

# Impact of communication medium on task performance and satisfaction: an examination of media-richness theory

Kil Soo Suh\*

*College of Business and Economics, Yonsei University, Seoul 120-749, South Korea*

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## Abstract

Among several theories to explain how communications media affect task performance, media-richness theory is often cited. It proposes that task performance will be improved when task-information processing requirements are matched to a medium's ability to convey information richness.

The objective of the work reported here was to examine media-richness theory using a laboratory experiment. The investigation focused on the effect of four different communication media (text, audio, video, and face-to-face) on task performance and satisfaction of both, intellectual and negotiation tasks. For the negotiation task, a social psychological factor, consonancy, was used to examine the effect of interaction on media and performance.

Overall, the study did not support media-richness theory. There were no task-medium interaction effects on either decision quality or decision time. Decision quality was the same for both the tasks. Audio was the most efficient medium, but not necessarily the most satisfying. This study did not support the combined theory of media richness and social psychology for the negotiation task. There was no significant media-by-consonancy interaction in the negotiation payoff. © 1999 Elsevier Science B.V. All rights reserved.

*Keywords:* Communication media; Media-richness theory; Social psychology; Computer conferencing; Video conferencing

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## 1. Introduction

A number of new electronic communication media, such as computer and video-conferencing systems, have been employed to facilitate organizational communication. As a result, managers who are not working in the same place or within the same time period can get together more quickly and less expensively. Also, more people can participate in important decisions and share additional resources because electro-

nic meetings are easier to arrange than face-to-face ones [18]. However, the technical feasibility of these new media does not guarantee that any of these are seen ultimately as actual benefits. Thus, the effects of these new media on task performance are an important research issue for the emerging 'network' forms of the organization.

Among several theories [21, 31, 34, 35] that try to explain how different communications media affect task performance, the media-richness theory (MRT) [4, 5] is one of the most frequently cited one. It suggests that task performance will be improved when task information processing requirements are matched

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\*Tel.: +82-2-361-2522; fax: +82-2-313-5331; e-mail: kssuh@base.yonsei.ac.kr

with a medium's ability to convey information richness. A lean medium (e.g. a memo) is sufficient to exchange an unequivocal message (e.g. a routine communication), while a rich medium (e.g. a face-to-face meeting) is recommended to resolve an equivocal situation (e.g. negotiation).

Even though this theory seems to be very likely, it was not well supported (or was at best partially supported) by previous empirical studies [38]. The criticisms fall into two categories: one directed at the theory itself and another at the prior research that attempted to test the theory. MRT has been faulted for its failure to consider situational elements (e.g. time and place) that might affect behavior and social factors (e.g. social norm and attitude) that might shape perceptions of the media [22]. Meanwhile, Kinney and Dennis [20] argued that most tests of the theory [6, 10, 28] had examined perceptions of media fit by surveying the media choice of message senders, not by examining the actual performance effects of media use. Because perceptions of effectiveness may differ from actual effectiveness, they encouraged researchers to seek more empirical data on performance to support or refute previous findings.

One type of task that is especially sensitive to the characteristics of media involves negotiation. Several communication media research studies [24, 25, 33] found that the negotiation process and result were significantly affected by the interactive dynamics between communication media and social psychological factors. For example, Morley and Stephenson [26] found that the party with the stronger case was more successful in telephone situations than in face-to-face situations. This finding suggests that it might be useful to consider social psychological factors as an additional dimension in studying MRT, especially for the negotiation task.

Another type of task is an intellectual one. It is a problem-solving task in which an evidently correct answer needs to be invented, selected, or computed, and then agreed upon.

The main objective of this paper was to examine the MRT in a laboratory experimental design that accommodates some of the foregoing criticism and findings. The investigation focused on the effects of four different communication media (text, audio, video, and face-to-face) on objective task performance and task satisfaction for both, an intellectual and a negotiation task.

## 2. Prior research

### 2.1. Media-richness theory

Communication media differ in the richness of the information processed. This is based on feedback capability, the communication channels utilized, language variety, and personal focus. The more a medium incorporates these characteristics, the richer it is. Face-to-face is considered the richest medium, because it allows rapid mutual feedback, permits the simultaneous communication of multiple cues (e.g. body language, facial expression, tone of voice), uses high-variety natural language, and conveys emotion. The telephone, addressed written documents (e.g. notes, memos, letters), and unaddressed documents (e.g., bulletins, standard reports) follow face-to-face communication in media richness, in a descending order (see Fig. 1).

According to MRT, rich media enable people to interpret and reach agreement about unanalyzable, difficult, and complex issues, while lean media are appropriate for communicating about routine activities. McGrath and Hollingshead [23] suggested task-media fit hypotheses as a modification to the MRT. They presented media characteristics and task types and the effect of their fit on performance in a  $4 \times 4$  matrix form (Fig. 2). The matrix classifies patterns of differential fit between the information richness requirements of the tasks assigned and the information richness capability of the communication media.

The best fits between media and task are argued to lie near the main diagonal of the matrix. Task/media combinations northeast of the diagonal tend to be inefficient, because the media might be too rich for the task and cause the distraction of communications that are not essential for the effective communication. On the other hand, task/media combinations southwest of the diagonal tend to be ineffective because the media might be too lean for the task and incapable of transmitting enough information.

Empirical studies testing the MRT treat it as either a prescriptive or a descriptive model. Prescriptive views focus on the effects of matching between task and media richness on individual or organizational effectiveness, while descriptive views test hypotheses about how managers actually perceive and select media [36].

