empirical validity sufficient to warrant investing additional thought and research" [36]. Attempting to reconcile media richness' basic intuitive appeal and its poor empirical performance with regard to newer communication technology, many researchers have combined media richness with complementary theoretical approaches [70, 94]. The social influence model [35, 37] suggests that media richness perceptions are in part socially constructed, and can be influenced, for example, by coworkers' statements. Trevino et al. [86] propose that media choice can be affected by rational evaluations of situational determinants, such as the distance between communication partners.

In more recent studies, El-Shinnawy and Markus [27] and Rice et al. [73] suggest that features of communication systems (such as ease of use, flexibility, and adaptability) can be important additional determinants of use. In the same vein, Dennis and Valacich [22] indicate that important additional media features include the enabling of parallel communication and rehearsal and reprocessing of messages. Rice et al. [73] and Carlson and Zmud [10] focus on the importance of contextual issues, such as level of analysis, vertical and horizontal equivocality, and individuals' experiences with the media.

The above studies suggest the need to add more predictors of media choice and performance to media richness theory. However, Fulk and Boyd [36] argue that rather than adding more predictors, we should refine our understanding of the core processes involved, and that current notions of media richness are oversimplified, which "belies the rich panorama of complex cognitions that are implicated in media behavior." They go on to suggest that the intervening effects of media on organizational information processing are an important area of inquiry. Hedlund et al. [40] make a similar suggestion based on their finding that while certain intervening effects of a communication medium (e.g., effect of medium on information exchange) may enhance decision performance, other intervening effects of the same medium (e.g., effect of medium on ability to judge others' expertise) may detract from decision performance.

As part of this inquiry, and in accord with the central proposition of media richness theory, we examine factors that mediate impacts on performance due to a communication medium's ability to provide multiple cues and immediate feedback. This focus on multiplicity of cues and immediacy of feedback is chosen because they have been identified as the most important factors distinguishing very rich (such as face-to-face) from very lean (such as written) communication [15, 21].

Although media richness theory postulates impacts on performance, it is unclear as to how performance should be defined. Media richness theory researchers typically identify performance in terms of decision quality, decision efficiency (time required for decision-making), and consensus among participants (e.g., [21, 85, 87]). We focus on decision quality, since the laboratory study employed here has already been used to examine consensus among participants [52]. This is not to suggest that decision efficiency in unimportant. Rather, we believe that in most cases, efficiency is less important than quality and consensus.

Our examination of the mediating paths in the media richness–decision quality relationship complements related work on the effects of computer-mediated communication on decision quality. Reviews of the effects of computer-mediated communication suggest a positive effect on output quality (e.g., [60, 66]). However, only a few studies (e.g., [40]) have attempted to examine this relationship at a deeper level. The current work contributes by opening the "black box" surrounding the effects of media richness on decision quality via several mediating variables.

Past studies that have focused on opening the "black box" surrounding the effects of computer-mediated communication have typically examined process variables without relating the process variables to outcome variables. For instance, studies by Huang and Wei [46] and Zigurs et al. [101] focused on influence behaviors in group support systems versus face-to-face systems without relating influence behaviors to outcome variables such as decision quality. A few past studies relating process and outcome variables (e.g., [43, 76]) employed correlational analyses. Such analyses are problematic because they do not partial out the effects of process variables that may be correlated with process and outcome variables of interest. In this study, we employ partial least squares (PLS) to better understand the effects of media richness on decision quality via several mediating variables. PLS is a second-generation multivariate analysis technique, which permits the simultaneous analysis of multiple criterion and predictor variables [4] and overcomes many problems associated with correlational analyses.

This article complements our earlier article [52]; both use data from the same experiment, thereby employing the same communication systems and experimental conditions. However, whereas the earlier work examined impacts on agreement and acceptance (which are elements of consensus), the current work examines impacts on decision quality. This different focus results in significant theoretical differences.

A research model is developed next, linking media richness to decision quality. Subsequent to model development, characteristics of the experiment and associated results are described. This is followed by insight into the results, focusing mainly on the few findings that are counter to the original model. Implications concerning when richer media are desirable or not desirable and how our results relate to past and future research on CMCS are then presented.

Research Model

NEGOTIATION TASKS ARE MIXED-MOTIVE TASKS that promote idiosyncratic and equivocal interpretations about the target phenomena and have no demonstrably correct solutions [64]. Such tasks require group discussions for their effective accomplishment [15, 79]. Media richness theory suggests that to facilitate negotiation task effectiveness, media employed for group discussions should enable: (1) multiple cues, which involves the use of multiple information channels, such as voice inflection and body gestures included with the verbal message; (2) immediacy of feedback, which allows for rapid bidirectional communication and, hence, rapid reinterpretation and clarification of messages; (3) personalization, which allows the infusion of personal

feelings and emotions as well as the tailoring of messages to the needs and current situation of the receiver; and (4) language variety, which refers to the range of meanings that can be conveyed by the available pool of symbols in a language [15, 17, 18].

This paper focuses on richer versus leaner media that differ in terms of multiplicity of cues and immediacy of feedback. Richer media that enable face-to-face communication can provide multiple cues, taking nonverbal and verbal forms. In contrast, leaner media, such as electronic mail, enable verbal and pictorial cues but restrict the nonverbal cues that can be transmitted.[1] Verbal cues are those that can be represented linguistically, whereas pictorial cues are those that are provided by images. Nonverbal cues include general appearance and dress, body movements, facial expressions, eye contact and gaze, smell, paralanguage (vocal cues beyond the spoken words), space and distance, and touch. Three of these types of nonverbal cues can be communicated to a limited extent when leaner electronic media (such as e-mail) are employed. One's appearance and dress may be communicated using pictures. A facial expression (e.g., a smile, a wink) may be communicated to a limited degree via an emoticon or a smiley. Paralanguage, which includes vocal characterizers (laughing, crying, yelling, whining, yawning), vocal qualifiers (volume, pitch, rhythm, tone, rate), and vocal segregates (uh-huh, shh, oooh, mmmh) may be communicated to limited degrees using emoticons or verbal equivalents (ha-ha, shh, etc.).

In addition to providing multiple cues, richer media can also enable immediate feedback, such as (1) concurrent feedback, which takes place simultaneously with the communication of a message (as when a receiver nods or indicates surprise vocally) and (2) sequential feedback, which occurs when the receiver interrupts the sender or uses a pause in the sender's communication to indicate understanding of a message or to direct the sender.

Multiplicity of cues and immediacy of feedback are likely to influence quality via their impact on (1) social perceptions, (2) message clarity, and (3) the ability to develop evaluations of others' expertise and deception [21, 30, 40, 95]. These influences are included in our model, and discussed below. Dennis and Kinney [21] also suggest that multiplicity of cues can affect quality via their influence on communication production costs. They propose that leaner media requiring typing can result in senders altering the creation of messages in ways that reduce message clarity. However, since media leaner than face-to-face are not limited to that requiring typing (e.g., one can create textual messages using voice-recognition software), we suggest that, though production cost may be correlated with multiplicity of cues, it is not a function of multiplicity of cues. We therefore do not include production costs as an integral part of our research model. We do, however, account for production costs as a control variable due to the nature of the media employed in the laboratory experiment.

Impact on Decision Quality Due to Social Perceptions

According to McGrath's time, interaction, and performance (TIP) model [65], a group performs member-support and group well-being functions, which involve development and maintenance of relationships between individual participants and the group

as well as development and maintenance of the group as a system. Social perceptions are important results of these functions, playing significant roles in communication among members and resulting decision quality. Social perceptions are perceptions of being in a situation where others are also present [21]. According to social presence theory, multiplicity of cues and immediacy of feedback promote such perceptions [31, 71, 77]. When others are perceived to be present in a group discussion, participants are more personal in their communication and engage in socio-emotional communication (defined as communication oriented toward maintaining social and emotional relations) more frequently [43, 89]. Thus, social presence theory predicts that richer media enabling multiple cues and immediate feedback will lead to more frequent socio-emotional communication [43]. This prediction is in accord with social information processing theory's prediction for initial encounters in lean media [91, 92] and leads to the following:

> *H1: Richer media that enable multiple cues and immediate feedback will result in greater total socio-emotional communication.*

Socio-emotional communication tends to be evaluative (e.g., indicating agreement or disagreement) and may be positive (showing friendliness and support) or negative (showing hostility and rejection) [43]. The level of negative socio-emotional communication relative to positive socio-emotional communication can be thought of as defining the socio-emotional climate of a social interaction. When this ratio increases, the socio-emotional climate is becoming less positive and more negative; when the ratio decreases, the socio-emotional climate is becoming less negative and more positive.

