THE EFFECTS OF MEDIA RICHNESS ON DECISION-MAKING UNDER UNCERTAINTY

by

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ABSTRACT

THE EFFECTS OF MEDIA RICHNESS ON
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by

Norman A. Johnson

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Media richness theory holds that managers (or decision-makers) should use rich media, which have significant information-carrying capacity, to process information for complex tasks (Daft and Lengel, 1984). From a social perspective and in a normative sense, media richness theory has been largely supported by early research that used perceptual metrics, such as self-reporting in surveys and predetermined standards or references. However, some studies that have used direct metrics for essential constructs, such as task characteristics, performance measures, and media usage, found mixed support for the theory (Rice, 1992; Kinney and Watson, 1992; Valacich et al, 1994).

Understanding the relationship between media richness and risk propensity may explain many conflicting results in previous research studies on performance from the media richness perspective. Furthermore, it will be valuable to assess the theory in the context of decision-making tasks under uncertainty. Accordingly, this research study

examines how media richness affects decision-making, subjective judgment, and risk propensity.

In this study, different communications channels are used in a laboratory setting to investigate how media richness affects decision-making under uncertainty. Pairs of experimental subjects participated in a trading game, using pre-assigned communications channels to conduct negotiation for the exchange of notional lottery tickets and points. Two types of tickets, which were derived from risk averse and risk prone utility functions, are traded between research subjects.

The study shows that increasing or decreasing richness of media does not uniformly alter decision-making constructs, such as message significance, message representation, and subjective judgment. The findings indicate, among other things, that individuals tend to center their decision making on fewer unrelated ideas or less divergent perspectives in rich media; and that irrespective of the risk induced preference situation, individuals tend to ascribe more importance and meaning to messages conveyed when using an instant messaging communications medium.

Communications media are varied and are rapidly becoming more ubiquitous. Therefore investigating the impact of these media on decision-making can help us to better appropriate them to suitable settings - in the design of decision support systems and in the domain of decision framing research.

DEDICATION

To my family

ACKNOWLEDGEMENTS

He who finds though that lets us penetrate even a little deeper into the eternal mystery of nature has been granted great grace. He who, in addition, experiences the recognition, sympathy, and help of the best minds of his times, had been given almost more happiness than one man can bear.

--Albert Einstein

It is in the spirit of Einstein's quote that I acknowledge the invaluable contributions of the members of my committee, who diligently guided this research study. My chair, Dr. Richard Holowczak, shaped my initial ideas into meaningful theories and taught me the virtues of patient thinking. He generously gave much needed support, which was uniquely demonstrated by his willingness to consistently provide unsolicited help. I am grateful for his contributions to this project and my personal development.

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CHAPTER 1

Introduction

This chapter presents the main ideas covered in this thesis document. It includes an overview of the research domain, media richness and decision-making. The research questions, the motivation for this research, and its potential contributions are also included in this chapter. It concludes with a description of the main concerns for subsequent chapters.

1.1 Overview

Growing use of different communications media such as instant messaging, electronic messaging, and online systems in organizations will provide managers with many kinds of communication channels to use for gathering and processing information for decision-making under uncertainty. Already, many different kinds of communication channels or media have been deployed throughout organizations. Today, for example, most investment decisions are made using any or a combination of the following communication channels: face-to-face, telephone, electronic messaging, instant messaging, and other computer mediated communications system for processing information. These multiple means of communication are intended to improve task outcomes an organization's business environment.

Researchers have argued that organizations respond to complexities, an ill-defined business environment, and their own internal challenges, by reducing uncertainty and

clarifying ambiguity[1] (Galbraith, 1977; Weick, 1979; Daft and Lengel, 1984). In this context, uncertainty refers to the difference between the amount of information required to perform a task and the amount of information already possessed by an organization (Galbraith, 1973). By this definition, uncertainty is dependent on the types of task being performed and so researchers (Rice, 1992; Valacich et al., 1994) have examined task analyzability and media usage.

The reduction of uncertainty and the clarification of ambiguity depend on an organization's ability to efficiently process information of appropriate richness and it is theorized that managers should use rich media for complex tasks (Daft and Lengel, 1984). In particular, managers should use rich media to reduce uncertainty. It is also argued that task effectiveness will be improved when task needs are matched to a medium's ability to convey information (Daft et al., 1987). Accordingly, many different communication tasks have also been used to examine these claims.

Presumably, the use of many different communications media and tasks can result in more occurrences of misfit between task complexity and media richness, potentially affecting the decision-making tendencies of individuals. The degree of richness of media characterized by feedback, cues, language variety, and personal focus ought to impact the way in which individuals perceive opportunities to use media to realize gains or prevent losses. Ultimately, communications media could affect the risk propensities and behavioral choices of managers.

[1] In this context, ambiguity refers to a degree of vagueness, which in terms of probability is not a measurable construct.

Past examinations of many communication tasks and media richness theory have not considered decision-making under uncertainty and risk propensities. Rather than examining communication tasks of so many variations, it would be valuable to examine a generic decision-making problem, such as a game of chance or notional asset trading that is carried out using different communications media. Furthermore, sixty percent of managerial decisions are made in dyadic settings and games of chance in these settings capture the essence of managerial decisions (Panko and Kinney, 1995).

It is also important to consider uncertainty from a decision theorist perspective, that is, as a measurable construct that can be represented by precise probabilities upon which individuals make assessments while using communications media that vary in richness. If uncertainty is represented by precise probabilities in a decision-making problem, ambiguity only alters a decision-maker's degree of confidence in his or her judgment (Ellsberg, 1961; Fox and Tversky, 1991). Therefore to examine media richness theory from the decision theorist perspective does not compromise the theory's fundamental meaning, but presents an opportunity for the theory to be assessed through objective and measurable probabilistic constructs.

In general, the actual processing of most information occurs as individuals use specific media, operate within specific units (Rice, 1992) and are given some latitude with decision-making. Economists, operations researchers, and some statisticians have investigated decision-making by using axiomatic models that are prescriptive.

Behavioral researchers, however, have made the prescriptive models more descriptive by examining the degree to which decision makers have conformed to these models (Beach, 1997). This research study also examines the degree to which decision makers conform to prescriptive utility models when making decisions using different communications media.

1.2 Summary of Research Study

This thesis is interdisciplinary - it incorporates theories from the information systems and the behavioral economics disciplines. Media richness theory, from the information systems discipline, is the cornerstone of this study. From the second reference discipline, several important theories and their underlying constructs are appropriated to this research study. These include utility theory, prospect theory, and the induced value theory.

Past research studies have neglected to assess the impact that communications media, which directly affect, the resolution, and presentation or the framing of choices, have on decision-makers' choices under uncertainty, and risk propensity. This thesis responds to the need for such an assessment. By using three different communication

media: telephone-to-telephone; instant messaging, and computer-to-computer system[2] - for comparison in a laboratory setting, this thesis investigates:

i. The extent to which media richness affects information acquisition for decision-making under uncertainty
ii. The extent to which media richness affects the judgment of individuals
iii. The extent to which media richness affects individuals' risk propensities

In this study, a conceptual model that is used as a basis for theories that addresses the foregoing concerns is also presented. Six sets of hypotheses, or eighteen unique hypotheses, centered on the decision-making constructs and media richness are tested.

Investigation of the hypotheses posited is based on a 3 x 2 factorial design, varying media richness (rich (R): telephone-to-telephone; moderately rich (M): instant messaging; lean (L): non-mediated computer-to-computer; and risk propensity (risk-averse and risk-prone). The dependent variables include message significance, message representation, message redundancy, subjective judgment and the degree of risk aversion – all of which are measured with respect to number of points assigned to

[2] Here and throughout this paper, we consider this type of communications system to be a computer-to-computer or PC-to-PC communication that allows users to exchange one type of predefined information, such as numbers only, with no provision for interposition or qualification.

notional lottery tickets, which are traded between subjects and self-reported responses of subjects.

1.3 Justifications for Research Study

Understanding the relationship between media richness and risk propensity may explain many conflicting results in previous research studies on performance from the media richness perspective (see Carlson and Davis (1998) for a discussion on anomalous results, p.338). Communications media, which are believed to increase productivity (Rice and Bair, 1984; Trauth et al., 1984), can alter risk propensities unknowingly, resulting in additional costs or loss opportunities for increased profits. This study develops, reformulates and examines theories in the computer information systems and behavioral economics disciplines from new perspectives.

It also responds to the need for studies of mixed media in areas of group support systems (Fjermestad and Hiltz, 1998). Still, it is necessary to make an important qualification on the research stream into which this study belongs. Readers of this thesis might be tempted to consider it a group support systems research study. In some sense it is, but it is a "nonconforming study" according to Fjermestad and Hiltz's (1998) classification scheme for group support systems research studies. It violates the criterion for what is considered a group - it uses dyads and not triads or larger sized groups.

There are several other justifications for this research. Communications media are proliferating. Hence, investigating and understanding their impact ensures that they are appropriated to suitable settings, such as in the design of decision support systems and in the domain of decision framing research. Additionally, understanding the adverse effects of misappropriated communication media decreases the likelihood of repeat occurrences of their misappropriation, and the associated costs. Better understanding of these communications media and their effects provide a basis and a starting point for future research.

Decision-making under uncertainty is a multifaceted construct with numerous interpretations, but interpretations have largely been referenced by the behavioral economics discipline. Fortuitously or by design, references to the computer information systems discipline has been neglected. Therefore this thesis provides a contribution to theories on decision-making under uncertainty from an information system's perspective.

The laboratory setting for the experiment facilitates the rigorous testing of the hypotheses prior to the use of field data, providing also a basis for their examination. In particular, the results of this study can be generalized to settings such as investment brokerages, where vast amounts of unused data exist.

The methodological approach of this study can be appropriated to many other research interests and domains. Therefore, in light of ongoing research concerns in

both the information systems and behavioral economics disciplines, the methodology and instruments used in this research are a significant contribution to future research studies for combined perspectives for both disciplines.

1.4 Organization of Study

The thesis document is organized as follows. Chapter 2 discusses past research studies on media richness theory. The theory, which derives from information richness theory, is fundamental to this research study. The chapter is a review and synthesis of existing literature, focusing on the three main areas – media characteristics, media selection and task characteristics and performance. The chapter also discusses the relevance of decision-making under uncertainty in the context of media richness, concluding with a description of a new research direction for the theory.

Chapter 3 presents the theoretical framework for this study, focusing on two of the main characteristics of media richness – feedback and cues. First a detailed discussion of media feedback and cues is presented and the relevance of these constructs to decision-making constructs, which are concerned with information acquisition, judgment and risk propensity, is established. Six sets of testable hypotheses or eighteen distinct hypotheses on the relationship between these decision-making constructs and media richness are posited.

Chapter 4 describes the research methodology. This includes a description of the research model, the experimental design and a description of the dependent and independent variables. These descriptions are followed by the experimental procedures and measurements of the dependent variables. The chapter concludes with a description of results for the pilot study, manipulations checks, and accounts of steps taken to ensure procedural reliability, internal validity, external validity and construct validity.

Chapter 5 presents the results. First, a summary of the data sets that are used for the statistical analyses is presented. Second, the assumptions of the ANOVA technique are discussed. These include the independence assumption, the homogeneity of variance assumption and the normality assumption. Finally, the set of statistical analyses, which include the normality tests and descriptive statistics for each dependent variable, is presented in run.

Chapter 6 presents the discussion of the results, including implications of the findings. The results provide full and mixed support for the hypotheses that are investigated in this study. Results indicate, among other things, that variability in message representation is lower in telephone-to-telephone communications than in either instant messaging or non-mediated communications systems; message redundancy is about 32% more in telephone-to telephone communications than it is in either instant messaging or non-mediated communications systems; and that

individuals are more responsive to the presence or absence of cues and media feedback in each medium for risk prone induced preference situations.

Chapter 7 presents the main conclusions that follow from the findings of this study. It also covers the contributions of this study to theory and practice. Finally, the limitations of the study and future research directions are discussed.

CHAPTER 2

Literature Review

Media richness theory, which derives from information richness theory, is the central to this research study. In this chapter, a synthesis of existing literature on the theory, highlighting the most relevant notions that are appropriated to this study, is presented. The review focuses on the three main areas – media characteristics, media selection and task characteristics and performance. The chapter also discusses the relevance of decision-making under uncertainty in the context of media richness, concluding with a description of a new research direction for the theory.

2.1 Media richness theory

Media richness theory, which originated in the 1970s, is one of the most cited theories on information processing within an organization. Motivated by the work of Galbraith (1977) and Weick (1979), Daft and Lengel (1984) posited that in order for organizations to respond to complexities, an ill-defined business environment, and their own internal challenges, they must impose order and certainty. To this end, organizations rely on the efficient processing of information.

Efficient processing refers to use of information with appropriate richness to reduce uncertainty and clarify ambiguity (Daft and Lengel, 1984) and richness defines the potential information–carrying capacity of data (Daft and Lengel, 1984). In a

prescriptive context, it is theorized that managers should use rich media to resolve and complete complex tasks (Daft and Lengel, 1984).

Research studies on media richness theory have been done within three main contexts. First, the notion of richness, which is a critical construct of the theory, was defined and used to classify different kinds of communications media. Many research studies have considered the notion of richness in a social context (Trevino et al., 1987; Argyle, 1969; Birdwhistle, 1970; Markus, 1987; Rice and Shook, 1990; Zhmud, Lind and Young, 1990; Russ et al., 1990). Second, the theory has been examined from a social perspective with focus on media selection (Daft and Lengel, 1984, 1986; Trevino et al., 1987). Third, and more recently, the theory has been investigated based on task characteristics and performance. However, studies have also asserted that the theory is no longer relevant to today's communications media (Dennis and Kinney, 1998; Dennis and Valacich, 1999).

2.1.1 Media characteristics

Media characteristics, such as feedback capability, language variety, personal focus[3], and the ability to convey multiple cues, determine the degree of richness attributed to different media. Media richness was originally conceptualized based on two of these characteristics – a medium's capacity for multiple cues and for rapid feedback (Daft and Lengel, 1984; 1986).

[3]This refers to the extent to which the sender and the receiver are inclined to customize messages (Trevino et al., 1990).

In most research studies, media richness is treated as a categorical variable and degree of richness is a relative basis for differentiating among various kinds of communications media, based on the criteria that define richness (Daft and Lengel, 1986; Rice, 1992; Valacich et al., 1994; Trevino et al., 1987; Argyle, 1969; Birdwhistle, 1970; Markus, 1987; Rice and Shook, 1990; Zhmud, Lind and Young, 1990; Russ et al., 1990; Dennis and Kinney, 1998; Dennis and Valacich, 1999; Sia et al., 2002). In particular, communications media decrease in richness as the extent to which they support feedback and cues decreases.

2.1.2 Media selection

The selection of communications media has not been determined solely on the basis of the richness that characterizes these media (Markus, 1987; Rice, 1992; Zhmud, Lind and Young, 1990; Russ et al., 1990). High language variety and rapid feedback are believed to give some media, such as face-to-face and telephone, the capacity for symbolic expressions[4] (Trevino et al., 1987) and personal focus and the ability to convey multiple cues are believed to facilitate a social presence[5] in communications media (Trevino et al., 1987). The other factors have impacted the characterization of media as well as their selection.

Social presence depends not only on words conveyed during communication, but also upon a range of nonverbal cues including facial expression, direction of gaze, posture,

[4] These include facial expressions, gaze, posture, pauses, and tonal inflections etc.
[5] Social presence is the degree to which the medium facilitates awareness of the other person and interpersonal relationships during interaction (Short et al., 1978).

attire, physical distance and many verbal cues (timing, pauses, accentuations, tonal inflections etc. (Argyle, 1969; Birdwhistle, 1970). By definition, social presence decreases from rich media to lean media.

One of the main models for media selection comes from a combination of several other social theories. This central model, the social influence model of technology use (Schmitz, 1990; Fulk et al., 1987; 1990), was posited to explain media selection. Drawing on the premises from social information processing theory (Salancik and Pfeffer, 1978), social learning theory (Bandura, 1986), and symbolic interactionism (Blumer, 1969; Mead, 1934), the model proposes that media perceptions are in part socially constructed. It predicts that there will be considerable variation in the perceptions and use of communication technologies caused by a social process and that mismatching of media choices will occur where social forces come into play to influence media selection.

The face validity and intuitive appeal of the social influence model of technology use make has contributed to the widespread acceptance of this model, however, it is a normative model and lacks empirical support. It is predicated on the assumption that perceptions are socially constructed, but research studies have shown that users' perceptions of communications media are also derived from their experiences (Davis, 1989; Adam, 1992; Agarwal and Prasad, 1998). Research has also shown that individuals can manage information by controlling the selection of sources and

media, ignoring the social implications of their choice (Saunders and Jones, 1990; Rice, 1992).

2.1.3 Task characteristics and performance

Research studies on media richness theory from a social perspective did not explicitly consider task characteristics[6], task analyzability[7] and performance. In particular, these studies ignored the possibility that task characteristics might impact an individual's perception – for example, a task might inherently require more cognitive skills than intellective skills and alter the perceived value of the information that is used to complete it. Studies have shown that there is a dependent relationship between task characteristics and media usage (Valacich et al., 1994; Rice, 1992).

Task characteristics have been examined in terms of the extent to which they can be analyzed. In this context, a task was considered either analyzable or narrowly focused and well defined. Research studies have concluded that whether tasks are analyzable or narrowly focused and defined, there are no certain and conclusive results that support media richness theory (Rice, 1992).

[6] Meaning whether a task is cognitive or intellective (Valacich et al., 1994)
[7] This refers to the way that individuals are able to respond to problems that arise in the process of task completion (Rice, 1992; Perrow, 1970).

2.2 New research direction for media richness

Many research studies (Rice et al., 1990; Markus, 1987; Rice and Shook, 1990; King, Hartman and Hartzel, 1992; McGraith and Hollingshead, 1994; Carlson and Zhmud, 1994; Walther, 1992; Burke and Chidambaram, 1999) have made meaningful and valuable contributions on media richness theory. Yet among these studies, inconclusive results are pervasive.

From a social perspective and in a normative sense, media richness theory has been largely supported by early research that used perceptual metrics, such as self-reporting in surveys and predetermined standards or references. Studies that have used direct metrics for essential constructs, such as task characteristics, performance measures, and media usage, have found mixed support for the theory (Rice, 1992; Kinney and Watson, 1992; Valacich et al., 1994).

Other recent studies have completely rejected media richness theory (Dennis and Kinney, 1998; Dennis and Valacich, 1999) and posit that the only effect of varying media richness is time; specifically, richer media support quicker decisions. Furthermore the central proposition – matching media richness to task equivocality improve performance – is not supported for new media[8]. And there is no need for researchers to retrofit new media into the theory, which was based on old media (Dennis and Kinney, 1998)

[8] New Media are those communication technologies typically involving computer capabilities that allow or facilitate interactivity among users and information (Rice, 1984).

Media synchronous theory has been proposed to replace media richness theory (Dennis and Valacich, 1999). This theory posits that regardless of the task, individuals (as well as groups) perform a set of fundamental micro-level communication processes. All tasks are composed of two fundamental processes – conveyance[9] and convergence[10]. And media synchronicity, the extent to which individuals work together on the same activity at the same time (that is have a shared focus), determine task processes mutually exclusive from task equivocality and uncertainty. Accordingly, low media synchronicity is preferred for conveyance and high synchronicity is preferred for convergence (Dennis and Valacich, 1999).

Past research studies on media richness theory lack a comprehensive theoretical framework that explains media richness theory based on media richness, as it was originally conceptualized, and decision-making under uncertainty, which directly affects performance. In particular, research studies that assess the theory in the context of decision-making tasks, instead of the many variations of tasks that have been used, are needed. Furthermore, rather than examining performance in isolation, it would be valuable to examine the consistency or coherence of individuals' judgment as well as individuals' risk propensities when using different communications media.

[9] According to these authors, conveyance of information focuses on the dissemination of a diversity of information, which was not previously known to participants, from many sources

[10] The development of a shared meaning for information.

Figure 1, below, shows the main researched domains on media richness theory, highlighting overlooked or neglected areas that may explain some inconsistencies that have emerged from the assessment of media richness theory. The domain, which is primarily concerned with decision-making under uncertainty, is the main research focus of this thesis.

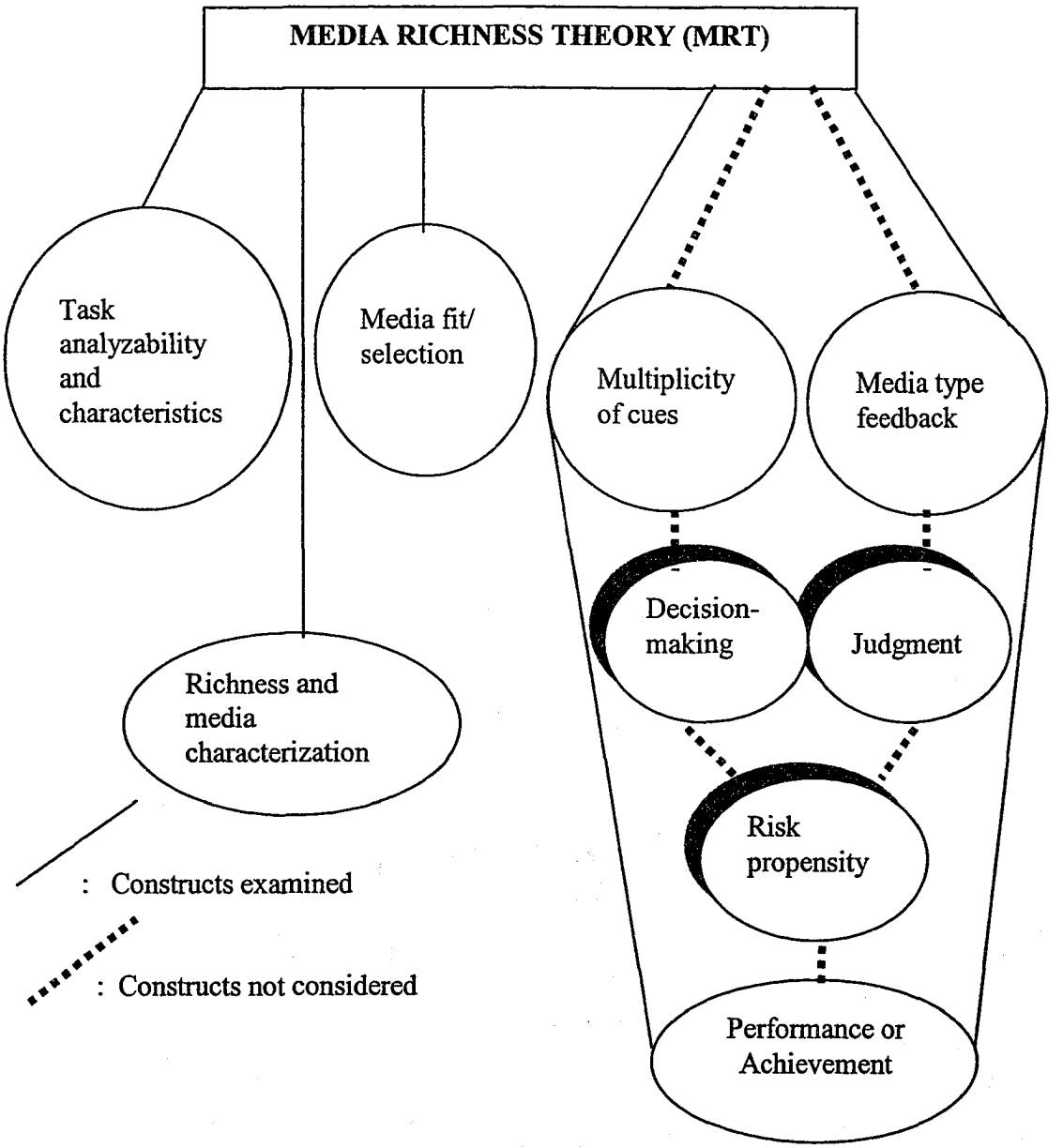


Figure 1: Research domains of media richness theory and decision-making constructs not considered previously.

2.3 Decision making under uncertainty

In general, the actual processing of most information occurs as individuals use specific media, operate within specific units (Rice, 1992) and are given some latitude with decision-making. Economists, operations researchers, and some statisticians have investigated decision-making by using axiomatic models that are prescriptive. Behavioral researchers, however, have made the prescriptive models more descriptive by examining the degree to which decision makers have conformed to these models (Beach, 1997).

The analysis of decision-making commonly distinguishes risky and riskless choices (Tversky and Kahneman, 1984). The study of decision making under risk has focused on the choices between simple gambles with monetary outcomes and specified probabilities, which reveal basic attitudes toward risk and value. Simple gambles are believed to represent the structure and nature of most decisions (Edwards, 1954; Beach, 1997).

Bernoulli (1954) developed the psychophysical analysis of responses to evaluate risky choices. Bernoulli (1954) suggested that dollar amounts do not accurately reflect the attractiveness of payoffs, but rather by the expectation of the subjective worth of

outcomes. The subjective worth, called utility[11], of a gamble is a weighted average determined by assigned probabilities. Probabilities (or chances), in turn, capture the notions of risk propensity, uncertainty or doubt in decision research (Bazerman, 1998).

It is known that individuals are typically neither rational nor consistent in making judgments under uncertainty, however a theoretical "rational" structure is assumed for risky problems (Bazerman, 1998). Researchers use this reference structure to investigate systematic deviations from rationality that individuals are prone to when making decisions under uncertainty (Von Neumann and Morgenstern, 1947; Savage, 1954; Edwards, 1954; Luce and Raiffa, 1957; Fishburn, 1970; Berg et al., 1986; Bazerman, 1998).

2.3.1 Risk propensity, expected value and certainty equivalent

There are three categories of risk propensity or tendencies – risk-averse, risk-seeking (or -prone), and risk-neutral (Raiffa and Keeney, 1976). Each of the three types is defined in terms of two risk constructs – expected value and certainty equivalent.

Expected value is the long run average of an uncertain event or the sum of all probability weighted (the product of potential payoffs and their associated

[11] This construct differs from that of the economist's description of utility, which is concerned with an incremental change of X from x to x+1 decreasing as x increases and without mention of a probabilistic notion (Von Neumann and Morgenstern, 1947; Raiffa and Keeney, 1976).

probabilities) potential outcomes (Bazerman, 1998). The component parts of the expected value are the value of the outcome (or utility) to the decision-maker and the associated probability, which is either objective or subjective. Four variations of expected value models account for the variability in risk propensity (Edwards, 1955). They include the following combinations of knowledge about probabilities and utilities:

- The decision maker knows the objective probability and his or her utility is isomorphic,[12] the payoff computed here conforms to the expected value model;

- The decision maker knows the objective probability and his or her utility is not isomorphic; the payoff here conforms to the expected utility model;

- The decision maker has his or her subjective probability[13] and his or her utility is isomorphic; the payoff computed conforms to the subjective expected value model;

[12] That is, the probability and the utility are in a one-to-one correspondence with each other.
[13] Subjective probability is the predictive probability estimate assigned to an uncertain event. It can be determined with reference to objective probabilities, such as those based on relative frequencies (Beach, 1974).

- The decision maker has his or her subjective probability and his or her utility is not isomorphic; the computed payoff here conforms to the subjective expected utility model.

The certainty equivalent, on the other hand, is that guaranteed value that would make a decision-maker indifferent to an uncertain event and the guaranteed value (Raiffa and Keeney, 1976). For example, if a decision-maker had an opportunity to accept a 50 per cent chance to win $100 or nothing, and elects to take a guaranteed or certain amount of $20, an amount which is less than the expected value of $50 (figured as 0.50*100), then the amount of $20 is the decision-maker's certainty equivalent for a 50 percent chance of $100.

An individual with a certainty equivalent that is less than the expected value of the uncertain event's payoff is risk-averse with regard to that decision (Raiffa and Keeney, 1976; Bazerman, 1998). In the above example, the decision-maker is risk averse. Risk aversion is the tendency to act conservatively. A risk-averse preference indicates that an individual prefers to avoid a gamble rather than to accept the chance to win the potential payoff. Most people are assumed to be risk averse. Mathematically, a decision maker is risk averse if and only if his utility function, which is a value function that derives from the subjective probabilities and the potential gains or losses for a gamble, is concave (Raiffa and Keeney, 1976; 1995).

A risk-seeking decision maker prefers a gamble to the certain consequence of the gamble itself. In this case, the acceptance of the chance to win is desirable to the decision maker. In terms of certainty equivalent, a risk-seeking decision-maker's certainty equivalent for an uncertain event is greater than the expected value for that uncertain payoff (Raiffa and Keeney, 1976; Bazerman, 1998). In the above example, a decision maker with certainty equivalent greater than 50 is risk-seeking. Mathematically, a decision maker is risk-seeking if and only if his utility function is convex (Raiffa and Keeney, 1976).

Between risk-averse and risk-seeking tendencies is a risk-neutral tendency. Individuals who have a certainty equivalent for an uncertain event that is equal to the expected value of the uncertain payoff is risk neutral (Bazerman, 1998). The utility function for a risk neutral decision-maker is a positively sloped straight line (Raiffa and Keeney, 1976). The three types of risk tendencies are expressed in terms of certainty equivalent, CE, and expected value, EV, as follows:

- CE < EV; risk averse
- CE > EV; risk-seeking
- CE = EV; risk-neutral.

All three types of risk tendencies occur to varying degrees; that is, a decision-maker who is risk-averse, might be described as being more risk averse than another, who is also risk-averse. The relative risk aversion of individuals can be objectively measured

by the differences between their respective certainty equivalent and the expected value for given uncertain events (Harrison, 1986; Bell et al., 1988; Berg, Dickhaut and Rietz, 1999). A similar metric can be used to differentiate degrees of risk-seeking tendency (Harrison, 1986; Bell, 1986; Bell et al., 1988).

There are different sets of axioms that hold for utility functions and provide a guide for consistent decision-making in a normative context. (Von Neumann and Morgenstern, 1947; Savage, 1954; Luce and Raiffa, 1957; Fishburn, 1970). These axioms are predicated on the assumption that decision-makers do what is best for themselves or the organizations for which they are making decisions; that is, they are rational (Beach, 1997).

2.3.2 Prospect Theory

The variants of the expected value model, which is mentioned above, do not completely describe choices, because they are predicated on the questionable assumption that a decision-maker's total possession (wealth or asset) is the reference point for value – such that each additional unit of gain means less to a decision-maker who has many and, more to one who has few (Tversky and Kahneman, 1979). Tversky and Kahneman (1979) argue that gains or losses, under uncertainty, are assessed relative to specific reference points, which are situational, more frequently than they are assessed relative to total assets.

The claim that a decision-maker's point of reference is specific and situational implies that expected values are assessed differently from one situation to another. Specifically, and according to Tversky and Kahneman's (1979) Prospect Theory, in decision-making, subjective probabilities are reinterpreted as decision-weights. Decision-weights reflect the decision-maker's uncertainty and are represented as a transformation of objective probabilities, such that a decision-maker tends to overweight the probability of low-probability events and underweight the probability of moderate- and high-probability events (Tversky and Kahneman, 1979; 1992). Therefore there are systematic deviations from rationality in probability assessments, which depend on points of reference and the situation in question.

Prospect theory evaluates choices in a manner similar to the variants of the expected value model. Specifically, the products of the payoff values and corresponding decision-weights (uncertainty) determine the attractiveness of one choice over another (Tversky and Kahneman, 1979; 1992). The significance of points of reference and situational concerns has motivated many research studies on prospect theory (see Tversky and Kahneman (2000) for a comprehensive set of research studies). Still, it is argued that the theory lacks examination in a natural setting where decision-makers actively work to influence events in order to make their choice the right choice (Wagenaar and Keren, 1988; Daly, 2001). In this thesis, different communications media are used to simulate a natural setting and the effects of these media on judgment and choice are assessed.

2.4 Judgment and Choice

In a normative sense, judgment and choice can be considered equivalent constructs. For example if x is preferred to y, then the satisfaction derived from x is greater than that which is derived from y, so after x is judged against y, it is the preferred choice. However, psychologist researchers assert that judgment is an aid to choice, but it is neither necessary nor sufficient for choice, since judgment can be ignored at the choice point (Einhorn and Hograth, 1988). Specifically, judgments serve to reduce uncertainty in choice by process of reasoning and evaluation of information or evidence. It is in this regard that both these constructs are considered for the purposes of this study.

Past research studies have looked at judgment and choice in terms of subprocesses, which include information acquisition,[14] evaluation, action and feedback or learning (Brunswik, 1956; Slovic and Lichtenstein, 1971; Anderson, 1970; Einhorn et al., 1979). These research studies concluded that attention; causal thinking; and cue redundancy affect information acquisition, which forms the basis for judgment and choice.

Information acquisition, which occurs in our memory and from the external environment, relies on attention. Kahneman and Tversky (1979) found that like

[14]Acquisition refers to the process by which an individual searches and stores information (Einhorn and Hogarth, 1988).

perception, attention is derived from the cognitive decomposition of stimuli[15] and that different decompositions may lead to different task representations. Representation, in turn, depends on some salient[16] features of an object or phenomenon (Tversky, 1977). So judgment varies according to the representation that corresponds to attention.