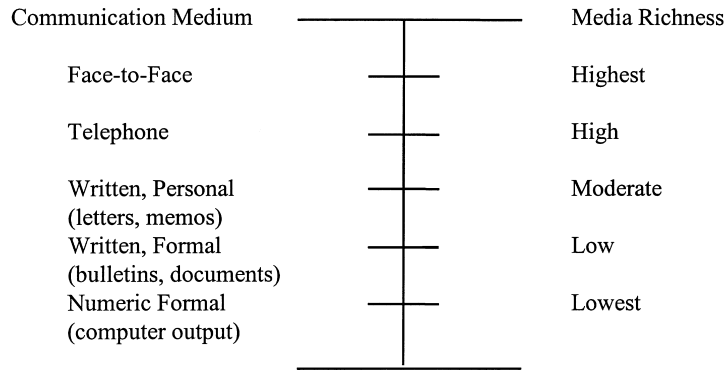


Fig. 1. Communication media and media richness.

Increasing potential richness required for task success	Communication Media			
	Increasing potential richness of information			
Task type (s)	Computer Text Systems	Audio Systems	Video Systems	Face-to-Face Communications
Generating ideas & plans	Good fit	Marginal fit Info too rich	Poor fit Info too rich	Poor fit Info too rich
Choosing correct answer: intellectual tasks	Marginal fit Medium too constrained	Good fit	Good fit	Poor fit Info too rich
Choosing preferred answer: judgment tasks	Poor fit Medium too constrained	Good fit	Good fit	Marginal fit Info too rich
Negotiating conflicts of interest	Poor fit Medium too constrained	Poor fit Medium too constrained	Marginal fit Info too lean	Good fit

Source: McGrath and Hollingshead

Fig. 2. The task and media fit on information richness.

This study adopted the prescriptive view and scrutinized the effect of a match between information requirements of the task and a medium’s ability to convey information richness on individual performance.

Kinney and Watson [19] conducted a laboratory experiment examining dyadic communication in face-to-face, audio, and computer-mediated text modes by

using a high-equivocality task that involved a budget-allocation problem and a low-equivocality task using Graduate Record Exam (GRE) problems. Their dependent variables were decision time, consensus change, and communication satisfaction. While the findings supported the hypothesis that decision time varied as a function of the medium, they failed to support similar hypotheses for consensus change and

communication satisfaction. Overall, MRT was not supported.

Kinney and Dennis examined the effects of media richness on decision-making in dyadic communication for a high and a low equivocal task. The high-equivocal task dealt with college admissions, and the low-equivocal task used a set of scholastic aptitude test (SAT) problems. Subjects in this laboratory experiment received two treatments related to media richness – three levels in multiplicity of cues (face-to-face, audio-video, and computer-mediated text) and two of immediacy of feedback (immediate vs. delayed). Even though subjects perceived differences in media richness because of cues and feedback and in social presence due to cues, these varying cues and feedback had no effect on decision quality, consensus change or communication satisfaction. The results did not support the MRT.

Valacich et al. [38] conducted a laboratory experiment comparing face-to-face, video, audio, and computer-mediated text modes in a dyadic communication environment. Two types of tasks, intellectual (low-equivocal) and cognitive conflict (high-equivocal), were used. The intellectual task was a directory and map-searching problem, and the cognitive conflict task was a budget-allocation problem. The results of the study presented partial support for the MRT with regard to perceptual satisfaction. The results followed a predicted pattern of higher richness leading to higher satisfaction for the cognitive conflict task, but no pattern showed for the intellectual task. The pattern of objective performance measures was not consistent across tasks or media, and did not support the MRT.

Hollingshead et al., [17] conducted a longitudinal study comparing computer-mediated and face-to-face work groups to test task–media fit hypotheses suggested by McGrath and Hollingshead [23]. Face-to-face groups outperformed computer-mediated groups for negotiation and intellectual tasks, but no significant differences were indicated between the two groups on generate and decision-making tasks. These results provided only partial support for the task–media fit hypotheses. They found that the relationship between communication medium and task performance appeared to be more dependent on experience with the medium and with group membership than on the type of task on which the group was working.

In summary, prior research related to the prescriptive view has failed to support, or, at best, only partially supported the MRT. Most of the previous studies employed two or three media to examine the effects of the medium of communication. While the study by Valacich et al. involved four media, the low video image quality and periodic delay of the picture transmission in video condition might affect the results as the authors mentioned. To be thorough, this study employs four media: face-to-face; video; audio; and computer-mediated text, including state-of-the-art personal video communication systems. Most MRT tests have examined perceptions as substitute measures of task performance, especially for high-equivocal tasks. This study measures the actual performance and satisfaction for both these tasks.

## 2.2. *Social information processing perspective*

Recent studies have raised the question of the effectiveness of the MRT as a predictor of media choices [29, 30] or of individual effectiveness. Increasingly, the social information processing (SIP) perspective is used to clarify patterns of media acceptance and is employed as an alternative explanation.

While MRT proposes that individuals will effectively employ media whose inherent characteristics are congruent with task demands, the SIP perspective posits that attitudes and behaviors are partially determined by information provided by the social environment as well as by objective characteristics and constraints in the work environment [14]. A key assumption of the SIP perspective is that rationality is subjective, retrospective, and influenced by information provided by others. The key differences between the MRT and SIP perspective is summarized in Table 1.

The SIP perspective is useful to explain managers' communication and media choice behavior in the organizational context from a descriptive perspective. This perspective may justify patterns of findings that are not explicable from a media characteristics perspective. For example, Rice and Shook [29] found that, contrary to MRT, upper-level managers did not necessarily use electronic mail less often than did low-level clerical workers. In fact, usage of different media was highly correlated with organizational level and job categories.

Table 1

A comparison of the assumptions of the media characteristics and social information perspective

	Media characteristics perspective	Social information perspective
Properties of media	objective – inherent, physical attributes recognizable by users	subjective – influenced by attitudes, statements, and behaviors of others
Saliency of media properties	a function of individuals' perceptions of media properties and task attributes	a function of the assessments of coworkers (including supervisors)
Media choice process	rationality based on a matching of media attributes with task requirements	rationality influenced by past statements and behaviors, as well as social norms

Source: Fulk et al. [14].

