

Risk amid Protection and Motivation:

**A Communicative Cardiovascular Physician-Patient
Model of Message Preparation-Perception (CPMP)²**

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Thesis submitted to
the Faculty of Graduate and Postdoctoral Studies
in partial fulfillment of the requirements for
the M.A. in Communication

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Abstract

Effective risk communication is essential in the field of health to ensure patients understand the information being presented to them by medical professionals and appreciate the level of risk involved in treatments. Cardiovascular disease, being the leading cause of death worldwide, is relevant to consider when examining risk communication in a health setting. Those afflicted with cardiovascular ailments are both high in number and exposed to information communicating risk. This research aims to identify presentation formats that are more effective communicating risk information to recovering cardiovascular patients at the University of Ottawa Heart Institute. The formats' effectiveness is measured by gauging the population's understanding of the material and perception of the information as it relates to risk and motivation. The research draws on Max Weber's concept of rationality and subsequent scholars who developed social judgment theory, the heuristic-systematic model, expected utility theory, protection motivation theory, and the extended parallel process model. Utilizing an experimental research design, risk information handouts and questionnaires are distributed to, and completed by, a stratified sample of cardiovascular disease patients. Effective presentation formats are examined, and the results identify comparatively effective presentation formats for minimizing and maximizing risk perception. The results also identify presentation formats' impact on a patient's level of motivation to avoid / indulge in behaviours that may maximize or minimize risk. The results, synthesized herein, suggest a model (communicative cardiovascular physician-patient model of message preparation-perception), which may contribute to the effectiveness of risk communication between physicians and cardiovascular disease patients.

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Acknowledgements

Firstly, I would like to thank Dr. Mahmoud Eid for his encouragement, guidance, and support throughout my graduate studies. I sincerely appreciate the time and energy that was dedicated to my academic growth. I would also like to thank Dr. Salah Basalamah and Dr. Isaac Nahon-Serfaty for their enthusiasm, direction, and feedback over the course of my thesis.

This research would not have been possible without the assistance and support of Kathleen Turner and the entire team at the Cardiovascular Rehabilitation Centre at the University of Ottawa Heart Institute. I would like to thank Kathleen for her consistent communication and dedication to ensuring that the data collection was a success.

I owe my deepest gratitude to my family and friends. In particular, I would like to thank my parents, Claude and Daniela, and my brothers, Jon and Michael, for their ongoing encouragement, love, and support. Finally, I would like to thank Amanda. Even though I have achieved an M.A. in Communications, I cannot find the words to express the extent to which I appreciate your understanding, collaboration, devotion, patience, and love throughout this journey. It is one of many.

Chapter 1

Introduction

Preface

Risk communication is a field of study in constant flux. Updating the public on the latest wartime events, discussing different treatment options with patients, and explaining waivers to be signed before undergoing bungee jumping all involve risk communication in some fashion. Risk communication involves informing individuals of a level of uncertainty. This uncertainty is what creates the classification of “risk” and necessitates that the information be communicated in a sensitive, informative, and accurate manner.

One division of risk communication is that within a health setting. Many people can relate to dealing with risk when it comes to either their own health or the health of a family member or friend. Deciding whether or not to take a certain drug, listening to the risks associated with a grandparent’s surgery, and tuning into the news to hear the latest details on the flu season are all examples of the overlap of health and risk communication.

Research regarding risk and health communication yields interesting findings. One specific area that peaks interest involves the manner in which information is presented and how different individuals perceive its presentation. Studies show that, “framing variations and other manipulations of information have important influences on perceptions of risk and decisions made by patients” (Edwards, Elwyn, Covey, Matthews & Pill, 2001: 75). For example, one study conducted by Kimihiko Yamagishi demonstrates how people understand statistics with regards to the number of deaths due to cancer (1997). He finds that “participants rated cancer as riskier when it was described

as ‘kills 1,286 out of 10,000 people’ than as ‘kills 24.14 out of 100 people’” (Yamagishi, 1997: 495). The participants interpreted the larger figure (10,000 as opposed to 100) as being more of a risk when it is in fact the other way around. Would this information have been received and interpreted differently if it was displayed as a percentage? Or would a graphical display help to illustrate this information more effectively than just the use of numbers? Similar research also identifies differences in perception with regards to the viewing of graphical displays rather than text and the presentation of information in the form of percentages rather than frequencies (Waters, Weinstein, Colditz & Emmons, 2006). The way in which information is presented can greatly affect how that information is perceived and understood. The following is a press release from the World Health Organization:

The number of hip fractures worldwide due to osteoporosis is expected to rise threefold by the middle of next century, from 1.7 million in 1990 to 6.3 million by 2050.