As hypothesized above, the overall level of socio-emotional communication is likely to be lower in leaner media that do not enable multiple cues and immediate feedback. However, the level of negative socio-emotional communication is likely to be higher in leaner than in richer media [53, 78], thereby creating a more negative climate. This is posited to be due to lower perceptions of being in a social situation, which leads to a reduction in the influence of social norms and constraints, thereby making individuals more likely to engage in anti-normative behaviors, such as negative socio-emotional communication [53, 78]. This implies the following:

> *H2: Leaner media that do not enable multiple cues and immediate feedback will result in a more negative socio-emotional climate.*

Cooperation is behavior that helps a group advance its thinking, and includes seeking help from others by asking questions, helping others by clarifying the problem or solution, and assessing peer input in the form of criticism and support [39, 80, 93]. Thus, both positive and negative evaluative comments, in the form of socio-emotional communication, can be important aspects of cooperation, stimulating the group to advance its thinking. Positive evaluation can signal that an idea is adequate and let the group advance to other issues, potentially providing ideas on which to piggyback. Negative evaluation can signal that an idea is inadequate (perhaps also indicating why it is inadequate), encouraging the development of new ideas [13]. Participants

working within cooperative conditions tend to share more task-relevant information [96], leading to greater task-oriented communication, defined as nonevaluative communication that helps the group solve its problem [3]. This implies the following:

H3: Greater total (positive and negative) socio-emotional communication leads to increased task-oriented communication.

Socio-emotional climate may affect inhibitions, which are likely to reduce task-oriented communication. West [97] suggests that supportive and friendly conditions created by a more positive socio-emotional climate are likely to reduce such inhibition, whereas nonsupportive and hostile conditions created by a more negative socio-emotional climate are likely to increase inhibition. However, an alternative mechanism [13] indicates opposite effects. According to this mechanism, members of a group with a more positive socio-emotional climate will have a greater attraction toward their group, and therefore communication inhibition increases due to a desire not to look foolish [13]. Consequently, a more positive socio-emotional climate is likely to be associated with higher levels of such inhibition whereas a more negative socio-emotional climate is likely to be associated with lower levels of inhibition. Based on this discussion, it is not possible to determine the direction of the overall effect of socio-emotional climate on task-oriented communication. Therefore we hypothesize:

H4: Socio-emotional climate affects task-oriented communication.

Higher levels of task-oriented communication are likely to improve decision quality [66]. This is likely due to the introduction of a greater number of diverse perspectives on the task, a more thorough consideration of various aspects of the decision, and the correction of a participant's errors by others [26, 32, 49, 62, 100], and leads to the following hypothesis:

H5: Greater task-oriented communication leads to higher decision quality.

Impact on Decision Quality Due to Message Clarity

In addition to member support and group well-being functions, groups perform a production function, which consists of their goal-achieving activities [65]. An important part of a group's production function involves participants understanding others' messages [22]. Media that enable multiple cues and immediate feedback influence decision quality by enabling a receiver to have a clearer understanding of messages [56]. Nonverbal channels communicate information beyond spoken words, often emphasizing or complementing the spoken message, such as when emphasizing the importance of a point, indicating one's feelings, and showing authority [69]. In the absence of such channels, attempts by senders to encode such information verbally or pictorially are likely to lead to unclear messages [91]. In addition, both concurrent and sequential feedback make communication clearer by enabling a sender to recognize whether or not the receiver understands a message and present it differently if necessary [21]. This leads to the following:

H6: Richer media that enable multiple cues and immediate feedback will result in clearer communication.

Clearer messages are likely to enhance understanding of the discussion topic, thereby improving decision quality [21, 95]. On the other hand, clear messages about an unstructured problem may wrongly convey a clear understanding where in fact clear understanding is lacking [16, 17]. By excluding potentially reasonable interpretations, clear understanding may thereby lead to lower decision quality. Therefore, we cannot predict the direction of communication clarity's effect on decision quality, which leads to the following:

H7: Communication clarity affects decision quality.

Impact on Decision Quality Due to Evaluations of Others

As part of a group's production function [65], group members evaluate the input of others before incorporating it into their understanding of the problem. Both multiple cues and immediate feedback enabled by richer media can affect the ability of participants to develop evaluations of others [14, 95], such as evaluations of others' deception and knowledge [5, 9, 30]. According to Interpersonal Deception Theory, evaluation of deception by others is an interactive process engaged in by both senders and receivers in a communication process [8, 9]. With richer media, senders continuously monitor feedback from their receivers and use this feedback to strategically provide cues to influence receivers' evaluations of the sender; at the same time, receivers continuously monitor and evaluate senders' cues to determine levels of deception [9]. Leaner media that restrict cues and immediate feedback significantly reduce these monitoring activities for both senders and receivers. This leads to the following hypothesis:

H8: Richer media that enable multiple cues and immediate feedback are likely to increase participants' perceptions that they can identify deception by others.

Burgoon et al. [8, 9] suggest that analogous interactive mechanisms involving the production of strategic cues apply when participants evaluate others in terms of expertise. This leads to the following:

H9: Richer media that enable multiple cues and immediate feedback are likely to increase participants' perceptions that they can identify others' expertise.

Participants use the evaluative information provided to them to make judgments about how to weigh others' input and incorporate it in their problem-solving process, potentially affecting decision quality [40]. Participants who are better able to detect deception are likely to discount input from participants engaging in deception thereby improving decision quality. In addition, groups make better decisions when participants can recognize expertise [67]. For example, when participants are better able to determine others' expertise they are likely to defer to more knowledgeable participants, thereby improving decision quality [74]. However, the literature examining

individuals' accuracy in their perceptions of others' deception and expertise is mixed. Some findings suggest that humans are poorly calibrated for recognizing deception and expertise [29, 40, 61] whereas other findings suggest that humans are reasonably accurate in such evaluations [30, 41, 42, 74]. Therefore, it is not possible to predict the effect on decision quality of individuals' perceived abilities to evaluate others. Consequently, we hypothesize:

H10: Participants' perceptions of deception by others will be associated with decision quality.

H11: Participants' perceptions of others' expertise will be associated with decision quality.

Method

THIS SECTION DESCRIBES AN EXPERIMENT that tests the above hypotheses. All or part of the material presented in the Subjects, Manipulation of Media Richness, Experimental Tasks, Task Process, and Data Collection sections are reproduced from Kahai and Cooper [52] for the reader's convenience.

Subjects

As part of a course assignment, 94 undergraduate students (71 percent males and 29 percent females; 84 percent junior level and 16 percent senior level) enrolled in an Introduction to Management Information Systems course at a large university participated in a laboratory experiment. At the beginning of the semester, these participants were randomly assigned to 31 groups of mixed gender; 30 groups consisted of three members and one group consisted of four members.[2] The groups worked on course assignments with deliverables before and after the study. Thus the groups had histories and expectations of future interaction.

Manipulation of Media Richness

Four communication systems are used in this study to manipulate media richness in terms of multiple cues and feedback immediacy. Two communication systems that enable face-to-face communication are used to represent the richer media condition and two that enable only electronic communication are used to represent the leaner media condition. Two communications systems are used for each condition in order to reduce confounding due to the specific nature of the communication systems themselves. The four communications systems are:

1. *Face-to-Face System 1: Unsupported Face-to-Face Meeting.* During each unsupported face-to-face meeting, participants sat down at the conference table in a conference room to perform their task. The conference room was equipped with a blackboard, which was in full view of the participants during their

discussions. Each participant recorded important points raised during discussions on paper.

2. *Face-to-Face System 2: Supported Face-to-Face Meeting.* During each supported face-to-face meeting, participants employed a shared group editor called ShrEdit. Participants sat face-to-face and performed their tasks by speaking to one another as in unsupported face-to-face meetings. However, each participant also employed a common ShrEdit document to record important points raised during discussions. This document was available on computer monitors placed in specially designed tables in front of participants. The monitors were placed at angles that permitted all participants the same views of each other that participants in the unsupported meetings had.
3. *CMCS 1: Electronic Conferencing.* With the electronic conferencing system, Confer II, participants could not see or hear each other. Messages were exchanged by posting responses to a conference topic set up for each group. Confer II appended sender names to all responses. Responses were stored in an electronic file accessible by all participants. Participants viewed responses through computer monitors.
4. *CMCS 2: Electronic Mail.* With the electronic mail system, participants could not see or hear each other. A mailing list was set up for each group. To send a message, participants entered the mailing list name for their group. Mailed messages, with sender names appended, were received immediately and resulted in a statement of message receipt on the monitors of the participants. No communication records were maintained; participants deleted electronic records of incoming messages after reading them. Participants viewed messages through computer monitors.

Both the face-to-face and ShrEdit participants can see and hear each other. These systems enable the entire range of nonverbal, verbal, and pictorial cues. Confer II and electronic mail only allow written communication. These systems restrict communication to verbal and pictorial cues (cues such as physical distance and verbal inflections cannot be communicated). As a result, multiple cues are expected with face-to-face and ShrEdit, whereas only restricted cues are expected with Confer II or electronic mail.