Other researchers have noted that there is interdependence between information acquisition and evaluation (Einhorn and Hogarth, 1988). Like attention, the interdependence between acquisition and evaluation is affected by the relative importance that decision makers attach to stimuli in their judgment system (Einhorn and Hogarth, 1988). In particular, the evaluation of information in making predictions from multiple stimuli raises several concerns in regard to conflict in judgment and accuracy (Brunswik, 1943; Hammond et al., 1975; Einhorn et al., 1979). These concerns include:

- If there is a criterion available for comparison, uncertainty can arise from sources in the environment;

- If there is a criterion available for comparison, there may be inconsistency in judgment strategies;

[15] Stimuli refer to attributes of a construct or phenomenon that influence action or response (Tversky, 1977)
[16] Salience is the intensity, frequency, familiarity or the signal-to-noise ratio of features (Tversky, 1977).

- If there is a criterion available for comparison, there may be uncertainty regarding the weighting of cues used for prediction purposes.

Information acquisition and use are also affected by causal thinking (Tversky and Kahneman, 1981). Information that receives a causal interpretation by a decision-maker is weighted more heavily in judgment than information that is diagnostic[17] (Tversky and Kahneman, 1981). These authors also noted that the weighting of information that results from causal interpretation leads to asymmetries in the use of information.

Finally, information acquisition is affected by cue redundancy, which is concerned with the availability of multiple stimuli that are similar. Research has shown that there are differential effects in the acquisition of information from intact or decomposed stimuli of a task or phenomenon (Phelps and Shanteau, 1978). Decision-makers, when presented with many decomposed stimuli, are able to use all decomposed stimuli in forming their judgment by finding patterns in these stimuli; however when presented with intact stimuli, their judgment are based on a few stimuli (Phelps and Shanteau, 1978).

Cue redundancy is important and beneficial to information acquisition. Some benefits include: (a) dimensionality of information space is reduced, thereby preventing information overload; (b) information search is limited without loss of predictive

[17] This refers to the kind of information that simply differentiates one idea from another based on distinct or marked points of differences.

accuracy; (c) attention is highly selective; (d) unreliability of information is alleviated by having multiple measures of the same stimuli; and (e) intersubstitutability of stimuli is facilitated (Einhorn et al., 1979).

Research studies on judgment and choice in terms of the other subprocesses - action and feedback or learning – have been concerned with conflict in action and conflict in judgment as separate notions, and the ability to learn specifically (Corbin, 1980; Luce, 1977; Beach and Mitchell, 1978). In this thesis, learning as it relates to judgment and choice, will not be considered, and it is assumed that action is explained by risk propensity constructs.

Conflict in action differs from conflict in judgment as the former implies greater commitment (Beach and Mitchell, 1978). Furthermore unlike judgments, actions are tied to notions of regret, responsibility, and avoidance (Corbin, 1980). For example, the decision to go to college might be tied to potential regret of not going, the responsibility of the choice not to go, and the avoidance of making the choice to go. Ultimately, choice is inevitable, and without loss of generality, it is also implicitly defined by risk propensity.

Similar to judgment and action, choice also involves conflicts. In the literature, choice conflicts are concerned with compensation and have been examined around the expected utility models, which were mentioned in the previous section (Einhorn and Hogarth, 1988). In these models, choice is assumed to follow evaluation by picking

alternative with the highest expected payoff or utility, but conflicts result from the uncertainties that characterize evaluation (Einhorn and Hogarth, 1988; Luce, 1977). Prospect theory, however, attempts to resolve these conflicts with a compensatory rule through decision weights. It is in this context that this thesis considers choice.

2.5 Summary and Implication of Literature Review

Media richness theory holds that managers or decision makers should use rich media, which have significant information-carrying capacity, for complex tasks (Daft and Lengel, 1984). From a social perspective and in a normative sense, the theory has been largely supported by early research that used perceptual metrics, such as self-reporting in surveys and predetermined standards or references.

However, when the theory was examined in the context of task characteristics and analyzability, studies have concluded that there are no certain and conclusive support for media richness theory (Valacich et al., 1994; Rice, 1992; Kinney and Watson, 1992). Additionally, other recent studies have completely rejected media richness and posit that the only effect of varying media richness is time; specifically, richer media support quicker decisions (Dennis and Kinney, 1998; Dennis and Valacich, 1999).

All these findings, suggest that there are new directions for research on media richness theory. Specifically, it would valuable to examine media richness theory based on media richness, as it was originally conceptualized, giving focus to

information acquisition. It would also be valuable to progress from the kinds of communication tasks that have been used to assess the theory and examine decision-making tasks under uncertainty. Additionally, rather than examining performance in isolation, it is necessary to examine the consistency or coherence of individuals' judgment as well as individuals' risk propensities when using different communications media.

CHAPTER 3

Theoretical Framework and Hypothesis Development

This chapter presents the theoretical foundation for this research study, focusing on two of the main characteristics of media richness – feedback and cues. Explanatory variables that relate feedback and cues to decision-making under uncertainty are also described in this chapter. Finally, several testable hypotheses, concerning these explanatory variables, media richness, subjective judgment, and risk propensity are justifiably formulated.

3.1 Theory Development

Recent empirical studies have directly examined two of the four[18] media characteristics relevant to media richness theory – feedback and cues (Dennis and Kinney, 1998). In these studies, cues and feedback have been informally operationalized. Here, cues and feedback are also examined, but both constructs are operationalized with quantifiable proxies.

In the context of this research, the other two characteristics, personal focus and language variety are less significant. Media have inherent degrees of personal focus, which describes the extent to which a message is conveyed with personal feelings and emotions. Personal focus affects performance when mixed media are used to assess a specific single task (Trevino et al., 1990; Dennis and Kinney, 1998). The conceptual

[18] The four characteristics include personal focus, language variety, feedback and cues.

model for this thesis is predicated on the assumption that communications media of different types are not mixed with each other in order to complete the experimental task, which is used to assess the model. Furthermore, the emotional attribute of personal focus is also expressed by cues, which are explicitly considered in this study. Therefore for the purposes of this study, personal focus is a stable construct and its attributes are captured by cues.

This study views language variety in its broadest sense to encompass various ways to transmit ideas, emotions, and concepts. There are two categories of this construct – natural language and numbers (Daft and Lengel, 1984; Daft and Wiginton, 1979; Dennis and Kinney, 1998). Provided media types are restricted to video, audio, and computer text, and that tasks use natural language and numbers, language variety will depend entirely on cues (Dennis and Kinney, 1998). In other words, the discussion on cues covers the theoretical consideration of language variety.

In the next section, the two media characteristics, feedback and cues, are presented in turn. It is shown that these constructs are fundamentally different from each other, yet they coexist almost inseparably. The conceptual model that theorizes and defines the relationship between different types of feedback and cues and decision-making under uncertainty is presented. It is important to note that the justification for theorized relationships is based on the belief that individuals set out to rationally use feedback and cues to optimize decision-making.

3.1.1 Media Feedback

Fundamentally, there are two distinct roles fulfilled by an individual during communication – the role of a sender and that of a receiver (Shannon and Weaver, 1949). As a sender, the individual creates and sends the initial version of a message to be communicated; and as a receiver, the individual accepts and responds to the message from the sender. A message is information that is either understood after it is first passed to a receiver from a sender or not understood, thus requiring clarification or retransmission. Feedback intermediates the process of message transmission by providing the means for understanding and reaching agreements. Specifically, it provides relevant and explicit information for the convergence of understanding between a sender and a receiver.

There are several types of feedback that have been identified in the behavioral science literature (Clark and Brennan, 1991; Clark and Wilkes-Gibbs, 1986; Clark, 1992). Four types of feedback are believed to be relevant to understanding the effects of media richness on communication (Dennis and Kinney, 1998). They include:

- A positive acknowledgment that indicates understanding;
- A negative acknowledgment that indicates a lack of understanding;
- A repair that clarifies or corrects messages;
- A proxy in which the receiver completes the message for the sender.

For the purposes of this study, these types of feedback are collectively referred to as media feedback or simply feedback.

The capability of communications media to accommodate media feedback with immediacy provides a relative basis for rating different types of communications media on their degree of richness. Telephone-to-telephone communications medium can facilitate positive and negative acknowledgments, repair and proxy feedback more readily than either instant messaging or non-mediated computer-to-computer systems. Instant messaging can facilitate positive and negative acknowledgment, repair, and some proxy feedback more readily than can the non-mediated systems, but less than telephone-to-telephone. Non-mediated systems can facilitate positive and negative feedback only. In general, richer media have greater feedback capabilities. So based on the capability to support media feedback with immediacy, from telephone-to-telephone to instant messaging to non-mediated computer-to-computer systems, media richness decreases (Dennis and Valacich, 1999).

Based on anecdotal evidence, it is believed that there are structural limitations to media that alter the different types of feedback (Dennis and Kinney, 1998; Dennis and Valacich, 1999). Studies assert that immediate feedback is more difficult in text communication media since it takes longer to type for both the sender and a receiver than it takes for them to speak; in written media, negative acknowledgments may be ignored because of preoccupation with writing a response to previously sent messages; and proxy feedback is contingent upon some minimum amount of message transmission (Dennis and Kinney, 1998; Dennis and Valacich, 1999). Thus they have concluded that the only effect of varying media richness is time, such that richer media support quicker decisions, ignoring the likelihood that individuals might

intentionally manipulate their need for immediate responses whenever it is beneficial to do so.

Research studies have, explicitly or implicitly, considered rapid feedback to be a goal for both senders and receivers (Clark and Brennan, 1991; Clark and Wilkes-Gibbs, 1986; Clark, 1992). Presumably this is so because media richness was originally conceptualized based on the notion of immediacy of feedback, which is defined as the extent to which a medium enables users to give rapid responses (Daft and Lengel, 1984; 1986). Furthermore, it is believed that the rate of feedback indicates the accuracy of communication and the level of understanding achieved between sender and receiver (Daft and Lengel, 1984; 1986).

3.1.2 Cues

Cues consist of information that goes beyond the content of the message during communication. Unlike media feedback, which consists of explicit information that is intended to directly clarify a message, cues are not explicit information. Specifically, the relationship between a message and some associated cues has to be inferred by the sender or the receiver, but is expected to be discernable. In other words, during communication, cues are understood by perception.

Cues are used to emphasize importance, to show degrees of certainty, to display acceptance, to invoke dominance, and to demonstrate other similar social gestures

that go beyond the literal meaning of a message (Williams, 1977; Dennis and Kinney, 1998). The number of ways in which information can be communicated, such as tone of voice (verbal), physical gestures (nonverbal), pauses (nonverbal), and text is termed multiplicity of information cues (Daft and Lengel, 1986; Daft and Wiginton, 1979).

Cues are believed to affect the communication and understanding of messages in at least four distinct ways (Dennis and Kinney, 1998). The effects are concerned with: the amount and accuracy of information transmitted, the rate of message transmission, feedback, and social perception. Apart from the effects related to social perceptions, all other effects of cues tend to occur together and each affects the other. For example, whenever cues are such that the accuracy of information is compromised, more feedback is required for resolution and the rate of message transmission might increase. However, the effect on social perception ranges from depersonalization to high levels of sensitivity and kindness when cues are moderated (Kerr and Hiltz, 1982; Walther, 1993). Suffice it is to say that whenever cues are entirely removed from communications, there is a loss of social presence (Short, 1978; Walther, 1992; 1993; Rice, 1993; Dennis and Kinney, 1998).

The conveyance[19] of cues varies from medium to medium (Dennis and Valacich, 1999). It is theorized that media with fewer cues are less rich (Daft and Lengel, 1987; Dennis and Kinney, 1998). The extent to which media vary in their ability to convey different cues leads to a classification scheme for media richness that is similar to the scheme based on feedback. In particular, on the basis of its ability to convey cues, telephone-to-telephone communications medium is richer than either instant messaging or non-mediated computer-to-computer systems. Instant messaging has evolved with its own types of cues such as capitalization for intonations and emphases, smiling/angry faces or emoticons for emotions, and many other symbols and characters that accentuate social presence.

Thus far the discussion on media feedback and cues informs that these constructs are fundamentally different from each other, yet they coexist and serve a common purpose – to augment understanding during communication. The theoretical relationship between cues and feedback is certain – cues affect feedback, which in turn affect information acquisition and hence understanding. It is difficult, if not impossible, to empirically assess their separate impact on performance. However, their impact on performance can be explained through other constructs, which are more conducive to empirical investigation.

[19] Based on definition of cues, the expression: "conveyance of cues" is not different from the "conveyance of information" which is concerned with the resolution of equivocality with a focus on the dissemination of a diversity of information (not previously known to participants) from many sources (Dennis and Valacich, 1999).

3.2 Conceptual Model

In this section, prior research is integrated and used to develop a conceptual model, which theorizes and justifies relationships that exist among media feedback, cues, and decision-making constructs. These decision-making constructs are related information acquisition, evaluation, subjective judgment and risk propensity.

3.2.1 Feedback, Cues and Decision-making

Increased immediacy of feedback and multiplicity of cues increase media richness, and the use of richer media for equivocal tasks results in better performance (Daft and Lengel, 1986). Research studies have considered performance in terms of the degree of accomplishment of a task. Accordingly, performance has been evaluated in terms of the time to complete a task, the extent of cooperation among individuals, and with reference to predetermined outcome criteria (Dennis and Kinney, 1998; Rice, 1992; Kinney and Watson, 1992; Valacich et al., 1994).

This study argues that in the context of media richness theory and in a behavioral sense, it will be valuable to consider performance as the manner in which a decision-maker responds to messages conveyed by communications media. Experiments have shown that decision-makers interpret stimuli (or messages) rather than merely respond to them (Tversky and Kahneman, 1981; Kubovy, 1977). This definition[20] of performance provides an objective standard for measuring the effects of media

[20] Such a broad definition makes it possible for performance to be considered objectively, in the sense that the personal goals of individuals that conflict with standards of performance that are predefined are accounted for.

richness on decision-making independent of task, not to the exclusion of assessing performance by subjective standards.

Five factors are assumed to affect performance: equivocality, uncertainty, routineness, complexity, and emotional content (Daft and Lengel, 1986; Daft et al., 1987; Dennis and Kinney, 1998). This thesis will focus on the uncertainty factor due to its significance in decision-making, its effect on judgment and choice as well as performance. More importantly, past research studies on media richness theory have not explicitly considered this factor.

Equivocality and uncertainty (or degree of certainty) were initially described as two different factors, but uncertainty has been deliberately ignored (Dennis and Kinney, 1998) or understandably treated as a component element of equivocality in later studies. Since equivocal tasks are inherently characterized by multiple interpretations, it is conceivable that the choice of one interpretation or another must be made with some concern for uncertainty. Additionally, the judgment of multiple interpretations ought also to be affected by feedback and cues.

A past research study, which investigated the main proposition of media richness theory, did not find support for the claim that decision quality decreases as immediacy of feedback and multiplicity of cues decrease (Dennis and Kinney, 1998). A plausible explanation for this finding is that with less feedback and cues, individuals are less informed and they make more random choices, which on average

result in "unexpectedly better" decisions or outcomes. That is, individuals make choices that are based on inconsistent judgment strategies (finding it better to perhaps guess), or based on factors outside the reference task domain (using personal experiences that might be less relevant), or based on inaccurate weighting of cues and feedback.

Of the media feedback and cues discussed in the preceding section, none directly affects judgment in decision-making. This study argues that the extent of their presence in communications media impact sub-processes that are associated with information acquisition, evaluation, and judgment.

In the context of communications media and decision-making, a stimulus and a message are intrinsically linked to each other.[21] Accordingly, the impact of media feedback and cues on decision-making can be assessed in relation to sub-processes, such as attention, message representation and message redundancy, which are associated with information acquisition. The impact of these media characteristics can also be assessed in terms of evaluation criteria such as message significance and judgment, and ultimately, risk propensities. Collectively, these assessments can explain performance related outcomes based on media richness theory.

[21] Stimuli depend on attention and are explicit attributes of a construct (Tversky, 1977), making it similar to a message. Stimuli must not be confused with cues, as the meaning of cues in terms of media characteristic differs from the meaning of cues in terms of information acquisition and judgment. As a media characteristic, cues depend on perception (Williams, 1977; Dennis and Kinney, 1998).

The conceptual model, upon which this research study is based, is shown in Figure 2, below. It holds that when individuals are presented with and set out to resolve a decision-making problem under uncertainty, using communications media that vary in richness, sub- processes of information acquisition and evaluation are affected by the richness of media. Additionally, subjective judgment and risk propensity are affected by media richness.

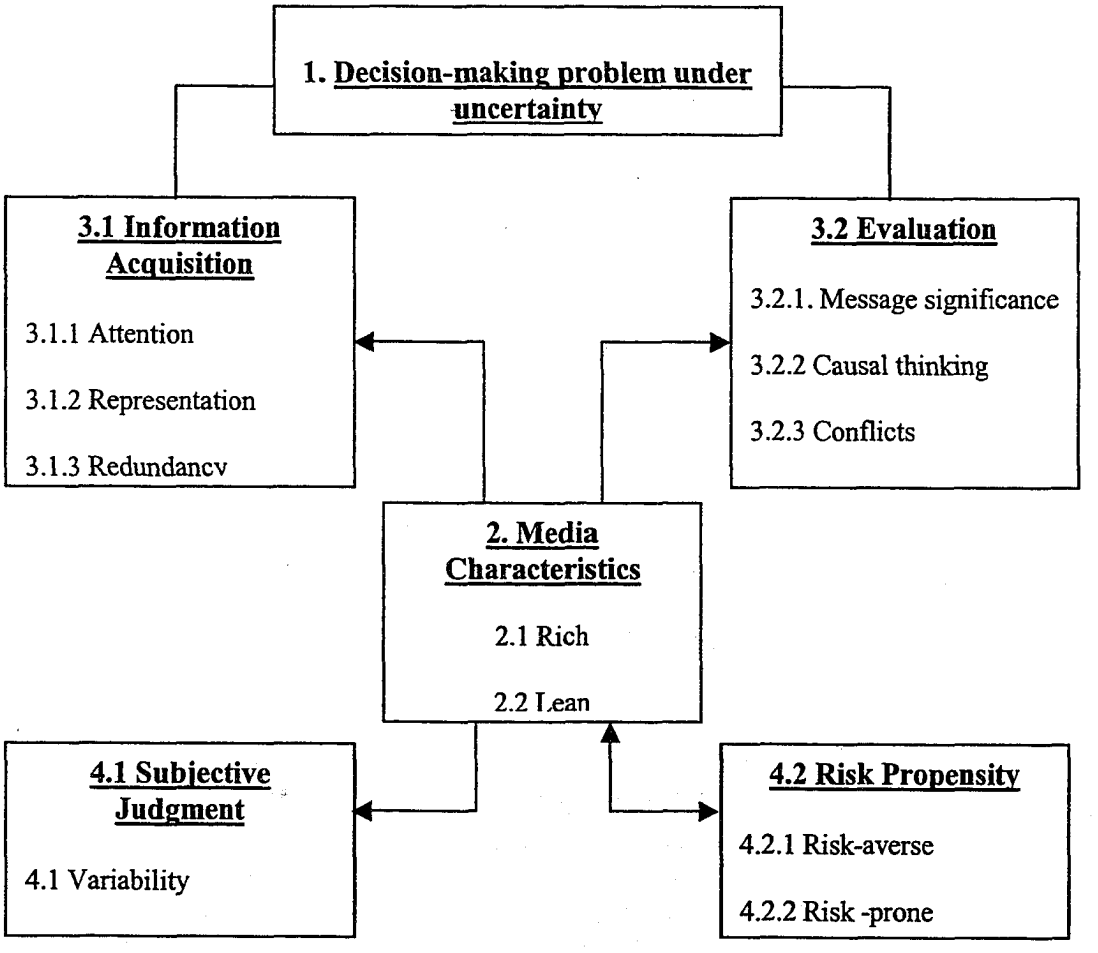


Figure 2: Conceptual model of relationships among media richness, information acquisition, evaluation, subjective judgment and risk propensity; Arrows indicate theorized relationships between sets of variables.

3.3 Hypothesis Development

In this section, based on the foregoing conceptual model and the definition of implied theoretical constructs of the model, six sets of testable hypotheses or eighteen distinct hypotheses are posited.

3.3.1 Message representation and attention

Research studies indicate that rich media provide greater feedback capabilities and support multiplicity of cues more than do lean media (Daft and Lengel, 1986; Dennis and Valacich, 1999). Feedback in rich media helps to clarify understanding, and it is believed that rapid feedback indicates that understanding is achieved (Daft and Lengel, 1984; 1986). However, it is possible that feedback in rich media also supports attention, rather than only to clarify understanding. Therefore rapid feedback, which is conveyed by communications media, can also represent a sender's effort to preserve or maintain a minimum level of attention from a receiver.

Like feedback, multiplicity of cues in rich media might restore attention that is lost during communication. For example, during a telephone conversation, a particular tone of voice might be introduced to ensure or to restore a listener's attention, in much the same manner that it is used to show emphasis and dominance. So both media feedback and multiplicity of cues in rich media facilitates attention between a sender and a receiver. Feedback and cues make it less likely for the attention of either the sender or the receiver to fall during communication in rich media.

In lean media, media feedback and cues are less than those in rich media (Daft and Lengel, 1986; Dennis and Valacich, 1999). If the attention of either a sender or a receiver or both falls during communication in lean media, there are less media feedback and cues to restore or ensure that attention does not fall below a minimum level. In this situation, the attention of a sender and or a receiver is restored independently, that is without the support of media feedback and cues.

Task representation, which is derived from the decomposition of stimuli, is directly related to attention, such that more attention reflects less variability in task representation (Tversky and Kahneman, 1979). In a similar sense, task representation is derived from message representation, which refers to the capacity of the message to influence the opinions or actions of senders and receivers. It also follows that more attention indicates less variability in message representation.

Since it is theorized that attention is affected by media richness, and given the relationship between attention and message representation, it can also be theorized that message representation is affected by media richness. In particular, message representation will have more extreme variations in lean media than in rich media, because of the different levels of attention supported by these respective types of media. Less variability in message representation implies that on average, not only are decisions made faster, but also that on average deviation from a referenced construct is less in rich media.

In view of the relative richness of telephone-to-telephone communications system, instant messaging system and a non-mediated computer-to-computer system, it is argued that message representation will vary with the richness of the communications media that are used to convey messages, such that:

> *Hypothesis 1a: In a telephone-to-telephone communications system between two decision makers concerning uncertain outcomes, on average, the variability in message representation is less than the variability in message representation in an instant messaging communications system.*

> *Hypothesis 1b: In a telephone-to-telephone communications system between two decision makers concerning uncertain outcomes, on average, the variability in message representation is less than the variability in message representation in a non-mediated computer- to-computer communications system.*

> *Hypothesis 1c: In an instant messaging communications system between two decision makers concerning uncertain outcomes, on average, the variability in message representation is less than the variability in message representation in a non-mediated computer- to-computer communications system.*

3.3.2 Message significance

Media feedback and multiplicity of cues are also likely to affect the importance and value (how is the message used) attributed to a message – termed, message significance. In rich media, feedback capabilities and multiplicity of cues make it possible for senders and receivers to give emphasis to messages, which influence action. Negative feedback and positive feedback, for example, provide two distinct ways to convey the significance of a given message.

Similarly, multiplicity of cues in rich media enables senders and receivers to show emphasis through tone of voice, physical gestures and other social gestures that go beyond the literal meaning of a message (Williams, 1977; Dennis and Kinney, 1998). Therefore messages can be delivered with more emphasis in rich media through the use of feedback and cues, causing them to have more significance to a sender or a receiver.

In lean media, the ability to give emphasis to messages is significantly less than in rich media. Reduced feedback capabilities and range of cues limit the extent to which emphasis on messages can be achieved in lean media. With less emphasis inherently being possible in lean media, the significance attributed to messages is comparable less in lean media than in rich media.

Based on the preceding points, it is argued that:

> *Hypothesis 2a: In a telephone-to-telephone communications system, on average, the significance attributed to messages is greater than the significance attributed to messages in an instant messaging system.*

> *Hypothesis 2b: In a telephone-to-telephone communications system, on average, the significance attributed to messages is greater than the significance attributed to messages in a non-mediated computer-computer communications system.*

> *Hypothesis 2c: In an instant messaging communications system, on average, the significance attributed to messages is greater than the significance attributed to messages in a non-mediated computer-to-computer communications system.*

3.3.3 Message redundancy

Feedback capabilities and multiple cues are also likely to affect message redundancy, which is defined as the duplication of the message characterized by redundant information and a reduction in the dimensionality of the information space. Specifically, media feedback and multiple cues can increase message redundancy. In rich media, for example, a negative and a positive feedback can be considered two different ways of communicating the same message, increasing redundancy. Similarly, a combination of a proxy feedback and a positive feedback on a single stimulus augments redundancy.

Multiple cues are likely to affect message redundancy indirectly. These cues will affect message redundancy through feedback. For example, a soft tone of voice in relation to a stimulus might invoke positive feedback on that message. Thus increasing the occurrence of the message redundancy.

Message redundancy, as defined in this study, implies that there is a reduction in the dimensionality of the information space of the message or the amount of distinct types of data and the relations among them. Furthermore, fewer message properties, which refer to effects that a message has on the sender or the receiver, are communicated with a message whenever message redundancy is high. In rich media, there are more opportunities for different combinations of feedback and cues to occur than are there opportunities to do so in lean media. Therefore, all things being equal, message redundancy is likely to be greater in rich media than in lean media. Accordingly, it is posited that:

> *Hypothesis 3a: In a telephone-to-telephone communications system, on average, less message redundancy occurs than in an instant messaging system.*

> *Hypothesis 3b: In a telephone-to-telephone communications system, on average, less message redundancy occurs than in a non-mediated computer-to-computer communications system.*

Hypothesis 3c: In an instant messaging communications system, on average, less message redundancy occurs than in a non-mediated computer-to-computer communications system.

3.3.4 Judgment

Judgment is based on information acquisition, evaluation, action and learning. Information acquisition is a critical component of judgment and the factors that affect information acquisition are also likely to affect judgment. A research study has asserted that it is necessary to differentiate between judgments for long-run events, such as those based on objective probabilities, and unique events, such as those based on knowledge (Lopes, 1981). In the literature, two kinds of strategies are associated with judgment – aleatory (related to long-run events), and epistemic (related to unique events) (Beach, 1997). Furthermore, individuals are believed to use these strategies according to the nature of a task and the environment in which the task is performed.

This research study is concerned with judgment that is based on an epistemic strategy and the level of chance associated with statements such as such as "sure thing", "very likely" or "unlikely". For the purposes of this study, this kind of judgment is referred to as subjective judgment. In the absence of explicit consideration of the other factors relating to subjective judgment, such as conflict in action, it is possible to hypothesize the effects of media richness on subjective judgment.

In the context of media richness, causal thinking is a useful reference construct for subjective judgment because of its relationship to information acquisition and use. Causal thinking refers to the identification of relationships between message and response, and it arises from information acquisition and use (Tversky and Kahneman, 1981). Information that receives a causal interpretation by a decision-maker, which can be a sender or a receiver during communication, will be weighted more heavily in subjective judgment than information that is diagnostic[22] (Tversky and Kahneman, 1981).

Rich media, because of media feedback and cues, are likely to favor the derivation of relationships between messages and responses for either a sender or a receiver. It follows that causal thinking will increase with increased richness of a medium. Thus messages that are exchanged in rich media will be more heavily weighted in subjective judgment. The combined effect of heavily weighted subjective judgment and more causal thinking should result in fewer instances of observable or reported changes in subjective judgment in rich media.

Conversely, in lean media, the derivation of relationships between message and response for either a sender or a receiver is less favored. Causal thinking will decrease as a medium becomes leaner and there should be more instances of observable or reported changes in subjective judgment in lean media.

[22] Recall that this refers to the kind of information that simply differentiates one idea from another based on distinct or marked points of differences.

Hence, it is posited that:

Hypothesis 4a: In a telephone-to-telephone communications system, on average, changes in subjective judgment are less than in instant messaging system communications.

Hypothesis 4b: In a telephone-to-telephone communications system, on average, changes in subjective judgment are less than in a non-mediated computer-to-computer communications system.

Hypothesis 4c: In an instant messaging system communications systems, on average, changes in subjective judgment are less than in a non-mediated computer-to-computer communications system.

3.3.5 Feedback, cues, and risk propensity

The remaining propositions are based on the appropriation of Prospect Theory to a situational context in which decision-makers' choices are influenced by communications media. In this regard, we are primarily concerned with risk propensity constructs, media feedback and cues.

Consider a telephone-to-telephone communications setting in which two decision-makers, identified as subject 1 and subject 2 and characterized as a sender and a receiver, set out to determine the degree of certainty that is specified by a given

objective probability or chance. The message exchange and media feedback, which is indicated in squared brackets, might occur as follows.

Subject 1: *A 70% chance is as good as a sure win (said with dominance)* [MESSAGE]

Subject 2: *How sure is sure? (reply with uncertainty)* [NEGATIVE FEEDBACK]

Subject 1: *As sure as certain, so definitely as goo... (said with greater emphasis)* [REPAIR]

Subject 2: *.....od as a winner (reply with less uncertainty than before)* [PROXY]

Subject 2: *I guess most people will agree that a 70% chance is a sure win (still a little doubtful)* [POSITIVE]

Subject 1: *That's correct (less dominant than at the start)* [POSITIVE].

In the context of the above message exchange, the sender and the receiver readily understand all the intonations and emphases. The sender uses intonations and emphases to express his or her certainty about the claim made; the receiver uses fewer intonations and emphases to indicate his or her uncertainty. However at the end of the exchange both understand a balanced view, which is likely to be different than what

was initially believed by the sender and the receiver before the exchange about the meaning of a 70% chance.

In an instant messaging setting, which is considered a leaner medium than a telephone-to-telephone setting, a message exchange is characterized by the use of fewer words and of more symbols and abbreviations (webdings and emoticons) to express intonations, emphases and emotions. Accordingly, the above message exchange may occur in an instant messaging setting as follows:

Subject 1: *70% chance is a WINNER!!!* [MESSAGE]

Subject 2: *'ow sure R U ??????* ☹ [NEGATIVE]

Subject 1: *100% !!!* ☺ [REPAIR]

Subject 2: *I guess U R rite* ☺ [POSITIVE].

Contextually, the degree of certainty about a 70 percent chance reached by both the sender and receiver in this setting is likely to be different from that which is reached in the telephone-to-telephone exchange. There are several dimensions on which degree of certainty would be affected from one medium to another. First, the perception of influence would be different (Hollingshead, 1996); second, the extent of depersonalization will be different (Short, 1976; Walther, 1992; 1993; McGrath and

Hollingshead, 1994,); and third, a large proportion of the meaning is contained in the verbal cues (Mehrabian, 1971).

Suppose the sender and the receiver are risk-averse on the decision to go for the potential payoff associated with the 70 percent chance. This study argues that in the telephone-to-telephone communication, the decision weight or the transformed objective probability of 70 percent is greater than the transformed objective probability of 70% in the instant messaging exchange.

In the instant messaging setup, the absence of a proxy feedback and the reduction in the number of instances of positive feedback and cues lead to less confidence in the decision weight for both the sender and the receiver compared to that which would be reached in the telephone-to-telephone setup. The depersonalized instant messaging communications system prevents the sender from imposing his or her influence verbally, which expresses confidence about the 70 percent chance. Additionally, the sender is unable to get some validity, which is expressed as consensus agreement in the form of positive feedback, from the receiver. The direction of decrease in decision-weight, which is assigned by risk-averse decision-makers, is the same, but the magnitude by which the decision weight is decreased varies with the richness of the communications media.

In reference to the above illustration, the most striking difference between the communications media that will affect decision-weight is the proportion of verbal

cues that each allow. There are no verbal cues in the instant messaging setup, however, emoticons and webdings provide some compensation for loss verbal cues. The absence of actual verbal cues ought to significantly affect decision-weight, such that a decision-weight for the same uncertain event in the instant messaging medium would be different from the decision-weight in the telephone-to-telephone medium.

The differences in ascribed decision-weight from one medium to another directly affect risk propensity. In particular, the decision-weight for the same objective probability is likely to be greater in a rich medium than in a lean medium, for the same potential payoff, the expected value of the uncertain event will also be greater in a rich medium than in a lean medium.

Recall that the expected value is the product of the decision-weight and the payoff value. So a risk-averse decision-maker will have expected value, say EV_{RM} in a rich medium, and expected value EV_{LM} in a lean medium, with EV_{RM} greater than EV_{LM}. Unfortunately, neither EV_{RM} nor EV_{LM} is observable and both are notional to the decision-maker. However, a decision-maker's certainty equivalent will indicate the magnitude of the difference in the expected values (or decision weight) based on the decision-weights.

In particular, for a given uncertain event, the certainty equivalent of a risk averse decision-maker will be greater in a rich medium than his or her certainty equivalent in

a lean medium. In other words, a decision-maker will be more risk averse in a rich medium than in a lean medium. Accordingly, it is theorized that:

> *Hypothesis 5a: In a telephone-to-telephone communication between two decision makers concerning a risk averse preference alternative, on average, the absolute risk aversion will be greater than the absolute risk aversion using an instant messaging communication.*
>
> *Hypothesis 5b: In a telephone-to-telephone communication between two decision makers concerning a risk averse preference alternative, on average, the absolute risk aversion will be greater than the absolute risk aversion using a non-mediated communication system.*
>
> *Hypothesis 5c: In an instant messaging communication between two decision makers concerning a risk averse preference alternative, on average, the absolute risk aversion will be greater than the absolute risk aversion using a non-mediated communication system.*

A risk-seeking decision-maker, unlike a risk-averse decision-maker, prefers a gamble. In other words, uncertainty is not a deterrent for a risk-seeking decision-maker. So although less feedback and cues result in a lower decision-weight (or certainty) in a lean medium, the risk-seeking decision-maker finds this decision-weight acceptable. In essence, a communications medium that facilitates a theoretical increase[23] in uncertainty also makes uncertainty more desirable to a risk-seeker. So for a given uncertain event, a risk-seeking decision-maker will have a certainty equivalent that is

[23] In general, increased uncertainty is accompanied by higher payoffs, but in this case the thrill of beating the odds appeals to the risk-seeker.

greater in a lean medium than his or her certainty equivalent in a rich medium. Put differently, a decision-maker will be less risk averse in a rich medium than in a lean medium. Therefore it is theorized that:

Hypothesis 6a: In a telephone-to-telephone communication between two decision makers concerning a risk prone preference alternative, on average, the relative risk aversion will be less than the absolute risk aversion using an instant messaging communication.