(cited in Brase, 2002: 398)

Brase comments on this fact by stating that “if the above numbers are converted to relative percentages, the rise in the number of hip fractures is from 0.03% to 0.07% of the world population (which seems less impressive)” (2002: 398). This information is just as accurate as the statement made by the World Health Organization. However, the perception of these two statements is very different. The jump from 1.7 million to 6.3 million sounds much more impressive than the jump from 0.03% to 0.07%. The presentation format the WHO uses creates a riskier interpretation of the information than the relative percentages. The goal of this press release is to promote bone health, and therefore the riskier presentation may encourage more people to take interest in their own bone health. Findings such as these, which demonstrate variance in information

presentation and how this information is perceived, serve as both a catalyst and inspiration for the research undertaken in this thesis. Based on the implications of such findings, the current research aims to further explore how perceptions of information involving risk vary according to the ways in which said information is presented.

The current research focuses on one particular group of patients and their experiences with risk communication. Cardiovascular disease is “a general term for a variety of conditions that affect the heart and blood vessels. It is a chronic disease that can lead to serious events, including heart attack and death” (“University of Ottawa Heart Institute”, 2011). Cardiovascular disease is the leading cause of death not only in Canada but worldwide, and these patients are exposed to information and decisions that can be challenging to assimilate (Ibid). Due to the nature of their diseases, cardiovascular patients are often counseled to make many changes with regards to their health, whether the changes relate to nutrition habits, exercise habits, medication choices, or overall lifestyle choices. The importance of these changes is frequently discussed between patients and their medical practitioners, and these discussions often include the risks associated with changing or not changing said behaviours.

The University of Ottawa Heart Institute is the largest of its kind in Canada and in 2010 alone performed over 1700 open-heart procedures, 8800 angioplasties and angiograms, 450 ablation procedures, 500 pacemaker implantations, and 380 defibrillator implantations (Ibid). Many patients converge at the University of Ottawa Heart Institute to seek heart-health care and participate in exercise classes, nutrition workshops, and health seminars. Given the breadth of the institute’s services, the size of its patient

population, and its location in Ottawa, it is an ideal site to collaborate with for the purposes of this research.

Purpose of Research

The purpose of this research is to determine the most effective ways to present information that communicates risk to recovering cardiovascular patients at the University of Ottawa Heart Institute. For risk communication to be effective, an individual's understanding must be accurate, and his or her perception of risk must be maximized or minimized depending on the content and goals of the message. In order to determine these levels of patient understanding and risk perception, and in some cases levels of motivation, presentation formats are assessed. More specifically, those presentation formats deemed effective at maximizing risk perception, minimizing risk perception, and producing a sense of motivation are presented. The results from this study allows those who attempt to present similar communications in the future to do so from a more informed perspective. Ultimately, when patients can feel confident in their understanding of information and can have risks explained effectively, more successful risk communication can take place.

Thesis Overview

The following chapter, Chapter 2, is a review of the literature which establishes the foundation for the research. Max Weber's understanding of rationality and his perceptions of how decisions are made from an objective, logical, and reasonable point of

view provide an introduction for how information travels from the medium of the presentation to the minds of individuals. Five theories emerge from this foundation and provide explanations for how messages are prepared, perceived, and understood. These five theories are social judgment theory, the heuristic-systematic model, expected utility theory, protection motivation theory, and the extended parallel process model.

A review of the literature on various presentation formats and their effects on understanding and perception is then discussed, which assists in the development of the risk information handouts for the current research. The ways in which this research uses the theoretical framework to determine the methodology is also discussed.