Face-to-face communication enables feedback immediacy; feedback in face-to-face communication can be concurrent (taking place simultaneously with the communication of a message) and sequential (occurring when the receiver interrupts the sender or uses a pause in the sender's communication to indicate understanding of a message or to direct the sender). CMCSs such as e-mail do not allow concurrent or sequential feedback. As such, the two face-to-face communication systems that enable multiple cues also enable immediate feedback, whereas the two CMCSs employed that restrict multiple cues also limit feedback immediacy. Data presented later suggest successful manipulation of media richness.

To isolate the effects of multiple cues and immediacy of feedback, other group meeting characteristics that (1) are associated with one or more of these communica-

tion systems and (2) are known to impact decision quality are controlled. Based on the organizational and CMCS literatures, anonymity, media speed (production costs), task support, task structure, and process structure are potential problems.

- *Anonymity* is the degree to which the participants in a communication process do not know the source of a message. Anonymity can encourage participation by reducing or eliminating participation inhibition arising from fear of social disapproval, anxiety about social skills, and status differences [50]. Anonymity can reduce social constraints [68], which in turn can encourage negative socio-emotional communication in the form of critical comments and increase participation inhibition. Since we expect participation inhibition to affect decision quality, anonymity was controlled by allowing only non-anonymous communication. Non-anonymous communication was chosen over anonymous communication because three of the communication systems employed (a face-to-face meeting, ShrEdit, and the electronic mail system) enable only non-anonymous communication.
- *Media speed (production costs)* refers to speed of transferring messages, such as speed of typing, reading, speaking, and listening; the typing associated with CMCS results in slower message transfer than verbal communication [68]. Media speed can affect participation inhibition (and, hence, decision quality) if time restrictions are placed on a communication process, since extra time is needed to transfer and receive messages when slower media are employed [90]. There was no time restriction imposed, thereby mitigating the effect of this characteristic. However, groups were rewarded in part based on the time taken to reach a decision, which provides the perception of time pressure. Therefore media speed should be controlled. Given their total dependence on keyboard input, Confer II and electronic mail provide for slower communication than face-to-face or ShrEdit. An appropriate control path is therefore added to the research model to reflect this issue.
- *Task support* refers to informational and computational support for task-related activities including external databases and spreadsheets [68]. Task support can affect decision quality by increasing the use of relevant information and decision analysis [68]. This was controlled in the experiment by providing no such support to subjects.
- *Task structure* refers to techniques, rules, or models employed for analysis of task-related information such as stakeholder analysis [68]. Task structure can affect decision quality by increasing decision analysis [68]. This was controlled in the experiment by providing no such support to subjects.
- *Process structure* refers to techniques or rules that direct the pattern, timing, or content of task communication such as an agenda [68]. Depending on the level and nature of intervention, process structuring can affect decision quality. For example, an agenda can affect decision quality by affecting the issues focused on during decision-making. Providing no process structuring support to subjects during their discussions controlled process structure.

Experimental Tasks

During the study, each group performed two tasks, one pertaining to substance abuse and the other pertaining to student housing (see Appendix A for problem statements). Each group solved one problem in a face-to-face setting (face-to-face or ShrEdit) on one date and the other with a CMCS (Confer II or electronic mail) on another date. To the extent possible, the ordering of the communication systems and problems was balanced across groups.

This research design included a simulation of several organizational conditions. As described earlier, the groups had histories and expectations of future interaction, which are typical for organizational groups [24]. Like problems encountered by members of an organization, the problems assigned were relevant to the subjects. In order to encourage a stake in the task and encourage serious participation, the following rewards were offered. For groups in each problem–communication system pair (there were seven or eight groups in each pair):

- the group with the best plan earns $8 per person;
- the group with the second best plan earns $6 per person;
- the group with the third best plan earns $4 per person.

Students were told that the goodness of any plan depended on both its quality, as determined by experts, and how quickly it was done. Consistent with organizational conditions, the quality-time trade-off was left ambiguous. Data analysis reported later indicates that participants generally cared about both the quality of their output as well as the time that they spent.

The tasks are negotiation tasks because of their mixed-motive nature (described next) and because the problems assigned had no demonstrably correct solutions (supported by participant perceptions reported later). To create mixed motives, competitive individual rewards greater in value than the group rewards described above were offered. The following rewards were offered to individuals whose ideas, irrespective of their quality, were most represented in their group's plan. Of all individuals in a problem–communication system pair:

- the most represented individual earns $20;
- the second most represented individual earns $15;
- the third most represented individual earns $10.

These rewards based on an individual's representation in a group's plan are competitive [51] because an increase in representation of one individual's ideas reduces the potential representation of others. Results presented later support the success of competitive individual rewards in creating conflict and deception that characterize negotiation tasks due to their mixed motive nature.

Task Process

In all conditions, members of any group executed their tasks synchronously, that is, at the same time. Members' tasks were divided into an idea generation phase—where

alternative solutions were generated—followed by a discussion phase—where group members discussed alternative solutions to determine the list of five best actions that could be taken to solve the problem. All groups began their discussion phase soon after idea generation. Our research model pertains to discussions that occur among group members attempting to overcome differences in views. Consequently, the discussion phase is the focus of data gathering and analysis.

The following procedures were followed for each task performed by subjects. At the beginning of their task, participants were provided hands-on training if they were using ShrEdit, Confer II, or electronic mail. All training procedures were tested and found to be satisfactory during the pilot studies. Written task instructions were then handed to the participants. These included the problem statement, the required output, the reward scheme, and the procedure they had to follow to do their task. After they read the instructions, important portions of the instructions were reiterated verbally, and they began their tasks. After each group finished its task, a questionnaire was administered (see Appendix B). Participants were instructed not to discuss their task experiences with their classmates until after they all had completed the experiment.

Data Collection

Data were collected using group meeting transcripts and a post-test questionnaire. Group meeting transcripts were coded to obtain measures of positive and negative socio-emotional communication and task-oriented communication. Group meeting transcripts for ShrEdit and face-to-face meetings were obtained from videotapes. Electronic mail transcripts were created by adding the first author's account to the mailing lists employed by subject groups. Confer II transcripts were obtained from the archive created by the system.

Because of the time and expense involved in the coding group meetings, only 25 percent of each meeting was coded. The strategy to employ a subset of a group's communication exchanges has been validated [6] as well as employed in past CMCS research (e.g., [90, 101]). Billings et al. [6] reported validity coefficients of 0.8 or better for four-category interaction process analysis (IPA) coding in a 20 percent subset of the total interaction. Moreover, a comparison of four-category IPA coding to 12-category IPA coding suggested that fewer categories require smaller subsets to achieve a given level of validity. The coding for the current study employed three broad categories (positive socio-emotional, negative socio-emotional, and task-oriented interaction) from the IPA scheme [3], whereas 25 percent of each group's total interaction was coded. Prior research therefore supports the validity of coding subsets in this study.

Past research suggests the emphasis of socio-emotional versus task-oriented communication is likely to vary with time and number of messages. It has been found that there is a greater task orientation during the initial exchanges and that this task orientation reduces relative to the socio-emotional orientation as meetings progress (see [32] for a review). In order to control this bias, an equal number of first-, second-, third-, and fourth-quarter portions were coded. The portion coded for any group was

kept the same across its two problem-solving tasks. With minor exceptions, the groups included for coding a particular quarter were balanced in terms of the communication systems employed.

The indicators of *total socio-emotional communication*, *socio-emotional climate*, and *task-oriented communication* were obtained by parsing and coding group meeting transcripts. Comments in the transcripts were parsed and coded by an assistant who was blind to the study's hypotheses. The assistant's parsing and coding showed a 95 percent and 98 percent agreement, respectively, with the first author' parsing and coding. A parsed comment is defined as a separate idea [13]. After parsing, task-oriented and positive and negative socio-emotional communication were coded based on the IPA scheme [3]. Task-oriented communication consisted of giving suggestions, asking for suggestions, giving opinion, and asking for opinions, giving orientation, or asking for orientation (e.g., "Rent control will prevent the landlords from taking advantage of students"). Positive socio-emotional communication demonstrated solidarity, tension release, or agreement (e.g., "I agree with your idea"). Negative socio-emotional communication demonstrated antagonism, tension, or disagreement. Total socio-emotional communication was obtained by adding the counts of positive and negative socio-emotional communication. Socio-emotional climate is the ratio of negative socio-emotional communication to positive socio-emotional communication.