Hypothesis 6b: In a telephone-to-telephone communication between two decision makers concerning a risk prone preference alternative, on average, the relative risk aversion will be less than the absolute risk aversion using a non-mediated communication system.

Hypothesis 6c: In an instant messaging communication between two decision makers concerning a risk prone preference alternative, on average, the relative risk aversion will be less than the absolute risk aversion using a non-mediated communication system.

All the hypothesized relationships discussed in this study are shown in Figure 3, below.

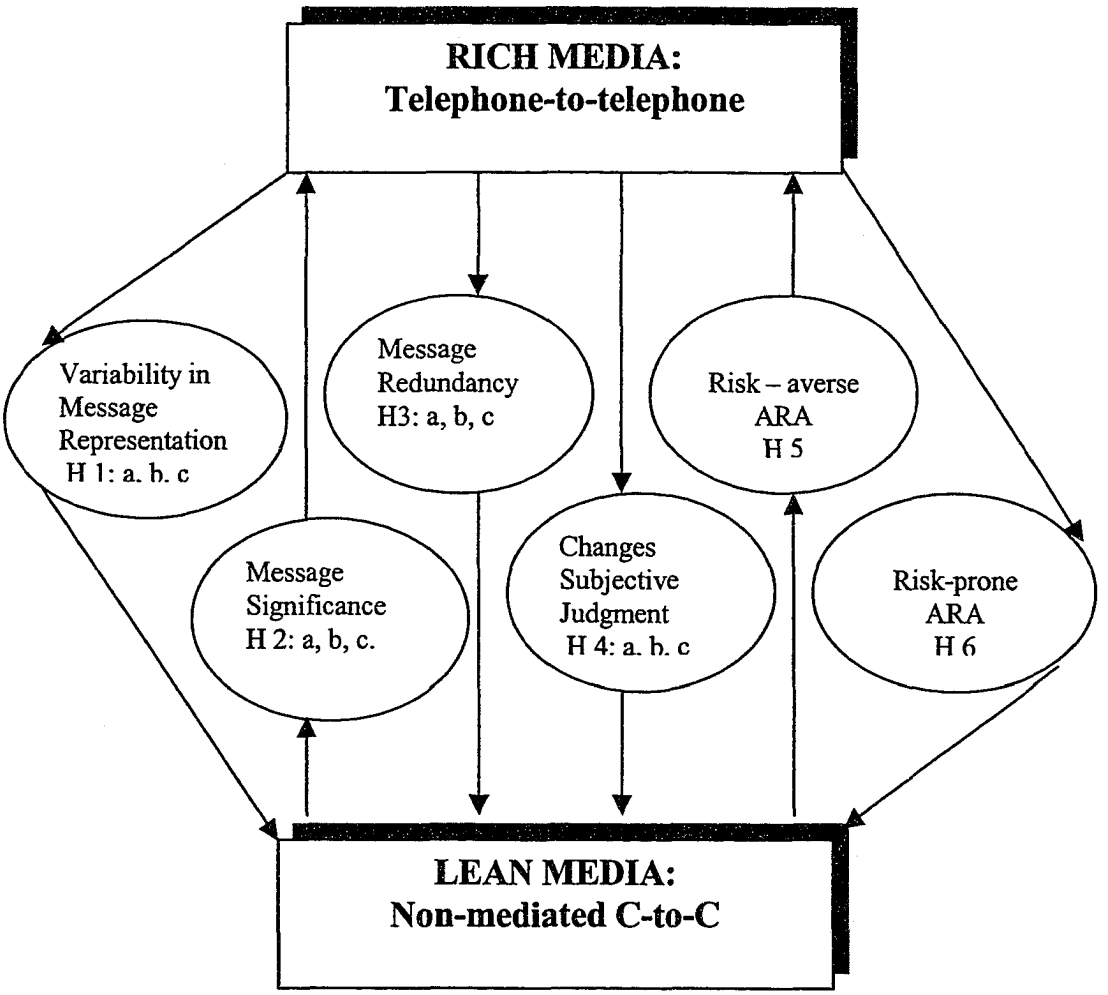


Figure 3: Hypothesized relationships on media richness and decision-making constructs. Arrows pointing from top to bottom indicate that constructs on average show decreasing tendency; and upwards pointing arrows indicate increasing tendency.

CHAPTER 4

Research Methodology

The research methodology is described in this chapter. This includes a description of the general research model, the experimental design and a description of the dependent and independent variables. These descriptions are followed by the experimental procedures and measurements of the dependent variables. The chapter concludes with a description of results for the pilot study, manipulations checks, and accounts of steps taken to ensure procedural reliability, internal validity, external validity and construct validity.

4.1 General Model

The general model of this research study is derived from several conceptual models that have examined media richness theory at the extremes of task and outcome, relying on perceptual metrics, but neglected to examine the impact of media richness on information acquisition and evaluation in the context of decision-making under uncertainty. The theorized model examines five decision-making constructs, which are the dependent variables for this study. These constructs include message significance, message redundancy, message representation, risk propensity and subjective judgment.

It is posited that these constructs depend on media richness and risk propensity, which is defined by two levels of risk induced preferences, namely risk averse induced and

risk prone induced preferences. In particular, the objective is to investigate the individual and combined effect of these categories of independent variable on the dependent variables. Figure 4, below, shows the relationship among the different sets of variables that is examined in this research study.

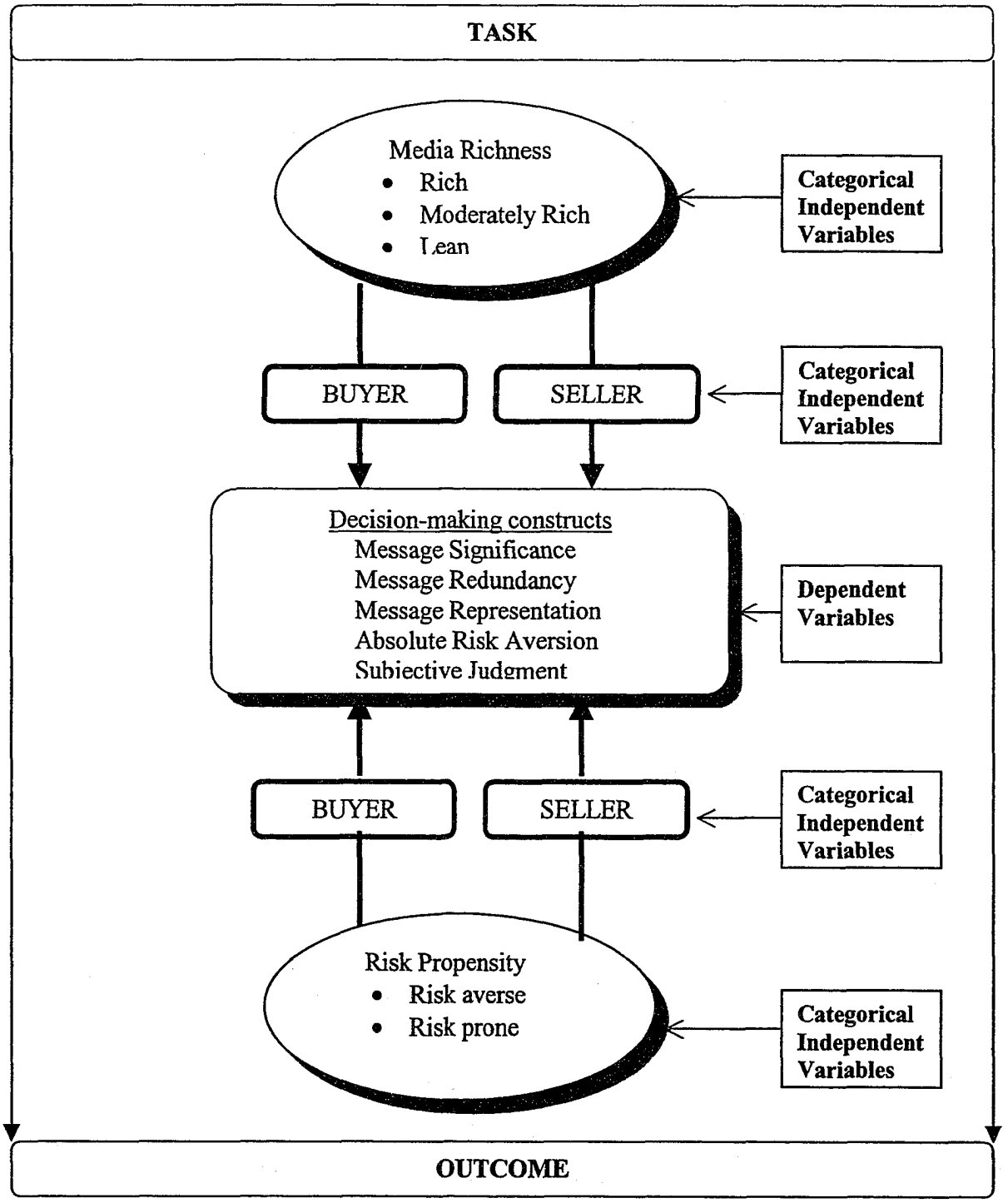


Figure 4: General model of the relationship decision-making constructs, media richness and risk propensity.

In terms of parametric estimates of the independent categorical variables, the general form of the theoretical model is expressed mathematically as follows:

$$Y_{dmr} = \mu + m_r + r_p + (mr)_{rp} + b(m_r + r_p) + s(m_r + r_p) + e_{drp}$$

where Y_{dmr} = the value of the dependent variable for each subject exposed to treatments m_r and r_p; μ = the grand mean of the dependent variable; m_r = effect of media richness treatment; r_p = effect of risk propensity treatment; $(mr)_{rp}$ = effect of treatment combination or interaction for media richness and risk propensity; $b(m_r + r_p)$ and $s(m_r + r_p)$ = the interaction effect of the assigned roles, b-buyer and s- seller, and the treatment combinations of media richness and risk propensity; e_{drp} = error or residual for each subject exposed to treatments m_r and r_p.

The hypotheses being tested are based on orthogonal comparisons among the three levels of media richness and the two levels of risk propensity. All two-way interactions that are related to the primary categorical variables – media richness and risk propensity are included in the model. The two-way interaction terms with the role of subjects (buyer and seller) are included because it is possible that the relationship

between dependent variables and media richness or risk propensity may be modified[24] by these independent variables.

4.2 Experimental Design

The experimental design adopted in this research study is post-measures only of the dependent variables. It is important to note that treatment control[25] in this design is achieved by randomly assigning experimental subjects to the different levels, thereby equating groups on all variables, except for the independent variables. Hence, differences among treatment categories are entirely attributable to whatever the categories or levels represent.

The design for this study is a 3 x 2 factorial design (Table 1), with the categorical independent variables, which were described in the preceding section, defined as follows:

- Media richness, with three levels - (rich (R): telephone-to-telephone (T); moderately rich (MR): instant messaging (I); lean (L): non-mediated computer-to-computer (Q);

- Risk propensity, with two levels - risk-averse induced preferences (A), and risk prone induced preferences (P);

[24]Specifically, depending on the role of subjects, the relationship between the decision-making constructs and media richness/risk propensity may be different. The means by which subjects gain points indicated that sellers were endowed with a right of ownership to the tickets and buyers were endowed with a costless opportunity to acquire tickets. So, there is a strong likelihood that their motivation to trade is different.

[25] In fact, researchers have argued that it is neither practical nor feasible to use control groups in this kind of design (Basham, 1986)

- Role of subjects, with two levels – buyer and seller.

		Risk Induced Preference Types, b_r	
Media Richness, a_m	**Factor level Buyer Seller**	***Risk-averse, A***	***Risk-Prone, P***
	Rich, R	R and A on DV, N=26	R and P on DV, N=26
	Moderately Rich, MR	MR and A on DV, N=26	MR and P on DV, N=26
	Lean, L	L and A on DV, N=26	L and P on DV, N=26

Table 1: Factorial design (3x2) of media richness and risk induced preferences – risk averse and risk prone.

A laboratory experiment was used in this study to assess the hypotheses that are posited. Laboratory experiments are widely used in the MIS research (Sharda et al., 1988; Davis and Cosenza, 1993; Valacich et al., 1994; Rice, 1992; Dennis and Kinney, 1998; Dennis and Valacich, 1999; Sia et al., 2002), and even more extensively in behavioral economics research (see Roth, 1987 for a comprehensive discussion on the kinds of laboratory experimentation in Economics) – both of which are referenced domains for this research study.

The laboratory setting for this experiment facilitates the rigorous and explicit testing of the hypotheses contained herein, allowing the principal investigator to precisely

isolate and measure the effects of treatments. Additionally, by giving experimenters the freedom to determine the number of participants exposed to the same condition, laboratory experiments tend to yield results with higher statistical power (Roth, 1987), which is desirable.

4.2.1 Subjects

One hundred and eighty four (184) students were recruited from the student population at Baruch College, City University of New York. Students that elected to participate in the experiment received a guaranteed $10 gratuity payment, and the possibility of an additional $10 payment, which was determined by a lottery draw.

Two procedures were used to recruit students for the experiment. First, recruitment statements (Appendix A) were posted in the college environment requesting that interested persons contact the principal investigator (PI, the author). Second, the PI, (who completed the Human Participants Protection Education for Researchers), with the permission of class instructors, announced the study to students. In sum, participation was completely voluntary. Interested students were contacted either by email or telephone to schedule their participation. All students signed an informed consent form (Appendix B).

4.3 Experimental Procedure

Subjects were randomly assigned one of two roles, either buyer or seller, and paired (dyads) for participation. Subjects completed the experiment from different rooms/locations. Each subject, of a pair, was not able to identify the other with whom he or she negotiated during the experiment. Subjects with a similar role (for example, all sellers) were escorted to their respective experimental locations at different times from others who were assigned a different role (for example, all buyers). Whenever a group of students, who knew each other, showed up for participation, they were assigned to the same room. This procedure ensured that anonymity for each subject of a dyad was preserved throughout the experiment.

At the start of the experiment, subjects completed a questionnaire, which elicited information about their abilities to make inferences from information communicated by a telephone or a computer. This questionnaire was also used to gather demographic information.

After the questionnaire was completed, subjects were given instructions on how to complete the experimental task. Two types of instructions were given to each of the two types of participants – those who were assigned the role of buyer and others who were assigned the role of seller. The instruction sheets for sellers and buyers are given in Appendix C and Appendix D respectively. Participants were also given, fundamentally, the same instructions, in the form of a power point presentation, by the author. The presentation included two complete illustrations of the task, the

objective for players, as well as a Q & A (question-and-answer exchange between subjects and the author) session. The presentation slides for buyers are given in Appendix E and those for sellers are in Appendix F.

The above procedures ensured that, prior to beginning the task, participants attained the required level of understanding to effectively complete the task and meet the stated objective. Further, subjects were also given the opportunity to obtain explanations from the author throughout the entire experiment. On average, fifteen minutes were required to give complete instructions to each set of participants (buyers and sellers).

The experimental task involved the trading game of notional lottery tickets. Games of this nature are ideal for risk assessment. In the absence of extraordinary gambling skills, competing subjects will invariably utilize the cues and feedback to improve their performance. Gambling games also capture the essence of managerial decision-making and in the literature it is argued that most managerial decisions – almost 60% - are dyadic (Panko and Kinney, 1995).

Microsoft Access was used to develop a trading game interface solely for the purpose of this research study. A centralized database was constructed that contains a user-configurable number of lottery tickets. The system architecture is shown in Figure 5. Buyers and sellers received and exchanged information from the LAN server.

Information about the current game was displayed in a Microsoft Access database form.

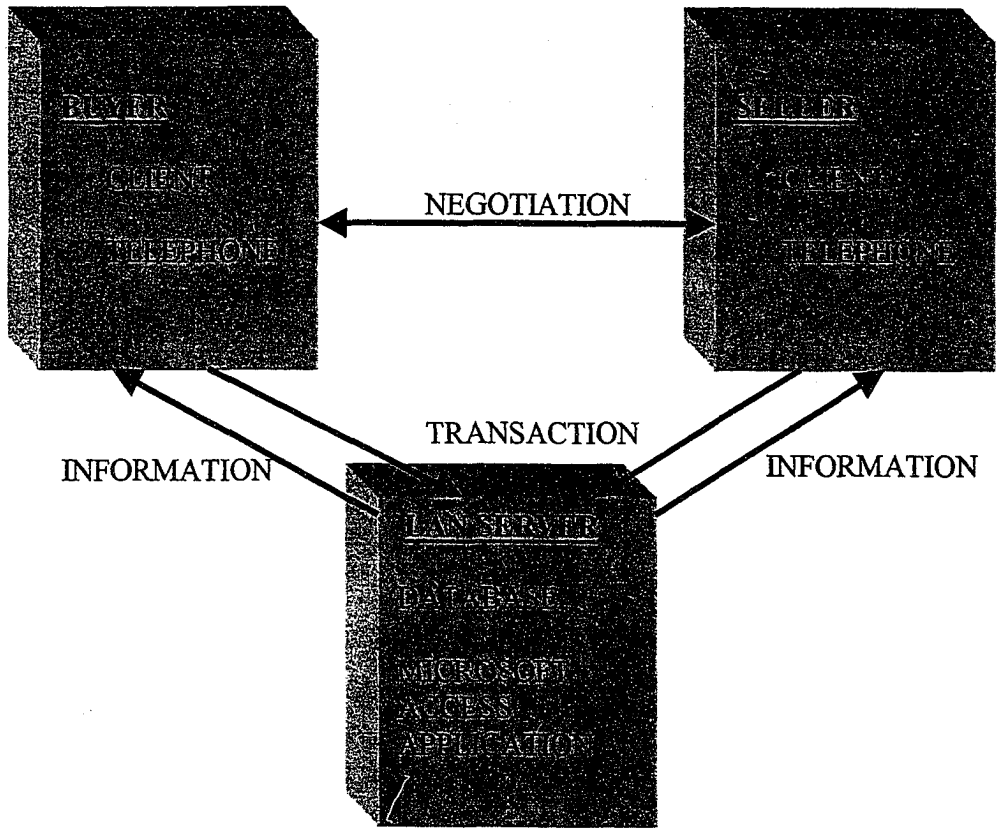


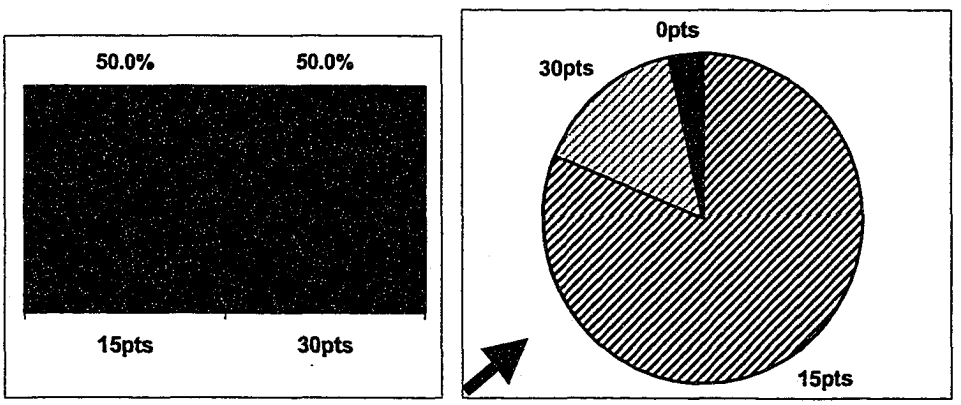
Figure 5: Experimental game system's architecture

For the experimental task, subjects were presented with screen-displayed lottery tickets and a prize wheel and their main objective was to maximize the number of points that they could obtain for each lottery ticket. Each lottery ticket, with a two-faced points value, gave subjects a 50:50 chance to play for one of the two points values displayed on the ticket. The prize wheel ultimately determined if the points being played for were won, but all outcomes were actually determined before the

actual experiment was conducted and they remain unchanged for the entire experimental study.

A random number generator function was used to determine the outcome of the initial random event, which determined the number of points that subjects played for. Similarly, this function was used to determine the outcome for the prize wheel, which determined the number of points won. Effectively, all subjects were tested with the same "instrument" – all were allocated the same points to be played for and all derived the same number of wins and losses, for each role assigned.

Figure 6 shows the two-prize gamble structure of a typical ticket and its corresponding prize wheel. The number of points that a subject played for, whenever a ticket is retained or acquired, was randomly determined.



TICKET **PRIZE WHEEL**

Figure 6: A ticket and the associated prize wheel. If the a subject is given the chance to play for 15 points, then he or she wins whenever the prize wheel stops on the black striped area, indicated by the arrow.

Subjects responded to two questions before negotiation started. First, subjects indicated the maximum number of points they would give up to acquire the ticket (if they were buyers) or the minimum number of points they would accept for the ticket (if they were sellers). Neither buyers nor sellers knew each other's minimum and maximum values. Second, subjects indicated their subjective judgment, which was measured on a 7-point Likert scale (ranging from poor to excellent), of the chance to win each of the number of points shown on each ticket based on the prize wheel.

Buyers either acquired a ticket (in an effort to win the points displayed on the ticket), by giving sellers guaranteed points (buyers' bids) for the ticket, or elected not to do so - all depending on the chances associated with the ticket's face value. Buyers were allowed to acquire tickets with an interest free loan, capped at the maximum face value or number of points for each ticket. Borrowed points were recovered from the buyer's reward after each lottery draw.

Sellers, on the other hand, submitted the number of points they would accept for a ticket (sellers' offers) and would either retain the ticket if their indicated offer was not accepted by the buyer, or elect to accept the buyer's bid (thus, receiving guaranteed points) - all depending on the chances associated with the ticket's face value.

There were three distinct sessions in which subjects set out to trade the notional lottery tickets. Negotiations were conducted over three communications media or channels – namely, (i) telephone-to-telephone (ii) computer mediated instant messaging system, and (iii) non-mediated computer-to-computer system. The instant messaging system provided a communications medium in which subjects were able to exchange a few lines of typed text, displayed on a computer screen, with each other. The non-mediated computer-to-computer system, on the other hand, provided a medium in which subjects exchanged only numerical data. Finally, the telephone-to-telephone communications medium allowed subjects to negotiate over the telephone and the information exchanged (voice data) was recorded to a pre-assigned folder on the local PC.

Pairs of subjects negotiated the trade of lottery tickets until an agreement was reached or until the game timed[26] out. A timer, which was displayed on screen during negotiation, counted down the remaining time to complete a trade. Whenever the game timed out, negotiating subjects received zero points. After negotiation was completed, a random event determined the number of points that the ticket-holder played for. Before the prize wheel was spun to determine the final outcome, the ticket-holder was required to record his or her subjective judgment of the chance to win the assigned number of points based on the prize wheel.

[26] Purdy and Nye (2000) found that less time is needed for negotiation in rich media, but negotiation depends on the task. A pilot study was used to determine an appropriate negotiation time for the communications media (See section on pilot study).

Following all the steps described above, dyads traded nine tickets using each communications medium. Nine tickets were used because research studies have shown that in the quantification of judgment eight (8) to ten (10) carefully selected bets determine subjective probabilities to the 3rd degree (Harrison, 1986; Winkler, 1967).

The order of the media that subjects used for negotiation during trading was completely randomized. Specifically, subjects used media in the following orders, either:

- the instant messaging system followed by the non-mediated computer-to-computer system followed by the telephone–to-telephone; or

- the telephone–to-telephone followed by instant messaging system followed by the non-mediated computer-to-computer system; or

- the non-mediated computer-to-computer system followed by the telephone–to-telephone followed by the instant messaging system.

4.3.1 Classification of Independent Variables

Media Richness

The first of our two independent categorical variables is media richness. We classify the different levels of media richness according to established criteria. Specifically, the capacity of a medium to facilitate the exchange of different types of feedback, as well as social cues, which were discussed in chapter 3, provide a relative basis for rating or categorizing different kinds of communications media in terms of their degree of richness. By these criteria, communications media increase in richness as the extent to which they support feedback and cues increases. Many research studies have relied on this classification scheme for media richness (Daft and Lengel, 1986; Rice, 1992; Valacich et al., 1994; Trevino et al., 1987; Argyle, 1969; Birdwhistle, 1970; Markus, 1987; Rice and Shook, 1990; Zhmud, Lind and Young, 1990; Russ et al., 1990; Dennis and Kinney, 1998; Dennis and Valacich, 1999; Sia et al., 2002). Consistent with this classification scheme, this study also considers the varying degree of richness among the different types of communications media. The next subsection presents a description of the classification scheme.

Rich medium. The telephone-to-telephone communications medium, which facilitated the exchange of positive and negative acknowledgments, repair and proxy feedback, as well as verbal cues, between participants in this experiment is classified as a rich medium. In particular, it is considered a richer medium than both instant

messaging and non-mediated computer-to-computer communications media, which are used in this study.

Moderately rich medium. The instant messaging communications medium,[27] which did not facilitate verbal cues and degraded positive feedback between participants is considered a moderately rich medium. Relative to the other media, it is considered a richer medium than the non-mediated computer-to-computer medium, but not as rich as the telephone-to telephone medium.

Lean medium. The non-mediated computer-to-computer system allowed subjects to exchange only numerical data during negotiation, and thus degraded feedback and cues[28] to lower levels than instant messaging. Relative to the other media that is used in this study, the non-mediated computer-to-computer medium is considered a lean medium.

Risk Propensity

The second independent categorical variable is risk propensity, which is defined by two levels of risk induced preferences, namely risk averse induced and risk prone[29] induced preferences. The two preference types are based on the Induced Value

[27]The instant messaging system allowed subjects to exchange lines of text messages asynchronously. With this medium, subjects must click on a send icon to send messages and while a message is being typed, only the typist sees it.

[28]During the experiment, most subjects informed the author that they looked for patterns in the rate of change numbers/quotes that were submitted, and treated these patterns as cues.

[29] The terms risk prone and risk seeking are the same, and both are used interchangeably.

Theory (IVT) posited by Smith (1976) and extended to the domain of decision theory by Plott and Sunder (1982; 1983), Plott and Wilde (1982) and Berg et al., (1986). This study uses a procedure that is similar to that of Berg et al., (1986). It exploits the fact that in a two-prize gamble,[30] expected utility is linear in the probability of winning a preferred prize. The preferred prize can be stated in units that are determined by the researcher. The two-prize gamble also requires an intermediate trading commodity that is expressed as probabilities.

Research studies have shown that a function, which defines the intermediate trading commodity, enables the researcher to effectively and exogenously control the preferences of individuals (Becker et al., 1964; Berg et al., 1986; Berg, Dickhaut and Rietz, 1999). Consistent with these ideas, and as was done in previous research studies (Becker et al., 1964; Bell et al., 1988; Berg et al., 1986; Berg, Dickhaut and Rietz, 1999), the desired induced risk preferences are transformed utility functions expressed by the probability distributions on the prize wheels. A description of the two levels of risk propensity that are used in this study is given below.

Risk Averse. As mentioned in Chapter 2, a risk averse behavior is mathematically expressed by a concave utility function. In this study, the prize wheels for risk averse

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[30] In bargaining settings, where the outcome space is described by a subject's expected utilities, Roth and Malouf (1979), and Roth and Shoumaker (1983) introduced a mechanism where subjects bargain based on probabilities. Subjects play a two-prize gamble where the preferred prize is based on exchange units that are probabilities, which are linear transformations of expected utilities.

induced preferences are based on the concave function and defined by the equation that follows.

$$U(p) = -e^{(-0.11p)}, \text{ on the interval } [0,50].$$

The concave function is represented graphically as shown Figure 7.

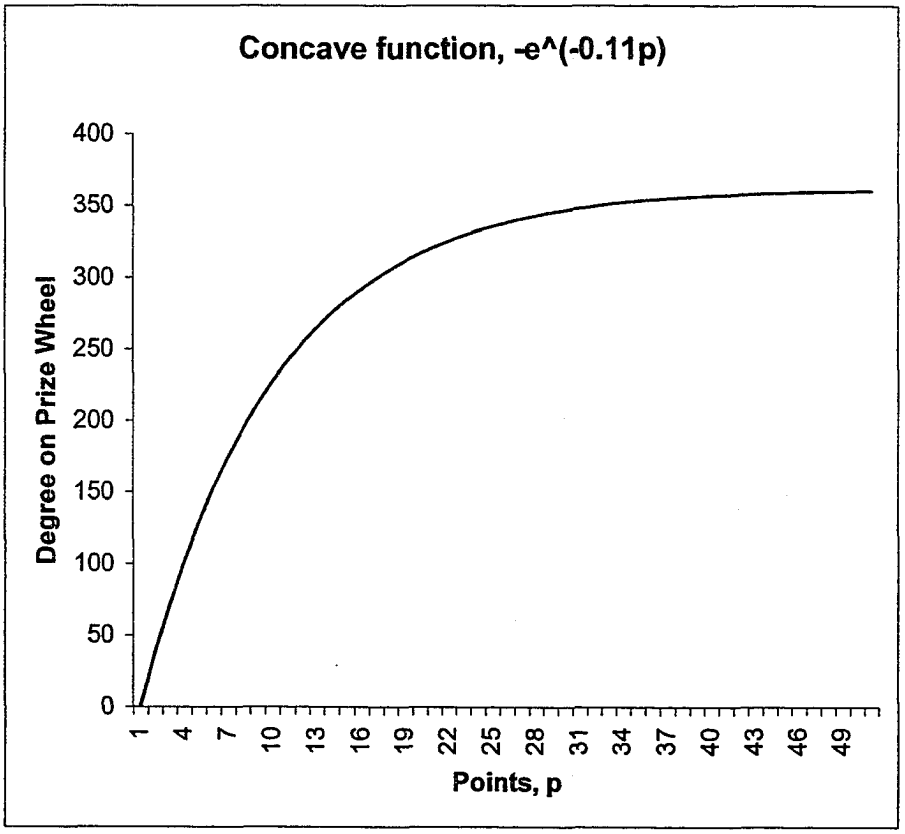


Figure 7: Concave function that defines risk averse induced preferences

Risk-prone. As mentioned in Chapter 2, a risk prone behavior is mathematically expressed by a convex utility function. In this study, the prize wheels for risk prone induced preferences are based on the convex function and defined by the equation that follows.

$$U(p) = e^{(0.11p)}, \text{ on the interval } [0,50].$$

The convex function is represented graphically as shown Figure 8.

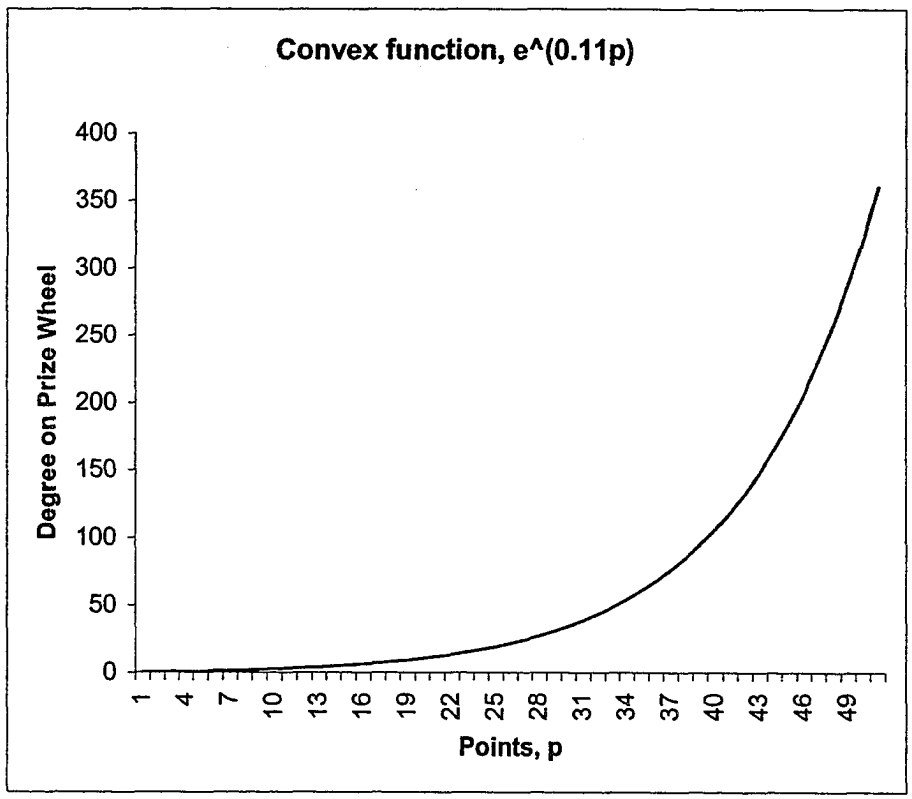


Figure 8: Convex function that defines risk prone induced preferences

Induced valuation is predicated upon the postulate of *non-satiation*. That is, a costless choice between two alternatives, which are identical and, say, the first is valued more than the second, the first will always be preferred to the second by an autonomous individual (Smith, 1976). This postulate, though designed to test price theory propositions, has been used to test propositions in preference theory (Plott and Sunder, 1982; 1983; Plott and Wilde, 1982; and Berg et al., 1986).