Chapter 3, Methodology, outlines how the research will be conducted using an experimental design. The core concepts are defined as they provide the framework for understanding how to effectively communicate risk messages to cardiovascular patients. The experimental design is described, which includes an explanation of the concepts and variables, a description of the maintenance of reliability and validity, and a discussion of the importance in creating equivalent groups of participants. The hypotheses are then presented, which stipulate that there is a relationship between the presentation format of information and the effectiveness of risk communication to recovering cardiovascular patients. Ethical clearance is obtained from two research ethics boards, the production of the risk information handouts and questionnaire is explained, and the procedure for the distribution of the materials is outlined. Statistical analysis procedures conclude the chapter and introduce the findings.

Chapter 4, Findings and Discussion, provides a detailed explanation of the results from the questionnaires. Significant relationships that are found between presentation

formats and understanding, risk perception, and motivation are presented in graphs and tables. A discussion then takes place outlining the most effective presentation formats so as to enhance understanding, minimize or maximize risk perception, and create motivation. The model, (CPMP)² is then put forth, which outlines presentation formats and their effectiveness on risk communication to recovering cardiovascular disease patients.

Chapter 5, the Conclusion, reiterates the importance of the research and summarizes the important findings. These findings can be applied to future communication materials that are used for this group of patients in the future. Limitations of the research are discussed alongside suggestions for future research. Additional research is encouraged so that the information learned from the current research can be strengthened and built upon. A summary concludes the thesis and highlights the main components of each chapter.

Chapter 2

Literature Review

In order to learn more about creating effective presentation formats, it is important to understand how patients absorb, process, and perceive information in ways that ultimately inform the decision-making process. A theoretical framework for how messages travel from the medium of their presentation to the minds of individuals is formulated for the purposes of this research to establish a basis for understanding how to approach an analysis of message preparation and patient perception as it relates to cardiovascular patients. The first element of this framework explores the epistemological roots of Max Weber's understanding of rationality and his perceptions of how decisions are made from an objective, logical, and reasonable point of view. Additional elements of the framework consist of five subsequent theories that emerge out of Weber's understanding. These theories are: social judgment theory, the heuristic-systematic model, expected utility theory, protection motivation theory, and the extended parallel process model. The five theories both stem from, and build upon, Weber's concept of rationality to consider ideas of message preparation, understanding, perception, risk, and motivation. Ultimately, the framework under consideration serves to demonstrate how the various concepts and theories related to risk, perception, motivation, and message preparation can be applied to approaches for framing risk for, and assessing the level of understanding and perception of, cardiovascular patients. Weber's contribution is considered first, followed by the theoretical offshoots of his body of work.

Weber's Rationality

Central to the core concepts of how information is understood, perceived, and interpreted is the idea of rationality. Max Weber made many contributions to the field of sociology, one being his interpretation of rationality. Although he is not the first to introduce the concept, Weber explores rationality in a new light and is even said to have “recast the entire discussion of the subject” (Levine, 1981: 5). Rationality can be defined as involving “conscious (or subliminal) thought processes that in some manner weigh values, ends, means, likely outcomes, and the like” (Bolan, 1999: 5). It is a process of using logic and reasoning to arrive at certain conclusions. Weber applies the concept of rationality to an explication of the development of Western society and capitalism (Kalberg, 1980). He recognized how a rational decision-making process is incorporated into the ways in which societies and cultures functioned. Weber compared religious rituals that are performed with the aim of receiving favours from a god to a modern businessman’s calculation of the most efficient means to achieve the optimal outcome or greatest profit (Ibid). Essentially, Weber perceives how individuals make decisions, or arrive at certain conclusions, based on the likelihood of maximizing gain. He observes the process as a set of social actions governed by logic, reasoning, and a rational pursuit of interests for the individual, the community, or society as a whole.

There are four different types of rationality identified by Weber: practical rationality, theoretical rationality, substantive rationality, and formal rationality. All four branches seek to “banish particularized perceptions by ordering them into comprehensible and ‘meaningful’ regularities” (Kalberg, 1980: 1160). Rationality is

viewed as a way of eliminating extremes and developing normative perceptions that objectively, make the “most sense”.