### 2.3. Social psychology of bargaining

Another concern for MRT and McGrath and Hollingshead's task-media fit hypotheses is that their concepts are at a very high level, classifying tasks too simply. For example, the judgment tasks row in the model suggests that face-to-face communication is too rich for judgment. This is overly simplistic, especially for strategic judgment. It is difficult to imagine that a top manager would make a major strategic judgment without considerable face-to-face communications with all of the concerned parties.

Other cells in the model can be similarly challenged, especially those which involve negotiation tasks. The model suggests that all media, with the exception of face-to-face, are not adequate for a negotiation task. However, some empirical studies have shown that various negotiation tasks were completed successfully even with the computer-mediated communication, the most constrained medium among the four. For example, Arunachalam and Dilla [2] found that computer-mediated structured groups performed almost as well as face-to-face groups on a transfer pricing negotiation task as they gained experience with the system.

Furthermore, there are two very different types of negotiation tasks: integrative (where certain objectives can produce better overall results for both the parties) and zero-sum (where any gains by one party are accumulated at the expense of the other). It is believed that the communication processes for integrative negotiation are different from those for zero-sum negotiation. Most empirical studies testing MRT, however, have focused only on the integrative type of negotiation. Strong empirical evidence indicates that certain social psychological factors influence the

effects of communication media on zero-sum negotiation performance.

Morley and Stephenson [24] focused on collective bargaining between representatives of groups, and their approach derived in part from Douglas' suggestion [9] that negotiations can be characterized according to changes in the balance between the interpersonal and the interparty forces. According to their study, negotiators have to respond to requests to represent their parties on the one hand, and maintain a personal relationship with their opposites on the other.

Morley and Stephenson designed two experiments to test the effects of communication media on a zero-sum type negotiation. Subjects playing the role of either the management or the union representative communicated either by telephone or face-to-face to negotiate a settlement involving a simulated industrial wage dispute. Specimen arguments from each side were provided, giving an initially stronger case either to the management representative or to the union representative.

In both these experiments, the side with the stronger case was more successful in telephone conditions than in face-to-face conditions. The essential conclusion was that telephone conversations deal more with interparty exchange and less with interpersonal exchange. In other words, negotiators in a telephone situation were likely to pay more attention to what was being said and be more task-oriented, and to be less concerned with the presentation of self. This would lead to more likelihood of a settlement in accordance with the objective merits of the case (the interparty considerations) compared to a face-to-face situation.

Short [33] designed an experiment which examined the complementary situation of Morley and Stephenson's. In their experiments, the intrusion of interper-

sonal considerations in the face-to-face exchange was expected to result in a disadvantage for the stronger case. On the other hand, Short's experiment assumed that the intrusion of interpersonal considerations would be advantageous for the stronger case. This is because its strength was based on interpersonal considerations rather than on interparty considerations.

In this experiment, the scores of subjects performing a budget-allocation task over one of the three communication media (face-to-face, closed circuit television, or a loud-speaking audio link) were compared. One person was required to argue a case that reflected her/his personal views (i.e. consonant type), while the other person was required to argue a case that bore no necessary relationship to her/his personal views (i.e. non-consonant type). The medium of communication had a significant effect on the outcome of the negotiation: the consonant type was more successful in face-to-face than in audio communication, while the non-consonant type was more successful in audio than in face-to-face communication. Results in the video situation were similar to those in the face-to-face condition.

### 3. Theoretical foundations and research model

The MRT of Daft and Lengel [4, 5, 6] provides a conceptual foundation for this research. The research model of this study is shown in Fig. 3. The two

independent variables were task characteristics and communication-media characteristics. The media characteristics were operationalized into text, audio, video (including audio), and face-to-face modes. All four modes were synchronous.

Task types were operationalized into an intellectual task and a negotiation task. Among the four tasks mentioned by McGrath and Hollingshead [23], only two task types were selected because of practical limitations, such as experiment time and cost. Since it has been repeatedly reported that tasks requiring groups to generate ideas were most effectively conducted in a computer-mediated text mode [8, 15, 37, 39], the idea-generation task was excluded. Among the remaining three tasks, the intellectual and the negotiation tasks were chosen to maximize the treatment effect. The negotiation task was further divided into consonant and non-consonant types.

Task performance and satisfaction were the dependent variables. Objective task performance is one of the most important dependent variables, and was measured in terms of decision quality and decision time.

Group decision-making can be considered as a social process which takes individual preferences and combines them into a single group preference. Task satisfaction is an important indicator of user acceptance of a system [7]. Since both the tasks involved a group decision-making process, this study employed two satisfaction constructs concerning group decision making: process satisfaction, which

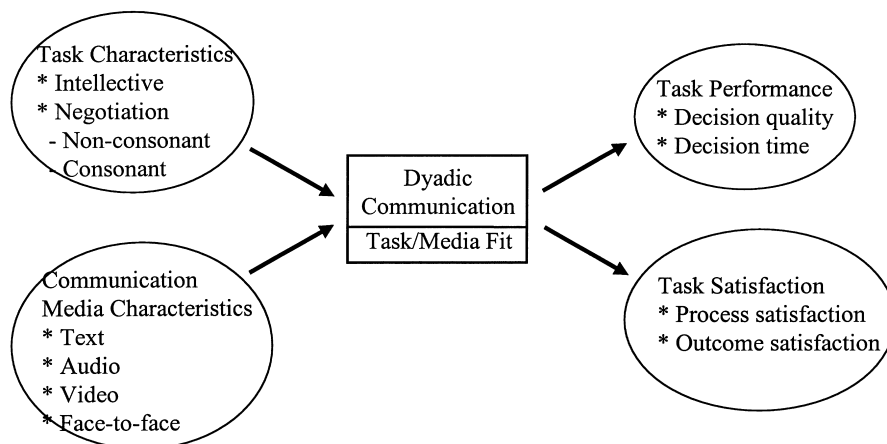


Fig. 3. The research model.

refers to a cognitive state resulting from the group problem-solving process itself, and solution satisfaction, which refers to the degree of fulfillment that an individual seeks.