In order to appropriate the non-satiation postulate to preference theory and to successfully induce risk preference, five qualifications are necessary. These include

i. Minimize the subjective cost[31] to transact in the experimental task;

ii. Minimize game values that might be attached to experimental outcomes;

iii. Assure individuals' autonomy;

iv. Ensure that there is an incentive for individuals to optimize;

v. Ensure that individuals do not place independent value on experimental outcome other than that provided by the reward scheme.

Several steps were taken to ensure that the above requirements were met. First, there were no costs to execute a transaction in this experiment. Additionally, the communications media easily supported negotiation between subjects, requiring no extra effort to make or receive quotations. Hence, condition (i) was satisfied.

Second, the points-based reward system and the assignment of roles to subjects minimized game values that might be attached to experimental outcome. Specifically, subjects naturally think of themselves as role-players, who do not incur transaction costs, making profitable decisions that are measured in points. The points-based

[31] The cost the subject incurs to execute transactions, monitor, and make quotations.

rewards system, which is also associated with a probabilistic outcome, guarantees a fixed monetary reward irrespective of the outcome. Additionally, subjects did not play for items with idiosyncratic values. Ultimately, this arrangement reinforces monetary rewards in absence of transaction costs.

The assurance of individuals' autonomy requires that individuals act as their own-reward maximizers. That is, there are no interpersonal utility criteria for individuals in the experimental setting or are there incentives to collude. This requirement is achieved by the random assignment of experimental subjects to dyads and their assignment to different locations or rooms, such that they are unknown to each other.

The fourth and fifth requirements were specifically addressed by the reward scheme[32] that is used in this study. There were two components to the reward scheme. First, subjects were guaranteed a $10 gratuity for their participation. Second, and most importantly, subjects could double their reward, if a randomly selected trade that they completed indicated that they received more points than the other subject with whom they traded. Hence, subjects were simultaneously motivated to optimize and place independent value on outcomes, entirely because of the reward scheme.

Meeting all the above requirements ensured that the simulated game situation conforms to the requirements for preference induction and by extension almost

[32] Previous studies have noted that a failure to provide adequate incentives is known to affect results (Plott and Smith, 1978; Grether, 1981).

guaranteed that subjects choose between events based on their utility as defined by the specified functional forms. However, two additional specifications were required increase the likelihood that subjects' choices were based on the utility functions.

Becker, DeGroot and Marschak (1964), who posited the original theory on stochastic models on choice behavior, asserted that (i) a random event[33], which does not affect the worth of the reward to subjects, must be included in the model and; (ii) if subjects are offered sets repeatedly, sufficient precautions must be taken to insure that subjects have forgotten offered sets.

These requirements were accounted for as follows:

- For each lottery ticket, with a two-faced points value, there was a 50:50 chance, which represented the random event, to play for one of the two points values displayed on the ticket; the prize wheel ultimately determined if the points being played for were won.

- Subjects received nine unique tickets per game session per communications medium (27 total). The same nine tickets were used with each communications, and the order of their presentation was unchanged, making it difficult for subjects to remember tickets from medium to medium and within game sessions.[34]

[33] It is essential that the only feature of this event that is relevant to the subject's choice is the probabilities of the events.
[34] The pilot study provides strong support for this claim – see study results

The distribution of the prize wheels' win areas and the number of points offered for each ticket, corresponding to the risk averse and risk prone utility functions, is given in Tables 2 and 3. Note that the given percentages represent the all or nothing outcome for the number of points offered. That is, after the random event, the subject played for one of the two points value (x or y) and the outcome was either the points being played for were won or no points were received.

Tickets: (x or y)	**Proportion of prize wheel to win minimum points, x**	**Proportion of prize wheel to win maximum points, y**
T1: (12 or 34)	74%	98%
T2: (10 or 45)	67%	99%
T3: (18 or 28)	87%	96%
T4: (14 or 41)	79%	99%
T5: (13 or 38)	76%	99%
T6: (9 or 30)	63%	97%
T7: (16 or 32)	83%	97%
T8: (11 or 40)	59%	98%
T9: (15 or 42)	70%	99%

Table 2: Tickets and prize wheel win areas for the indicated number of points that were used for the risk averse induced preferences

Tickets: (x or y)	Proportion of prize wheel to win minimum points, x	Proportion of prize wheel to win maximum points, y
T1: (12 or 34)	1%	17%
T2: (10 or 45)	1%	58%
T3: (18 or 28)	3%	9%
T4: (14 or 41)	2%	37%
T5: (13 or 38)	1%	26%
T6: (9 or 30)	1%	11%
T7: (16 or 32)	2%	13%
T8: (11 or 40)	1%	21%
T9: (15 or 42)	1%	33%

Table 3: Tickets and prize wheel win areas for the indicated number of points that were used for the risk prone preference induction

4.4 Measurement of dependent variables

During the negotiation process, subjects exchanged quotes - bids from buyers and offers from sellers - for each ticket. It is established in the financial economics and market microstructure literature that quotes, similar to those that are exchanged between subjects in this study, are a function of a decision-maker's (or trader's) belief about prices or values based on information that has been gathered (for full

description of information-based models and information and the price process see O'Hara, 1997, p53-178). Elsewhere in the literature, bids and offers have also been used to assess risk propensity. Specifically, both were used to indicate a decision-maker's assessment of the chance associated with a lottery (Raiffa, 1968; Keeney and Raiffa, 1976). Here, quotes are used to simultaneously measure the information content of messages, in the broadest sense, and risk tendencies.

Negotiations for trading the notional lottery tickets are centered on the chance of winning the points displayed on the tickets. The information space upon which these negotiations are based is narrowly defined and relate largely to the beliefs of subjects. The beliefs of subjects were in turn expressed by their quotes. Since belief is informed by the cues and feedback, the quotes are valid measure, which can be used to assess the hypotheses that are posited in this research study. Hence, the measures of the dependent variables are derived from the quote data or points exchanged between buyers and sellers during trading. The submitted quotes for each type of ticket (risk averse and risk prone) were grouped together for measurement and analyses, since all were taken from the same function, defining the level of risk induced preferences indiscriminately.

4.4.1 Message Representation

During negotiation, revision of quotes (bids and offers) is related to the amount of attention that is given to the message. Recall that attention is, in turn, related to the

way messages are represented, but message representation is intrinsically time-adjusted. For example, something may be said in an abbreviated manner whenever time is limited, but may be prolonged (since silence can also be a cue) whenever time is not limited. In any event, the representation of the message accounts for the time constraints.

This study posits that quotes provide a valid measure of message representation, since they can be used to influence the actions of subjects. For example, a high rate of quote submission by either a seller or a buyer may indicate or be interpreted as a strong desire to trade, or a low rate not to do so. The extent of the influence of these actions is best measured from a referenced value, which captures variability in quotes from a fixed position with some bearing on the outcome. The expected value (say, E_v) of each gamble is a suitable reference point, since it represents the theoretical indifference point of risk neutrality. Against this background, message representation is measured by the variability of the ratio of the difference between the submitted quotes (say, q) per negotiation and the expected value of a lottery ticket to the expected value of the lottery ticket.

That is, message representation is determined by the equation that follows.

$$\textbf{Message representation} := \textbf{Variability of } \frac{(E_v - q_q)}{E_v}$$

4.4.2 Message Significance

During negotiation, revised quotes provide an identifiable measure of the significance of a message. Each revised[35] quote, assuming it is different from the current quote, indicates the number of points the sender or receiver believes the other might accept based on the message exchanged and corresponding to the chance of winning the lottery based on the prize wheel.

Revised quotes also indicate a changed belief about future outcome, whereas quotes that are not revised indicate an unchanged or a more certain belief about prevailing conditions. A subject who revises a quote must have considered the message important enough to cause a change in his or her belief, which is informed by cues and feedback that are dependent on the communications media. Hence, the number of changes in successive quotes as a percent of the total number of quotes submitted for each negotiation is a valid measure of message significance. This is a conservative estimate, as it does not include reinforced belief or unchanged quotes.

Thus, message significance (on a per negotiation basis) is estimated by the given equation that follows.

[35] For consecutive quotes that are different from each other, the latter quote is a revision of the former one, and is referred to as a revision or a revised quote. Identical consecutive quotes are treated as revised quotes.

$$\text{Message significance} := \frac{(\#\text{ of quote changes})}{(\#\text{ of quotes})}$$

4.4.3 Message Redundancy

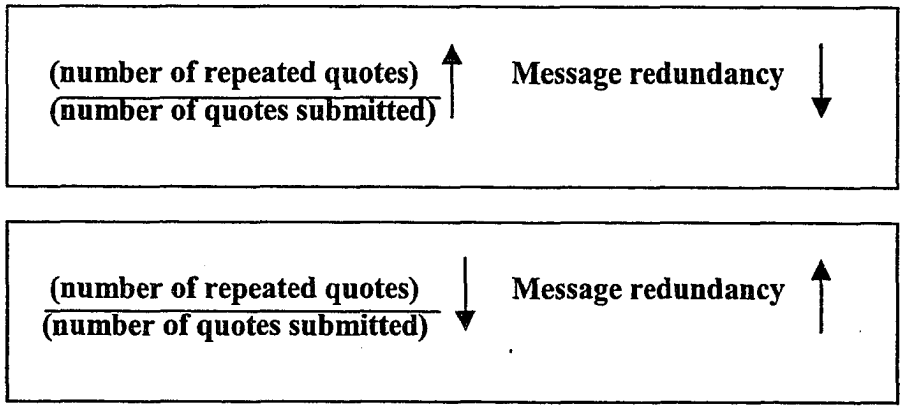
The foregoing measure of message significance does not account for the effects of feedback and cues expressed by unchanged quotes. According to this study, unchanged quotes provide a valid measure of message redundancy.

Message redundancy indicates that there is a reduction in the number of distinct types of information conveyed by a message. Message redundancy also implies that there is a reduction in the dimensionality of the information space and fewer message properties are conveyed by a message whenever message redundancy is high. Therefore the number of repeated quotes indicates the extent of message redundancy that characterizes a communication.

More repeated quotes per number of quotes (or less revised quotes) submitted indicates that there are more properties of a message that motivate the sender and the receiver not to change their belief (expressed by their quotes), and implies higher message redundancy. Conversely, many more repeated quotes per number of quotes (or fewer revised quotes) submitted indicates that there are many more properties of a message that motivate the sender and the receiver to change their belief (expressed by their quotes), and implies lower message redundancy. In other words, a higher

(lower) number of repeated quotes per number of quotes submitted imply that message redundancy is lower (higher).

This study does not argue that there is a mathematical relationship[36] between message redundancy and the number of repeated quotes per number of quotes submitted. Instead, it uses the number of repeated quotes per number of quotes submitted as a surrogate measure of message redundancy, providing a relative basis for comparing message redundancy across media. Therefore, message redundancy is estimated by the expressions that are given below.



[36] A possible mathematical equation would be message redundancy = (number of quotes/ number of repeated quotes), but this would easily breakdown whenever the number of repeated quotes is zero. Furthermore, this equation would be predicated on the assumption that at least one quote is always repeated during negotiation, which is a baseless assumption.

4.4.4 Subjective Judgment

Many methods have been tried to measure subjective probabilities including – direct assessment; psychophysical measurements, inferences from bets, confidence ratings and verbal statements such as "sure thing" or "toss up". Beach (1974), Beach and Phillips (1967), Beach and Wise (1969), Galanter (1962), and Wise (1970), all compared these approaches. It is believed that direct assessment is about as good as any other method (Von Winterfeldt and Edwards, 1986).

A seven point Likert scale was used to measure subjective judgment directly. The scale measured subjective judgment in the range poor to excellent, pre- and post-negotiation. Pre and post responses were grouped into three distinct categories – more, less, unchanged – corresponding to whether scaled ratings were increased, decreased, or remained unchanged respectively from pre to post measure of self-reported subjective judgment. These tabulated data for the derived grouped responses were used as the final measure of subjective judgment.

4.4.5 Absolute Risk Aversion

The most established measures of risk propensity are Arrow-Pratt[37] measures of risk-aversion, which include absolute risk aversion (ARA), decreasing absolute risk aversion (DARA), constant absolute risk aversion (CARA), increasing absolute risk

[37] Based on the work of Arrow (1965) and Pratt (1964).

aversion (IARA), and other similar types of measures for relative risk aversion (RRA). These measures are essentially the negative of the ratio of the second derivative of the univariate utility function to the first derivative. There are many utility functions that have known theoretical values for these different measures of risk aversion. For example, the utility function given by $U(x) = \alpha x$ where $\alpha \in (0,1)$ displays decreasing absolute risk aversion and constant relative risk aversion, $(1 - \alpha)$.

Utility functions, similar to those that are used to induce risk preference in this study, have theoretical degrees of risk aversion that can be measured by absolute risk aversion, which is given by the equation below.

$$ARA = - U''(w) / U'(w)$$

In the above equation, $U^k(x)$ is the k^{th} derivative of the function U(x) with respect to x and w is the level of wealth. In general, these utility functions have constant ARA. Specifically, the parametric form of the risk averse function is given by

$$U(x) = -e^{-\alpha x}, \text{ which has an } ARA^a = \alpha \text{ ..... (i).}$$

The parametric form of our risk prone function is given by

$$U(x) = e^{\beta x}, \text{ which has an } ARA^s = -\beta \text{ ..... (ii).}$$

In this study, the measures of risk propensity are based on the above theoretical results. In particular, derived estimates for these theoretical values of ARA that are

based on the quote data from the risk induction procedures are used to assess the hypothesized relationships concerning risk propensity.

Recall that the risk induced preference functions were expressed by the probability distribution for the prize wheels. In particular, levels of risk induced preferences were based on the transformation of the utility functions to a unique linear relationship[38] on the range 0 to 360 degrees, which are associated with the lowest and highest number of points possible in the defined range for our utility function (p_l =0, p_h =50), such that:

$$\mathbf{k + m\,U(p_l) = 0} \quad \text{.....(iii); and}$$

$$\mathbf{k + m\,U(p_h) = 360} \quad \text{.....(iv).}$$

The above equations are solved for constants k and m, corresponding to each utility function. The respective values for these constants are ${}^{a}\underline{k = 361.477 = {}^{a}m}$, the unique values of k and m for the risk averse function and ${}^{s}\underline{k = -1.477 = {}^{s}m}$, the unique values of k and m for the risk prone function.

The relationships between the probabilities in degrees and the utility functions are then uniquely given by

$$\mathbf{360\ Pr(x) = {}^{a}k - {}^{a}m(e^{-\alpha p})} \quad \text{.....(v);}$$

for our risk averse induced preferences; and

$$\mathbf{360\ Pr(x) = sk + sm(e^{\beta p})} \quad \text{.....(vi);}$$

[38] A full description of the basis for this result can be found in Berg et al., 1986.

for our risk prone induced preferences.

In equations (v) and (vi), above, $\alpha = 0.11 = \beta$, $P(x)$ is the win area of the prize wheel for x, the number of points to be won, and p is the certainty equivalents (Becker, DeGroot and Marschak, 1964) in points for a given ticket. It also follows from equations (v) and (vi) that:

$$\alpha = -(1/p) \ln [({}^{a}k - 360Pr(x))/{}^{a}m] \ldots\ldots \text{(vii); and}$$

$$\beta = (1/p) \ln [(360Pr(x) - {}^{s}k)/{}^{s}m] \ldots\ldots\ldots \text{(viii).}$$

Therefore, from equations (i) and (ii), the ARA for each risk induced preference functions can be expressed in terms of the probability distribution for the prize wheels. Specifically,

$$ARA^{a} = -(1/p) \ln [({}^{a}k - 360Pr(x))/{}^{a}m] \ldots\ldots \text{(ix); and}$$

$$ARA^{s} = -(1/p) \ln [(360Pr(x) - {}^{s}k)/{}^{s}m] \ldots\ldots\ldots \text{(x).}$$

Implicitly, it is assumed that since subjects do not know their wealth (by design), which would be their accumulated points,[39] they perceived their wealth as the number of points to be won. For example, a subject might assert that if the available points,

[39] Recall that during the experiment subjects were not permitted to record any information and their accumulated points were never disclosed to them.

say x, were acquired then I would be x points "rich" or "wealthy" and then proceed to acquire the ticket (buyer) or accept the offered points (seller).

This study posits that during trading, buyers' lowest bids and sellers' highest offers are valid best estimates of the respective certainty equivalents (associated with each ticket) for buyers and sellers. Past research studies have also asserted that whether a bid is crossed with an offer, the bid indicates the bidder's certainty equivalent, which indicates the bidder's judgment on the chance associated with the lottery (Raiffa, 1968) and that the offer price of a lottery is also equivalent to the certainty equivalent for sellers (Raiffa, 1968; Keeney and Raiffa, 1976).

In virtue of the foregoing qualifications, all the variables on the right hand side of the equations (ix) and (x) are known. Hence, these equations are used to measure the actual absolute risk aversions for subjects that participated in the experimental study.

4.5 Pilot Study

Twenty eight (16 males and 12 females) of the 184 students that were recruited from the student population at Baruch College participated in the pilot study. Seventy nine percent of the participants either completed their undergraduate degree or were in the process of doing so and twenty one percent either completed their graduate degree or were doing so. The participants were paired. Seven pairs were exposed to the risk prone induced preferences, using all three media for communication and the other seven pairs were exposed to the risk averse induced preferences, also with the three media.

The pilot study was used to pretest and refine the experimental procedures. Specifically, it was used for the manipulation checks, which are discussed in the next section, to test the game application, and to determine the amount of time to be allocated per trade for each lottery ticket.

The game application was rigorously tested prior to the pilot study, but it was discovered that two minor, yet important, changes to the application and task were required. First, under the original specification, whenever the game timed out, each subject was awarded a guaranteed minimum number of points (5 points). During the pilot study, it was discovered that subjects intentionally elected to let the games time out, which affected the negotiation process and caused them to disregard the outcome of getting zero point from a spin of the prize wheel. Hence, it was decided that zero

point would be given to subjects whenever the game timed out. Thereafter, subjects did not intentionally set out to let the games time out.[40]

Second, under the original specification, subjects traded ten tickets per communications medium. During the pilot study, subjects indicated that negotiating the trade of the ten tickets per communications medium was demanding and the recorded data indicated that subjects exchanged fewer quotes on the 10th ticket, as well as less negotiation was done for this ticket. The data files indicated that on the eighth or ninth ticket, subjects were concerned if a session was nearing its end, often times explicitly stating that they would give up the tenth ticket, in the case of sellers, or take it at any cost, in the case of buyers, because they were exhausted.

Finally, in order to decide on the amount of time to be allocated per trade for each lottery ticket, subjects were given 300 hundred seconds to trade each ticket initially. The average time per trade per ticket with: telephone-to-telephone communication was two hundred and twenty five seconds, instant messaging was one hundred and ninety seconds, and non-mediated computer-to-computer system was two hundred and sixty five seconds. The average for all media was approximately two hundred and twenty six seconds and modal time was two hundred and five seconds.

[40] Prior to the removal of the 5-points minimum reward for timed out games, 45% of the risk prone tickets were timed out, whereas, when the minimum reward was set to zero 10% of the risk prone tickets were timed out.

In addition to the above statistics, consideration was given to fact that subjects' willingness to participate in the experiment would be affected by the total time that would be required to complete it. Additionally, it was felt that subjects would be encouraged to participate, and do so with diligence, provided they had some control over the time it takes them to complete the experiment. The author decided that equalizing time in all media would be the most optimal solution, all things[41] considered. Hence, the allotted time per trade in all media was set at 210 seconds.

4.5.1 Manipulation check

In order to ensure validity of the manipulations used in our experiment, the 28 participants from the pilot study were asked to complete questionnaires, which were used to assess the manipulations of the independent variables. Fourteen subjects (seven of whom were assigned the role of buyers and the others the role of sellers) were given one type of a questionnaire. The other fourteen of subjects, with similar role assignments, were given a second type of questionnaire.

Prior to completing the questionnaires, subjects were given a brief explanation on the meaning of feedback and cues, consistent with the definitions upon which the theories of this study are based. During a verbal discussion, subjects were asked to provide examples of feedback and cues. From these discussions, it was established that

[41] Additional consideration was given to the distribution of unused time, as well as the amount of trading activity that occurred, when the trading time was set at three hundred seconds. Since there was a small amount of data available at this stage, the author's best judgment was used to decide on the allotted time.

subjects understood the meaning and context in which these terms applied to the study.

The questionnaires, each consisting of eight questions, were designed and used solely for the purpose of the manipulation checks. Essentially, the two types (1 and 2) of questionnaires differed on their assessment of the two types of risk induced preferences and media richness (explicitly comparing the feedback and cue that each supports). Together they facilitated simultaneous checks of the manipulations and validate the effectiveness, as well as the reliability, of the induced risk preference methodology. Tables 4 and 5 show the questions and the percentage of responses from subjects who participated in the pilot study.

Question	Buyer responses		Seller responses	
	YES	NO	YES	NO
1. The prize wheel offered poor chances to win points.	14%	86%	0%	100%
2. The prize wheel offered good chances to win points.	100%	0%	100%	0%
3. From one communication medium to another, tickets were different.	86%	14%	86%	14%
4. I got more feedback and cues by using the non-mediated quote system than by using telephone.	0%	100%	0%	100%
5. I got more feedback and cues by using telephone than by using instant messaging.	86%	14%	100%	0%
6. I got more feedback and cues by using the non-mediated quote system than by using instant messaging.	14%	86%	14%	86%
7. Within each game session, tickets were not the same.	100%	0%	100%	0%
8. I traded with different individuals in each medium.	86%	14%	100%	0%

Table 4: Type 1 questionnaire that was issued to subjects who played with a risk averse induced preference prize wheel for all three communications media.

Question	Buyer responses		Seller responses	
	YES	NO	YES	NO
1. The prize wheel offered poor chances to win points.	100 %	0%	86%	14%
2. The prize wheel offered good chances to win points.	0%	100%	14%	86%
3. From one communications medium to another, tickets were the same.	0%	100%	14%	86%
4. I got less feedback and cues by using the non-mediated quote system than by using the telephone system.	86%	14%	100%	0%
5. I got less feedback and cues by using telephone than by using instant messaging.	0%	100%	0%	100%
6. I got less feedback and cues by using the non-mediated quote system than by instant messaging.	100%	0%	86%	14%
7. Within each game session, tickets were the same.	0%	100%	0%	100%
8. I traded with the same individual in each medium.	14%	86%	14%	86%

Table 5: Type 2 questionnaire that was issued to subjects who played with a risk prone induced preference prize wheel for all three communications media.

Subjects who received the type 1 questionnaire were given risk averse induced preference prize wheels, which were characterized by good chances to win points. Questions 1 and 2, which were reverse coded, indicated subjects' recognition of our manipulated treatment - risk propensity. For these questions on the type 1 questionnaire, 13 of 14 subjects indicated that the prize wheel offered poor chances to win points and 14 of 14 subjects indicated that the prize wheel offered good chances to win. Taken together, 96% of the subjects' responses correctly indicated that they were given risk averse prize wheels.

Subjects, who received the type 2 questionnaire, were given risk prone induced preference prize wheels, which were characterized by poor chances to win points. On questions 1 and 2 of this questionnaire 13 of 14 subjects indicated that the prize wheel offered poor chances to win points and 13 of 14 subjects indicated that the prize wheel did not offer good chances to win. The combined results indicated that 93% of the subjects' responses to questions 1 and 2 correctly indicated that they were given risk prone prize wheels.

Questions 4, 5 and 6, which were reverse coded across each type of questionnaire, indicated subjects' recognition of the manipulated treatment – media richness. As stated before, differences between media richness levels are uniquely characterized by the relative amount of feedback and cues that each supports. Therefore, these questions determined the extent to which subjects recognized differences between media.

On the type 1 questionnaire, 13 of 14 subjects indicated that they did not get more feedback and cues by using the non-mediated quote system[42] than by using the telephone; 13 of 14 subjects also indicated that they got more feedback and cues by using the telephone than by using instant messaging; and 12 of 14 subjects indicated that they did not get more feedback and cues by using the non-mediated quote system than by using the instant messaging system. Taken together, 90% of subjects' responses on the type 1 questionnaire correctly indicated the relative richness of the media consistent with this manipulation.

On the type 2 questionnaire, 13 of 14 subjects indicated that they got less feedback and cues by using the non-mediated quote system than by using the telephone; 14 of 14 subjects also indicated that they did not get less feedback and cues by using telephone than by using instant messaging; and 13 of 14 subjects indicated that they got less feedback and cues by using the non-mediated quote system than by using the instant messaging system. Taken together, 95% of subjects' responses on the type 2 questionnaire correctly indicated the relative richness of the media consistent with this manipulation.

Questions 3 and 7 were used to determine the extent to which the manipulation of the risk induced preferences in terms of the basic units, lottery tickets, was achieved. Here, the intent was to ensure that tickets were recognized to be different within each communications medium and to appear different from one communications medium

[42] The 'non-mediated computer-to-computer system' and the 'non-mediated quote system' are the same.

to another. Based on both questionnaires, ninety eight percent (98%) of subjects' responses were consistent with the manipulation.

Question 8 was used to determine the extent to which anonymity among subjects was successful manipulated. Based on both questionnaires, eighty nine percent (89%) of subjects' responses were consistent with the manipulation.

4.5.2 Procedural reliability

Procedural reliability is concerned with the quality of the measures and the consistency of the treatment that yields such measures. Acceptable levels of procedural reliability can be achieved by using established measures, consistently monitoring research activities, and using test-retesting methods (Davis and Cosenza, 1993). In this study, the first and second approaches were used to ensure that the requisite procedural reliability was attained.

First, the induced risk preference approach was used to generate measures for the dependent variables. The procedures were employed are closely similar to those used by Berg et al., (1986) and Harrison (1986) in their work on controlling and inducing risk preference.

Second, the principal investigator was always present at the experimental site, actively ensuring that subjects followed all experimental procedures. Before subjects

began the experimental task, the principal investigator instructed them on how to complete the experimental task. The same set of instructions (see Appendix E) was given to each subject. Additionally, subjects were allowed and encouraged to seek clarification on procedures at anytime during the experiment. The principal investigator handled all expressed concerns about procedures.

4.5.3 Internal validity

Internal validity is concerned with the degree to which the experimental design establishes cause and effect relationships between manipulations and the dependent variables (Pedhazur, 1991). It examines whether the observed results are due to the manipulated variables or can be attributed to other variables. Therefore, it is strongest when alternative relationships are eliminated (Pedhazur, 1991; Davis and Cosenza, 1993).

Experimental controls play a central role in attempts to maximize internal validity. In particular, other things being equal, the more powerful controls are, the more internally valid is a study (Pedhuzar, 1991). Against this background, experimental research studies are generally more internally valid than non-experimental research studies, since in the former treatments are manipulated and units are randomly assigned to levels of treatment.

This study is based conducted as an experimental research and so it has an inherently strong internal validity, however, several precautionary measures were taken to ensure that threats to its internal validity are minimized. These threats include maturation, mortality, history, selection, regression toward the mean, testing and instrumentation.

First, the experiment was conducted in a close setting for a predetermined time period, which was known to all subjects. These conditions ensured that exposure to threats such as maturation, mortality and history was minimized. Second, the random assignment of subjects to experimental groups ensured that exposure to threats such as selection and regression toward the mean[43] was minimized. Finally, the posttest only design of this study, the same trading conditions and objectives, and the random outcome reward structure ensured that testing and instrumentation threats, such as learning, altruism and varying degrees of complexity in task, are minimized.

In sum, the appropriate measures were taken to ensure that the internal validity of this study was high. The importance of internal validity becomes apparent, when one recognizes that it is a necessary, although not sufficient, condition for external validity, which is discussed in the next section.

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[43] Regression toward the mean (RTM) is increased when random errors are greater. It occurs in situations where extreme scores or responses revert to mean levels upon measurement. Threats to internal validity from RTM is of greater concern when subjects are selected because of their extreme standing on a variable and measures are taken twice on the same construct (Pedhazur, 1991). In this study, subjects did not indicate extreme risk propensities and measures were taken once.

4.5.4 External validity

External validity is concerned with the generalization of findings "to" or "across" target populations, settings, or times (Pedhazur, 1991; Cook and Campbell, 1979). The term 'generalizing to' is concerned with generalizations from samples to populations and so the validity of this type of generalization is based on the sample selection procedures. The term "generalization across", on the other hand, is concerned with generalization across populations and so the validity of this type of generalization is predicated on the populations being compared and logically presupposes validity of generalization to (Cook and Campbell, 1979).

Researchers have noted that in laboratory experiments, external validity is always a concern (Cook and Campbell, 1976). Furthermore, threats to external validity are more difficult to delineate than threats to internal validity. Pedhazur (1991) provides some useful guidelines to follow that will help to increase external validity. Most of these guidelines were followed in this study.

First, treatments were randomly allocated to subjects, which were diverse in their attributes.[44] This ensured that threats to treatment attributes were minimized, as by this procedure attributes are less likely to show interaction with treatments. Second, the pilot study indicated that the distinct role of subjects was a factor in advance of the actual experiment, so it was controlled. This ensured that generalization of the results is qualified. Third, subjects were neither pre-tested nor post-tested on

[44] Attributes refer to variables on which subjects differ – example gender, education and personality

treatments, ensuring that there was no pretest interaction with treatment or was there an opportunity for subjects to be sensitized to treatment. Finally, although subjects were exposed to multiple treatments, the potential for cross over effect and interaction between treatments was minimized because one treatment[45] was always the same and to subjects the task was made up of independent events without pre-deterministic outcomes. Furthermore, the order of the communications media used by subjects was also completely randomized.

In sum, the study is generalizable to settings, where multiple communications media are used to support decision-making under uncertainty, such as investment brokerage offices, where investment decisions are made using a combination of the following communication channels: telephone, instant messaging, and other computer mediated communications system for processing information. The study is also generalizable across populations of decision-makers, many of whom have attributes similar to the sample of college students, who participated in this study. These populations include brokers and the clients of investment brokerages. Finally, the external validity of this study is enhanced because most communications technologies are designed primarily for dyadic communication (Panko and Kinney, 1992).

[45] The same risk induced preference levels, which were represented by nine tickets (given in the same order and thus reducing the likelihood that they were remembered by subjects), were repeated across all media.

4.5.5 Construct Validity

Construct validity is concerned with the degree to which the measurement instrument measures the construct or variable that is supposed to be measured (Davis and Consenza, 1993). Construct validity is made up of convergent validity, which measures the degree of association between maximally different measures that purport to measure the same concept, and discriminant validity, which measures the degree to which one measurement scale can be differentiated from other scales that is purported to measure maximally different constructs (Davis and Consenza, 1993). Researchers can achieve high construct validity by using well-established and accepted scales (Davis and Consenza, 1993).

In this study, established measures were used for the dependent variables. These include common measures such as bid and offer quotes, absolute deviations of quotes, expected values, and frequency or counts. The study also used established measure such as absolute risk aversion, which was developed by Arrow (1965) and Pratt (1964), and is extensively used in decision-making research studies.

Measures were also derived from others that are established. These measures include those concerned with the induced risk preferences, which are based on the induced value theory, and with the absolute risk aversion. The induced value theory was posited by Smith (1976) and extended to the domain of decision-making research by Berg et al., (1986) and Plott and Sunder (1982; 1983).

CHAPTER 5

RESULTS

This chapter presents the results. First, a summary of the data sets that are used for the statistical analyses is presented. Second, the assumptions of the ANOVA technique are discussed. These include the independence assumption, the homogeneity of variance assumption and the normality assumption. Finally, the set of statistical analyses, which include the normality tests and descriptive statistics for each dependent variable, is presented in run.

5.1 Data Collection

Research sessions were conducted in two labs, each for a designated role player (subjects who were buyers and subjects who were sellers), for several hours per day over ten weeks in the spring semester. In addition to role assignments, subjects were also randomly assigned tickets that were either risk averse or risk prone. Dyads completed trading activities, using the strictly ordered set of media for negotiations. On average, subjects took approximately eighty minutes to complete the experiment.

Demographic information, which is used to give a contextual perspective to this study, was collected from the experimental participants. One hundred males (54% of the participants) and 84 females (46% of the participants) participated in the experiment – 28 subjects participated in the pilot study and one hundred and fifty six subjects participated in the main study.

Forty five percent of the participants were between ages 18 and 23, 37 percent were between ages 24 and 29, and 18 percent were over 30. Sixty eight percent of the participants either completed their undergraduate degree or were in the process of doing so and 32 percent either completed their graduate degree or were doing so. The income distribution reported by participants indicated that sixty two percent of them earned $25, 000 or less.

Of all the participants in the main study, one subject elected to discontinue participation after 23 trades.[46] The recorded trades for this subject were used and the missing trades were treated as missing data in the analyses. In a few other instances,[47] during negotiation, network failures caused trades to be terminated before subjects reached an agreement. The recorded data for the completed trades were also included in the analyses. Table 6 shows a summary of the demographic profile of experimental participants and that 174 subjects reported that they used instant messaging with proficiency.

[46] Recall that nine tickets are presented for trading in each of three media, totaling 27 trades per experiment for each dyad.
[47] It is estimated that less than 1.5% of trades were affected by network failures.

Number of male participants	100
Number of female participants	84
Aged 18-23	64
Age 24-29	68
Undergraduates	110
Proficiency with IM	174

Table 6: Summary of demographic information for experimental participants

When testing hypotheses with general linear models, data points with missing values are ignored using the statistical application software, SAS. The validity of the results is not compromised, since regression (and correlation) analysis do not require equal number of data points per treatment group. Hence, in all analyses, missing data were never replaced through mean substitution.