The first type of rationality is practical rationality and is described by Weber as “the methodical attainment of a particular given practical end through the increasingly precise calculation of adequate means” (Levine, 1981: 12). In other words, the individual considers the end results and decides the best course of action in order to achieve the desired ends. Kalberg describes this type of rationality as existing “as a manifestation of man’s capacity for means-end rational action” (1980: 1152). It is a process of viewing the end result and developing the path to reach that result.

Theoretical rationality, on the other hand, is abstract and is defined as “a conscious mastery of reality through the construction of increasingly precise abstract concepts rather than through action” (Kalberg, 1980: 1152). This rationality is centered in thought, and contains philosophical and spiritual influences. Theoretical rationality involves developing an abstract understanding of the world as meaningful.

Substantive rationality is described as a rationality that “exists as a manifestation of man’s inherent capacity for value-rational action” (Kalberg, 1980: 1155). This rationality involves an assessment of values that correspond to various constructs. For example, friendship and its associated values of honesty, loyalty, and compassion is an example of substantive rationality. Certain values are assigned to friendship, and it is these values that create substantive rationality.

The final type of rationality is formal rationality, and Kalberg explains that “formal rationality ultimately legitimates a similar means-end rational calculation [to practical rationality] by reference back to universally applied rules, laws, or regulations”

(1980: 1158). It is a rationality that is formed based on adherence to certain rules specifically with regards to economic, legal, and scientific domains. Rules exist, are recognized, and then referred to in determining an end result.

Practical rationality is the most applicable rationality for the current research given that it focuses on viewing an end result and achieving that result through completing specific steps. This occurs when patients receive information regarding their health and are required to formulate their own understanding and perception of messages. Patients perceive a message as being risky or not risky, as being motivating or not motivating, and make a decision as to how they will reach an end result. For example, if a patient is given information on a recommended heart procedure, he or she would do his or her best to understand what is involved, assess the risks and benefits, and make a decision based on this information. Practical rationality is at the core of this decision. As such, the theory is highly applicable to the current research, wherein risk information is presented to participants via risk information handouts.

Overall, the concepts informing rationality, as espoused by Weber, involve logic, reasoning, a calculation of means, and decision-making. These concepts are elaborated on by various scholars whose successive works led to the emergence of further theories. Social judgment theory, expected utility theory, protection motivation theory, the heuristic-systematic model, and the extended parallel process model all posit information relevant and informative to this research.

Message Perception

Weber's concept of rationality involves an adoption of an objective lens to the process of making decisions and developing an understanding based on logic and reasoning. An application of rationality arises when individuals are faced with interpreting and perceiving various messages. That interface between individual and message is examined in social judgment theory. More specifically, the theory, proposed by Muzafer Sherif and Carl Hovland, focuses on messages and the perception of messages. The theory "focuses on perceptions of how much a message agrees or disagrees with one's current attitude proposing that one's attitude acts as an anchor, from which messages are interpreted or judged" (Cameron, 2009: 312). It accounts for individual differences in attitudes and values that shape how messages are perceived. Perception and interpretation of given messages vary from individual to individual, and social judgment theory accounts for these individual differences in message perception. There are two essential outcomes of message perception according to social judgment theory; contrast, which is a shift away from one's established attitude, or assimilation, which is a shift toward one's attitude (DeCarlo, Parrott, Rody & Winsor, 1997). The theory posits that messages that do not correspond with a receiver's attitude are likely to be ineffective (Cameron, 2009). Therefore, relating social judgment theory to the current research, messages created for the participants should not be too extreme. Maintaining relatively neutral messages prevents participants from perceiving the information as being too far off from their own attitudes and beliefs.