### 3.1. Hypotheses

#### 3.1.1. Task performance

The general effects on task performance by a misfit between task and media can be summarized into two types:

- If a medium is too rich for the task, then it is vulnerable to inefficiency caused by the distraction of communications that are not essential.
- If a medium is too lean for the task, then it may be ineffective because of its inability to transmit information sufficiently.

The best-fitting combinations for the intellectual task are supposed to be an audio and video mode. The computer-mediated text mode is too constrained for the intellectual task, hence the decision quality could be expected to be impaired. On the other hand, the face-to-face mode is too rich for the task. Even though too much richness may reduce task efficiency, it is not expected to decrease task effectiveness. For example, Rice found that using richer media than required did not impair performance effectiveness. Thus, decision quality may not be different among audio, video, and face-to-face groups. However, the decision quality of the text group is expected to be lower than the other three groups.

**H1a.** For the intellectual task, decision quality of the text group will be lower than the other groups.

Here the negotiation task was a zero-sum game between the consonant subject and the non-consonant subject. The consonant subject was allowed to create her/his own logic, actually believing in what she/he was negotiating for, while the non-consonant subject was not. The sum of their payoff was always 270 points. Thus, even though the MRT argues that the best-fitting combination for the negotiation task is a face-to-face mode, negotiation payoff (decision quality) comparisons among the media are not meaningful unless the consonancy factor is considered. According to Short's study, the subjects whose interests were

consonant with their convictions were relatively more successful in the face-to-face mode than in the leaner mode (i.e. telephone), while the reverse situation held true for the non-consonant subjects. One of the main differences between the consonant and non-consonant groups was the perceived reasonableness of their case. Since the case of the non-consonant groups was so weak, it was probable that they were compelled to lie. With the removal of certain non-verbal cues, deception might be easier in a leaner communication medium than in the face-to-face mode. Thus, it is expected that the payoff of the consonant subjects will be higher as the richness of the medium increases.

**H1b.** For the negotiation task, the consonant subjects will be most successful in terms of payoff in the face-to-face group, followed by video, audio, and text.

The computer-mediated text mode is expected to require the most decision time for both the tasks. Several studies [3, 32] have consistently shown that written communication or communication requiring keyboarding is more time-consuming than voice communication. Face-to-face dyads will take more time in intellectual tasks than audio or video dyads because of their vulnerability to the exchange of non-essential facts which do not increase (nor decrease) decision quality.

**H1c.** For the intellectual task, the text group requires the most decision-making time, followed by the face-to-face group.

On the other hand, the best-fitting combination for the negotiation task should be a face-to-face mode. All other modes are too constrained for the negotiation task, thus the decision time will be longer. The richer the medium is, the more efficient it is, because the negotiation task requires an exchange of rich information.

**H1d.** For the negotiation task, the text group requires the most decision-making time, followed by audio, video, and face-to-face groups.

#### 3.1.2. Task satisfaction

The MRT does not specifically mention task satisfaction according to task/media fits. In a normative

view, efficient and effective processes will result in higher process satisfaction and better outcome, which, in turn, will produce higher outcome satisfaction, if all other factors are equal. Since the best-fitting combinations for the intellectual task, considering both efficiency and effectiveness, are an audio and a video mode, their process and solution satisfaction is expected to be the highest.

**H2a.** For the intellectual task, process satisfaction will be higher in the audio and the video groups than in other groups.

**H2b.** For the intellectual task, outcome satisfaction will be higher in the audio and the video groups than in other groups.

It is expected that there are interaction effects between consonancy and media on process and outcome satisfaction for the negotiation task. The subjects whose personal views are not consonant with the case they are required to argue will be relatively more comfortable in a leaner communication medium where personal feelings are not visible. On the other hand, the consonant subjects may feel more frustrated in a leaner medium because of unreasonable arguments of the other party. Thus, it is hypothesized that:

**H2c.** For the negotiation task, process satisfaction of consonant subjects will be highest in the face-to-face group, followed by video, audio, and text, while process satisfaction of non-consonant subjects will be the reverse.

Outcome satisfaction is expected to depend on actual payoff. Higher payoff should result in higher

outcome satisfaction. Since the consonant subjects are expected to be relatively more successful in a richer medium, and the reverse holds for the non-consonant subjects, it is hypothesized that:

**H2d.** For the negotiation task, outcome satisfaction of consonant subjects will be highest in the face-to-face group, followed by video, audio, and text, while outcome satisfaction of non-consonant subjects will be the reverse.

#### 4. Research method

Since this study required careful controls, it employed a laboratory experiment. A  $2 \times 4$  factorial design incorporating communication media and task types was used to answer research questions. Communication media were divided into four levels: computer-mediated text, audio, video, and face-to-face. Task types had two levels: intellectual and negotiation. Each member assigned to the negotiation dyads took one of the two roles of either consonant or non-consonant subjects. The research design and subject numbers assigned in each cell are shown in Fig. 4.

##### 4.1. Subjects

The subjects were drawn from undergraduate business classes at a large Korean university. By participating, they satisfied a course requirement. They were mainly sophomore and junior students whose average age was 22 years (ranging from 19 to 27); they were randomly assigned to the twelve treatments. Subjects in each group were not statistically different in terms of age, gender, major and computer experience. A \$20

Media Task	Communication Media			
	Text	Audio	Video	Face-to-Face
Intellective	40 (20 dyads)	40 (20 dyads)	40 (20 dyads)	40 (20 dyads)
Negotiation	c. 19; n.c. 19 (19 dyads)	c. 20; n.c. 20 (20 dyads)	c. 19; n.c. 19 (19 dyads)	c. 20; n.c. 20 (20 dyads)

Note: c.= consonant subject; n.c.= non-consonant subject

Fig. 4. Research design.



prize, based on the decision quality, was promised to the top dyads (for the intellectual task) or individuals (for the negotiation task) who participated under the same experimental conditions. Members of each dyad did not know one another. Of the 320 students, participating in this experiment, four subjects were discarded because their data were incomplete. The data of the remaining 316 subjects (37 female and 279 male) were analyzed.