Next, the underlying assumptions of the statistical technique (factorial analysis of variance), which is used to test the model presented in chapter 4, are discussed. In particular, if these assumptions are met, F-ratio can be used to test the posited hypotheses. Relevant statistics and explanations are provided to demonstrate the extent to which these assumptions were satisfied.

5.2 Factorial Analysis and Assumptions of ANOVA

One assumption for ANOVA requires that groups be composed of randomly and independently sampled subjects (McCall, 2001). The validity of this assumption depends on the care taken to administer manipulations - that is, the care taken to ensure the random assignment of treatments to subjects (Myers, 1972). This assumption was met based on the procedure that randomly assigned subjects to different media, to risk induced preferences, and to the role of buyer or seller. Hence, subjects were independently and randomly assigned to different sets of manipulations.

A second assumption of ANOVA requires that groups of data units for analyses are independent. This assumption was met based on: (i) the random event that was used to decide the number of points that subjects played for; (ii) the random outcome of the prize wheel (iii) the random draw reward structure that was used to determine the extra $10 payment for participation; and (iv) the strict ordering of tickets, which offered different number of points as a reward. Collectively, these procedures ensured that subjects treated each trade independently and so data units (quote data) were independent.

A third assumption of ANOVA requires that there is homogeneity of variance across treatment populations (Aguinis and Pierce, 1998a; Dretzke, Levin, and Serlin, 1982; Stone and Hollenbeck, 1989), or equivalently, it is necessary to check that the variance in the dependent variable is equal across groups. The validity of this

assumption depends upon: (i) how careful the experimental treatments are administered to subjects; (ii) upon the type of measurements taken; and (iii) upon the treatment levels employed (Myers, 1972).

Manipulations were consistently administered to subjects, which helped to stabilize variances from group to group. In particular, subjects all traded in the same set of tickets, which were denominated in the same units of notional points, and represented distinct levels of risk induced preferences. Additionally, the three types of communications media and the screen display of tickets were the same for the entire experiment. In sum, manipulations were unaltered and consistent, ensuring that variances in dependent variables that could arise from exogenous factors were minimized.

In the event that the homogeneity of variance assumption is not completely satisfied, the alpha level of significance will be inflated (Myers, 1972). However, if all treatment populations are approximately normally distributed and if all groups are of the same size, the inflation is slight (Myers, 1972). Furthermore, if experimental groups are not of equal size, or if error variances differ extremely over treatment levels, it is still possible to test the hypothesized relationship at the desired alpha level of significance, provided that the treatment population distributions are approximately normal (Myers, 1972).

A fourth assumption of ANOVA requires that samples be drawn from a population of data that is normally distributed. However, researchers have noted that violations of normality are not terribly damaging if a sufficient number of cases are sampled and if departure from normality is not severe (McCall, 2001).

In general, if the independence and normality assumptions hold, and the number of data points of the dependent variable are equal (or unequal), type I error rates will be only slightly inflated (Myers, 1972). A combination of two violations, heterogeneity of variance and non-normality, is not worse than heterogeneity alone, provided that all treatments populations have the same distribution (Myers, 1972).

An orthogonal design is used in this study, and group memberships were fixed. Given the latitude, implied by the above explanations, concerning the two violations, the normality of each dataset was rigorously tested. First, extreme observed values or outliers were removed from the data, because there were a few instances when subjects indicated they inadvertently submitted incorrect quotes and the number of points to be exchanged had pre-specified upper and lower bounds. Second, the assumption that the dataset for the dependent variables are normally distributed was tested by comparison with a normal distribution. Specifically, the residuals for the modeled relationship between the dependent and independent variables were tested for normality.

Komlogorov-Smirnov (K-S) statistics were computed and examined to assess the normality of the residuals. The results of the tests of normality and the corresponding K-S statistics are reported. Other useful statistics, which include skewness, kurtosis, and the normal probability plots of the residuals were determined and examined to further assess the normality of the data. Following the above preliminary tests, F-ratio tests were performed to assess the hypotheses that are posited and all relevant results are presented together in run.

The F-ratio tests are based on the distribution of dataset indicated in Table 7, which shows the number of data points that were used in each test. These data points correspond to the factor levels of the research design.

Med	Induced Risk Preference	Msg Rep. # of Trades	Mes. Sig	Msg. Red	Subj. Judgment	ARA
T	A	518	337	537	54	592
I	A	661	552	660	54	676
Q	A	605	462	618	54	640
T	P	523	370	520	54	560
I	P	609	452	556	54	576
Q	P	536	444	540	54	532

Table 7: Factor level breakdown of data points for F-ratio tests

5.2.1 Factorial ANOVA: Message Representation

An ANOVA was performed with message representation, which is measured by the average percentage deviation from expected value, as the dependent variable and manipulation of media richness, subjects' role, and risk preferences as fixed factors.

Normality Test and Descriptive Statistics

The test for normality of the dependent variable message representation begins with an examination of several descriptive statistics. These include skewness and kurtosis statistics that were generated from SAS and are presented in Table 8 (where I – instant messaging; Q- non-mediated computer-to-computer system; T-telephone).[48]

Media	Risk Averse		Risk Prone	
	Skewness	Kurtosis	Skewness	Kurtosis
T	-0.5475	-0.0793	-0.1758	-0.8251
I	0.4301	-0.2746	-0.234	-.0.844
Q	-0.4087	-0.2392	-0.2876	-0.9317

Table 8: Normality test statistics for message representation

The skewness statistic indicates whether the distribution of message representation is symmetrically distributed, providing a basis for comparison with a normal distribution. A normal distribution has a skewness value of zero, as there are equal

[48] Hereafter, I, Q, and T are used to identify instant messaging, non-mediated communications and telephone-to-telephone communications media respectively. All subsequent references to these media follow this coding scheme.

numbers of cases on either side of the midpoint of the distribution. Negative and positive skewnesses indicate that a distribution is left-leaning and right-leaning respectively. The values shown in Table 8 indicate that skewness is close to zero in all cases, indicating that the data is nearly normally distributed based on this statistic

The kurtosis statistic indicates the peakedness of a distribution. Like skewness, the kurtosis of a normal distribution is zero. Positive values represent a high degree of peakedness, whereas negative values indicate that the distribution is flat and has too many cases in the tails of the distribution. The values shown in Table 8 indicate that the kurtosis statistics are all close to zero, also indicating that the data is nearly normally distributed.

Komlogorov-Smirnov (K-S) statistic of the residuals for the relationship between message representation, media richness and risk induced preferences is 2.389, which provides evidence that the data is normally distributed. The K-S test for normality and the normal probability plot of the residuals are given in Appendix G. These results confirm that the dataset is normally distributed. There are small deviations from normality, but these will not significantly affect the analyses.

The results for the ANOVA for the message representation data, which are analyzed using the Proc GLM procedure in SAS, are presented Figure 9. The analysis determines the extent to which each of the following hypotheses is true, based on the measure of message representation:

$$\mathbf{H1a:} \quad {}_{Mrp}\delta^2_T < {}_{Mrp}\delta^2_I$$

$$\mathbf{H1b:} \quad {}_{Mrp}\delta^2_T < {}_{Mrp}\delta^2_Q$$

$$\mathbf{H1c:} \quad {}_{Mrp}\delta^2_I < {}_{Mrp}\delta^2_Q.$$

Dependent Variable: Message Representation

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	623.583534	69.287059	415.05	<.0001
Error	3442	574.593704	0.166936		
Corrected Total	3451	1198.177238			

R-Square	Coeff Var	Root MSE	Msg_rep_ Mean
0.520443	560.0319	0.408578	0.072956

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Media	2	0.8532681	0.4266340	2.56	0.0778
Risk_Type	1	542.7850190	542.7850190	3251.46	<.0001
Role	1	67.9819523	67.9819523	407.23	<.0001
Risk_Type*Media	2	5.9618988	2.9809494	17.86	<.0001
Media*Role	2	4.0725463	2.0362732	12.20	<.0001
Risk_Type*Role	1	2.1701500	2.1701500	13.00	0.0003

Figure 9: Factorial ANOVA SAS output for message representation

The results show that the relevant F-statistics for media and risk type by media interaction are statistically significant, in explaining relationships between message representation and these factors. The F-statistic (2.56) for media effect, though less than the others, is statistically significant with a p-value less than 0.08 and for (F, 17.86) the interaction term is also significant with a p-value less than 0.0001. The R-square statistic indicates that approximately 52% of the variation in message representation is explained by the linear relationship expressed by the fixed factors.[49]

Examining and comparing the variances for the different levels of the fixed factors assess the hypotheses on message representation. A breakdown of the variances for message representation across media is given Table 9, along with a graph showing their relative values in Figure 10.

Media Effect **Message representation**	
Media	**Variability**
T	**0.30**
I	**0.374**
Q	**0.361**

Table 9: Variability in message representation across communications media

[49] Fixed factors and manipulations are the same.

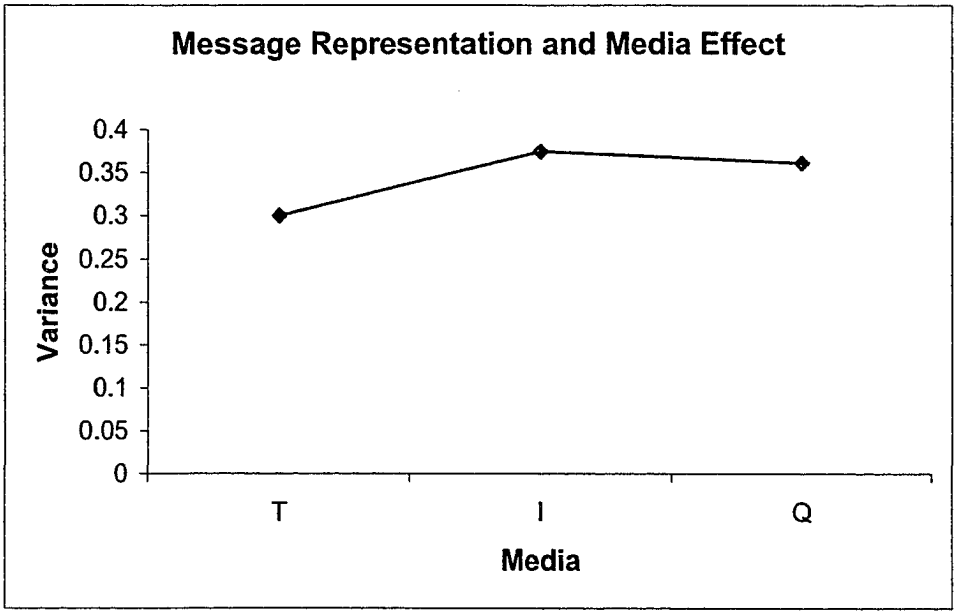


Figure 10: Graph of the variability in message representation across communications media

The results show that there is directional support for H1a and H1b. Specifically, message representation, as measured by the variability in percent deviation from expected value, is less varied in telephone–to-telephone communications than in either instant messaging or non-mediated communication. The results also show that H1c is not supported, that is message representation is not less varied in the non-mediated communications medium than in the instant messaging medium. The statistical significance of the supported hypotheses was examined and it is found that H1a and H1b are significant at the 5% level of significance, whereas H1c is not.

Hypotheses 1a, 1b and 1c were also assessed at different levels of risk propensity. Table 10 and Figure 9 show the variances message representation by risk levels.

Media by Risk type Effect Message representation		
Risk type	**Media**	**Variance**
*A	T	0.196
A	I	0.408
A	Q	0.245
*P	T	0.065
P	I	0.092
P	Q	0.080
*[50]risk levels		

Table 10: Variability in message representation across communications media by risk induced preference types

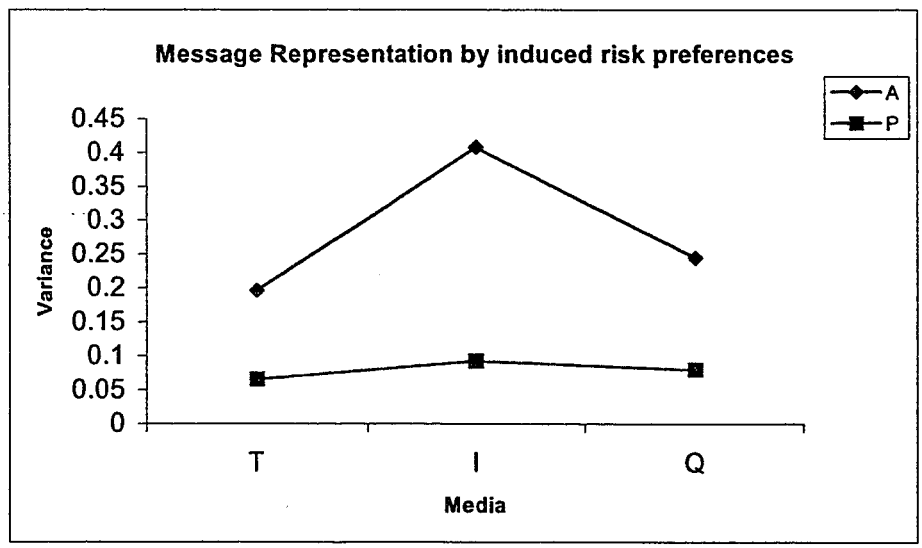


Figure 11: Graph of the variability in message representation across communications media by risk induced preference types

[50] Here and throughout the rest of presentation of the results 'P' refers to risk prone induced preferences and 'A' refers to risk averse induced preferences.

At different levels of risk propensity, message representation differs among media types. In particular, message representation is greater for risk averse induced preferences than for risk prone induced preferences. However, there is consistent support for hypotheses 1a and 1b and no support for 1c for both risk preference levels.

The hypothesized relationship was also examined in the context of roles assigned to subjects, since buyers and sellers were endowed differently and their motivation for making choices might have been different. Furthermore, the F-statistic (12.20, with a p-value less than 0.0001) for the interaction effect, media by role, shows that it is statistically significant. The results for media by role effect of the variability in message representation are given in Table 11, and the graph is shown in Figure 12.

Media by Role Effect Message representation		
*Buyer Mean response	*Seller Mean response	Media
0.506	0.566	T
0.574	0.619	I
0.523	0.615	Q
*Assigned role[51]		

Table 11: Variability in message representation across communications media for buyers and sellers

[51] Hereafter, 'B' refers to buyers and 'S' refers to sellers.

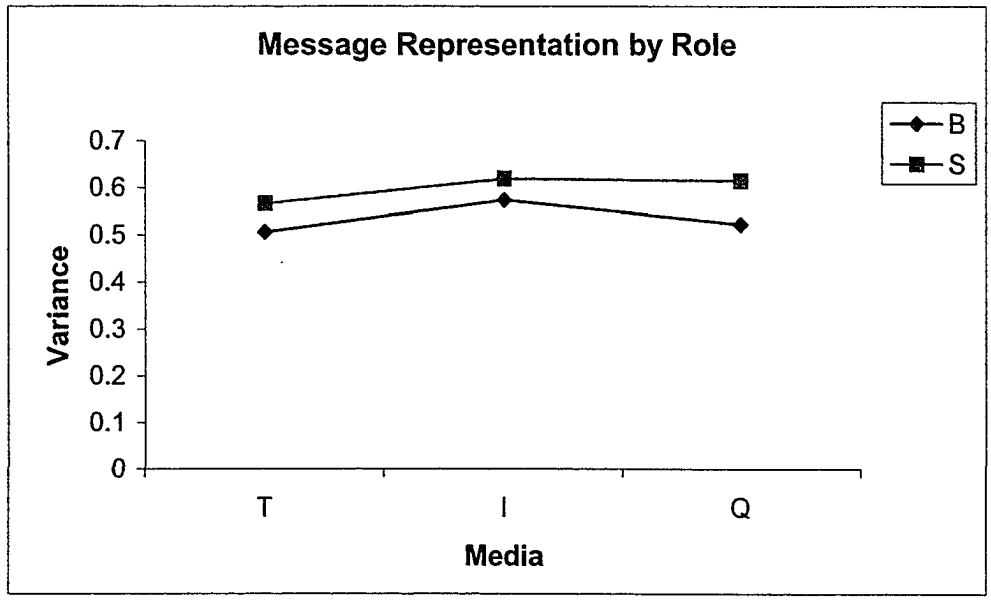


Figure 12: Graph of the variability in message representation across communications media for buyers and sellers

The above results also indicate that there is directional support for hypotheses 1a and 1b and there is no support for 1c, irrespective of subjects' role.

5.2.2 Factorial ANOVA: Message Significance

An ANOVA was performed with message significance, which is measured by the ratio of the number of quote changes to the number of quotes per negotiation, as the dependent variable and manipulation of media richness, subjects' role, and risk propensity as fixed factors.

Normality Test and Descriptive Statistics

The relevant descriptive statistics for the measure of message significance were examined. First, the data was checked for possible outliers. Based on the measure of message significance, it is known that valid data points are bounded on the open interval (0,1). Results indicated that there were six outliers, which were removed.

Further analysis indicated that the data was markedly skewed. The relationship between the means and standard deviations of the dataset within treatment category was examined. It was found that treatment standard deviations are proportional to treatment means. This result suggests that an appropriate transformation of the dataset will eliminate the systematic relationship between the treatment standard deviations and means, without compromising the underlying principle of ANOVA (Myers, 1972).

A cube root transformation was carried out on the dataset, since it consist of frequency measures and there is a constant of proportionality between the means and variances at all treatment levels. Therefore, the ANOVA was based on the cube root transformed measure of message significance.

A rerun of the descriptive statistics on the transformed dataset was completed and the measures for kurtosis and skewness, which were generated from SAS, are presented in Table 12.

Media	Risk Averse		Risk Prone	
	Skewness	Kurtosis	Skewness	Kurtosis
T	0.236	1.137	0.518	0.133
I	0.423	0.994	-0.101	-0.153
Q	0.666	1.224	0.155	-0.009

Table 12: Normality test statistics for message significance

The values shown in Table 12 indicate that skewness and kurtosis measures are reasonably close to zero, favoring a conclusion that the data is approximately normally distributed. The Komlogorov-Smirnov statistic of the residuals for the relationship between message significance, media richness and risk induced preferences is 1.892, which provides evidence that the data is normally distributed. The K-S test for normality and the normal probability plot of the residuals are given in Appendix H. These results confirm that the dataset is normally distributed. Again, there are small deviations from normality, which are expected, given that we have many data points (about 2,900), but these will not significantly affect the analyses.

In view of the foregoing results, the ANOVA on the transformed data was completed. The analysis determines the extent to which each of the following mathematically expressed hypotheses is true, based on the measure of message significance

$$\textbf{H2a:} \quad {}_{\text{Msg sig}}\mu^{T} > {}_{\text{Msg sig}}\mu^{I}$$

$$\textbf{H2b:} \quad {}_{\text{Msg sig}}\mu^{T} > {}_{\text{Msg sig}}\mu^{Q}$$

$$\textbf{H2c:} \quad {}_{\text{Msg sig}}\mu^{I} > {}_{\text{Msg sig}}\mu^{Q}.$$

Results for the ANOVA for the message significance data, which were analyzed using the Proc GLM procedure in SAS are given in Figure 13.

Dependent Variable: Message Significance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	10.15740433	1.12860048	51.48	<.0001
Error	2608	57.17067436	0.02192127		
Corrected Total	2617	67.32807869			

R-Square	Coeff Var	Root MSE	CbrtMsgSg Mean
0.150864	33.73716	0.148058	0.438858

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Media	2	2.94584658	1.47292329	67.19	<.0001
Risk_Type	1	5.66453993	5.66453993	258.40	<.0001
Role	1	0.34127537	0.34127537	15.57	<.0001
Risk Type*Media	2	0.44036898	0.22018449	10.04	<.0001
Media*Role	2	0.15204851	0.07602425	3.47	0.0313
Risk_Type*Role	1	0.59475958	0.59475958	27.13	<.0001

Figure 13: Factorial ANOVA SAS output for message significance

The results show that the relevant F-statistics for media and risk type by media interaction are statistically significant, in explaining relationships between message

significance and these factors. The F-statistic for both the media effect (F, 67.19) and the interaction term, media by risk type (F, 10.04), are statistically significant with a p-value less than 0.0001. The R-square statistic indicates that approximately 15% of the variation in message significance is explained by the linear relationship expressed by the fixed factors – media richness and risk levels.

Examining and comparing the means for the different levels of the fixed factors assess the hypotheses on message significance. A breakdown of the relevant retransformed means is given in Table 13, along with a graph in Figure 14, showing the relative values across communications media.

Media Effect Message Significance	
Media	**Mean**
T	**0.076**
I	**0.109**
Q	**0.067**

Table 13: Mean response for message significance across communications media

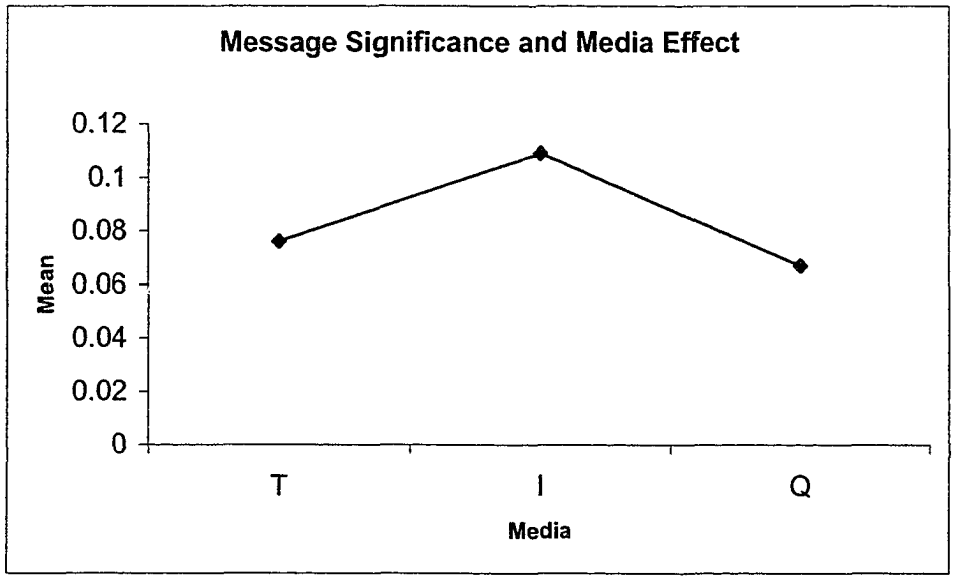


Figure 14: Graph of mean message significance across communications media

The above results indicate that there is no directional support for H2a, but there is support for H2b and for H2c. Specifically, message significance, as measured by the relative frequency of quote change, for telephone –to-telephone communications and instant messaging systems is greater than for non-mediated communications system. However, message significance is greater for instant messaging than for telephone-to-telephone communications systems.

The Tukey-Kramer method was used to compare differences between the mean responses for each medium. The result indicated that difference in means for all mean responses on media are statistically significant at the 5% level of significance.

At different levels of risk propensity, the relative differences in message significance are the same, but for risk averse situations, the difference between Q and T is very small. In particular, for all risk levels, H2a is not supported, but H2b and H2c are supported. Table 14 and Figure 15 show the mean message significance by risk levels across communications media.

Media by Risk type Effect For Message Significance		
Risk type	**Media**	**Mean**
A	**T**	**0.0527**
A	**I**	**0.0749**
A	**Q**	**0.0523**
P	**T**	**0.1034**
P	**I**	**0.1637**
P	**Q**	**0.0852**

Table 14: Mean message significance across communications media by risk induced preference types

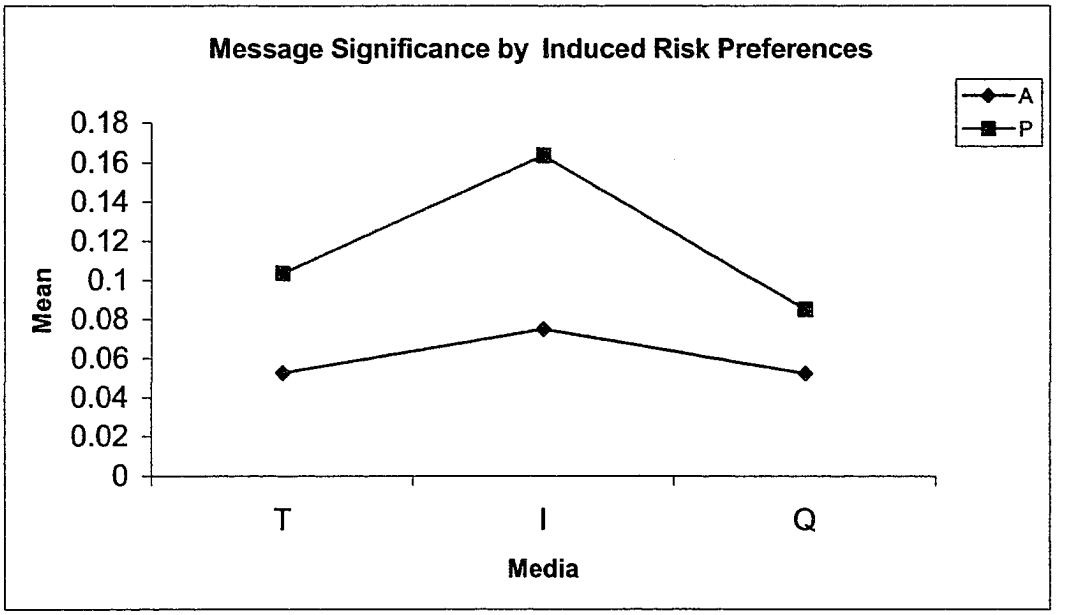


Figure 15: Graph of mean message significance across communications media by risk induced preference types

Least squared means (LS-means), which estimate the marginal means over a balanced population, were compared for different levels of the interaction term, media by risk type. The comparison examines the null hypothesis that paired LS means are equal. Results indicate that at all risk levels, differences between I and Q; between I and T; and between T and Q are significant at the 5% level of significance.

The hypothesized relationship in the context of roles assigned to subjects, given the statistical significance (F, 3.47), was also examined. The results for media by role effect – mean responses are given in Table 15 and displayed graphically in Figure 16.

Media by Role Effect		
Buyer Mean response	**Seller Mean response**	**Media**
0.089	**0.064**	**T**
0.116	**0.109**	**I**
0.071	**0.064**	**Q**

Table 15: Mean message significance across communications media for buyers and sellers

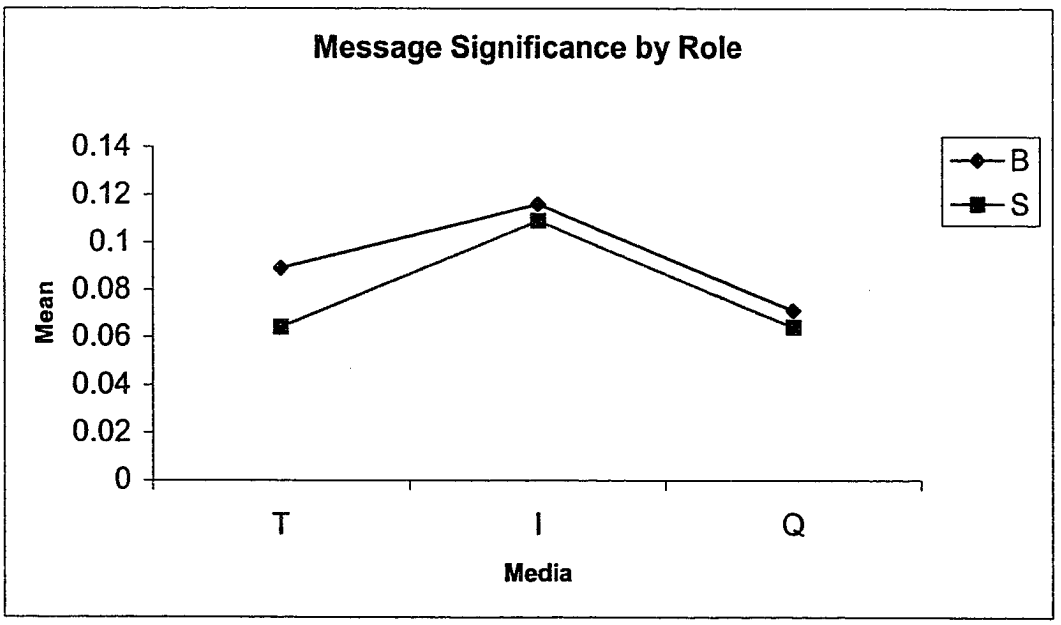


Figure 16: Graph of mean message significance across communications media for buyers and sellers

The above results indicate that there is directional support for hypotheses, 2b and 2c, but there is no support for H2a, irrespective of the role of subjects. The results also indicate that subjects, who were assigned the role of seller, regarded message significance in T and Q the same.

5.2.3 Factorial ANOVA: Message Redundancy

An ANOVA was performed with message redundancy, which is based on a surrogate measure - ratio of number of repeated quotes to number quotes - as the dependent variable and manipulation of media richness, subjects' role, and risk preferences as fixed factors.

Normality Test and Descriptive Statistics

The relevant descriptive statistics for the measure of message redundancy were examined. First, the data were examined for possible outliers, since it known that the measure of message redundancy is bounded on the semi-open interval [0,1). There were no outliers found in the data.

As before, the test for normality was based on the examination of relevant descriptive statistics. These include skewness and kurtosis statistics, which were generated from SAS and are presented in Table 16.

Media	Risk Averse		Risk Prone	
	Skewness	Kurtosis	Skewness	Kurtosis
T	0.270	-1.316	0.131	-1.320
I	-0.375	-1.243	-0.285	-1.270
Q	-0.111	-1.175	0.026	-0.980

Table 16: Normality test statistics for message redundancy

The values shown in the Table 16 indicate that skewness and kurtosis measures are reasonably close to zero, favoring a conclusion that the data is about normally distributed. The Komlogorov-Smirnov statistic of the residuals for the relationship between message redundancy, media richness and risk induced preferences is 7.063, which provides evidence that the data is normally distributed. The K-S test for normality and the normal probability plot of the residuals are given in Appendix I. These results confirm that the dataset is normally distributed.

Based on the foregoing results, an ANOVA was performed on the data. The analysis determines the extent to which each of the following mathematically expressed hypotheses is true, based on the measure of message redundancy

$$\textbf{H3a:} \quad {}_{\text{Msg red}}\mu^{T} < {}_{\text{Msg red}}\mu^{I}$$

$$\textbf{H3b:} \quad {}_{\text{Msg red}}\mu^{T} < {}_{\text{Msg red}}\mu^{Q}$$

$$\textbf{H3c:} \quad {}_{\text{Msg red}}\mu^{I} < {}_{\text{Msg red}}\mu^{Q}.$$

Results for the ANOVA for the message redundancy data, which were analyzed using the Proc GLM procedure in SAS are shown in Figure17.

Dependent Variable: Message Redundancy

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	11.4915284	1.2768365	17.65	<.0001
Error	3421	247.5437676	0.0723601		
Corrected Total	3430	259.0352961			

R-Square	Coeff Var	Root MSE	MsgRed Mean
0.044363	73.81803	0.268998	0.364407

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Media	2	6.98032762	3.49016381	48.23	<.0001
Risk_Type	1	0.22873195	0.22873195	3.16	0.0755
Role	1	2.99769752	2.99769752	41.43	<.0001
Risk_Type*Media	2	0.23357495	0.11678748	1.61	0.1992
Media*Role	2	0.17885147	0.08942574	1.24	0.2907
Risk_Type*Role	1	0.91065852	0.91065852	12.59	0.0004

Figure 17: Factorial ANOVA SAS output for message redundancy

The results show that the relevant F-statistics for media and risk type by media interaction are statistically significant, in explaining relationships between message redundancy and these factors. The F-statistic for media effect (F, 48.23) is statistically significant with a p-value less than 0.0001. The F statistics (1.61) for the interaction term, with a p value (0.1992), also indicates that effects due to this manipulation are

significantly greater than that which would be found due to natural variability in message redundancy. The R-square statistic indicates that approximately 4% of the variation in message redundancy is explained by the linear relationship expressed by the fixed factors.

Examining and comparing the means for the different levels of the fixed factors assess the hypotheses on message redundancy. A breakdown of the response means is given in Table 17, displayed graphically in Figure 18.