Decision quality was measured using expert judgments of four members of the substance abuse task force committee at the university and four members of the university housing task force committee. In order to reduce these experts' workloads, the solutions from all teams were put on a master list associated with the problem, with duplications eliminated. There were thus two master lists of solutions, one consisting of substance abuse solutions and one consisting of housing solutions. Each expert rated each solution on his or her problem's master list, using a five-point scale (1 = a poor suggestion, 5 = an excellent suggestion). Inter-rater reliability for the substance abuse and housing problems were 0.80 and 0.68, respectively. Each solution on a problem's master list was given a value equal to its average across the four experts. Each of a team's solutions was given its associated value from the master list. A team's decision quality was then determined by averaging these values of its solutions.

The remaining indicators employed in this study were based on the post-test questionnaire listed in Appendix B. The questionnaire included questions pertaining to constructs employed for hypotheses testing, that is, *perceived ability to identify others' expertise, perceived ability to identify others' deception,* and *communication clarity.* Perceived abilities to detect deception and others' expertise were based on McCornack and Parks [63]. Questions pertaining to perceived abilities and communication clarity were worded so that they directly address the target of interest. Two items were employed for each construct to ensure that the other captures nuances not captured by one. The post-test questionnaire also included questions employed to establish the existence of appropriate experimental conditions, such as the lack of demonstrably correct solutions. Questionnaire data were averaged across group members before

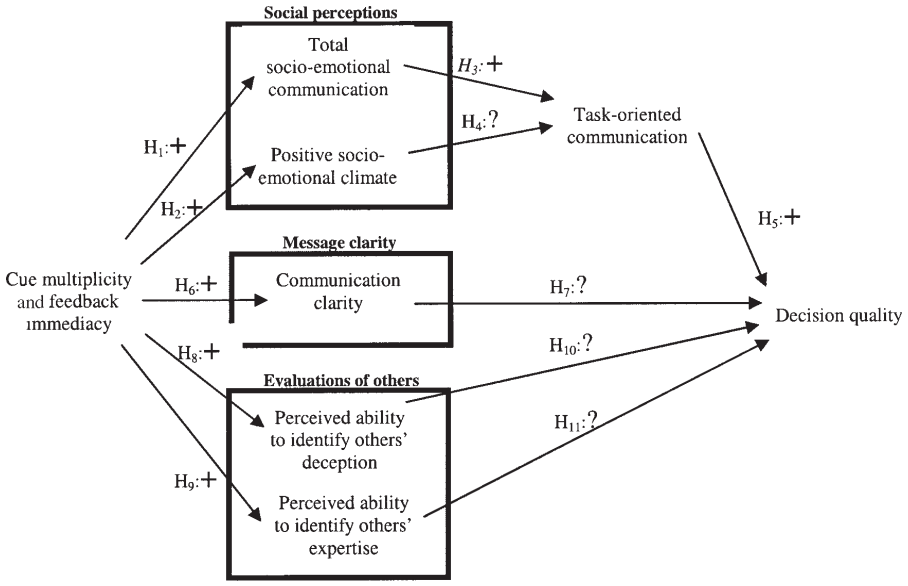

Figure 1. Hypothesized Model for Negotiation Tasks. *Notes:* + refers to a positive effect; – refers to a negative effect; ? refers to an effect of unknown direction.

being employed in the data analysis. This aggregation was justified by r_{wg} analyses [47] described later.

Partial Least Squares Analysis

In addition to the constructs in Figure 1, the model subjected to PLS analysis includes two control paths from cue multiplicity and feedback immediacy. The first goes to task-oriented communication in order to account for difference in media speed (production costs) discussed earlier, and the second goes to decision quality to account for media effects not accounted for by our mediating variables. The model was tested for each problem using PLS, a multivariate analysis technique for testing structural models [99]. Barclay et al. [4] present the features and benefits of using PLS. One important benefit is the ability of PLS to be employed with less data than other structural modeling packages. As Falk and Miller [28] indicate, PLS can be used in situations where there are at least five data points for each path leading to the construct that has the most incoming paths.[3] The minimum amount of data for our analyses is 25, since there are four hypothesized and one control paths leading to decision quality. Employing group level analysis, we have 31 data points for each problem, which is above the required minimum.

A PLS model contains both a structural component, representing the relationship among constructs, and a measurement component, representing the relationship between constructs and their indicators [33]. In PLS, indicators may be modeled as

reflective or formative [33]. Reflective indicators are determined by the construct they represent and, hence, covary with the level of that construct [12]. Formative indicators determine the construct they represent and permit the possibility that they do not covary with the construct they determine [12]. The indicators of all constructs are expected to covary with the level of the constructs they represent. Hence, indicators of these constructs are modeled reflectively.

PLS analysis reported in this study was performed using PLSGraph (version 2.91.03.04). The significance of model paths were determined by employing jackknifed standard error estimates which were obtained using the blindfolding procedure. An omission distance of 11 was used in the blindfolding procedure (see [75] for a description of the blindfolding procedure).

Substance Abuse Problem

THIS SECTION IS DIVIDED IN TWO, BEGINNING WITH results and ending with a discussion associated with the substance abuse problem. Results address the existence of assumed experimental conditions, the reliability and validity of measures, and the testing of the study's hypotheses. The discussion focuses on theoretical examinations of hypotheses that were either initially nondirectional or that ended up not to be supported by the data.

Results

The Existence of Experimental Conditions

The data suggest successful manipulation of media richness when the subjects discussed the substance abuse problem. An examination of videotapes of face-to-face communication systems and of CMCS transcripts confirms the expectation of a greater number of cues in the face-to-face communication systems. For example, we observe smiling, eye contact, voice inflections, and gesturing in face-to-face conditions but not in the CMCS conditions. Furthermore, communicators make negligible use (less than 1 percent of the total number of words in the transcripts) of verbal equivalents and emoticons to convey paralanguage cues in the CMCS conditions. No attachments were employed in the CMCS conditions.

Immediacy of feedback can be gauged from the exchange of messages among participants. More rapid exchanges would be associated with more messages per unit time, which is computed by dividing the number of message blocks or utterances by the length of each group's communication. A message block or utterance is defined as a block of text entered by a participant each time a participant sends out electronic communication to other participants [88]. Analysis of the transcripts (described earlier) indicates that after statistically controlling for variation in group size, there are fewer messages per unit time in the leaner "electronic" media condition compared to the richer "face-to-face" media condition (0.76 versus 4.18, $F_{1,28} = 49.34$, $p = 0.00$). It should be noted that this method of comparing messages per unit of time underesti-

mates the immediacy of feedback in the higher media richness condition because it ignores the feedback received and reacted to nonverbally.

The lack of demonstrably correct solutions for this problem is checked using a questionnaire item (Appendix B, item 1). The substance abuse problem lacks clear problem solutions: with one representing clear solution procedures, the substance abuse mean is 4.50 (s.d. = 0.82, $n = 31$), which is significantly different from one ($p < 0.01$).

The reward scheme was implemented to ensure that participants approached their tasks seriously and cared about the quality of their output as well as the time that they spent. Responses to two questionnaire items (Appendix B, item 2) indicates that participants care to a moderate extent about the quality of their output and the time taken to prepare it. With one representing a lack of concern for quality or time, the caring about quality mean is 4.94 (s.d. = 0.75, $n = 31$) and the caring about time mean is 4.69 (s.d. = 0.69, $n = 31$), both of which are significantly different from one ($p < 0.01$).

Results support the success of competitive individual rewards in creating some conflict, which can characterize negotiation tasks due to their mixed motive nature. With one representing a lack of conflict, the mean response concerning the presence of conflict (Appendix B, item 3) is 2.87 (s.d. = 1.15, $n = 31$), which is significantly different from one ($p < 0.01$).

Reliability and Validity

Table 1 provides descriptive statistics for the indicators employed to test the study's hypotheses for the substance abuse problem. PLS enables the assessment of the reliability and validity of the indicators by providing principal components factor loadings of indicators. Factor loadings presented in Table 2 indicates adequate reliability of indicators for all multi-indicator constructs, that is, abilities to perceive others' expertise, deception, and values. First, the factor loadings for all these constructs' indicators, except for one indicator of ability to perceive others' expertise, exceeds 0.7, suggesting that less than half of any indicator's variance is due to error [34]. The problematic factor loading (0.69) exceeds a less stringent criterion of 0.6 [2]. Second, for all multi-indicator constructs, the composite scale reliability, an internal consistency estimate similar to Cronbach's α, exceeds the recommended cutoff of 0.7 [34]. Third, average variance extracted by all the multi-indicator constructs from their indicators exceeds the recommended cutoff of 0.5 [34].

The indicators of multi-indicator constructs demonstrate convergent and discriminant validity according to two criteria similar to a multi-trait/multi-method analysis [11]. Specifically, from Table 3, we can see that the multi-indicator constructs share more variance with their indicators than with the other constructs. Moreover, as indicated in Table 2, the magnitude of the factor loading of any indicator on its corresponding construct exceeds the magnitude of its cross-factor loadings, that is, loadings on other constructs.