#### 4.2. Procedure

A few days before the laboratory session, subjects completed a background-information questionnaire and were randomly assigned to a dyad in one of the twelve treatment conditions. About 10 subjects assigned to the computer-mediated text mode were dismissed from the experiment because of their lack of typing skills, and other subjects were recruited. Subjects using the electronic mail and video conferencing system underwent a five-minute practice session before the experiment to acquaint themselves with the medium.

At the laboratory session, subjects assigned to the intellectual task were given the inheritance-tax calculation case and asked to solve the problem by exchanging the necessary information in one of the communication modes.

Both the subjects in the negotiation dyad were given a brief background regarding cuts in construction expenses that were required in a new hypothetical business-school building. Eight areas of potential cuts were listed (in classrooms, student lounges, computer labs, etc.). Subjects were told to read the case privately and to rank the importance for each facility before the negotiation began.<sup>1</sup> Next, they received sheets that assigned a numerical payoff for each item. The values assigned to the consonant subject for each facility were ordered in accordance with her/his own ranking. The values assigned to her/his partner (i.e. the non-consonant subject) for each facility were inversely ordered from those of the consonant subject. This type of negotiation is classified as a conflict-involving negotiation in which the goals (agreeing on three facilities to cut the budget) of opposing negotiators

are in complete conflict. The joint task was to agree on which three facilities from the list of eight would receive budget cuts. Each subject was given the objective of maximizing her/his individual payoff from agreement on the facilities.

After a dyad solved the tax problem or reached a consensus on three facilities, they filled out a debriefing questionnaire for media richness and satisfaction. For both these tasks, there was no time limit, but they were encouraged to finish as soon as possible because, other things being equal, the one with the faster time would win.

#### 4.3. Independent variables

##### 4.3.1. Task types

This study focused on two task types: intellectual and negotiation. The intellectual task, an inheritance-tax calculation problem, was based on a real but simplified case, developed with the assistance of a certified public accountant (CPA). Each subject received only about one-half of the necessary information to calculate the right tax amount, and the partner received the remainder. Thus, they had to coordinate and communicate effectively to convey the information that was not available to the other subject. For example, one subject was informed of the method to calculate building value, while the other subject received actual data about the inherited building. This problem required four procedures: calculation of land value; building value; deduction; and final inheritance tax. These were divided into 2–6 detailed steps each and necessitated the review of five tables. Typical business administration graduate students needed 20–25 min to solve the problem by themselves when complete information was provided.

The negotiation task, a two-person bargaining game, was from an example of Short, modified to use topics familiar to subjects. The experimental task involved a hypothetical situation for a particular university. It was hypothesized that this university was constructing a new building for its business school. On account of an unexpected reduction in their construction budget, a cut was required for three of the building's eight facilities. The negotiation goal of this task was to agree on which three facilities would suffer the budget cut.

<sup>1</sup>The rankings of non-consonant subjects were collected for the purpose of manipulation check and covariance analysis.

Dyads involved in the negotiation task were significantly different in terms of their consonancy with the case. One subject (say 'A') was required to rank the eight areas in order of dispensability and argue for the choice which reflected her/his personal views. Numerical payoff was assigned to each facility in accordance with her/his ranking. For example, the facility which she/he had ranked as most valuable was, for her/him, associated with the highest payoff. Thus, she/he was allowed to create her/his own logic, actually believing in what she/he was negotiating for (i.e. consonant type). Meanwhile, the payoff values assigned to her/his partner (say 'B') for each facility were inversely ordered to those of 'A'. In other words, the most valuable facility for 'A' was the least valuable facility for 'B'. Thus, 'B' was required to argue a case that bore no necessary relationship to her/his personal views or her/his own logic (i.e. non-consonant type).

#### 4.3.2. Media

This study employed four communication media. Subjects in the computer-mediated text mode were connected through synchronous electronic mail; subjects in the audio condition were connected via telephone; and subjects in the video treatment communicated through video conferencing systems that transmitted both, audio and video data. The electronic-mail software provided subjects with a split screen for simultaneous communication. The video-conferencing system used in this experiment was Intel ProShare Video System 150. It provided a headphone for audio transmission and a color screen with a transmission speed of 15 frames per second. Partners in these three media environments were in separate rooms. Dyads in the face-to-face condition sat in a room, approximately six feet apart across a small desk.

#### 4.4. Dependent variables

##### 4.4.1. Task performance

The experiment used two constructs of task performance for the task-media fit hypotheses: effectiveness and efficiency. Decision quality was measured for effectiveness and decision time (the number of minutes required for the dyad to agree on the decision) was employed for efficiency.

Decision quality was measured by the correctness of the solution for the intellectual task; it had one correct answer. It was necessary for 15 steps of calculation or table look-up to reach the right answer. Each dyad was required to write down the step-by-step procedures. Correctness was determined by the numbers of correct steps in the answer. For example, if a dyad was correct in the first 10 steps, and wrong in the next three steps, and then right (in terms of equation and process, not the numerical value) in the final two steps, then it received 12 points. A completely correct answer received 15 points. Each member of a dyad received the same points.