Media Effect **Message Redundancy**	
Media	**Mean**
T	**0.297**
I	**0.388**
Q	**0.402**

Table 17: Mean response for message redundancy communications media

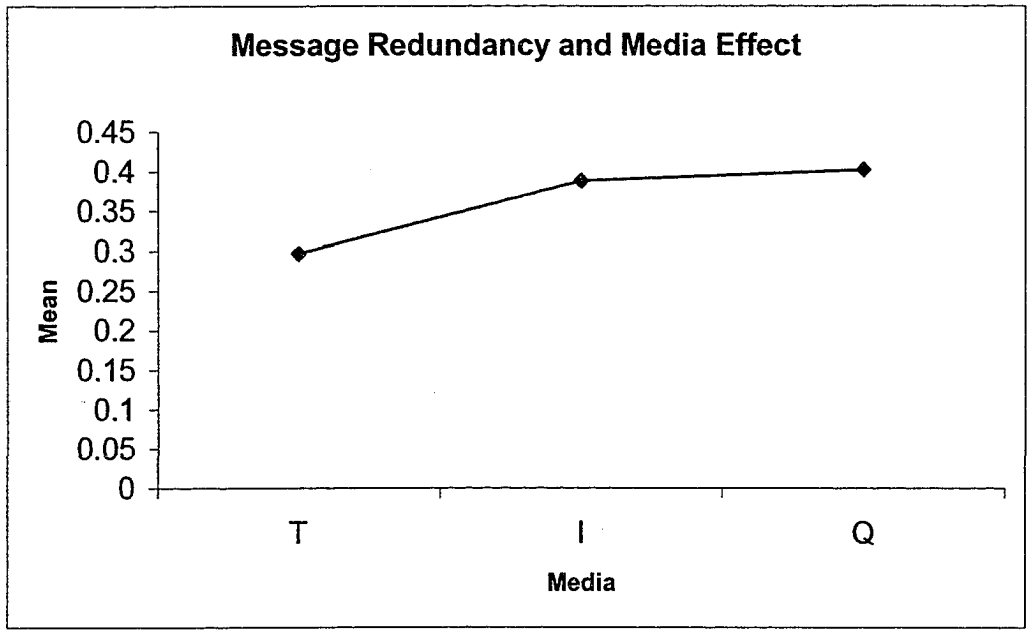


Figure 18: Graph of mean message redundancy across communications media

Recall that the measure of message redundancy is proportional to the reciprocal of the actual data points that are used. In which case lower mean responses for a factor indicate that message redundancy is higher on that factor. Therefore, in terms of message redundancy, the results indicate that message redundancy is higher for T than for I, which give directional support to H3a; higher for T than for Q, which gives directional support for H3b; and higher for I than for Q, which gives directional support for H3c. In sum, all hypotheses on message redundancy are directionally supported.

Tukey-Kramer method was used to compare differences between the mean responses for each medium. The result indicated that differences in mean responses on message

redundancy between T and Q and between T and I are statistically significant at the 5% level of significance.

At different levels of risk propensity, the relative differences in message redundancy between Q and T are about equal. However, message redundancy is about the same for both levels of risk propensity with instant messaging communications and the difference between I and Q is smaller at the risk averse level than at the risk prone level. Table 18 and Figure 19 show the mean message redundancy by risk levels across communications media.

Media by Risk type Effect Message Redundancy		
Risk type	**Media**	**Mean**
A	**T**	**0.289**
A	**I**	**0.389**
A	**Q**	**0.385**
P	**T**	**0.305**
P	**I**	**0.385**
P	**Q**	**0.420**

Table 18: Mean message redundancy across communications media by risk induced preference types

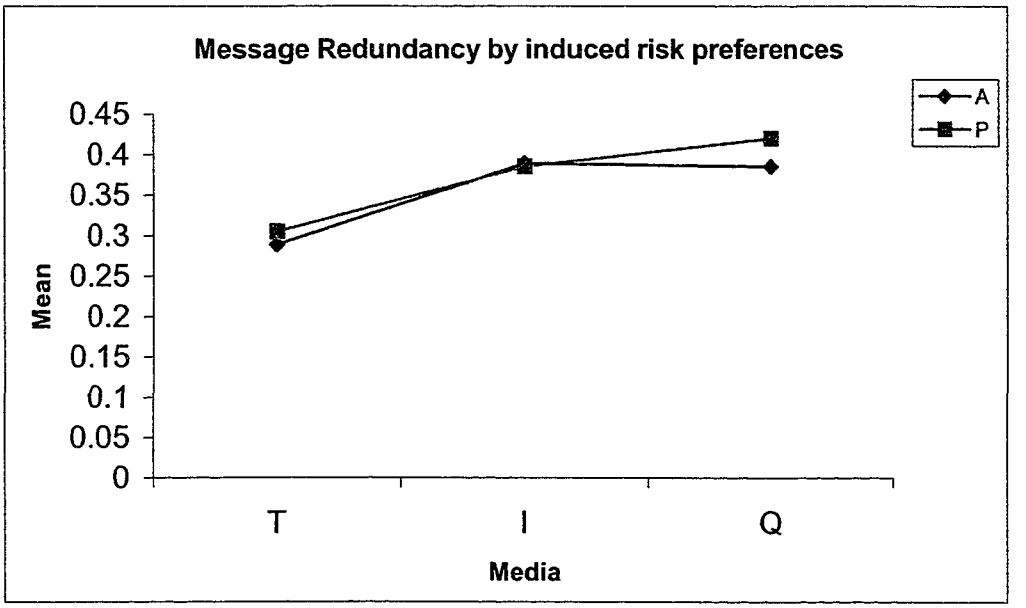


Figure 19: Graph of mean message redundancy across communications media by risk induced preference types

Least squared means (LS-means) were compared for different levels of the interaction term, media by risk type. The comparison examines the null hypothesis that paired LS means for the levels of the interaction term are equal. The results indicate that at the risk averse level, the difference between I and T is statistically significant at the 5% level, whereas at the risk prone level the means for I and T and for Q and T are statistically significant at the 10% level.

The hypothesized relationship was also examined in the context of roles assigned to subjects, given the statistical significance (F, 1.47) of this interaction term. The results for media by role effect mean responses are shown in Table 19 and Figure 20.

Media by Role Effect		
Buyer Mean response	Seller Mean response	Media
0.270	0.325	T
0.348	0.427	I
0.381	0.425	Q

Table 19: Mean message redundancy across communications media for buyers and sellers

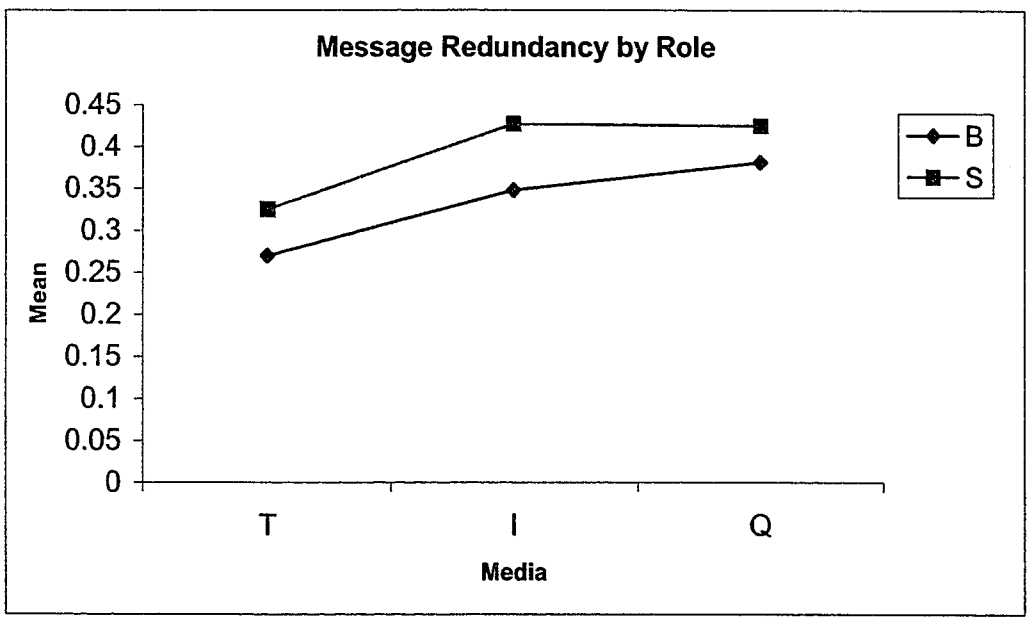


Figure 20: Graph of mean message redundancy across communications media for buyers and sellers

The above results indicate that there is directional support for all three hypotheses - 3a, 3b and 3c, irrespective of the role of subjects. The results also indicate that subjects, who were assigned the role of buyer, had higher levels of message redundancy than subjects who were assigned the role of seller.

5.2.4 Factorial ANOVA: Subjective Judgment

An ANOVA was performed for changes in subjective judgment, which is based on grouped measures from a 7-point Likert scale, ranging from poor to excellent and corresponding to whether scaled measures were changed or unchanged pre to post negotiation. The frequency of self-reported categorical responses was determined for the derived categories and used to measure subjective judgment. Self-reported measures were based on the attribute of the fixed factor, risk propensity, represented by the notional tickets, which were traded in different media, the other fixed factors.

Normality Test and Descriptive Statistics

The relevant descriptive statistics for the frequency of changes in subjective judgment were examined. These statistics tell the extent to which the normality assumption required for ANOVA is met. The primary statistics include skewness and kurtosis. The measures of skewness and kurtosis, which were generated from SAS, are presented in Table 20.

Media	Risk Averse		Risk Prone	
	Skewness	Kurtosis	Skewness	Kurtosis
T	0.776	0.462	1.125	1.519
I	1.126	1.383	0.651	-0.492
Q	0.288	-0.561	0.643	-0.178

Table 20: Normality test statistics for the changes in subjective judgment

The values shown in table 20 indicate that skewness and kurtosis measures are reasonably close to zero, favoring a conclusion that the data is approximately normally distributed. Komlogorov-Smirnov statistic of the residuals for the relationship between changes in the subjective judgment, media richness and risk induced preferences is 1.772, which provides evidence that the data is normally distributed. The K-S test for normality and the normal probability plot of the residuals are given in Appendix J. These results confirm that the dataset is normally distributed.

Based on the foregoing results, an ANOVA was performed on the data. The analysis determines the extent to which each of the following mathematically expressed hypotheses is true, based on the frequency of changes in self-reported subjective judgment on different risk preferences

$$\mathbf{H4a:} \quad \delta_{sj}\mu^{T} < \delta_{sj}\mu^{I}$$

$$\mathbf{H4b:} \quad \delta_{sj}\mu^{T} < \delta_{sj}\mu^{Q}$$

$$\mathbf{H4c:} \quad \delta_{sj}\mu^{I} < \delta_{sj}\mu^{Q}.$$

Results for the ANOVA for the message redundancy data, which were analyzed using the Proc GLM procedure in SAS are given Figure 21.

Dependent Variable: Changes in subjective judgment

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	243.808642	27.089849	9.60	<.0001
Error	314	886.191358	2.822265		
Corrected Total	323	1130.000000			

R-Square	Coeff Var	Root MSE	Changed Mean
0.215760	65.73756	1.679960	2.555556

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Media	2	1.1296296	0.5648148	0.20	0.8187
Risk type	1	60.4938272	60.4938272	21.43	<.0001
Risk type*Media	2	20.7839506	10.3919753	3.68	0.0263
Role	1	130.9753086	130.9753086	46.41	<.0001
Media*Role	2	28.9320988	14.4660494	5.13	0.0064

Figure 21: Factorial ANOVA SAS output for subjective judgment

The results show that the relevant F-statistics for media effect is not significant, indicating that changes in subjective judgment across media did not differ significantly and were not more variable than would normally be expected. However media by role and media by risk type are both statistically significant, and they account for some variability of the changes in subjective judgment. The R-square statistic indicates that approximately 22% of the variation in changes in subjective judgment is explained by the linear relationship expressed by all factors, except media alone.

The hypothesized relationship in the context of media by role effect, given that subjects were not equally endowed and the statistical significance of this interaction term in the ANOVA, was also examined. The results for media by role effect – mean responses for changes in subjective judgment, which were generated from SAS, are shown in Table 21 and Figure 22.

Media by Role Effect changes in subjective judgment		
Buyer Mean response	**Seller Mean response**	**Media**
3.463	**1.574**	**T**
3.370	**1.907**	**I**
2.741	**2.278**	**Q**

Table 21: Changes in subjective judgment across communications media for buyers and sellers

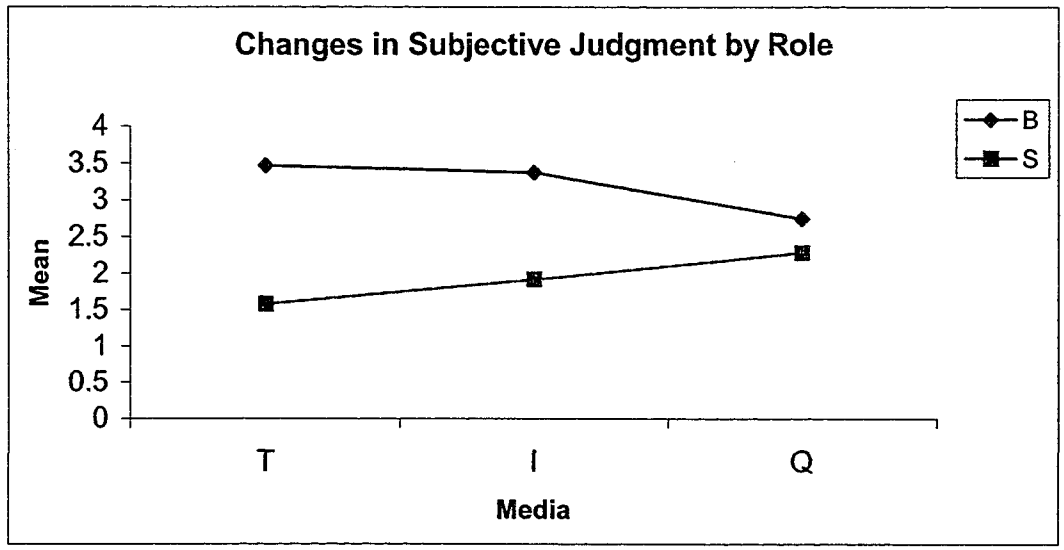


Figure 22: Graph of changes in subjective judgment across communications media for buyers and sellers

The results indicate that there is directional support for all three hypotheses - 4a, 4b and 4c, in the case of subjects who were assigned the role of sellers. However, there is no support for the hypotheses in the case of subjects who were assigned the role of buyers. In fact, the results were completely opposite to that which was hypothesized. Furthermore, subjects who were assigned the role of buyer, on average made more changes in their subjective judgment, irrespective of the media that was used for negotiation.

Least squared means (LS-means) were compared for different levels of the media by role effect. The comparison examines the null hypothesis that paired LS means for the levels of the interaction term are equal. The results indicate that for sellers, the difference between I and T; and between I and Q are not statistically significant,

however the difference between T and Q is significant at the 10% level of significance. None of the results for buyers were significant.

The hypothesized relationship in the context of media by risk type effect, given the statistical significance of this term (F, 3.68; p value = 0.026) at different levels, was also examined. The mean changes in subjective judgment are given in Table 22 and graphically displayed in Figure 23.

Media by Risk type Effect Subjective Judgment		
Risk type	**Media**	**Mean**
A	**T**	**2.593**
A	**I**	**3.241**
A	**Q**	**3.130**
P	**T**	**2.444**
P	**I**	**2.037**
P	**Q**	**1.889**

Table 22: Mean changes in subjective judgment across communications media by risk induced preference types

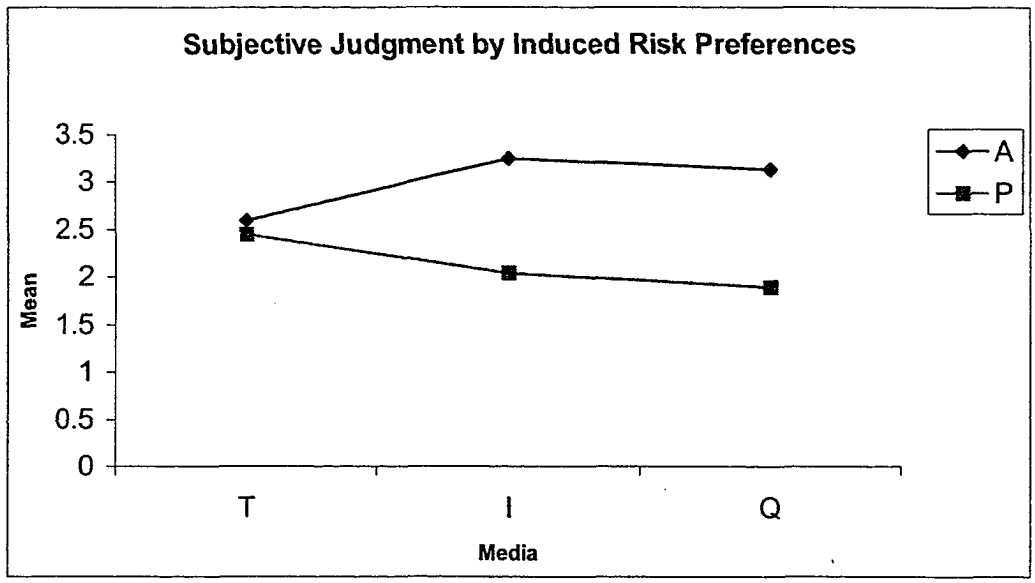


Figure 23: Graph of mean changes in subjective judgment across communications media by risk induced preference types

The above results indicate that there is directional support for hypotheses 4a and 4b, but there is no support for 4c - at the risk averse induced preference level. There is no support for the hypotheses at the risk prone preference level. At both levels of risk preferences, mean changes in subjective judgment for I is greater than that of Q, whereas mean changes for T is about the same.

Least squared means (LS-means) were compared for different levels of the risk type by media effect. The comparison examines the null hypothesis that paired LS means for the levels of the interaction term are equal. The results indicated that at the risk averse level, the difference between I and T; and between I and Q are not statistically

significant. However, at the risk prone level, the results that do not indicate support for the hypothesized relationship are statistically significant at the 5% level of significance.

5.2.5 Factorial ANOVA: ARA, Risk Averse Induced Preference

An ANOVA was performed for the derived measure of absolute risk aversion based on trades for the notional tickets, which represented risk averse induced preference. These set of trades represented one level of the fixed factor – risk propensity. Trades were conducted in all three media, the other fixed factors.

Normality Test and Descriptive Statistics

The relevant descriptive statistics for the measure of absolute risk aversion (ARA) were examined. These statistics tell the extent to which the normality assumption required for ANOVA is met. The primary statistics include skewness and kurtosis.

Analyses indicated that the data was markedly skewed. The relationships between the mean and standard deviations for responses within treatment category of the dataset were compared. It is found that treatment standard deviations are proportional to the square of treatment means. Under this condition, a logarithmic transformation of the dependent variable will eliminate the systematic relationship between the treatment standard deviations and means, without affecting the underlying principles of ANOVA (Myers, 1972). Therefore the ANOVA was based on the logarithm of the

derived absolute risk aversion, relating to the risk averse induced preferences. A rerun of the descriptive statistics on the transformed dataset was completed and the measures for kurtosis and skewness, which were generated from SAS, are presented in the Table 23.

Media	Risk averse	
	Skewness	Kurtosis
T	0.889	1.531
I	0.835	1.519
Q	0.693	0.584

Table 23: Normality test statistics for transformed absolute risk aversion in the case of risk averse induced preferences

The values shown in the tables, above, indicate that skewness and kurtosis measures are reasonably close to zero, favoring a conclusion that the transformed data is approximately normally distributed. Komlogorov-Smirnov statistic of the residuals for the relationship between the absolute risk aversion for the risk averse induced preference and media richness is 2.641, which provides evidence that the data is normally distributed. The K-S test for normality and the normal probability plot of the residuals are given in Appendix K. These results confirm that the dataset is normally distributed.

An ANOVA was then performed on the transformed data. The analysis determines the extent to which each of the following mathematically expressed hypotheses is true, based on the measure of absolute risk aversion

$$\textbf{H5a:} \quad {}_{ARA}{}^{a}\mu^{T} > {}_{ARA}{}^{a}\mu^{I}$$

$$\textbf{H5b:} \quad {}_{ARA}{}^{a}\mu^{T} > {}_{ARA}{}^{a}\mu^{Q}$$

$$\textbf{H5c:} \quad {}_{ARA}{}^{a}\mu^{I} > {}_{ARA}{}^{a}\mu^{Q}.$$

Results of the ANOVA for the transformed absolute risk aversion data, which were analyzed using the Proc GLM procedure in SAS, are given in Figure 24.

Dependent Variable: Absolute Risk Aversion (Risk averse preference)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	7.9288233	1.5857647	17.34	<.0001
Error	1902	173.8966063	0.0914283		
Corrected Total	1907	181.8254296			

R-Square	Coeff Var	Root MSE	RALN_ARA Mean
0.043607	-3.939223	0.302371	-7.675907

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Media	2	0.89132705	0.44566352	4.87	0.0077
Role	1	5.83753175	5.83753175	63.85	<.0001
Media*Role	2	1.15122477	0.57561239	6.30	0.0019

Figure 24: Factorial ANOVA SAS output for ARA based on risk averse induced preferences

The results show that the relevant F-statistics for media, subjects' role, media by role interaction are statistically significant, in explaining relationships between absolute risk aversion and the fixed factors. The F-statistic for media effect (F, 4.87) is statistically significant with a p-value less than 0.05. The F-statistics (6.30) for the interaction term, with a p-value (0.0019), also indicates that effects due to this manipulation are significantly greater that which would be found due to natural variability in absolute risk aversion. The R-square statistic indicates that approximately 4% of the variation in absolute risk aversion is explained by the linear relationship involving media and role.

Examining and comparing the means for the different levels of the fixed factors assess the hypotheses on absolute risk aversion. The breakdown of the relevant retransformed means is given in Table 24, and graphically displayed in Figure 25.

Media Effect, risk averse preference, ARA	
Media	**Mean**
T	**0.000473**
I	**0.000451**
Q	**0.000470**

Table 24: Mean absolute risk aversion of risk averse induced preference across communications media

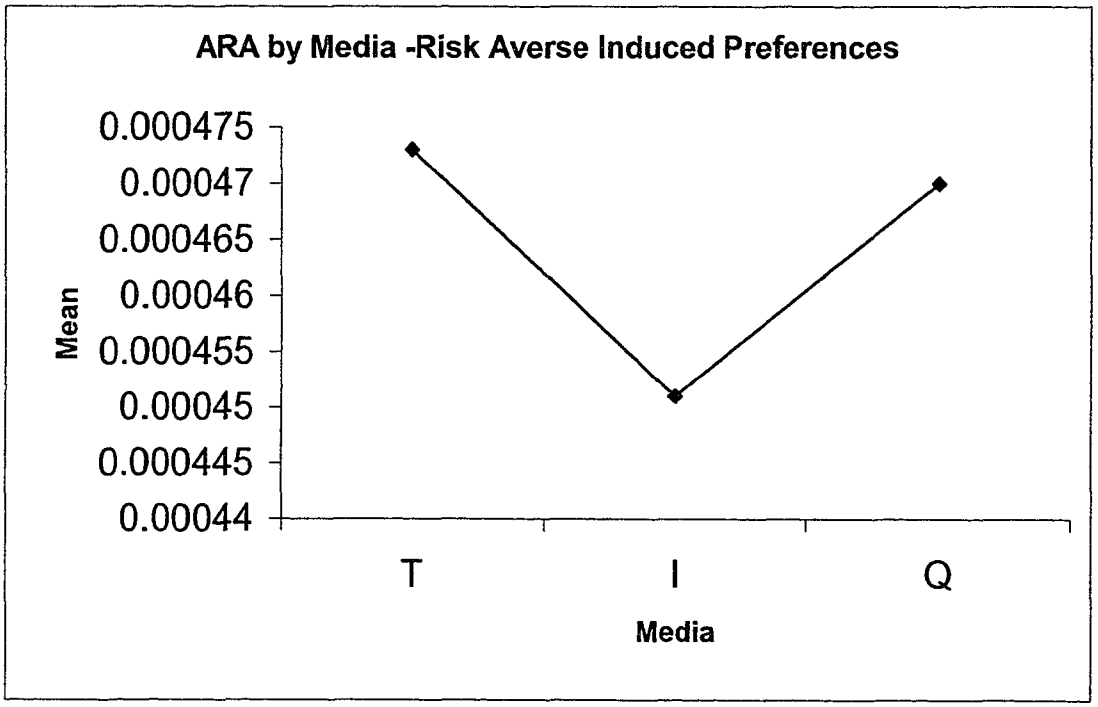


Figure 25: Graph of mean absolute risk aversion of risk averse induced preference across communications media

The above results indicate that there is directional support for H5a and H5b, but there is no support for H5c. Specifically, the absolute risk aversion, as measured based on the induced risk preference methodology, for subjects using telephone–to-telephone communications is greater than absolute risk aversion measured for either instant messaging or for non-mediated communications system. However, absolute risk aversion for subjects using non-mediated communication is greater than absolute risk aversion measured for instant messaging.

Tukey-Kramer method was used to compare differences between the mean responses for each medium. The result indicated that difference in means for mean responses

between T and I, T and Q, and between Q and I are all statistically significant at the 5% level of significance.

The hypothesized relationship was also examined in the context of roles assigned to subjects, given the statistical significance (F, 6.30 with p value less than 0.05) of the interaction term in the model. The results for media by role effect – mean responses are given in Table 25, and graphically displayed in Figure 26.

Media by Role Effect, Risk Averse Induced Preference, ARA		
Buyer Mean ARA	**Seller Mean ARA**	**Media**
0.000491	**0.000457**	**T**
0.000469	**0.000435**	**I**
0.000516	**0.000431**	**Q**

Table 25: Mean absolute risk aversion for risk averse induced preference across communications media for buyers and sellers

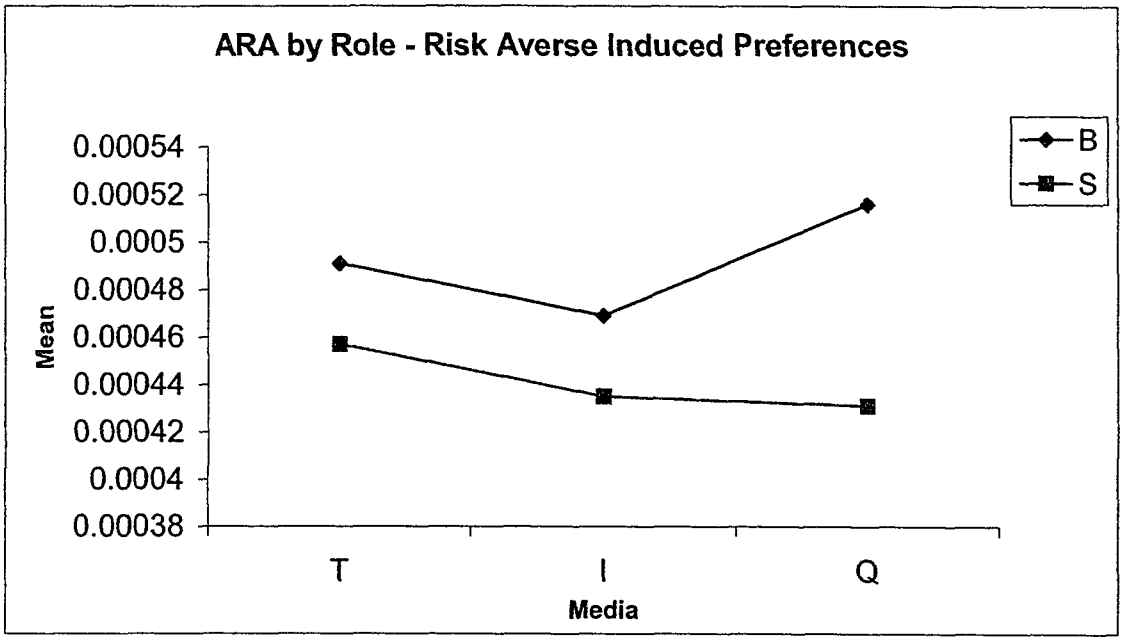


Figure 26: Graph of mean absolute risk aversion for risk averse induced preference across communications media for buyers and sellers

The above results indicate that there is directional support for all three hypotheses - 5a, 5b and 5c, based on the results for subjects who were assigned the role of seller. Support for hypothesis 5a and 5b are significant at the 5% level of significance. However, there is directional support for only hypothesis 5a, based on subjects who were assigned the role of buyer. Support for hypothesis 5a, in this case is not statistically significant. There is no support for either hypothesis 5b or 5c, in the case of buyers.

5.2.6 Factorial ANOVA: ARA, Risk Prone Induced Preference

An ANOVA was performed for the derived measure of absolute risk aversion based on trades for the notional tickets, which represented risk prone induced preferences. These set of trades represented one level (another was examined in hypotheses 5a, 5b and 5c) of the fixed factor – risk propensity. Trades were conducted in all three media, the other fixed factors.

Normality Test and Descriptive Statistics

The relevant descriptive statistics for the measure of absolute risk aversion (ARA) were examined. These statistics tell the extent to which the normality assumption required for ANOVA is met. The primary statistics include skewness and kurtosis.

Analyses indicated that the dataset was skewed. The relationships between the mean and standard deviations for responses within treatment category of the dataset were compared. As was the case for the absolute risk aversion measures in the 5^{th} set of hypotheses, it is found that treatment standard deviations are proportional to the square of treatment means. Under this condition, a logarithmic transformation of the dependent variable will eliminate the systematic relationship between the treatment standard deviations and means, without affecting the underlying principles of ANOVA (Myers, 1972). Therefore, the ANOVA was based on the logarithm of the derived absolute risk aversion, relating to the risk prone induced preferences.

A rerun of the descriptive statistics on the transformed dataset was completed and the measures for kurtosis and skewness, which were generated from SAS, are presented in Table 26.

Media	Risk prone	
	Skewness	Kurtosis
T	1.205	1.685
I	1.043	0.897
Q	1.148	0.702

Table 26: Normality test statistics for transformed absolute risk aversion in the case of risk prone induced preferences

The values shown in the tables, above, indicate that skewness and kurtosis measures are reasonably close to zero, favoring a conclusion that the data is approximately normally distributed. Komlogorov-Smirnov statistic of the residuals for the relationship between the absolute risk aversion for the risk prone induced preference and media richness is 4.151, which provides evidence that the data is normally distributed. The K-S test for normality and the normal probability plot of the residuals are given in Appendix L. These results confirm that the dataset is normally distributed.

An ANOVA was then performed on the transformed data. The analysis determines the extent to which each of the following mathematically expressed hypotheses is true, based on the measure of absolute risk aversion:

$$\textbf{H6a:} \quad {}_{ARA}{}^{p}\mu^{T} < {}_{ARA}{}^{p}\mu^{I}$$

$$\textbf{H6b:} \quad {}_{ARA}{}^{p}\mu^{T} < {}_{ARA}{}^{p}\mu^{Q}$$

$$\textbf{H6c:} \quad {}_{ARA}{}^{p}\mu^{I} < {}_{ARA}{}^{p}\mu^{Q}.$$

Results for the ANOVA for the transformed absolute risk aversion data, which were analyzed using the Proc GLM procedure in SAS, are given in Figure 27.

Dependent Variable: RSLNARA RSLNARA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	78.8157865	15.7631573	29.96	<.0001
Error	1662	874.5543170	0.5262060		
Corrected Total	1667	953.3701034			

R-Square	Coeff Var	Root MSE	RSLNARA Mean
0.082671	-46.21110	0.725401	-1.569754

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Media	2	4.70699235	2.35349617	4.47	0.0116
Role	1	50.23868314	50.23868314	95.47	<.0001
Media*Role	2	26.55945408	13.27972704	25.24	<.0001

Figure 27: Factorial ANOVA SAS output for ARA based on risk prone induced preferences

The results show that the relevant F-statistics for media, subjects' role, and the media by role interaction are statistically significant, in explaining relationships between absolute risk aversion and the fixed factors. The F-statistic for media effect (F, 4.47) is statistically significant with a p-value less than 0.05. The F-statistics (25.24) for the interaction term, with a p-value (<0.0001), also indicates that effects due to this manipulation are significantly greater that which would be found due to natural variability in absolute risk aversion. The R-square statistic indicates that slightly more than 8% of the variation in absolute risk aversion is explained by the linear relationship involving media and role.

Examining and comparing the means for the different levels of the fixed factors, media, assess the hypotheses on absolute risk aversion. The breakdown of the relevant retransformed means is given in Table 27, and graphically displayed in Figure 28.

Media Effect, Risk Prone Preference, ARA	
Media	**Mean**
T	**0.1956**
I	**0.2088**
Q	**0.2231**

Table 27: Mean absolute risk aversion of risk prone induced preference across communications media

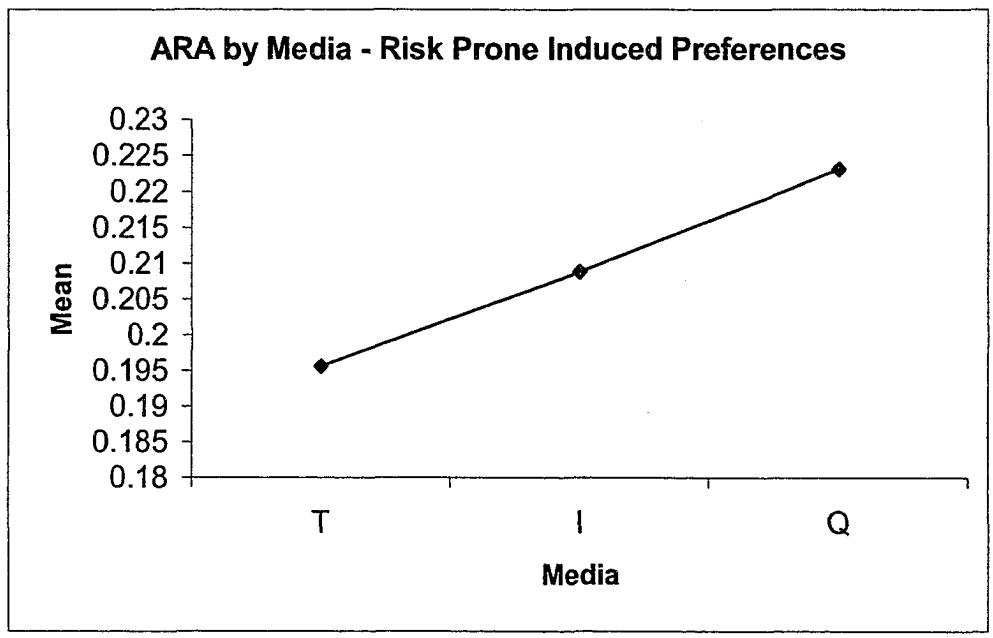


Figure 28: Graph of mean absolute risk aversion of risk prone induced preference across communications media

The above results indicate that there is directional support for all three hypotheses - H6a, H6b and H6c. Specifically, the absolute risk aversion, as measured based on the induced risk preference methodology, for subjects using telephone–to-telephone communications is less than absolute risk aversion measured for either instant messaging or for non-mediated communications system. Additionally, the absolute risk aversion for subjects using instant messaging is less than the absolute risk aversion for non-mediated communications system.