PLS analysis employed questionnaire measures of perceived ability to identify others' expertise, perceived ability to identify others' deception, and communication clarity, which were obtained at the individual level but were averaged across group

Table 1. Means and Standard Deviations of Indicators

		Face-to-face (n = 31)				CMCS (n = 31)			
		Substance abuse (n = 15)		Housing (n = 16)		Substance abuse (n = 16)		Housing (n = 15)	
Construct	Indicators	Session 1 (n = 8)	Session 2 (n = 7)	Session 1 (n = 8)	Session 2 (n = 8)	Session 1 (n = 8)	Session 2 (n = 8)	Session 1 (n = 7)	Session 2 (n = 8)
Cue multiplicity and feedback immediacy	x1	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Total socio-emotional communication	y1	22.25 (17.42)	26.86 (18.32)	44.50 (28.53)	21.00 (25.07)	12.63 (3.89)	14.63 (7.76)	16.71 (4.54)	9.88 (7.36)
Socio-emotional climate	y2	0.27 (0.46)	0.43 (0.61)	0.17 (0.25)	0.15 (0.34)	1.22 (2.76)	0.38 (0.47)	0.34 (0.26)	0.40 (0.56)
Task-oriented communication	y3	102.25 (62.06)	74.14 (25.91)	83.50 (28.11)	44.12 (19.42)	27.25 (13.55)	25.63 (10.00)	44.14 (29.53)	41.50 (22.66)
Perceived ability to identify others' expertise	y4	4.92 (0.50)	4.85 (0.53)	5.13 (0.73)	4.63 (0.65)	4.73 (0.90)	4.65 (1.19)	4.29 (0.91)	4.19 (0.60)
	y5	4.50 (0.85)	4.56 (0.54)	4.63 (0.70)	4.25 (0.58)	4.42 (0.75)	3.42 (0.90)	4.45 (0.60)	3.98 (0.48)
Perceived ability to identify others' deception	y6	4.92 (1.18)	4.49 (0.43)	4.58 (1.22)	4.83 (0.56)	3.40 (0.33)	2.77 (1.34)	3.85 (0.76)	3.38 (1.12)
	y7	5.25 (0.81)	4.81 (0.47)	4.79 (1.54)	4.73 (0.72)	4.27 (0.79)	4.02 (1.49)	4.27 (1.17)	4.31 (1.27)
Message clarity	y8	5.40 (0.88)	5.11 (1.05)	5.04 (0.72)	5.10 (0.62)	5.08 (0.64)	5.23 (0.87)	5.43 (0.50)	5.21 (0.35)
	y9	5.52 (0.50)	5.58 (0.51)	5.04 (0.81)	5.35 (0.40)	5.56 (0.46)	5.38 (0.98)	5.46 (0.33)	5.38 (0.55)
Decision quality	y10	3.04 (0.74)	2.99 (0.23)	2.42 (0.36)	2.54 (0.26)	3.34 (0.55)	3.29 (0.32)	2.71 (0.34)	2.42 (0.51)

Notes: x1 is a dummy indicator; y1, y2, and y3 are based on coding of behavior; y4 through y9 refer to similarly labeled questionnaire items in Appendix B; y10 is based on ratings of experts. Means are provided without parentheses and standard deviations are provided within parentheses.

Table 2. Construct Indicators, Factor Loadings, Average Variance Extracted, and Composite Scale Reliability

		Substance abuse (n = 31)				Housing (n = 31)			
Construct	Indicators	Factor loading	Range of cross-factor loadings	Average variance extracted	Composite scale reliability	Factor loading	Range of cross-factor loadings	Average variance extracted	Composite scale reliability
Cue multiplicity and feedback immediacy	x1	1	0.07–0.68	1	1	1	0.10–0.47	1	1
Total socio-emotional communication	y1	1	0.04–0.17	1	1	1	0.03–0.29	1	1
Socio-emotional climate	y2	1	0.17–0.67	1	1	1	0.02–0.50	1	1
Task-oriented communication	y3	1	0.14–0.68				0.01–0.47		
Perceived ability to identify others' expertise	y4	0.69	0.12–0.43	0.69	0.81	0.90	0.01–0.52	0.77	0.87
	y5	0.95	0.04–0.67			0.85	0.10–0.46		
Perceived ability to identify others' deception	y6	0.96	0.04–0.66	0.87	0.93	0.98	0.12–0.52	0.82	0.90
	y7	0.91	0.01–0.65			0.83	0.09–0.50		
Message clarity	y8	0.88	0.01–0.27	0.81	0.89	0.90	0.05–0.41	0.74	0.85
	y9	0.92	0.01–0.30			0.83	0.02–0.24		
Decision quality	y10	1	0.07–0.30	1	1	1	0.02–0.25	1	1

Notes: The "factor loading" column provides loading of an indicator on the construct it represents whereas the "range of cross-factor loadings" column provides the range of loadings of an indicator on other constructs in the model. The use of factor loadings, range of cross-factor loadings, average variance extracted, and composite scale reliability for reliability and validity assessment is relevant for multi-indicator constructs.

Table 3. Average Variance Extracted by Constructs (Diagonal Elements) and Shared Variance Between Constructs (Off-Diagonal Elements)

	Substance abuse (n = 31)								Housing (n = 31)							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1. Cue multiplicity and feedback immediacy	1.00								1.00							
2. Total socio-emotional communication	0.16	1.00							0.19	1.00						
3. Socio-emotional climate	0.03	0.00	1.00						0.08	0.00	1.00					
4. Task-oriented communication	0.46	0.45	0.03	1.00					0.13	0.10	0.08	1.00				
5. Perceived ability to identify others' expertise	0.11	0.04	0.02	0.07	0.69				0.13	0.25	0.00	0.22	0.77			
6. Perceived ability to identify others' deception	0.37	0.04	0.02	0.22	0.47	0.87			0.22	0.05	0.04	0.04	0.21	0.82		
7. Message clarity	0.01	0.10	0.01	0.02	0.04	0.06	0.81		0.06	0.00	0.00	0.00	0.01	0.15	0.74	
8. Decision quality	0.09	0.03	0.01	0.02	0.00	0.01	0.04	1.00	0.01	0.01	0.01	0.00	0.06	0.00	0.02	1.00

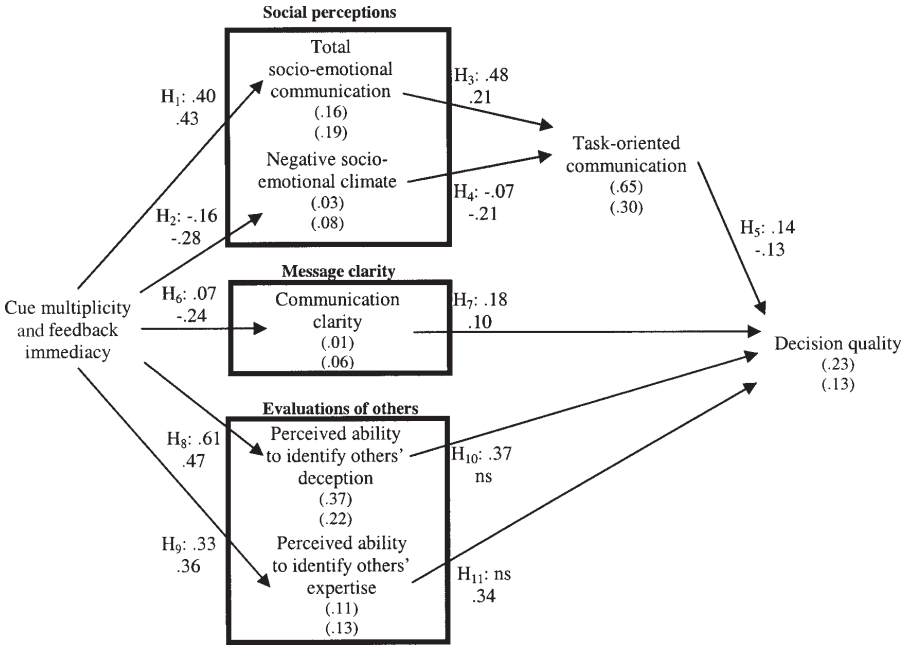

Figure 2. Results of PLS Analysis for the Substance Abuse and Housing Problem. *Notes:* Upper numbers refer to the substance abuse problem; lower numbers refer to the housing problem. Results pertain to $n = 31$. All paths except those denoted "ns" are significant at $p < 0.01$. Parenthetical numbers represent construct R^2.

members to obtain group level measures. This aggregation is justified by r_{wg} analyses [47]. The r_{wg} index, which measures within-group agreement, is used to determine whether there is enough agreement among group members to justify aggregating individual-level measurement to the group level [47]. It is customary to seek r_{wg} indices greater than 0.7 [55]; higher values suggest that the aggregation of individual-level responses to the group level is appropriate because raters achieve a group-level consensus regarding the target construct. For the abuse problem, 97 percent, 81 percent, and 97 percent of the groups have r_{wg} greater than 0.7 for perceived ability to identify others' expertise, perceived ability to identify others' deception, and communication clarity; the respective mean r_{wg}s are 0.91, 0.84, and 0.96. These results indicate adequate agreement among group members, justifying the aggregation of individual-level measures across group members.