For the negotiation task, decision quality was measured by the negotiation payoff. This represents the total points received by each subject during the experimental negotiation game. Different values of points were assigned to each of the eight facilities in accordance with the ranking of consonant subjects. These points ranged from 10 to 80. When the subjects agreed on which three facilities would suffer the required budget cut, the points assigned to each of the three facilities were added accordingly for each negotiator. These added points were the total payoff points gained by each subject. The score attained by each subject during the experiment ranged from 60 points (when a subject agreed on cutting the three most valuable facilities to her/him) to 210 points (when a subject agreed on cutting the three least valuable facilities to her/him). For the negotiation task, members of a dyad competed with each other for individual payoffs. Thus, this was a zero-sum negotiation in which the total of two members' payoff was always 270.

##### 4.4.2. Task satisfaction

Task satisfaction was evaluated by a previously validated post-session questionnaire that measured decision process and outcome satisfaction (see Appendix A for a copy of the instrument). The 10-item instrument (five items for each satisfaction) that measured these two constructs was that developed by Green and Taber [16]. Subjects reported their satisfaction in a seven-point Likert scale format. A score of one indicated negative satisfaction with the process or outcome, while a score of seven indicated positive satisfaction. The reliability (Cronbach's  $\alpha$ ) was 0.81 for process satisfaction and 0.87 for outcome satisfaction.

## 5. Data analysis

Dependent variables were measured at either the individual or the dyadic level. The two perceptual variables, process and outcome satisfaction, were measured at the individual level, and the two performance variables, correctness for the intellectual task and decision time for both the tasks, were measured at the dyadic level. Payoff for the negotiation task was measured at the individual level, but the payoff of a subject was completely contingent upon the payoff of her/his partner (i.e. the sum of both sides' payoffs was always 270). If members' scores in a group are not experimentally independent, as in this case, group scores were used as the unit of analysis [1]. Thus, only the data from one side (the consonant subject) were used for the analysis. Data analysis was performed using SPSS/PC<sup>+</sup> v5.0 package [27].

### 5.1. Manipulation checks

All subjects responded to eight questions, previously used in other studies (e.g. Ref. [40]), to report their perceptions of the media richness (see Appendix B for a copy of the instrument). Subjects reported their perception of the communication environment in a seven-point Likert scale format. Higher numbers indicated higher media richness. The reliability (Cronbach's  $\alpha$ ) of this measure was 0.86.

The ANOVA test showed that subjects clearly distinguished the media in terms of their perceived media richness ( $p < 0.01$ ), regardless of the tasks. As a normative media-richness perspective, face-to-face (4.71) communication was perceived as the richest medium, followed by video (4.36), audio (3.95), and text (3.46). Duncan's multiple range test at the 0.05 level revealed that all four media groups were significantly different from each other in terms of perceived media richness.

To check consonancy manipulation, the degree to which the subjects agreed in their initial rankings was examined. The Kendall coefficient of concordance ( $W = 0.25$ ,  $p < 0.001$  for consonant subjects, and  $W = 0.28$ ,  $p < 0.001$  for non-consonant subjects,  $W = 0.26$ ,  $p < 0.001$  for all subjects) indicated that there was a considerable agreement among the subjects' views in selecting which facilities to choose. Payoff of the consonant and non-consonant subjects

were compared. If the consonancy manipulation was correctly controlled, the reasonableness of the consonant subjects would be greater than that of the non-consonant subjects. Greater reasonableness should produce higher payoff, other things being equal. The consonant subjects (148) were more successful than the non-consonant subjects (122), and this difference was significant ( $p < 0.001$ ).

### 5.2. Objective performance

Since no significant correlation was found between decision time and decision quality, ANOVA was employed to test hypotheses on task performance. Because the decision quality measures of two tasks were completely different from each other, it is not meaningful to compare them directly. Raw data of decision quality were transformed to  $z$ -scores for each task separately to test the medium main effect and the interaction effects between task and media. The means of decision quality and decision time (standard deviations in parentheses and  $z$ -scores of decision quality in brackets) in various groups are shown in Table 2.

#### 5.2.1. Decision quality

Neither medium main effect ( $p = 0.71$ ) nor medium-by-task interaction effect ( $p = 0.89$ ) was found on decision quality. The subjects assigned in the four media groups showed almost the same level of correctness for the inheritance-tax calculation problem. Correctness of the computer-mediated text group was not significantly lower than the other groups; thus, Hypothesis H1a was not supported.

Furthermore, no significant difference among medium groups in terms of payoff was detected for the negotiation task.<sup>2</sup> The consonant subjects (148) were significantly ( $p < 0.001$ ) more successful than the non-consonant subjects (122), regardless of the media. Thus, Hypothesis H1b was not supported.

#### 5.2.2. Decision time

There was a significant medium main effect ( $p < 0.001$ ) on decision time, but the medium-by-task interaction effect ( $p = 0.97$ ) was not found. In other

<sup>2</sup>Covariance analysis to control any initial differences in rankings between consonant and non-consonant subjects for each dyad was performed, but there was no significant covariate.

Table 2  
Means and standard deviations of decision quality and decision time

Dependent variable	Task	Media				Total	Main effect		Interaction M × T
		text	audio	video	face-to-face		medium	task	
Decision quality	intellective	12.75 (2.81) [-0.15]	13.25 (1.71) [0.10]	12.75 (2.05) [-0.15]	13.45 (1.19) [0.20]	13.05 (2.01) [0.00]	$p = 0.71$	na <sup>a</sup>	$p = 0.89$
	negotiation	149 (36) [0.03]	149 (34) [0.01]	145 (30) [-0.09]	150 (33) [0.04]	148 (33) [0.00]			
Decision time	intellective	61.4 (12.4)	32.6 (10.5)	42.1 (13.0)	42.4 (17.3)	44.4 (16.9)	$p < 0.001$	na <sup>a</sup>	$p = 0.97$
	negotiation	57.0 (23.4)	32.0 (15.4)	41.1 (24.2)	39.9 (24.7)	42.3 (23.6)			
	Total	59.2 (18.6)	32.3 (13.0)	41.6 (19.0)	41.1 (21.1)	43.4 (20.5)			

<sup>a</sup> Not applicable.

words, decision times were significantly different among medium groups, and the effect of the medium was the same across the tasks. Post-hoc analysis revealed that the computer-mediated text groups (59.2 min) took the most time, and the audio groups (32.3) took the least time. The video (41.6) and the face-to-face groups (41.1) were not significantly different from each other in terms of decision time.