Tukey-Kramer method was used to compare differences between the mean responses for each medium. The result indicated that difference in means for mean responses

between T and Q are statistically significant at the 5% level of significance, whereas differences between T and I; and between I and Q, are significant at the 10% level of significance.

The hypothesized relationship was also examined in the context of roles assigned to subjects, given the statistical significance (F, 25.24 with p-value less than 0.05) of the interaction term in the model. The results for media by role effect – mean responses are given in Table 28, and graphically displayed in Figure 29.

Media by Role Effect, Risk Prone Induced Preference, ARA		
Buyer Mean ARA	**Seller Mean ARA**	**Media**
0.2108	**0.1814**	**T**
0.2290	**0.1905**	**I**
0.3179	**0.1566**	**Q**

Table 28: Mean absolute risk aversion for risk prone induced preference across communications media for buyers and sellers

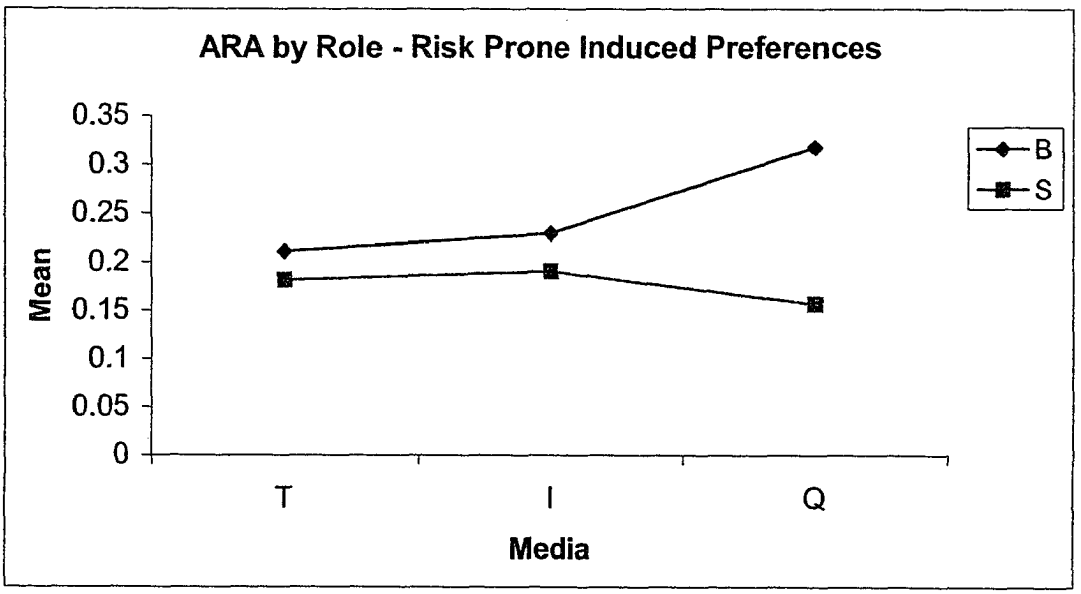


Figure 29: Graph of mean absolute risk aversion for risk prone induced preference across communications media for buyers and sellers

The above results indicate that there is directional support for all three hypotheses - 6a, 6b and 6c, based on the results for subjects who were assigned the role of buyer. Support for these hypotheses is significant at the 5% level of significance. There is also directional support for hypothesis 6a, based on subjects who were assigned the role of seller, however, it is not statistically significant. There is no support for either hypothesis 6b or 6c, in the case of sellers.

5.3 Summary of Results

A summary of all the results concerning the hypothesized relationships for the dependent variables is presented in Tables 29 and 30.

Dependent Variable	Hypothesis	Directional support	Statistically Significant (5% level)
Message Representation	$H1a: {}_{Mrp}\delta^2_T < {}_{Mrp}\delta^2_I$	*Yes*	*Yes*
Message Representation	$H1b: {}_{Mrp}\delta^2_T < {}_{Mrp}\delta^2_Q$	*Yes*	*Yes*
Message Representation	$H1c: {}_{Mrp}\delta^2_I < {}_{Mrp}\delta^2_Q$	*No*	*No*
Message Significance	$H2a: {}_{Msg\ sig}\mu^T > {}_{Msg\ sig}\mu^I$	*No*	*Yes*
Message Significance	$H2b: {}_{Msg\ sig}\mu^T > {}_{Msg\ sig}\mu^Q$	*Yes*	*Yes*
Message Significance	$H2c: {}_{Msg\ sig}\mu^I > {}_{Msg\ sig}\mu^Q$	*Yes*	*Yes*
Message Redundancy	$H3a: {}_{Msg\ red}\mu^T < {}_{Msg\ red}\mu^I$	*Yes*	*Yes*
Message Redundancy	$H3b: {}_{Msg\ red}\mu^T < {}_{Msg\ red}\mu^Q$	*Yes*	*Yes*
Message Redundancy	$H3c: {}_{Msg\ red}\mu^I < {}_{Msg\ red}\mu^Q$	*Yes*	*No*

Table 29: Summary of Results for Hypothesis Tests: 1, 2 and 3

Dependent Variable	Hypothesis	Directional support	Statistically Significant (5% level)
Subjective Judgment	***H4a:*** $\delta_{sj}\mu^{T} < \delta_{sj}\mu^{I}$	*^Yes*	*No*
Subjective Judgment	***H4b:*** $\delta_{sj}\mu^{T} < \delta_{sj}\mu^{Q}$	*^Yes*	*No*
Subjective Judgment	***H4c:*** $\delta_{sj}\mu^{I} < \delta_{sj}\mu^{Q}$	*^Yes*	**No*
ARA-Risk averse situation	***H5a:*** ${}_{ARA}{}^{a}\mu^{T} > {}_{ARA}{}^{a}\mu^{I}$	*Yes*	*No*
ARA-Risk averse situation	***H5b:*** ${}_{ARA}{}^{a}\mu^{T} > {}_{ARA}{}^{a}\mu^{Q}$	*Yes*	*No*
ARA-Risk averse situation	***H5c:*** ${}_{ARA}{}^{a}\mu^{I} > {}_{ARA}{}^{a}\mu^{Q}$	*No*	*No*
ARA-Risk prone situation	***H6a:*** ${}_{ARA}{}^{p}\mu^{T} < {}_{ARA}{}^{p}\mu^{I}$	*Yes*	**No*
ARA-Risk prone situation	***H6b:*** ${}_{ARA}{}^{p}\mu^{T} < {}_{ARA}{}^{p}\mu^{Q}$	*Yes*	*Yes*
ARA-Risk prone situation	***H6c:*** ${}_{ARA}{}^{p}\mu^{I} < {}_{ARA}{}^{p}\mu^{Q}$	*Yes*	**No*

Table 30: Summary of Results for Hypothesis Tests: 4, 5 and 6

^ For sellers only, and at different levels of risk propensity, support is mixed.
* There is significance at the 10% level.

CHAPTER 6

Discussion and Implications

This chapter presents the discussion of the results, including implications of the findings. The results provide full and mixed support for the hypotheses that are investigated in this study. The results for the hypothesized relationship between each dependent variable and the independent variables, along with implications that follow from these results, are presented together. In general, it is found that the decision-making constructs that were examined in this study are affected by media richness. Individuals tend to center their decision-making on fewer unrelated ideas or less divergent perspectives in rich media and in risk prone situations, individuals become less conservative as communications media become leaner.

6.1 Message representation

The existence of a statistically significant relationship between the dependent variable - message representation, which refers to the capacity of the message to influence the opinions or actions of senders and receivers, and the independent variables - risk propensity, media richness and the assigned role of subjects, in this study is confirmed by the ANOVA results. The difference between the variability in message representation in each communications medium indicates that effects due to the manipulation of the media are significantly greater than that which would be found due to natural variability in message representation.

The results indicate that variability in message representation is lower in telephone-to-telephone communications than in either instant messaging or non-mediated communications systems. However, there is hardly any difference in the variability between instant messaging and non-mediated communications systems. In telephone-to-telephone communications, the variability in message representation is about 20% less than it is in either instant messaging or non-mediated communications media.

These results suggest that individuals tend to center their decision making on fewer unrelated ideas or less divergent perspectives in rich media, such as telephones, than they do in the other kinds of media that were used in this study. Additionally, non-verbal cues that are expressed in text format, seem to augment variability in message representation. Furthermore, the variability in message representation does not strictly decreases with decreasing richness of media, but appears to be contingent on the presence of explicitly communicated non verbal cues.

It is also found that the variability in message representation differs at each level of risk preference for the communications media. The variability in message representation is greater (about three times more) in risk averse induced preference situations than it is in risk prone induced preference situations for all media. Irrespective of the risk preference situation, telephone-to-telephone communication is characterized by less variability than either instant messaging or non-mediated communications. Interestingly, variability in message representation is greatest in risk averse induced choices and with instant messaging communication. This outcome

suggests that individuals explore more varied perspectives in less risky situations and in the absence of verbal cues, or equivalently, individuals act more opportunistically in these situations.

6.2 Message significance

The existence of a statistically significant relationship between the dependent variable - message significance, which is concerned with the importance of a message and the way it is used by senders and receivers, and the independent variables - risk propensity, media richness and the assigned role of subjects in this study is confirmed by the ANOVA results. The statistically results indicate that the difference between message significance in each communications medium is more than that which would occur naturally or by coincidence.

The results indicate that message significance is greater in instant messaging communications than in either telephone-to-telephone or non-mediated communications. Message significance is about 30% more in instant messaging communication than in either of the other two media. It is also found that message significance is greater in telephone-to-telephone communications than in non-mediated communications. The result that message significance is greater in instant messaging communication than in telephone-to-telephone communication does not support the theorized relationship between these media.

The lack of support for the theorized relationship between telephone and instant messaging communications media suggests that individuals did not attribute importance to messages in the telephone medium, although messages were conveyed with more cues and media feedback. Accordingly, individuals were more reluctant to change their decisions in telephone-to-telephone communications, as opposed to instant messaging. A plausible explanation, which is consistent with the findings on message representation, is that individuals centered their decision concerns on fewer unrelated ideas or less divergent perspectives in rich media, such as telephones. Additionally, they might have also been concerned with establishing and maintaining their "reputation" during telephone communications.

It is also found that message significance varies with the levels of risk preference for each medium, and the findings across media types are all the same. However, message significance is greater (about twice as much) in risk prone induced preference situations than it is in risk averse induced preference situations for all media types. Irrespective of the risk preference situation, message significance is always greatest in instant messaging communications. In risk averse induced preference situations, message significance is about the same for telephone and non-mediated communications.

These findings suggest that individuals ascribe sufficient importance to, and act on, messages conveyed during instant messaging communications, but selectively ignore the emphases placed on messages in richer media, such as telephone. Furthermore, in

risk averse situations, individuals tend to ascribe about an equal amount of importance to messages conveyed by telephone and non-mediated communications. More importantly, the findings also suggest that individuals tend to ignore the importance of messages, when using non-mediated and telephone communications systems in risk prone situations, but tend to ascribe importance or meaning to messages conveyed when using instant messaging system for the same risky choices.

The findings on message significance and risk induced preferences also suggest that in risk prone situations, individuals were more concerned about their reputation than they were concerned about their reputation in risk averse situations.

6.3 Message Redundancy

The existence of a statistically significant relationship between the dependent variable – message redundancy, which is concerned with the duplication of messages characterized by fewer distinct types of information, and the independent variables - risk propensity, media richness and the assigned role of subjects in this study is confirmed by the ANOVA results. The statistically results indicate that the difference between message redundancy in each communications medium is more than that which would occur naturally or by coincidence.

The results indicate that message redundancy is greater telephone-to-telephone communication than in either instant messaging or non-mediated communications. Message redundancy is about 32% more in telephone-to-telephone communications

than it is for both of the other media. Additionally, it is found that message redundancy is greater in instant messaging communications than it is in non-mediated communications. All results are consistent with the theories posited on the construct, message redundancy.

It is also found that the message redundancy varies very little with the levels of risk preference for each medium, and is about the same across media. In particular, message redundancy is about the same for instant messaging and telephone communications, at both levels of risk preferences. However, message redundancy is slightly greater in risk averse preference situations and is the least in non-mediated communications.

These results suggest that indeed fewer message properties are communicated with messages in richer media, as there are more instances in which different combinations of feedback and cues are used to express essentially the same ideas. These findings are also consistent with previous results, which were concerned with variability in message representation and telephone-to-telephone communications, in the sense that the same ideas were possibly centered on less divergent perspectives in rich media.

6.4 Subjective judgment

There is no statistically significant relationship between the dependent variable – subjective judgment, which is concerned with causal thinking and the identification of relationships among messages, as well as with the level of chance suggested by statements such as such as "sure thing" or "unlikely", and the independent variables – media. That is, subjective judgment across media is no more variable than would naturally be expected. This is not such a surprising result, in view of the distinct roles that were assigned to subjects. It is conceivable that sellers might have felt more influential with the notional right of ownership to the ticket, whereas buyers felt less influential at the start. Therefore, the dataset for sellers and buyers was analyzed separately. Furthermore, there is a statistically significant relationship between subjective judgment and the fixed factors, specifically the interaction terms - media by role and media by risk type.

The results indicate that sellers changed their subjective judgment much less in telephone communication than they did in either instant messaging or non-mediated communications. They also changed their subjective judgment less in instant messaging than they did in non-mediated communications. These findings suggest that sellers attributed more causal interpretations to outcomes as the richness of the media increased. Interestingly, the outcomes for buyers were exactly the opposite. That is, buyers changed their subjective judgment much more in telephone communication than they did in either instant messaging or non-mediated communications. They also changed their subjective judgment more in instant

messaging communications than they did in non-mediated communication. The results for buyers suggest that these individuals attributed more causal interpretations to outcomes in leaner media than they did in richer media.

These results qualify the theorized relationship between subjective judgment and media effects. Specifically, the results suggest that the subjective judgment of individuals, who are less influential during communication supported by rich media, changes more often than they do in lean media. However, when individuals are more influential during communication supported by rich media, changes in their judgment occur less than they do in lean media. In the context of cues and media feedback, the results imply that individuals elect to use or not to use these sources of information as they see fit and the presence of cues and media feedback do not dictate their use.

It is also found that at the different levels of risk propensity and across media types, changes in subjective judgment was as expected in some instances. Specifically, in risk averse preference situations and with the use of telephone-to-telephone communication, changes in subjective judgment were less than in either instant messaging or non-mediated communications. However, changes in subjective judgment were more in instant messaging than in non-mediated communications. The latter result suggests that individuals attributed more causal interpretations in the leaner medium, the non-mediated communications system, possibly because in the absence of most cues and feedback, their subjective judgment is based on causal interpretations that are external to the media settings.

Changes in subjective judgment in the risk averse situations were on average more than the changes in the risk prone situations, but the relative difference among media was the same at both levels. In particular, changes in subjective judgment are about the same in telephone-to-telephone communication at both levels of risk propensity. All these results on subjective judgment indicate that there are no strict relationships between changes in subjective judgment and increasing or decreasing richness of media. Hence performance, which relies on judgment, will be neither strictly better nor worse in rich media or lean media.

6.5 Absolute risk aversion, risk averse induced preferences

The existence of a statistically significant relationship between the dependent variable – absolute risk aversion, as a measure of the risk attitude of individuals and expressed in terms of the curvature of a concave utility function (in the case of risk averse situations), and the independent variables - media richness and the assigned role of subjects in this study is confirmed by the results. The statistical results indicate that the difference between absolute risk aversion in each communications medium is more than that which would occur naturally or by coincidence.

The results indicate that absolute risk aversion is slightly higher in telephone-to-telephone communication than it is in either instant messaging or non-mediated communication, for risk averse situations. It is also slightly higher in non-mediated communication than it is in instant messaging. In terms of levels of uncertainty, the results suggest that individuals required about the same level of certainty for

outcomes or rewards in telephone-to-telephone communications as they did for non-mediated communications, but required less certainty in the case of instant messaging. That is, individuals were least conservative in instant messaging communications compared to the other media, but only marginally so, for risk averse situations.

These results suggest that, given risk averse induced preference, individuals were not strictly more risk averse in rich media than they were in lean media. More importantly, the results show that absolute risk aversion was about the same across all media, indicating that individuals are almost unaffected by the presence or absence of cues and feedback in risk averse situations.

When the role of individuals was taken into consideration, support for the theorized relationships were mixed. In particular, sellers' absolute risk aversion was as expected, whereas buyers' absolute risk aversion was as expected in the case of the comparison between telephone and instant messaging communications. In general, buyers were most conservative in the lean medium. All these results imply that individuals do not follow a strict pattern or trend in their responses to uniformly changing media characteristics and influence, opportunism, and reputation are factors that affect their responses.

6.6 Absolute risk aversion, risk prone induced preferences

The existence of a statistically significant relationship between the dependent variable – absolute risk aversion, as a measure of the risk attitude of individuals and expressed in terms of the curvature of a convex utility function (in the case of risk prone situations), and the independent variables - media richness and the assigned role of subjects in this study is confirmed by our results. The statistical results indicate that the difference between absolute risk aversion in each communications medium is more than that which would occur naturally or by coincidence.

The results indicate that absolute risk aversion is lower in telephone-to-telephone communication than it is in either instant messaging or non-mediated communication, for risk prone situations. Additionally, it is lower in instant messaging than it is in non-mediated communication. In sum, the results suggest that, given risk prone preference situations, individuals were less risk averse in leaner media they were in richer media.

Given the differences across these media, these results suggest that individuals were clearly more responsive to the presence or absence of cues and media feedback in each medium for risk prone preference situations. In terms of levels of uncertainty, the results further suggest that individuals required less certainty for the same reward in lean media than they required in rich media (for risk prone situations). Put differently, individuals were less conservative or more opportunistic as the communications media varied from rich to lean.

Figure 30 expresses these ideas graphically. The implied degree of certainty, which corresponds to the points rewards for each medium, is derived[52] from the average absolute risk aversion that was calculated based on quotes data.

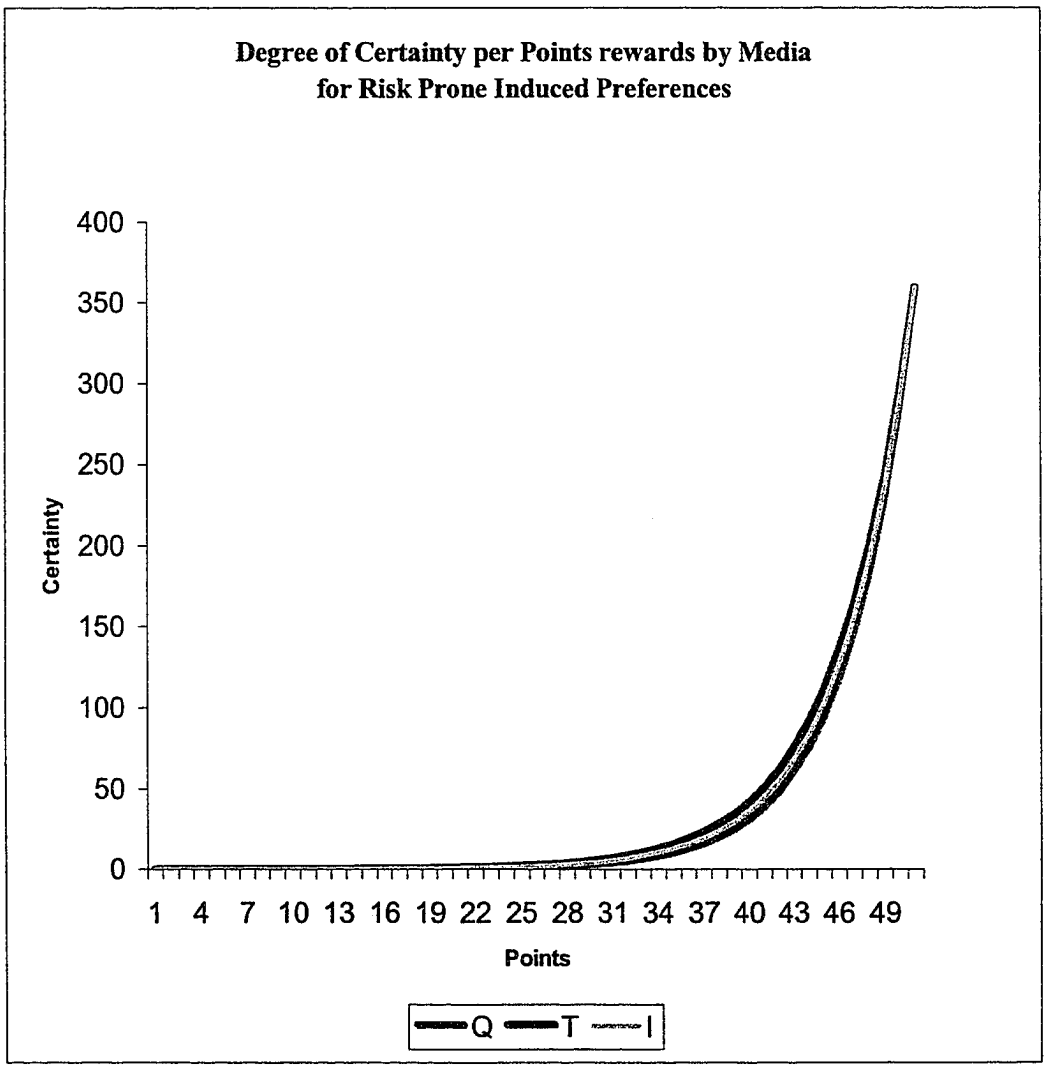


Figure 30: Shows that the curvature of the implied utility functions is different for each communication medium

[52] The mean absolute risk aversion represents the parameter for the utility functions that define individuals' preferences in each medium. This procedure is essentially a backward induction based on the initial utility functions that were used to induce the risk preferences.

When the role of individuals was taken into consideration, support for the theorized relationships were mixed. In particular, buyers' absolute risk aversion was as expected, whereas sellers' absolute risk aversion was as expected in the case of the comparison between telephone and instant messaging communications. In general, sellers were conservative in the lean medium. Again, these results imply that individuals do not follow a strict pattern or trend in their responses to uniformly changing media characteristics and opportunism and reputation are factors that affect their responses.

CHAPTER 7

Conclusion and Directions for Future Research

This final chapter presents the main conclusions that follow from the findings of this study. It begins with a recap of the primary motivation for this research, highlighting the primary concerns, which are followed by a list of the main findings. It also covers the contributions of this study to theory and practice. Finally, the limitations of the study and future research directions are presented.

7.1 Summary and Conclusion

Media richness theory holds that managers or decision makers should use rich media, which have significant information-carrying capacity, for complex tasks (Daft and Lengel, 1984). From a social perspective and in a normative sense, the theory has been largely supported by early research that used perceptual metrics, such as self-reporting in surveys and predetermined standards or references.

From a social perspective and in a normative sense, the theory has been largely supported by early research studies that used perceptual metrics. These studies used self-reporting in surveys and predetermined standards or references to assess the theory. However, when media richness theory was examined in the context of task characteristics and analyzability, studies concluded that there are no certain and conclusive support for the theory (Valacich et al., 1994; Rice, 1992; Kinney and Watson, 1992).

When media richness theory was examined in the context of task characteristics and analyzability, studies concluded that there are no certain and conclusive support for media richness theory (Valacich et al., 1994; Rice, 1992; Kinney and Watson, 1992). Additionally, other recent studies have completely rejected media richness and posit that the only effect of varying media richness is time. Specifically, these studies asserted that richer media only support quicker decisions (Dennis and Kinney, 1998; Dennis and Valacich, 1999).

In general, the actual processing of most information occurs as individuals use specific media, operate within specific units (Rice, 1992) and are given some latitude with decision-making. Yet media richness theory has not been directly assessed in the context of decision-making under uncertainty.

Past research studies that assessed media richness theory were predicated on the assumption that individuals work towards a common goal, without regard to personal goals or agenda. In general, studies also ignored the nature of the decisions made by individuals as well as the possibility that individuals might act in their own interest.

Communications media affect the resolution, and presentation or the framing of choices and therefore impact decision-makers' choices under uncertainty, and risky preferences. Thus this study assesses the impact of communications media on

decision-making under uncertainty, within the context of media richness theory, making explicit provision for individuals to act in their own interest. The three main concerns of this study include:

i. The extent to which media richness affects information acquisition for decision-making under uncertainty;
ii. The extent to which media richness affects the judgment of individuals;
iii. The extent to which media richness affects individuals' risk propensities.

In order to examine the foregoing concerns, the study presents a conceptual framework, which provides the basis for the empirical examination of the foregoing concerns. The framework integrates several constructs from the behavioral economics literature on decision making under uncertainty. These include information acquisition, subjective judgment and two types of risk preferences, representing levels of risk propensity.

In this study, different communications channels are used in a laboratory setting to investigate how media richness affects decision-making. Pairs of experimental subjects participated in a trading game, using pre-assigned communications channels to conduct negotiation for the exchange of notional lottery tickets and points. Subjects used three different communications media, which include instant messaging; non-mediated computer-to-computer communications, and telephone-to-telephone, to effect negotiation and facilitate trades.

The instant messaging system provides a communications medium for subjects to exchange a few lines of text, displayed on a computer screen, with each other. The non-mediated computer-to-computer system, on the other hand, provides a means for subjects to exchange only numerical data. The telephone-to-telephone communications medium allows subjects to negotiate over the telephone and a recorder is used to collect the voice data. Two types of tickets, which are derived from risk averse and risk prone utility functions - were traded between research subjects.

Microsoft Access was used to develop a trading game interface solely for the purpose of this research study. The experimental task involved the trading of notional lottery tickets. Games of this nature are ideal for risk assessment. In the absence of extraordinary gambling skills, competing subjects utilize the cues and feedback to improve their performance. Gambling games, of this type, capture the essence of managerial decision-making and in the literature it is argued that most managerial decisions – almost 60% - are dyadic (Panko and Kinney, 1995).

The main argument of this study is that media characteristics, such as cues and media feedback, impact the message significance, message representation, message redundancy, subjective judgment, and ultimately risk preferences. Here, it is shown that decision-making constructs do not change uniformly with increasing or

decreasing richness of media. Consequently, performance expectation is understandably less predictable.

The results show that media richness has significant impact on the decision-making constructs that are examined in this study. Many of the hypothesized relationships are supported, providing interesting insights that explain previous inconclusive findings on media richness theory. Others that are not supported also provide equally interesting and insightful findings. The results concerning the decision making constructs indicate, among other things, that

- Individuals tend to center their decision making on fewer unrelated ideas or less divergent perspectives in rich media;

  - Individuals are concerned with establishing and maintaining their "reputation" in the telephone medium;

  - Irrespective of the risk induced preference situation, individuals tend to ascribe more importance and meaning to messages conveyed when using an instant messaging communications medium;

  - In lean media, and risk prone situations, individuals tend to be "opportunistic"–In a lean medium, and risk prone situations,

individuals tend to make the least changes to their subjective judgment;

- In risk prone situations, individuals become less conservative as communications media become leaner;

- In risk averse situations, the absolute risk aversion of individuals is constant.

7.2 Contributions

Decision-making under uncertainty is a multifaceted construct with numerous interpretations, but interpretations have largely been referenced by the behavioral economics discipline. Fortuitously or by design, references to the computer information systems discipline has been neglected. This thesis provides a contribution to theories on decision-making under uncertainty from an information system's perspective.

The relationship between media richness and decision-making under uncertainty explains some conflicting results in previous research studies on performance. The contributions of this study provide some insights on these previously unexplained or neglected considerations. The contributions to theory and practice are detailed in the following subsections.

7.2.1 Contributions to Theory

This study proposed and justified the existence of relationships between media richness and decision-making under uncertainty. The conceptual framework provides a basis for future research study. It is important to note that varied communications media are rapidly proliferating. So, investigating and understanding their impact ensures that they are better appropriated to suitable settings, such as in the design of decision support systems and in the domain of decision framing research.

The trading game that was developed and implemented in this study can be appropriated to many other research domains. These include research on decision support systems in financial markets, and decision support systems in behavioral sciences. To the best of the author's knowledge, this is the first empirical research study that assesses media richness and risk induced preferences directly. Other studies have considered risk simply by categorizing risk in terms high and low levels. The direct, delineated and objective measure of the risk induced preference technique that is used in this study provide a novel means by which past research studies can be reassessed.

Understanding of the effects of communications media on decision-making under uncertainty also provides a basis and a starting point for future research from new perspectives. Accordingly, this study opens new directions for future research on

media richness and decision- making, as it defines a new situational context for the assessment of risk.

7.2.2 Contributions to Practice

The findings of this study can provide managers with a basis for the deployment of communications media within organizations. They can also be used to inform policy-making decisions concerning risky situations. Specifically, the findings will help managers to

- Identify the extent to which communications media are interchangeable with respect to risk exposures;
- Provide a new basis for the deployment of decision support systems in organizations;
- Formulate effective policy decisions that favor the reduction of costly risk-accepting decisions, from an information system's perspective.

7.3 Limitations of Study

The main limitations of this study are concerned with the extent to which its results are generalizeable. The limitations are as follows:

- Laboratory experiments allow more control over the environment and increase the internal validity of experiments, but exclude other important factors that exist in real world situations. This imposes some restrictions on the external validity of this study;

- The risk-induced preferences for this study were based on two types of univariate utility functions. Hence, the findings are specific to behaviors that conform to these functions.

Research studies that are completed in controlled environments, such as laboratories, are often designed to ensure that the results can be interpreted unambiguously in terms of the parameters in which the theory is expressed. Furthermore, it is often time virtually impossible to observe the phenomena of interest in natural situations. Hence, irrespective of the stated limitations of this research, the findings provide a strong basis for their inclusion in generalized situations.

7.4 Future Research Directions

The understanding of communications media and their effects on decision-making under uncertainty, which has been established in this study, provides a basis and a starting point for future research. Based on the theoretical framework and the results of this study, there are several future research directions that can be explored. Future research could examine the following questions

- How is the framing of choices affected by media richness?
- The effect of media richness on risk preference reversals?
- How does experience with communications media affect decision-making under uncertainty?
- In the context of media richness, to what extent do gender and culture affect decision-making under uncertainty?

Answers to the foregoing questions will make additional contributions to research on media richness and decision-making under uncertainty.

APPENDIX A: Recruitment Statement

Hello, my name is Norman Johnson and I am a doctoral student of Baruch College and the Graduate Center of the City University of New York. I am conducting a research study to investigate how people make decisions under uncertainty, that is, if there is chance associated with an event how is this event valued by an individual. Accordingly, I invite you to be a voluntary participant. Your academic performance will not, in any way, be affected whether you participate in this study.

Each participant receives a $10 gratuity for participating in this experiment, and the possibility of winning an additional $10 reward - based on your overall performance. The complete experiment is expected to last for approximately 60 minutes. If during the experiment you decide that you do not wish to complete it, you will be allowed to leave without any obligations or penalties.

If you agree to participate in this study, we will ask you to choose a lottery ticket from a pair of tickets that is presented on a computer screen. The tickets are designed for the purpose of this experiment only; and are of no real value outside of this setting. You will be offered a total of 27 lottery tickets. Each ticket offers a number of points and the likelihood to win these points. You will then be asked to try and trade your chosen lottery ticket with another subject. If you are unable to make a trade, or retain a ticket from another subject, a lottery draw will determine your points' reward or score.

All information will be kept confidential and your name will never be associated with any publications that may arise as a result of this study.

If you wish to participate, please write your name, email address, and telephone number(s) on the sign up sheet that is provided. I will then contact you to agree on a suitable time for your participation.

Thank you and best regards.

Norman A. Johnson

APPENDIX B: Informed Consent Form

Principal Investigator:
Norman A. Johnson, Doctoral student, Graduate Center, CUNY
Statistics and Computer Information Systems Department
Zicklin School of Business, Baruch College
1 Baruch Way, Box E-435
New York, NY 10010

Informed Consent Form

The purpose of this study is to investigate how people make decisions under uncertainty, that is, if there is chance associated with an event how is this event valued by an individual. You will be offered a total of 27 tickets (none of which is real) through a computer screen display. You will use three different communications channels to negotiate the trade of lottery tickets with another participant for a guaranteed number of points. If you are unable to make a trade or if you acquire a ticket, a lottery draw will determine your points' reward or score. The complete experiment is expected to last for approximately 60 minutes, however, you can discontinue participation without penalty whenever you wish to do so.

You will receive a $10 gratuity for participating in this experiment, and the possibility of winning an additional $10 reward, based on your overall performance. There are no financial risks to you.

All communications that occur during trading will be recorded. All records of this study will be kept confidential. No one other than the PI will have access to the data, which will be archived in a secure location after use. If desired, you can see the data collected from only your participation. Any resulting publications from this study will not identify individual participants but will refer to aggregate results.