The heuristic-systematic model, proposed by Shelly Chaiken, also provides insight into the message perception and decision-making processes. This model suggests

that information is processed using systematic strategies, heuristic strategies, or a combination (Trumbo, 2002). Trumbo perceives systematic processing as occurring “when an individual makes a judgment by carefully examining arguments and relat[ing] those arguments to information already held” (2002: 368). Heuristic processing takes effect “when individuals use simple decision rules to help them arrive at a judgment about message validity” (Ibid). These decision rules include things such as seeking expert opinions or agreeing with the majority (Ibid). This model builds off of social judgment theory and contributes to the idea of perception and reception of messages. Therefore, as mentioned for social judgment theory, messages within the current research should be created with neutral information. Neutral information, as opposed to extreme information, allows for a greater number of participants to access similar information that they already hold. Message preparation needs to take into account that the interpretation of information will vary from individual to individual, and how messages are created can decrease or increase this variation. The goal is to create a format that is understood and makes sense to the greatest number of individuals.

The Element of Risk

Individuals understand and perceive messages differently depending on the type of information that is being communicated. Messages that communicate risk rely greatly on how they are framed so as to make for the most effective reception (Graham & Clavel, 2003). Expected utility theory, put forth by Daniel Bernoulli and supplemented by contributions from von Neumann, Morgenstern, and Savage, specifically involves decisions regarding risk. Expected utility theory is defined as “the standard method used

to predict people's choices under uncertainty" (Hellinger, 1989: 273). It was first developed to describe how individuals make choices involving monetary outcomes and the risks that are associated with such choices (Ibid). However, the theory's application has since broadened and is now used greatly within the field of health, specifically as it pertains to individuals making decisions between different treatments or medications. In fact, the process of choosing the optimal treatment based on careful consideration of evidence and comparison of alternatives is quickly becoming an important issue in health care (Ferguson & Keown, 1995). Feeny and Torrance describe this theory as being "concerned with decision making in situations in which the outcome is not known with certainty and provides a method by which a person's preferences are revealed through their choices in a series of gambles among different health outcomes" (1989: S192). The breadth of the theory ultimately ties together ideas found in Weber's rationality theory, social judgment theory, the heuristic-systematic model involving message perception and interpretation, and the concept of risk. Health information that is being communicated to recovering cardiovascular patients contains an element of risk. Patients receive this information, calculate the level of risk associated, and form decisions based on these calculations. This information needs to be communicated in a way that is understood correctly while maintaining an appropriate sense of risk that is received effectively by patients.

Taking Action

Once the information is created, viewed, processed, and absorbed, the decision making

process takes place. A theory that influences decision making, risk, and rationality is protection motivation theory, developed by Ronald W. Rogers. There are two different appraisals within this theory: the threat appraisal and the coping appraisal. The threat appraisal involves perceiving the severity of the threat and the vulnerability to that particular threat (Prentice-Dunn, McMath & Cramer, 2009). The coping appraisal involves the “individual’s assessment of the response efficacy of the recommended behavior...as well as one’s perceived self-efficacy in carrying out the recommended actions” (Ibid: 298). Basically, the greater the perceived threat and the greater the perceived efficacy, the greater the likelihood that the decision is made and the adaptive behavior employed.

Protection motivation theory is commonly employed within the health field, particularly for campaigns aimed at preventing behaviours such as smoking or exposing oneself to midday sun without proper protection. Cismaru and Lavack indicate that protection motivation theory is “used to create health information campaigns that possess a high degree of persuasion” (2007: 480). If the viewer can recognize the importance and severity of the message, as well as their ability to do something to help guard against the perceived threat, the likelihood of persuasion is high and the message is most likely accepted.

In the current research, these appraisals occur as patients read and digest the risk information. The threat appraisal is assessed as participants are required to indicate how risky they perceive the information to be. The coping appraisal is also involved with risk perception as an individual may feel as though they are more able to cope if the information is perceived to be less risky. In addition, the coping appraisal is assessed as

in some instances participants are required to indicate how motivating they perceive the information to be.