As was expected, the computer-mediated text group (61.4) took significantly longer than the other groups for the intellective task. The face-to-face group followed the text group. However, the video group (42.1) took more time than expected, and the time was closer to face-to-face (42.4) rather than to the audio group (32.6). Overall, Hypotheses H1c was supported except that the video mode took as much time as the face-to-face mode.

The pattern was statistically the same for the negotiation task. Again, the text group (57.0) took significantly more time than the other groups, and the decision times of the face-to-face (39.9) and video (41.1) groups were close to each other. The audio group was expected to take longer than the video or face-to-face groups because of its limited channel, but the results showed that, in fact, the audio group (32.0) took the least time. Thus, Hypothesis H1d was not supported, except that the computer-mediated text

groups required significantly more time than other groups.

### 5.3. Task satisfaction

Bartlett's test of sphericity showed that there was a significant correlation ( $p < 0.001$ ) between process and outcome satisfaction. Therefore, the major statistical technique used to test the hypotheses on these two task-satisfaction variables was MANOVA. After transforming the raw data according to the method suggested by Erickson and Nosanchuk [11], the assumptions required for MANOVA were met. Given the results of the Bartlett test for both process satisfaction ( $p = 0.43$ ) and outcome satisfaction ( $p = 0.99$ ) and of the Box's  $M$  test ( $p = 0.39$ ), there appeared to be no reason to suspect the homogeneity-of-variance or the homogeneity-of-dispersion-matrices assumptions.

The MANOVA for task satisfaction did not indicate significant medium-by-task interaction effects ( $p = 0.26$ ), but significant main effects for media ( $p < 0.01$ ) and tasks ( $p < 0.001$ ) were found. Where appropriate, ANOVA and post-hoc analysis were performed to test the hypotheses. The means (standard deviations in parentheses) of process and outcome satisfaction in various groups and univariate  $F$ -tests results are presented in Table 3.

Table 3  
Means and standard deviations of process and outcome satisfaction

Dependent variable	Task	Media				Total	Main effect	
		text	audio	video	face-to-face		medium	task
Process satisfaction	intellective	5.06 (1.22)	4.70 (1.04)	5.48 (0.93)	5.38 (1.20)	5.15 (1.13)	$p < 0.02$	$p < 0.001$
	Negotiation (c.) <sup>a</sup>	4.13 (1.05)	4.36 (1.17)	4.68 (0.95)	5.04 (0.86)	4.56 (1.05)		
	Negotiation (n.c.) <sup>b</sup>	4.43 (0.98)	4.09 (1.01)	4.18 (0.87)	4.20 (1.21)	4.22 (1.02)		
	Total	4.68 (1.18)	4.46 (1.08)	4.96 (1.06)	5.00 (1.21)	4.77 (1.15)		
Outcome satisfaction	intellective	5.49 (0.93)	5.81 (0.82)	6.07 (0.74)	5.85 (0.79)	5.80 (0.84)	$p = 0.31$	$p < 0.001$
	negotiation (c.) <sup>a</sup>	4.62 (1.25)	4.71 (1.12)	4.77 (0.94)	4.98 (1.01)	4.77 (1.07)		
	Negotiation (n.c.) <sup>b</sup>	4.27 (1.34)	4.70 (1.02)	4.49 (1.04)	4.37 (1.13)	4.46 (1.13)		
	Total	4.98 (1.23)	5.25 (1.09)	5.39 (1.12)	5.26 (1.12)	5.22 (1.15)		

<sup>a</sup> Consonant.

### 5.3.1. Process satisfaction

Both, medium ( $p < 0.02$ ) and task ( $p < 0.001$ ) main effects were significant. Post-hoc analysis revealed that the intellective groups (5.15) were more satisfied with the task process than either of the negotiation groups; however, there was no difference between the negotiation groups – consonant (4.56) and non-consonant (4.22). The results show that subjects assigned to negotiation tasks, which was a zero-sum game, were more frustrated with the process, probably because of the conflicting situation.

Since there was no significant medium-by-task interaction effect, process satisfaction differences among each medium group were not analyzed by task but in total. The face-to-face group (5.00) was most satisfied with their task process, and were followed by video (4.96), text (4.68), and audio (4.46). Among these, the post-hoc analysis found that process satisfaction of the face-to-face group and the video group was significantly higher than that of the audio group. Thus, both hypotheses H2a and H2c were not supported.

### 5.3.2. Outcome satisfaction

ANOVA did not find a significant medium effect ( $p = 0.31$ ), yet a significant task main effect ( $p < 0.001$ ) was found again. The intellective groups (5.80) were more satisfied with the task outcome than either of the negotiation groups, and the consonant groups (4.77) were more satisfied than the non-consonant groups (4.46). Because there was no significant medium-by-task interaction effect nor medium main effect, both hypotheses H2b and H2d were not supported.

## 6. Discussion and conclusions

### 6.1. Discussion of findings

In general, the results of this study did not support the task/media fit hypotheses which were suggested by MRT. There were no task-medium interaction effects on either decision quality or decision time. Decision

Table 4  
Results comparison of four studies

Dependent variable	Study			
	Kinney and Watson [19]	Kinney and Dennis [20]	Valacich et al. [38]	This study
Media richness	not measured	F > V > T	I: F > V > A > T C: F > A > V > T	F > V > A > T
Satisfaction	F = A = T	F = V = T	I: T > V > F > A C: F > A = V > T	V = F > T = A
Decision quality	not measured	F = V = T	I: V > A = F > T	F = V = A = T
Decision time	T > F = A	T > F = V	I: A > F = V > T C: V > F = A > T	T > V = F > A

Note: F = Face-to-face; V = video; A = audio; T = text; I = intellectual task; and C = cognitive conflict task.

quality was the same for all communication media on both the tasks. The computer-mediated text medium demanded the most in terms of decision time, and the audio medium took the least time, regardless of tasks. These results are quite similar to the results of previous studies. The results from three previous studies employing similar treatments and dependent measures are compared with the present study's findings in Table 4.