If you have any questions regarding this research, you can call Norman Johnson at (646)-312-3402 or his advisor, Professor Richard Holowczak at (646)-312-3371. If you have any questions concerning your rights as a participant in this study, you can call the CAMPUS IRB Office at (646)-312-3791.

By signing below, you accept and understand the terms of this research study as stated above and that your participation is completely voluntary.

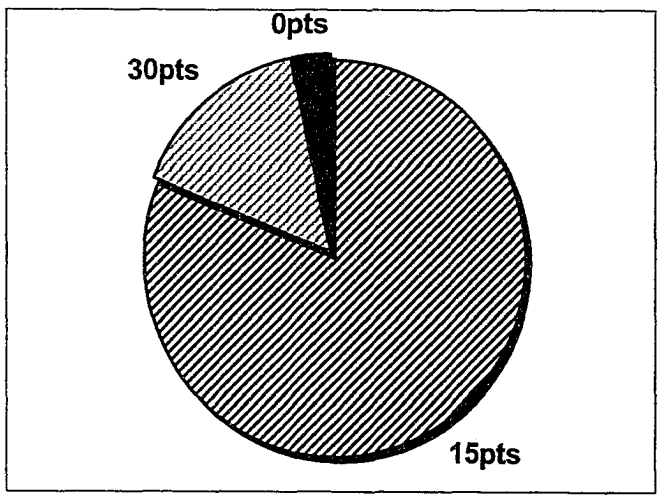
Student Signature	Researcher Signature
Full name	Full Name
Date	Date

APPENDIX C: Instructions To Seller

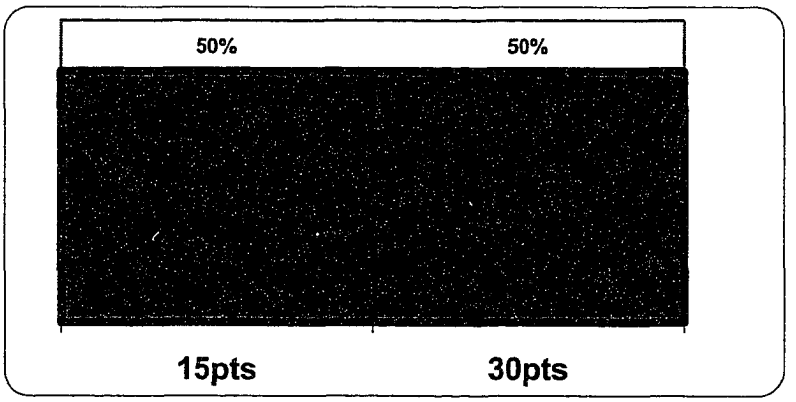
During this experimental game, you are not allowed to record any information !!!

In this game, you are presented with nine (9) lottery tickets and a prize wheel in each of three (3) sections. Each ticket, with a two-faced points value, gives you an opportunity to **PLAY FOR** one of the two points value displayed. The points value that you can play for is randomly determined and computer generated. For example, the ticket below gives you a 50 % chance to play for either 30 points or 15 points. An independent random event determines whether you will play for 30 points or 15 points, if you retain the ticket. The prize wheel will be spun to determine if you win the number of points that you play for.

Prize Wheel



Ticket



Before the number of points that you can play for is determined and the opportunity to trade the ticket is presented, you must indicate the **MINIMUM** number of points that you are willing to accept for the ticket and your judgment about the chance of winning each of the points offered based on the prize wheel - this information is never revealed to others. You must attempt to exchange the assigned ticket, in a timed negotiation, with another player for a number of points that can be agreed on. If you are unable to exchange the tickets for guaranteed points or time elapses, you are awarded 0 point. If you retain the ticket after negotiation is completed, you will be awarded points based on the spin of the prize wheel. **The outcome of the spin is determined as follows:**

- If the random event permits you to play for the greater number of points (30, in our example) shown on the ticket, you are a winner if the wheel stops on the striped area – gray or black;

- If the random event permits you to play for the lesser number of points (15, in our example) shown on the ticket, you are a winner if the wheel stops on the black striped area;
- If the wheel stops on the solid black area (in some cases there will be no black areas on the wheel), you get zero points.

You communicate with a buyer of tickets, using three different communications media - telephone-to-telephone, instant messaging and non-mediated computer-to-computer - in three distinct trading sections. Negotiation for the exchange of tickets and points is timed. A timer, which is in the right hand corner of your screen, displays the remaining time for negotiation.

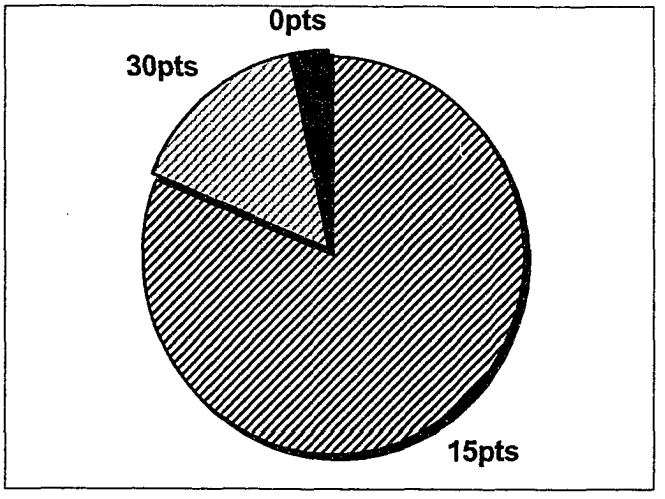
After all tickets have been shown, one of the trades in which you participated will be randomly selected and the number of points you received for the selected trade will be used to rank your performance against other participants, giving you the opportunity to receive a bonus $10 reward, in addition to your $10 participation gratuity. Good Luck !!!!!

APPENDIX D: Instructions to Buyer

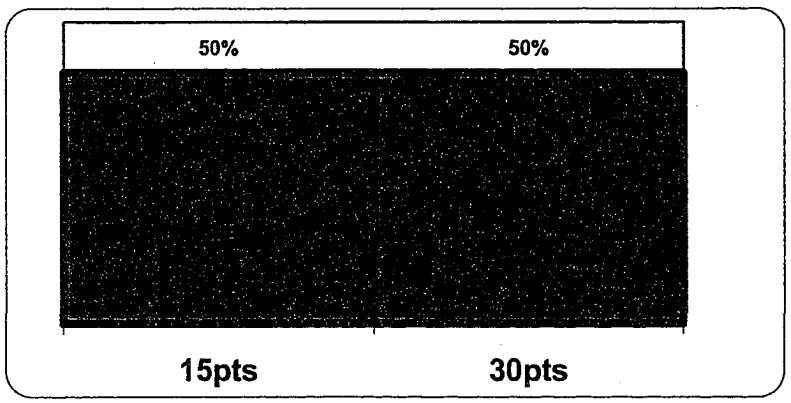
During this experiment, you are not allowed to record any information !!!

In this game, you are presented with ten (10) lottery tickets and a prize wheel in each of three (3) sections. Each ticket, with a two-faced points value, gives you an opportunity to **PLAY FOR** one of the two points value displayed. However, you must acquire the ticket to play for these points. The points value that you can play for is randomly determined and computer generated. For example, the ticket below gives you a 50 % chance to play for either 30 points or 15 points. An independent random event determines whether you will play for 30 points or 15 points, if you acquire the ticket. The prize wheel will be spun to determine if you win the number of points that you play

Prize Wheel



Ticket



Before the number of points that you can play for is determined, you must indicate the **MAXIMUM** number of points that you are willing to give up to acquire the ticket and your judgment about the chance of winning each of the points offered based on the prize wheel - this information is never revealed to others. You must attempt to exchange points for the ticket, in a timed negotiation, with another player for a number of points that can be agreed on. You receive an interest free points loan capped at the greater number of points value that you can use to acquire a ticket. If you acquire a ticket, your final points will be the number of points you win less the number of points you exchanged to acquire the ticket. If you are unable to acquire a ticket or the time elapses, you are awarded only 0 point. You are a winner if the wheel stops on the colored area of the number of points that the random event indicated that you would play for. Your prize wheel will show two or three colored areas. **The outcome of the spin is determined as follows**:

- If the random event permits you to play for the greater number of points (30, in our example) shown on the ticket, you are a winner if the wheel stops on the striped area – gray or black;
- If the random event permits you to play for the lesser number of points (15, in our example) shown on the ticket, you are a winner if the wheel stops on the black striped area;
- If the wheel stops on the solid black area (in some cases there will be no black areas on the wheel), you get zero points.

You communicate with a seller of tickets, using three different communications media - telephone-to-telephone, instant messaging and non-mediated computer-to-computer - in three distinct trading sections. Negotiation for the exchange of tickets and points is timed. A timer, which is in the right hand corner of your screen, displays the remaining time for negotiation.

After all tickets have been shown, one of the trades in which you participated will be randomly selected and the number of points you received for the selected trade will be used to rank your performance against other participants, giving you the opportunity to receive a bonus $10 reward, in addition to your $10 participation gratuity. Good Luck !!!!!

APPENDIX E: PowerPoint Presentation For Buyers

Instruction for Buyers

- General rules
  - Complete your consent form
  - Complete your questionnaire
  - Do NOT record any information during the experiment
  - All your actions are recorded, including your telephone conversations
  - You will receive your gratuity payment at the end of your participation
  - You can discontinue participation at any time

Playing the Game

- Procedure
  - You will play for one of the two points value displayed on the ticket
  - After negotiation, the computer determines which of the two points value you will play for
  - The prize wheel shows your chance to win points
  - Enter the **maximum** number of points you would give up to acquire the ticket ***(this information is never revealed to others)***
  - Enter your judgment of the chance to win points based on the prize wheel ***(this information is never revealed to others)***
  - Click trade to conduct a timed negotiation with sellers

Playing the Game

- Trading with sellers
  - Use instant messaging (IM) to negotiate;
    Or
  - Use computer quotation system (CQS) to negotiate; Or
  - Use telephone to negotiate

Playing the Game

- Performance and rewards
  - This is a game of chance, you can optimize your performance by consistently doing what you think is best
  - You will receive $10 for your participation
  - You can also receive an additional $10 bonus reward based on your performance

APPENDIX F: PowerPoint Presentation For Sellers

Instruction for Sellers

- General rules
  - Complete your consent form
  - Complete your questionnaire
  - Do NOT record any information during the experiment
  - All your actions are recorded, including your telephone conversations
  - Type in the number points agreed on to end a trade
  - You will receive your gratuity payment at the end of your participation
  - You can discontinue participation at any time

Playing the Game

- Procedure
  - You will play for one of the two points value displayed on the ticket
  - After negotiation, the computer determines which of the two points value you will play for
  - The prize wheel shows your chance to win points
  - Enter the **minimum** number of points you will accept for the ticket ***(this information is never revealed to others)***
  - Enter your judgment of the chance to win points based on the prize wheel ***(this information is never revealed to others)***
  - Click trade to conduct a timed negotiation with buyer
  - If the ticket is acquired by the buyer, record the number of points accepted for ticket

Playing the Game

- Trading with buyer
  - Use instant messaging (IM) to negotiate;
    Or
  - Use computer quotation system (CQS) to negotiate; Or
  - Use telephone to negotiate

Always remember to type in the number of points agreed on to end a trade !!

Playing the Game

- Performance and rewards
  - This is a game of chance, you can optimize your performance by consistently doing what you think is best
  - You will receive $10 for your participation
  - You can also receive an additional $10 bonus reward based on your performance

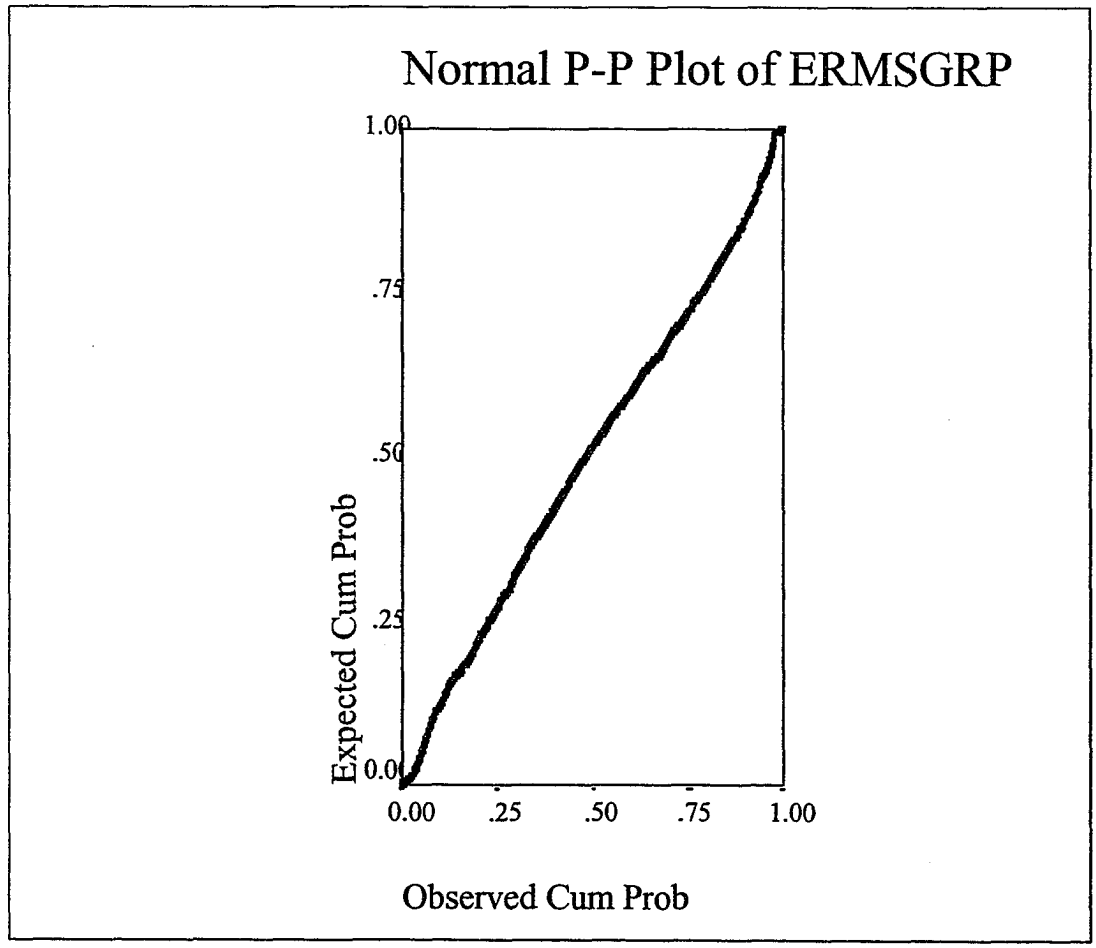
APPENDIX G: K-S Test and Normal Probability Plot of Residual for Message Representation Dataset

One-Sample Kolmogorov-Smirnov Test

		ERMSGRP
N		3452
Normal Parameters[a,b]	Mean	-2.319E-10
	Std. Deviation	.4080
Most Extreme Differences	Absolute	.041
	Positive	.041
	Negative	-.029
Kolmogorov-Smirnov Z		2.389
Asymp. Sig. (2-tailed)		.000

a. Test distribution is Normal.

b. Calculated from data.



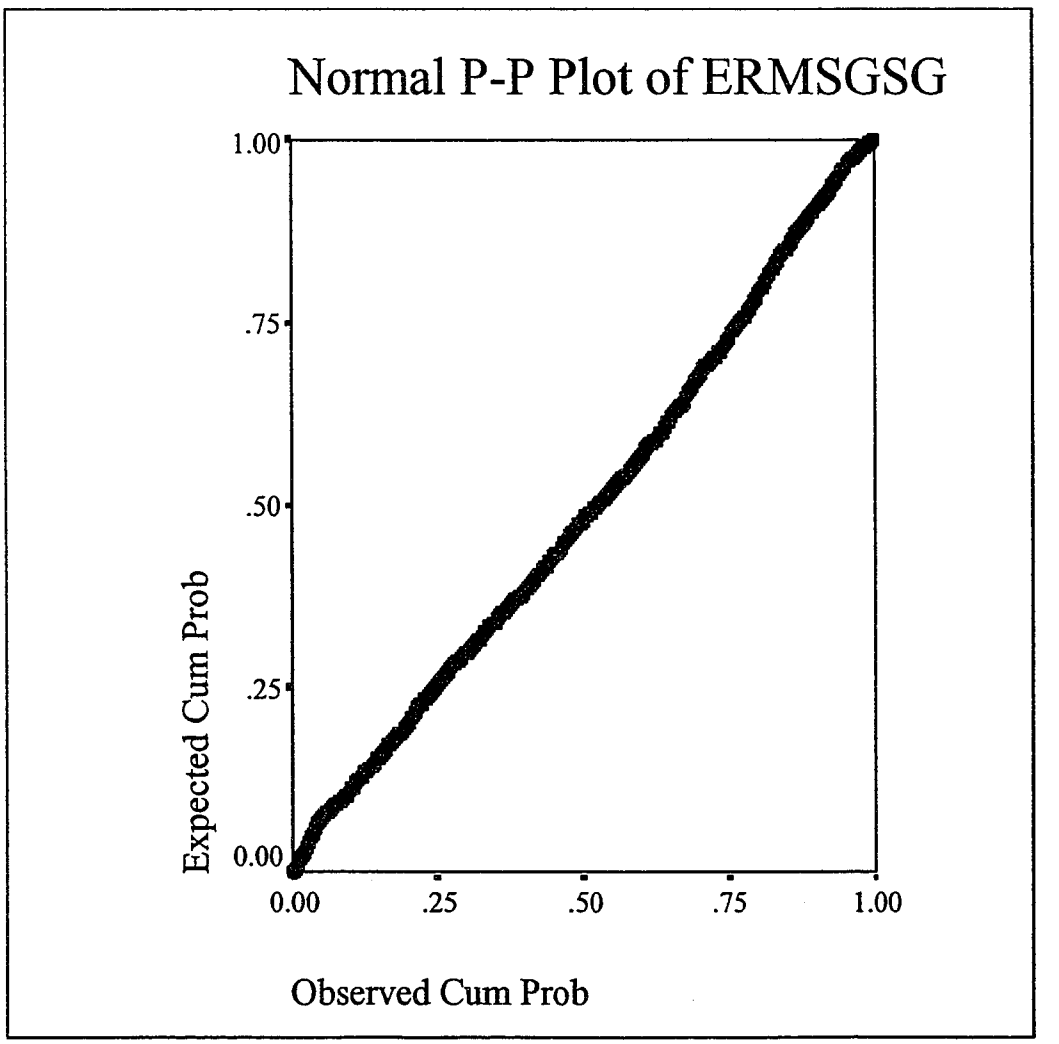
APPENDIX H: K-S Test and Normal Probability Plot of Residual for Message Significance Dataset

One-Sample Kolmogorov-Smirnov Test

		ERMSGSG
N		2618
Normal Parameters[a,b]	Mean	-1.06E-10
	Std. Deviation	.14780353
Most Extreme Differences	Absolute	.037
	Positive	.037
	Negative	-.025
Kolmogorov-Smirnov Z		1.892
Asymp. Sig. (2-tailed)		.002

a. Test distribution is Normal.

b. Calculated from data.



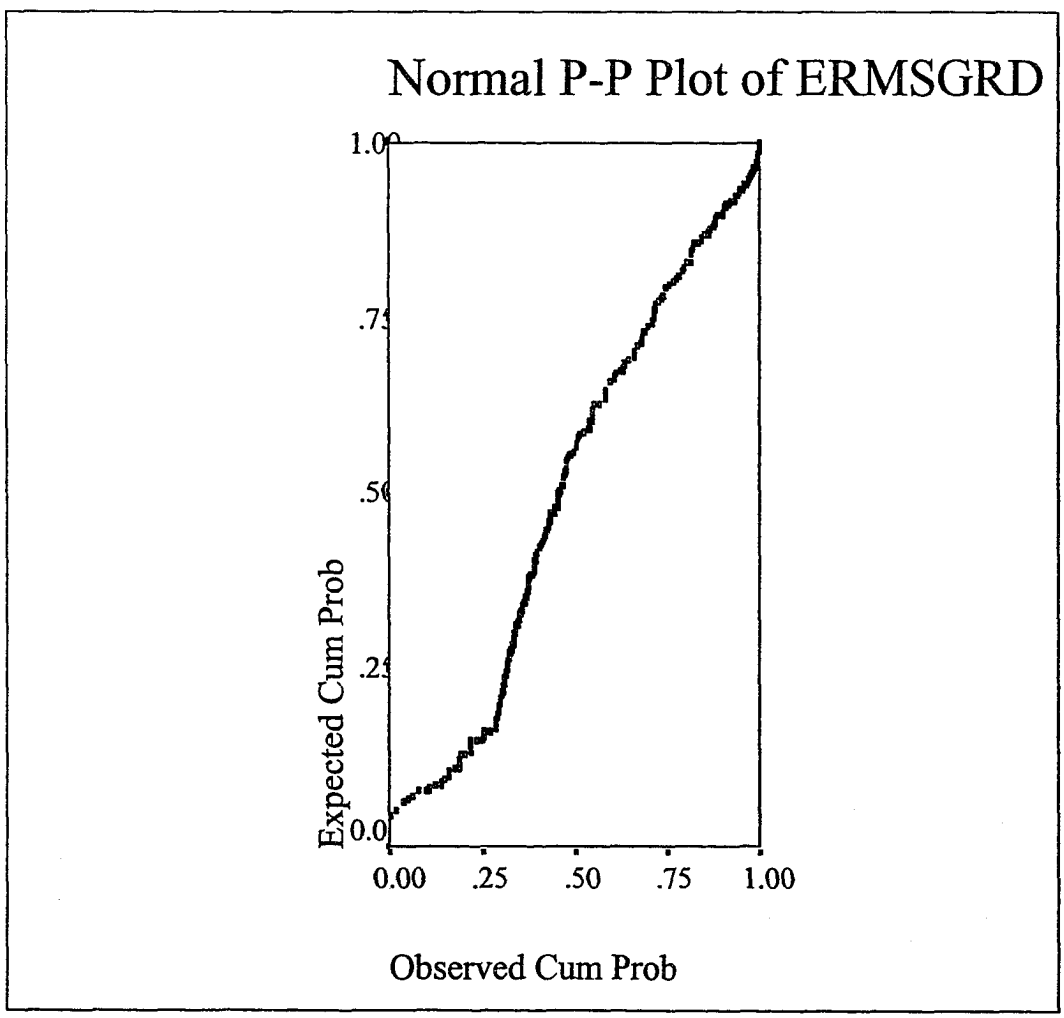
APPENDIX I: K-S Test and Normal Probability Plot of Residual for Message Redundancy Dataset

One-Sample Kolmogorov-Smirnov Test

		ERMSGRD
N		3431
Normal Parameters[a,b]	Mean	2.538E-10
	Std. Deviation	.2686
Most Extreme Differences	Absolute	.121
	Positive	.121
	Negative	-.079
Kolmogorov-Smirnov Z		7.063
Asymp. Sig. (2-tailed)		.000

a. Test distribution is Normal.

b. Calculated from data.



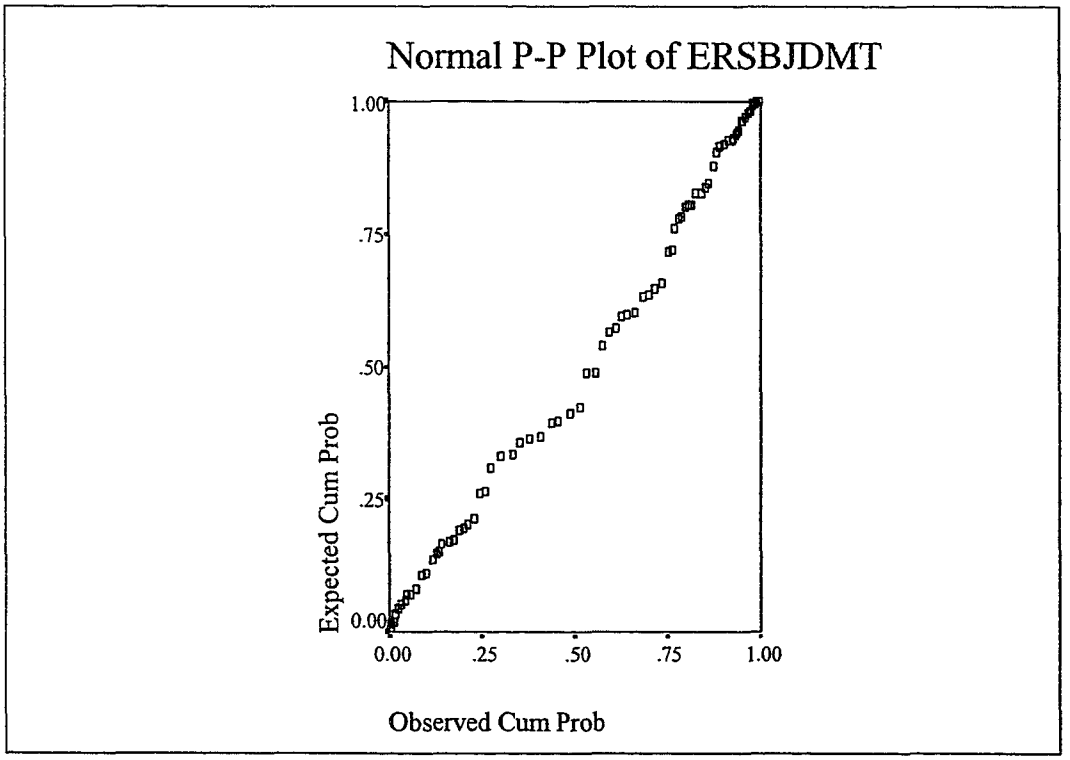
APPENDIX J: K-S Test and Normal Probability Plot of Residual for Subjective Judgment Dataset

One-Sample Kolmogorov-Smirnov Test

		ERSBJDMT
N		324
Normal Parameters[a,b]	Mean	-6.9907E-09
	Std. Deviation	1.6564
Most Extreme Differences	Absolute	.098
	Positive	.098
	Negative	-.053
Kolmogorov-Smirnov Z		1.772
Asymp. Sig. (2-tailed)		.004

a. Test distribution is Normal.

b. Calculated from data.



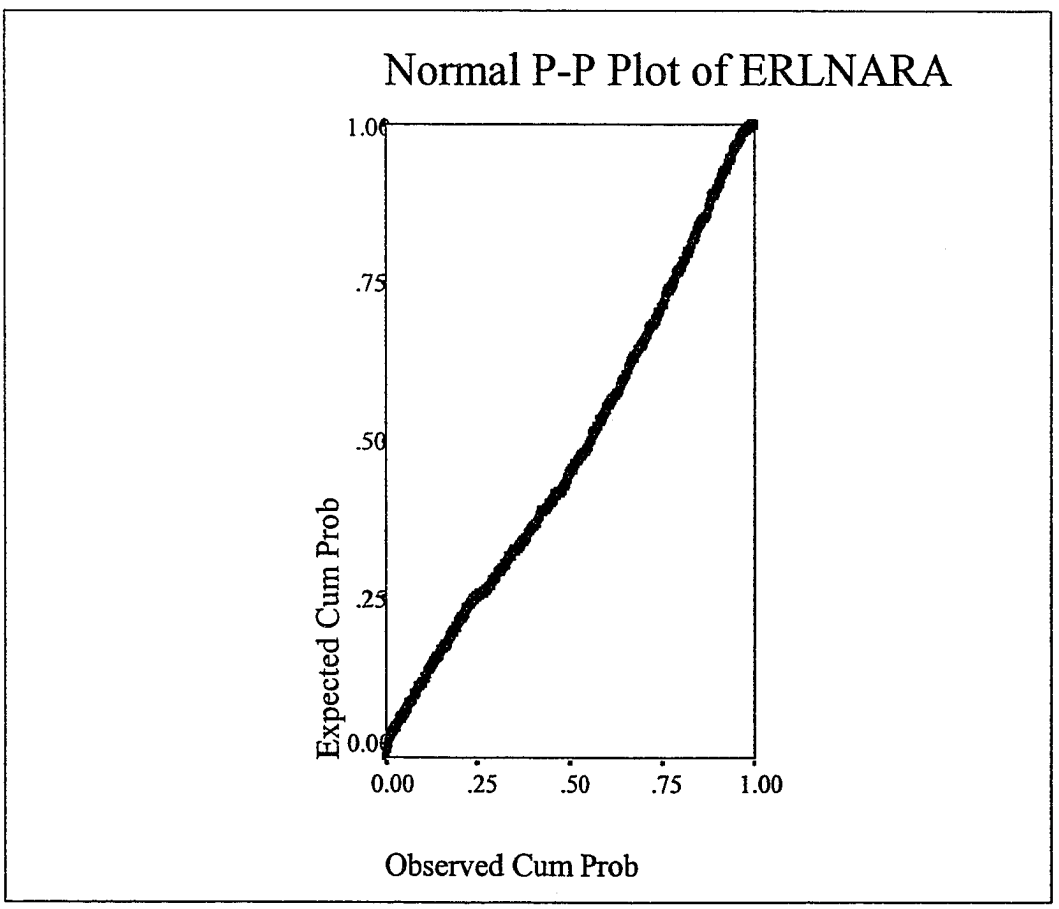
APPENDIX K: K-S Test and Normal Probability Plot of Residual for ARA, Risk Averse Induced Preference Dataset

One-Sample Kolmogorov-Smirnov Test

		ERLNARA
N		1908
Normal Parameters[a,b]	Mean	-1.74E-10
	Std. Deviation	.3020
Most Extreme Differences	Absolute	.060
	Positive	.060
	Negative	-.026
Kolmogorov-Smirnov Z		2.641
Asymp. Sig. (2-tailed)		.000

a. Test distribution is Normal.

b. Calculated from data.



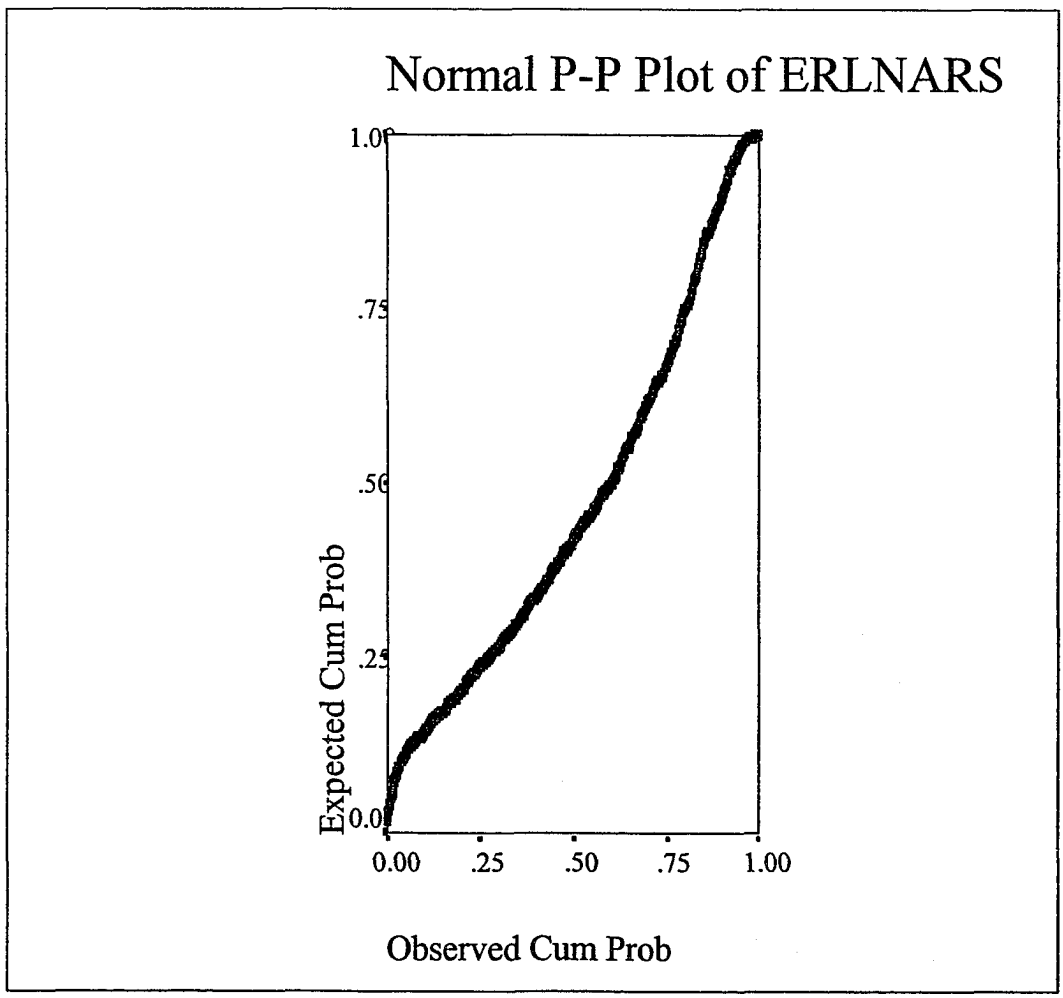
APPENDIX L: K-S Test and Normal Probability Plot of Residual for ARA, Risk Prone Induced Preference Dataset

One-Sample Kolmogorov-Smirnov Test

		ERLNARS
N		1668
Normal Parameters[a,b]	Mean	-2.48E-10
	Std. Deviation	.7243
Most Extreme Differences	Absolute	.102
	Positive	.102
	Negative	-.067
Kolmogorov-Smirnov Z		4.151
Asymp. Sig. (2-tailed)		.000

a. Test distribution is Normal.

b. Calculated from data.



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