One final theory is the extended parallel process model (EPPM), developed by Kim Witte, and it builds on similar notions to the protection motivation theory (Witte, 1992). Witte describes the EPPM as offering “a more balanced view of how people process fear appeals because it addresses both the cognitive and emotional factors associated with message processing and relates these processes to a fear appeal’s success or failure” (Witte, 1994: 114). There are two main appraisals that occur in the EPPM, the threat appraisal and the efficacy appraisal (Witte, 1992). Susceptibility and severity are integral to the threat appraisal where “susceptibility refers to one’s subjective perception of the risk of contracting a health condition (e.g., college students are at risk for contracting meningitis), whereas severity indicates one’s feelings concerning the seriousness of contracting an illness (e.g., meningitis is a potentially fatal disease) and its subsequent social consequences (i.e., effects of the conditions on work, family life, and social relations)” (Gore & Campanella Bracken, 2005: 28-29). The efficacy appraisal consists of “response efficacy, which refers to the effectiveness of the recommended response in averting the threat, and self-efficacy, which refers to a person’s ability to carry out a recommended response” (Witte, 1994: 114). Essentially, if the threat is perceived to be high, then fear is elicited and the efficacy appraisal sets in (Witte, 1994). Two different pathways are then revealed which are the danger control process and the fear control process. The danger control process is a positive pathway as it “elicit[s] protection motivation, which stimulates message acceptance responses such as attitude, intention, or behavior changes that control the danger” (Ibid: 115). The fear control

process on the other hand is a negative pathway as it is “primarily [an] emotional process where people respond to and cope with their fear, not the danger (Ibid: 116). Witte explains that danger control processes focus on the control of external concerns in dealing with the threat, whereas fear control processes focus on internal concerns such as emotions (1994). When information is communicated to recovering cardiovascular patients, they need to feel empowered to make changes in their lives such as changing nutrition or exercise habits. The information needs to be conveyed in a way that is understood, and that allows for the recognition of the need and ability to make a change. Both risk perception and motivation play a role in this need and ability to change, and are assessed within the current research.

Communicating Risk Information

Together, these theories provide the foundation for creating, delivering, and understanding how messages containing risk are perceived. The way thought processes occur, as outlined in Max Weber’s explanation of rationality, explains how to achieve a particular calculated end. In the current research, rationality is involved when patients view risk information and formulate decisions in terms of understanding and perception. Rational thought is important when it comes to making decisions, especially when those decisions relate to one’s health. Risk information handouts are created operating on the assumption that individuals will read the information and proceed to engage in rational understanding and decision-making processes to achieve the optimal result.

Branching off from Weber's rationality are several theories which help to explain how messages are perceived, how risk is interpreted, and how individuals complete the decision making process by taking action. Social judgment theory and the heuristic-systematic model explain how individuals perceive messages in comparison to their own attitudes, and decide the degree to which these messages agree or disagree with those attitudes, compare information to the knowledge they already hold, and use decision rules such as seeking an expert opinion or agreeing with the majority. If the messages are too overwhelming or outside of held beliefs, they are not likely to have an impact on the patient. For example, if an individual who has not exercised in over five years is told to run for at least an hour every day, the message is not likely to be met with acceptance.

Expected utility theory, protection motivation theory, and the extended parallel process model provide a more narrow focus of messages involving risk and motivation. These theories help explain how individuals make choices regarding their health and risk. Expected utility theory suggests that patients receive information, calculate the level of risk associated, and form decisions based on these calculations. Protection motivation theory and the extended parallel process model involve appraisals of risk levels and the ability and desire to protect oneself from the threat. An example of these theories in action is described below.

A presentation of statistics that illustrate the effectiveness of treatments or medications can greatly affect the perception of a risky situation. Risk information handout A could read: "100 000 people have had complications from this procedure" while Risk information handout B could read: "100 000 people out of 6 million have had complications from this procedure". The phrasing of the statements changes the

interpretation of how risky the procedure is. Expected utility theory is put into action. A third phrasing, such as: “100 000 people have had complications from this procedure however, these were all individuals who ignored the requirement to not consume sodium the week prior”, is in line with protection motivation theory and the extended parallel process model and increases the self-efficacy and the individual’s perception that he or she can do something to protect against the threat.

All together, this theoretical foundation guides how the messages are generated and presented on the two risk information handouts. Furthermore, they help to understand how and why messages are perceived and interpreted the way they are.