Hypotheses

Figure 2 shows results of the PLS analysis for this problem. PLS generates estimates of standardized regression coefficients (beta coefficients) for the paths in a model's structural component. Figure 2 also shows R^2 for endogenous constructs, that is, the

proportion of variance of an endogenous construct explained by constructs having paths leading to it.

- H1 is *supported:* Richer media results in greater socio-emotional communication (beta = 0.40, $p < 0.01$).
- H2 is *supported:* Leaner media results in a more negative socio-emotional climate (beta = –0.16, $p < 0.01$).
- H3 is *supported:* Greater socio-emotional communication increases task-oriented communication (beta = 0.48, $p < 0.01$).
- H4 is *supported:* Greater negative socio-emotional climate decreases task-oriented communication (beta = –0.07, $p < 0.01$).
- H5 is *supported:* Task-oriented communication increases decision quality (beta = 0.14, $p < 0.01$).
- H6 is *supported:* Richer media results in greater message clarity (beta = 0.07, $p < 0.01$).
- H7 is *supported:* Clearer communication increases decision quality (beta = 0.18, $p < 0.01$).
- H8 is *supported:* Richer media increases participants' perceptions that they can identify others' deception (beta = 0.61, $p < 0.01$).
- H9 is *supported:* Richer media increases participants' perceptions that they can identify others' expertise (beta = 0.33, $p < 0.01$).
- H10 is *supported:* Participant's perceptions of others' deception increases decision quality (beta = 0.37, $p < 0.01$).
- H11 is *NOT supported:* Participant's perceptions of others' expertise do not affect decision quality.

Discussion

Ten hypotheses are supported by the laboratory study. However, two of these hypotheses are based on competing theories. In addition, one hypothesis is not supported. The following discussion reconciles these results with the associated theories.

Based on competing theories, H4 was nondirectional. The data indicate that less supportive and less friendly conditions in this problem tended to decrease the amount of task-oriented communication. This is in accord with the notion by West [97] that less supportive and less friendly conditions created by a negative socio-emotional climate are likely to increase communication inhibition, thereby decreasing task-oriented communication.

Due to competing theories, H7 was nondirectional. The data indicate that message clarity increases decision quality. Although this is in accord with some research, other research suggests that clear messages about unstructured problems may wrongly convey a clear understanding where, in fact, clear understanding is lacking. By excluding potentially reasonable interpretations, clear understanding may lead to lower decision quality. As indicated earlier, participants felt that the problem was moderately unstructured. (Average response to the structuredness scale was 4.5, with seven

indicating highly unstructured.) Perhaps the semi-structuredness of this problem caused more positive than negative effects of message clarity.

H10 and H11 were bidirectional, depending on the accuracy of individuals' perceptions of others' deception and expertise. It appears that individuals' actual (as opposed to perceived) abilities to detect deception in this problem were superior to their abilities to detect expertise. This is based on a significantly positive relationship between their perceived ability to detect deception and decision quality (H10) and a nonsignificant relationship between their perceived ability to detect expertise and decision quality (H11). However, an alternative reason for these results may hinge on individuals' opportunities to employ these abilities. For example, all participants had significant expertise in substance abuse issues (M = 5.22, s.d. = 0.64). There may therefore have been enough expertise among all participants that perceiving similar expertise in others did not result in significant amount of deferring to them, and in that way did not impact decision quality.

Housing Problem

THIS SECTION IS DIVIDED IN TWO, BEGINNING WITH results and ending with a discussion of the results. Results address the existence of assumed experimental conditions, the reliability and validity of measures, and the testing of the study's hypotheses. The discussion focuses on theoretical examinations of hypotheses that were either initially nondirectional or that ended up not supported by the data.

Results

The Existence of Experimental Conditions

As with the substance abuse problem, the data suggest successful manipulation of media richness when the subjects discussed the housing problem. An examination of videotapes of face-to-face communication systems and of CMCS transcripts confirms the expectation of a greater number of cues in the face-to-face communication systems. For example, we observe smiling, eye contact, voice inflections, and gesturing in face-to-face conditions but not in the CMCS conditions. Furthermore, communicators make negligible use (less than 1 percent of the total number of words in the transcripts) of verbal equivalents and emoticons to convey paralanguage cues in the CMCS conditions. No attachments were employed in the CMCS conditions. Greater immediacy of feedback is supported by a greater number of messages per unit of time in the richer "face-to-face" condition compared to the leaner "electronic" media condition, after statistically controlling for variation in group size (3.97 versus 0.72, $F_{1,28} = 65.36$, $p = 0.00$).

The lack of demonstrably correct solutions for this problem is checked using a questionnaire item (Appendix B, item 1). The housing problem lacks clear problem solutions: with one representing clear solution procedures, the mean is 4.66 (s.d. = 0.76, $n = 31$), which is significantly different from one ($p < 0.01$).

The reward scheme was implemented to ensure that participants approached their tasks seriously by caring about the quality of their output as well as the time that they spent. Responses to two questionnaire items (Appendix B, item 2) indicate that participants care, to a moderate extent, about the quality of their output and the time taken to prepare it. With one representing a lack of concern for quality or time, caring about quality mean is 4.74 (s.d. = 0.70, $n = 31$) and caring about time mean is 4.63 (s.d. = 0.68, $n = 31$), both of which are significantly different from one ($p < 0.01$).

Results support the success of competitive individual rewards in creating some conflict, which can characterize negotiation tasks due to their mixed motive nature. With one representing a lack of conflict, the mean response concerning the presence of conflict (Appendix B, item 3) is 2.79 (s.d. = 0.93, $n = 31$), which is significantly different from one ($p < 0.01$).

Reliability and Validity

Table 1 provides descriptive statistics for indicators employed to test the study's housing problem hypotheses. Factor loadings provided by PLS analysis and presented in Table 2 indicated adequate reliability for all multi-indicator constructs. First, the factor loadings for the indicators of all these constructs exceed 0.7, suggesting that less than half of any indicator's variance is due to error [34]. Second, for all multi-indicator constructs, the composite scale reliability, an internal consistency estimate similar to Cronbach's α, exceeds the recommended cutoff of 0.7 [34]. Third, average variance extracted by all the multi-indicator constructs from their indicators exceeds the recommended cutoff of 0.5 [34].

The indicators of multi-indicator constructs demonstrate convergent and discriminant validity according to two criteria similar to a multi-trait/multi-method analysis [11]. Specifically, from Table 3, we see that the multi-indicator constructs share more variance with their indicators than with the other constructs. Moreover, as indicated in Table 2, the factor loading of each indicator on its corresponding construct exceeds loadings on other constructs.

For the housing problem, 100 percent, 75 percent, and 100 percent of the groups have r_{wg} greater than 0.7 for perceived ability to identify others' expertise, perceived ability to identify others' deception, and communication clarity; the respective mean r_{wg}s are 0.94, 0.93, and 0.95. These results indicate adequate agreement among group members, justifying the aggregation of individual-level measures across group members.

Hypotheses

Figure 2 shows results of the PLS analysis for this problem. PLS generates estimates of standardized regression coefficients (beta coefficients) for the paths in a model's structural component. Figure 2 also shows R^2 for endogenous constructs, that is, the proportion of variance of an endogenous construct explained by constructs having paths leading to it.

- H1 is *supported:* Richer media results in greater socio-emotional communication (beta = 0.43, $p < 0.01$).
- H2 is *supported:* Leaner media results in a more negative socio-emotional climate (beta = –0.28, $p < 0.01$).
- H3 is *supported:* Greater socio-emotional communication increases task-oriented communication (beta = 0.21, $p < 0.01$).
- H4 is *supported:* Greater negative socio-emotional climate increases task-oriented communication (beta = –0.21, $p < 0.01$).
- H5 is *NOT supported:* Task-oriented communication decreases decision quality (beta = –0.13, $p < 0.01$).
- H6 is *NOT supported:* Richer media results in less message clarity (beta = –0.24, $p < 0.01$).
- H7 is *supported:* Clearer communication increases decision quality (beta = 0.10, $p < 0.01$).
- H8 is *supported:* Richer media increases participants' perceptions that they can identify others' deception (beta = 0.47, $p < 0.01$).
- H9 is *supported:* Richer media increases participants' perceptions that they can identify others' expertise (beta = 0.36, $p < 0.01$).
- H10 is *NOT supported:* Participant's perceptions of others' deception do not affect decision quality.
- H11 is *supported:* Participant's perceptions of others' expertise increases decision quality (beta = 0.34, $p < 0.01$).