With one exception, the video medium is perceived as richer than the audio medium. This ordering is consistent with normative views of media richness. In terms of decision quality, this study found no difference across media, regardless of tasks.

This, and previous studies, except that of Valacich et al., agree that the text medium took the most time. In this study, the audio subjects finished both the tasks in the least amount of time, and the video and face-to-face subjects took almost the same amount of time.

From the results of this and of previous studies, it can be concluded that the MRT is not well supported. One plausible explanation is that, while the causal structure of the theory is correct, the communication media employed in these empirical studies are too similar in terms of richness to differentiate their effects on performance. Even though perceived media richness was statistically distinguishable, the difference might not be substantial enough for practical purposes. All four media are synchronous, and employ natural language; and all but one are oral media. The computer-mediated text took more time than other media, but this fact can be almost completely explained by the difference between oral and non-oral media. If this

is true, the task/media fit hypotheses need to be modified.

Another explanation for the results that differs from the predictions of MRT is that factors other than media richness strongly affect task performance and satisfaction. One interesting finding is that no strong correlation between actual performance and task satisfaction was discovered. For example, even though the audio medium is the best recommended by the theory for the intellectual task, and the audio subjects actually finished the task in the shortest time, their process satisfaction was the lowest. These results imply that people's satisfaction and media choice as a result might be different from the most rational one. This could help explain why previous studies showed an imbalance between managers' perceptions and choices. People may prefer visual contact and openness even though these take more time. Also, the subjects may prefer the media which make them feel as if they are using 'state-of-the-art' communication medium.<sup>3</sup> This could explain why the computer-mediated text groups were more satisfied than the audio groups and the groups using video conferencing system were most satisfied with their process. These results give stronger support to the SIP perspective which assumes that media choice process is influenced by past statements and behaviors, as well as by social norms.

Among the four media employed in this study, the text mode is the only written media; the others are oral

<sup>3</sup>This is especially true in a country such as Korea in which the government propagates the importance of new information technology.

Table 5  
Means and standard deviations of process satisfaction

Role	Media			Main effect		Interaction
	written	oral	total	media	role	M × R
Consonant	4.13 (1.05)	4.69 (1.02)	4.56 (1.05)	$p = 0.44$	$p = 0.04$	$p = 0.03$
Non-consonant	4.43 (0.98)	4.16 (1.02)	4.22 (1.02)			
Total	4.28 (1.02)	4.43 (1.05)	4.39 (1.04)			

media. Table 5 presents the means of process satisfaction recategorized as written (i.e. text) and oral (i.e. audio, video, and face-to-face) for the negotiation task. The non-consonant subjects were more satisfied with the process in the written mode than in the oral mode; the reverse was true for the consonant subjects. This interaction effect was significant ( $p = 0.03$ ). The non-consonant subject might find it easier to hide awkward feelings when an unreasonable position had to be insisted upon. However, even though the difference was statistically significant, the magnitude (the highest is 0.56) was practically small and the payoff was not affected.

This study contributed to the information systems area, both theoretically and practically. An introduction of social psychology factors into MRT is an important contribution and further research should presumably be undertaken.

According to this study's result, the video medium was much closer to the face-to-face medium than the audio medium in terms of decision time and task satisfaction, regardless of tasks. More importantly, the whole hypotheses set to test MRT might be reconsidered because all four media are too similar in terms of richness.

In terms of practical contributions, this research found that the video conferencing mode was more similar to the face-to-face mode. It implies that a video conferencing system can be a good substitution for a face-to-face communication for most of the tasks performed by the remote work groups. However, a word of caution is in order. A recent study [12], scrutinizing a prototype video telephony system, found that the use of the system and perceptions of it were more similar to intentional telephone calls than to the spontaneous and informal communication supported by face-to-face interaction. Users of the video phone also judged this medium's interactions

to be more invasive of privacy than face-to-face interactions.

Another interesting result is that computer-mediated text might be rich enough even for the negotiation task. It took more time, but it is the cheapest method to communicate at distance. Appropriate training and experience will minimize the problems and enhance efficiency and effectiveness. The results of this study also suggest that the audio medium might be more a satisfactory device in terms of performance than people perceive. Thus, its further utilization should be considered. Johansen et al. [18] and Fowler and Wackerbarth [13] provide a summary of each medium's strengths and weaknesses and practical guides for implementing them in organizations.

## 6.2. Limitations

Limitations of this research need to be kept in mind when interpreting the results. First, the research findings were based on the experiment using student subjects who had little experience in video conferencing systems and who had relatively less experienced use of synchronous electronic mail systems. Potential novelty effects were not controlled. Secondly, the use of zero-history groups for brief periods could be another limitation. Since many tasks in organizations entail larger groups working for long periods, the external validity of this study could be reduced. Thirdly, the communication media that were employed reflect today's technology. As Wheeler et al. [40] point out, the results might not directly relate to previous research because of the continuing evolution of technology. Finally, as with any laboratory experiment, the controlled nature of the setting, the use of student subjects, and the narrow focus of tasks reduce the external validity.







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**Kil Soo Suh** is Associate Professor of Information Systems at Yonsei University, Seoul, Korea. Professor Suh holds a Ph.D. in management information systems from Indiana University where he also earned his M.B.A. He holds a B.A. in Business Administration from Yonsei University. His research interests are in the areas of man-machine interfaces, communication media, internet marketing and conceptual modeling and implementation of information.