The two risk information handouts are created with this research in mind and build off of the material that is available for the cardiovascular patients to access. They contain variations in presentation format and are assessed for the understanding of the information, perception of the risk, and motivation to engage in or change a behaviour. In addition to the theoretical foundations informing this study, research in the field of risk communication is also considered to determine which presentation formats are included on the risk information handouts. A description of this research is outlined below.

Visual Displays

There are many different ways to visually display risk information ranging from pictographs, to pie charts, and bar graphs. Several studies show that visual displays are the most effective presentation format when communicating risk information. Davis, Fredrickson, Arnold, Murphy, Herbst, and Bocchini compare the perceptions of two different polio vaccine pamphlets for comprehension and preference (1998). Information

items that are presented with graphics are the only items that achieve statistical significance in improving comprehension (Ibid). Participants find the graphics to help them relate to and remember the information with greater ease than the equivalent information without the graphics (Ibid). Participants enjoy the use of visual displays rather than just reading words.

Smerecnik, Mesters, Kessels, Ruiter, de Vries, and de Vries also find graphic displays to be more effective in presenting risk information than numbers (2010). They present risk information in textual, tabular, and graphical format and assess understanding and attention. They examine attention by “using eye-movement registration as a continuous measure of attention as well as cognitive workload to control for its influence on attention” (Ibid: 1389). The researchers then assess comprehension of the information dependent on the presentation format, and this is mediated through attention (as described above). The researchers find that “graphical risk information was observed to elicit more and longer eye fixations than textual risk information and led to more understanding because of this increased attention” (Ibid: 1395). Graphical displays, rather than textual or tabular displays, enhance understanding of the risk information and attract more attention while eliciting a minimal cognitive workload.

Kennedy, Glasser, Covello, and Gust evaluate presentation formats in communicating vaccine risk communication messages (2008). They find that groups repeatedly ask for multiple presentations of the same information; that is graphical, numerical, and verbal forms. Viewing the same information shown in two or three different ways helps participants confirm that they understand the information. However,

in comparison to numbers, pictures are indicated to be good attention grabbers and are appreciated in providing supplemental information (Ibid).

Visual displays are common presentation formats used to convey information. They are shown to have different effects on understanding and perception and are therefore used on the risk information handouts within the current research. A more detailed investigation into the various types of visual presentation formats are outlined below.

Pictographs

Tait, Voepel-Lewis, Zikmund-Fisher, and Fagerlin look at communicating risk using different formats including text, tables, and pictographs (2010). They present information about two different drugs and assess verbatim understanding which they define as “the ability to correctly report the actual risk and benefit frequencies of drugs A and B”, and gist understanding which they define as “the ability to identify the essential meaning about the observed differences between the risks and benefits of drugs A and B” (Ibid: 493). The researchers find that the use of pictographs significantly outperforms text and tables in providing both verbatim and gist understanding (Ibid). Pictographs allow participants to correctly understand the risks and benefits of the different drugs and the differences between the outcomes of each drug. Furthermore, participants find that when information is conveyed through pictographs, the perception of risk is lower and the perception of benefits is higher than when communicated through text or tables (Ibid). Finally, the pictograph format is reported by participants to be more effective, helpful, trustworthy, and scientific than text or tables in communicating risks (Ibid).

Hawley, Zikmund-Fisher, Ubel, Jancovic, Lucas, and Fagerlin also find that the pictograph is an effective presentation format (2008). They assess verbatim and gist knowledge through presenting risk in different formats. They find that numbers presented in table format result in the greatest verbatim knowledge but have lower results in gist knowledge (Ibid). The pictograph produces adequate results in both verbatim and gist knowledge and is perceived by participants to be scientific and trustworthy (Ibid). The pictograph also produces these results even among those with lower numeracy abilities. The researchers thus recommend this format as the most beneficial format to use when communicating risk.