Discussion

Eight hypotheses are supported by the laboratory study. However, three of these hypotheses are based on competing theories. In addition, three hypotheses are not supported. The following discussion reconciles these results with the associated theory.

The results for H4 are similar to that associated with the substance abuse problem. Therefore, discussions surrounding this hypothesis are not repeated here.

Contrary to H5, we find greater task-oriented communication to be associated with lower decision quality. This differs from expectations based on the literature, which suggest, for example, that greater task-oriented communication will lead to more thorough consideration thereby increasing decision quality. Recent literature indicates that unique knowledge (e.g., based on different participant perspectives) is less likely to surface during group conversations [38, 98]. In addition, when unique knowledge is surfaced, it is less likely to have much impact on group decisions [59, 83]. Higher levels of task-oriented communication may therefore focus on repeating knowledge previously shared among participants, reducing the potential for a thorough consideration of a problem and improved decision quality. Stasser [82] suggests that such increased communication may serve as social validation, where individuals seek confirmation that shared knowledge is correct.

Although these findings may reduce (perhaps to zero) the potentially positive impact of task communication on decision quality, they do not explain the negative

relationship that we found. However, the following argument may help explain the negative relationship. In contrast to this problem, a positive relationship is found in the substance abuse problem. This indicates that continued discussion among participants is fruitful in the substance abuse problem in the sense that it leads to higher quality decisions. One reason that continued discussions may be fruitful is that participants have a significant degree of substance abuse expertise (M = 5.22, s.d. = 0.64). This allows increased communication to result in higher quality decisions. In contrast, the participants in the housing problem have less expertise (M = 4.49, s.d. = 0.79), reducing the potential for increased communication to generate higher quality decisions. Therefore, in the housing problem, greater task-oriented communication could indicate more confusion, which may provide opportunities for individuals to pursue the individual rewards, thereby decreasing decision quality. (Recall that individual rewards compensate participants for the number of their ideas adopted by the group, independent of idea quality.)

Contrary to H6, cue multiplicity and feedback immediacy have a negative impact on message clarity. Face-to-face communication provides multiple communication channels (verbal, pictorial, physical, and paralinguistic cues) that can result in higher levels of information transfer among individuals. Face-to-face communication also provides immediate feedback, thereby enabling real-time adjustments by senders based on receivers' understandings. These should serve to increase message clarity. Although this was found in the substance abuse problem, the opposite effects are found here. This may be due to the lack of preparation typical with face-to-face communication as opposed to asynchronous (e.g., e-mail) communication. Kock [56] notes that individuals typically talk "off the top" in face-to-face meetings, whereas asynchronous communication provides the opportunity for individuals to reflect on what they want to say and thereby provide much clearer communication. With greater expertise in the substance abuse problem, this opportunity to reflect does not appear to be important. However, in the housing problem, where participants had lower levels of expertise, the opportunity to reflect seems to help clarify communication.

The results for H7 are similar to that associated with the substance abuse problem. Therefore, discussions surrounding this hypothesis are not repeated here, except to briefly indicate that the housing data results support the earlier H7 discussion: average response to the "lack of demonstrably correct solutions" scale is 4.7, with seven indicating an extreme lack of clear solution procedures.

H10 and H11 were bidirectional, depending on the accuracy of individuals' perceptions of others' deception and expertise. It appears that individuals' actual (as opposed to perceived) abilities to detect expertise in this problem are superior to their abilities to detect deception. This is based on a significantly positive relationship between their perceived ability to detect expertise and decision quality (H11) and a nonsignificant relationship between their perceived ability to detect deception and decision quality (H10). However, as with the substance abuse problem, an alternative reason may be due to individuals' opportunities to employ these abilities. For example, there is a lack of deception by participants. When asked how often they tried to misinform (i.e., deceive) group members, the average across all participants for

this problem is 1.19 (s.d. = 0.32) on a scale from 1 (indicating never) to 7 (indicating very often). This is significantly less than that associated with the substance abuse problem (M = 1.35, s.d. = 0.51), and indicates the occurrence of very little deception. Therefore, the ability to identify deception may have played no role here because there was essentially no deception. As compared to the substance abuse problem, the relationship between perceived ability to detect expertise and decision quality may play an important role here because participants have significantly less expertise and greater variance (housing: M = 3.5, s.d. = 0.79; abuse: M = 5.22, s.d. = 0.64). This may provide greater opportunity for participants to defer to more knowledgeable individuals, thereby increasing decision quality.

Conclusions

CMCS CAN ALTER COMMUNICATION PROCESSES and outcomes in organizations. This, coupled with their increasing use, makes it important to develop an understanding of such CMCS effects in order to enable increased benefits from their use. This study examines the impact of CMCS on decision quality in terms of media richness theory. The focus is on cue multiplicity and feedback immediacy, which are primary factors differentiating richer (e.g., face-to-face) and leaner (e.g., CMCS) media. This study is significant in that, following suggestions by Fulk and Boyd [36] and Hedlund et al. [40], it examines the roles of three important constructs (social perceptions, message clarity, and abilities to evaluate others) that mediate the impact of cue multiplicity and feedback immediacy on decision quality; this takes a step at opening the "black box" that surrounds the path from CMCS to decision quality. Results of opening the "black box" across two different problems yield considerable support for media richness theory and insights of the theory for organizational performance.

Insights for Managers

Media richness theory proposes that managers will be more effective and efficient when richer media are used for more equivocal tasks. As implied by the vast array of mixed empirical findings in the media richness literature, our findings suggest that the simple answer to this question is that there is no simple answer. One cannot make such global statements, but rather should at least take into account the confluence of task and participants. For example, our results suggest that participant expertise in terms of the problem being solved may significantly affect the ability of richer media to increase decision quality.

With the substance abuse problem, richer media affects elements of social perceptions, message clarity, and perceived abilities to evaluate others. These mediating constructs, in turn, directly and indirectly affect decision quality. The direction of effects support the simple notion that richer media employed in equivocal tasks can increase decision quality. However, results from the housing problem provide a taste of the conflict evident in the literature. In contrast to the substance abuse problem,

here we find that (1) richer media affect social perceptions but that these perceptions, working through task communication, decrease decision quality and (2) richer media decrease communication clarity, and thereby decision quality. Post hoc explanations considering data from both problems suggest that the knowledge participants have concerning a problem may play an important role in the decrease in quality due to social perceptions and communication clarity. That is (1) social conditions that promote task communication may produce more communication than is necessary when participants have a poorer understanding of the problem and (2) the ability to reflect before communicating (as offered by leaner media) may be more important when participant expertise is lower.

Exploring a bit more into the elements of social perceptions, it seems that when participants have a greater understanding of the problem area (as with the substance abuse problem), both positive and negative socio-emotional communication play almost equally large roles in facilitating further discussion. And, this further discussion results in greater decision quality. It may be that when participants have more knowledge in the problem area, they have a more solid foundation on which to question ideas of others. In addition, when their ideas are questioned, they may have greater confidence to stay with the discussion and not withdraw, and therefore less need for a supportive atmosphere in order to continue participating. In contrast, when participants have less understanding of the problem area (as with the housing problem), they may have less confidence in their input, and as a result, a supportive atmosphere promoted by a positive socio-emotional climate can facilitate greater task communication. Interestingly, this increase in task communication among individuals having less problem understanding can decrease decision quality.

Another issue brought out by a comparison of the two problems is the impact on decision quality of the perceived abilities to identify others' deception and expertise. It would appear that these perceptions are reasonably accurate, but that the resulting impacts on decision quality depend on the levels of deception and expertise among participants. In accord with intuition, it seems that the (perceived) ability to detect deception influences decision quality to the degree that deception exists. In addition, it appears that the (perceived) ability to detect expertise influences decision quality to the degree that there is less expertise among participants, and therefore more motivation to defer to experts.

In general, then, managers contemplating the employment of leaner versus richer media for groups involved in equivocal tasks should take into consideration the degree of participants' task knowledge as well as factors (such as compensation schemes) that may lead participants to deceive one another. Leaner media may lead to better quality decisions when participants have less knowledge, whereas richer media can increase decision quality in the face of significant participant deception.

Insights for Researchers

The overall level of validity for the study's results is indicated by the consistent support of seven out of eleven research hypotheses across the two problems (H1, H2, H3,

H4, H7, H8, and H9). In addition, support is found for H5, H6, and H10 with the substance abuse problem and H11 with the housing problem. Results from these problems demonstrate support for media richness theory and encourage further exploration of constructs mediating the impact of richness on decision quality.

We find that cue multiplicity and feedback immediacy significantly affect total socio-emotional communication, socio-emotional climate, communication clarity, perceived ability to identify others' deception, and perceived ability to identify others' expertise. These effects are consistent across problems for all but communication clarity, which seems to depend on the level of participant task-relevant knowledge. Further, the impacts of these mediating constructs on decision quality appear to depend largely on the level of participants' task-relevant knowledge. For example, the need for a more positive socio-emotional climate and the efficacy of the ability to identify others' expertise seems to increase with lower levels of knowledge.

Our study offers a coherent model relating media, decision quality, socio-emotional communication, task communication, message clarity, and perceptions surrounding expertise and deception. This helps tie together previous studies (mentioned during our model development) that focus on these individual issues and provides an important context for researchers interested in group process. For example, the path from media to decision quality through socio-emotional communication and task-oriented communication provides a framework that can be used to tie together work in social perceptions (e.g., social presence theory [43]), in cooperation (e.g., cooperation theory [25]), and in decision quality (e.g., [23]). Tying these research streams together in this fashion provides greater insight into the potential effects of media on decision quality. In addition, examining the intersections of our study with other group process literature can identify potentially important areas for future research. For example, if influence within groups is of research interest (e.g., [46, 101]), it would appear that participants are in a better position to evaluate the expertise and deception underlying influence attempts when richer media are employed. There are thus opportunities for media richness and influence researchers to work together to build better understandings of media and group processes.

Future research can be further guided by findings of the current study. For example, the R^2 associated with decision quality for both problems suggests that media richness theory can account for up to 23 percent of decision quality variance. However, when the control path from media richness to quality is omitted, the highest R^2 is 0.10. This suggests that there are more mediating variables within (or in addition to) social perceptions, message clarity, and evaluation of others that should be explored. For example, Jarvenpaa et al. [48] suggest that perceptions of others' abilities and niceness can play important roles.

Future research can also be guided by the following limitations to our study. (1) *Generalizability*—this study examines the effects of media richness within the context of several important organizational conditions: group histories and expectations of future interaction, relevant problems with no correct solutions, incentives for performance, and mixed motives. These conditions mitigate external validity concerns associated with laboratory studies [24], while extending media richness research

to a combination of conditions not found in previous studies.[4] Nevertheless, the study's generalizability is still limited due to the use of relatively few, small-sized student groups. (2) *CMCS*—the results may be peculiar to the attributes of the communication systems employed. For instance, a CMCS that supports multiple dialogues is likely to stimulate more task-oriented ideas than one that does not support multiple dialogues [4]. The CMCS employed in this study did not support multiple dialogues, which may have resulted in less task-oriented communication. (3) *Task equivocality*—the tasks are perceived by participants to be somewhat equivocal—approximately halfway on an equivocality scale. Whereas this "semi-equivocality" aided in evaluating group results [54], it is not clear that the results would hold with tasks that are highly equivocal. For example, whereas message clarity increases decision quality for the two problems, it may be that such clarity would decrease quality for highly equivocal tasks because it may wrongly convey a clear understanding where in fact clear understanding is lacking [16, 17, 81]. (4) *Time frame*—the study takes place over a few hours, whereas other studies have indicated some potential for perceptions and abilities to change over longer time periods (e.g., [48, 101]). Therefore, it would be interesting to test our results with teams working together over a longer period of time. (5) *Reliability and validity*—unfortunately, the most interesting findings—those associated with different levels of task-relevant knowledge and deception—are the result of post hoc analyses rather than an integral part of the experimental design. In addition, several participant perceptions are captured via two-item scales. This decreases confidence in the study's reliability and validity. In future work it would be interesting to specifically manipulate task-relevant knowledge and deception as well as employ expanded perceptual scales.

In general, rather than reducing support for media richness theory, inconsistencies found between the two problems provide insight into how the employment of communication systems and associated impacts through mediating constructs to decision quality can be contingent on participant expertise and levels of deception. However, due to the limitations cited above, the study's findings should be treated as tentative and employed to direct the design of future experiments.

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NOTES

1. As demonstrated by, for instance, Carlson and Zmud [10], in certain circumstances, individuals employing leaner media can compensate to a limited degree for the media's restricted ability to communicate multiple cues, thereby increasing perceived media richness. For example, when communication partners have had a prior history of working together, textual messages received by individuals can be supplemented with a priori knowledge concerning their communication partners. In addition, individuals can attempt to communicate emotional information through the use of emoticons (e.g., smiley faces). Nevertheless, the amount of cues communicated in leaner media is less than the cues communicated in richer communication media.

2. We performed a "group size" × "media condition" cross-tabulation (2 × 2 table) to determine if the distribution of group size was significantly different across the "richer" versus "leaner" media conditions. The cross-tabulation was performed separately for the two tasks that each group performed in this study because the study's hypothesized model was eventually tested separately for each task. The significance of Fisher's exact test in each case was 0.484 (Fisher's exact test is appropriate here because the frequency of one of the cells was below the expected value), suggesting that the distribution of group size was not significantly related to the media conditions.

3. This assumes, as is true here, that there are no constructs with formative indicators.

4. For example, Adrianson and Hjelmquist [1], Daly [19], Hiltz et al. [43], and Straus and McGrath [84] employed time-limited tasks. Also, although these studies employed problems with no correct solutions, and Straus and McGrath [84] offered rewards for quality, these studies did not introduce mixed motives in the tasks.

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Appendix A. Problem Statements Provided to Participants

Substance Abuse Problem

THE STUDENTS' ASSOCIATION IS CONCERNED about the prevalence of substance (drugs and alcohol) abuse among students on the university campus, and it would like you as a group to come up with a written plan to reduce this problem. Your plan should include what you as a group think are *five* best actions that can be taken to solve the problem. Rank-order the actions you suggest in terms of their attractiveness, with the most attractive ranked as one. *While judging the attractiveness of any action, take into consideration the various pros and cons of that action.* You should try to look at the problem from multiple perspectives.

Housing Problem

The university administration is concerned about the problem of student housing. The administration would like you to come up with a written plan to reduce the housing problem for its students. Your plan should include what you as a group think are *five* best actions that can be taken to solve the problem. Rank-order the actions you suggest in terms of their attractiveness, with the most attractive ranked as one. *While judging the attractiveness of any action, take into consideration the various pros and cons of that action.* You should try to look at the problem from multiple perspectives.

Appendix B. Questionnaire

ITEMS IN QUESTIONNAIRE ADMINISTERED TO PARTICIPANTS. Headings are provided here for the purpose of organizing the items. Questions in section 3 and after were preceded by a statement instructing the respondents to focus on the discussion phase of their task while answering those questions. Where provided, the designations at the beginning of any questionnaire item (y4, y5, etc.) are in reference to Tables 1 and 2.

1. Lack of demonstrably correct solution

   To what extent was there a clearly known way to solve the problem you just faced? (1 = to no extent at all, 4 = to a moderate extent, 7 = to a large extent)

2. Caring about quality and time

   To what extent did you care about the quality of the plan produced? (1 = to no extent at all, 4 = to a moderate extent, 7 = to a large extent)

   To what extent did you care about the time taken to produce the plan? (1 = to no extent at all, 4 = to a moderate extent, 7 = to a large extent)

3. Conflict

   Describe the amount of conflict that existed among you all during your discussion. (1 = to no extent at all, 4 = to a moderate extent, 7 = to a large extent)

4. Perceived ability to determine expertise of other participants

   y4. How well could you judge how knowledgeable your group members were about the issues raised during the discussion? (1 = not well at all, 4 = moderately well, 7 = very well)

   y5. How confidently could you judge how well somebody knew the topic of interest? (1 = with no confidence at all, 4 = with moderate amount of confidence, 7 = very confidently)

5. Perceived ability to detect deception

   y6. How well could you judge whether any of your groupmates was lying or saying the truth? (1 = not well at all, 4 = moderately well, 7 = very well)

   y7. How confidently could you judge whether somebody was being truthful or not? (1 = with no confidence at all, 4 = with moderate amount of confidence, 7 = very confidently)

6. Message clarity (reverse coded)

   y8. To what extent were the messages of your group members vague? (1 = to no extent at all, 4 = to a moderate extent, 7 = to a large extent)

   y9. How often were the messages of your group members unclear? (1 = never, 4 = moderately often, 7 = very often)

7. Expertise (reverse coded)

   How often were your statements not based on a fairly sound knowledge? (1 = never, 4 = moderately often, 7 = very often)

8. Frequency of deception

   How often did you deliberately try to misinform your group members? (1 = never, 4 = moderately often, 7 = very often)