Stone, Yates, and Parker look at “how much more money” an individual will pay depending on the format the information is presented in (1997). They find that pictographs using drawings of stick figures are more persuasive in getting individuals to pay more money than the presentation of numbers (Ibid). The researchers propose some reasons as to why individuals have this preference: the first explanation is that “the stick figures would cause the participant to see that real people, perhaps including the participant or people close to him or her, might be among those experiencing the adverse outcomes” (Ibid: 248). That is that the visual display of stick figures may make the situation seem more real and therefore increase the perception of risk. The second explanation the researchers provide is that the counting of the figures takes more processing time rather than just looking at a number, which in turn heightens the differences between two numbers (Ibid). The final explanation for this preference is simply that visual displays are more effective in communicating risk information than numbers (Ibid). Further research demonstrates that regardless of whether stick figures or

asterisks are used, the same result occurs (Ibid). That is that the stick figures do not humanize the risk leading people to relate to the images of people; an asterisk produces the same outcome. Overall, the researchers find that visual displays prove to be more effective than numbers in getting individuals to pay more for an improved or less risky product. It is again important to note that this study assesses risk perception and behaviour, not whether or not the risk is understood. In fact, the researchers conclude that “[their] experimental results show that presenting risk information in a graphical format will increase professed risk-averse behavior, not that the risk information will be better understood in any absolute sense” (Ibid: 255).

Timmermans, Molewijk, Stiggelbout, and Kievit assess presentation formats and their perceived threat (2004). They find that pictographs have a greater perceived threat than percentages and frequencies, but are seen as less of a threat than bar graphs. Therefore if the goal of the communication message is to minimize risk, pictographs are more effective than bar graphs but less effective than percentages and frequencies.

Based on the findings of these studies, pictographs are used as a visual display within the risk information handouts in the current research. This visual format has shown to be received well in terms of both perception and understanding which are essential elements of this research.

Pie Charts

Pie charts are also shown to be effective formats in presenting risk information. Spence and Lewandowsky look at the visual display formats of pie charts and bar graphs, and the numerical format of tables (1991). They assess comprehension through asking

participants to identify the larger component(s). They find that for simple tasks, all of these formats are comparable in communicating the information effectively (Ibid). However, as the tasks become more complicated, they find that the pie chart is the most effective in communicating the information, followed by the bar graph, and lastly, the table (Ibid). They conclude that if the purpose of the information is just to show trends and not precise numerical values, that visual displays of bar graphs or pie charts are superior to the use of tables (Ibid).

Politi, Han, and Col discuss the use of pie charts when showing weather forecasts and explain that the pie chart is reported as being one of the most familiar formats for participants to work with (2007). They do however note that this familiarity with the pie chart is not associated with overall improved understanding. The pie chart is only significantly effective when it comes to demonstrating whether or not a value falls within a specified range (Ibid).

Hawley, Zikmund-Fisher, Ubel, Jancovic, Lucas, and Fagerlin also assess pie charts and they find the pie chart to be the most effective format in communicating general knowledge such as which treatment is better or worse, when compared to tables, bar graphs, and pictographs (2008).

Although the pie chart is shown to have positive results, Feldman-Stewart, Kocovski, McConnell, Brundage, and MacKillop find less favourable results for pie charts within their four experiments (2000). In their research, they find that pie charts (along with random ovals) are consistently producing inaccurate interpretations (Ibid). The participants misunderstand what the information is conveying when shown as a pie chart.

Lee, Lin, Tseng, Cassidy, and Hor look at the risk perception of pie charts in their research (2009). They find that 41.7% of participants find the pie chart to have a high level of risk, followed by 35.5% of participants who find the pie chart to have a low level of risk, and finally 22.8% of participants who find the pie chart to have a medium level of risk (Ibid). More participants find the pie chart to have a high level of risk rather than a medium or low level.

Pie charts are found to be positive in some instances and negative in others when it comes to effectively communicating information. Pie charts are used within the risk information handouts to determine their effectiveness in the context of communicating risk to recovering cardiovascular patients.

Bar Graphs

Bar graphs are another way to display information visually and communicate risk. Feldman-Stewart, Kocovski, McConnell, Brundage, and MacKillop look at many different presentation formats including vertical bars, horizontal bars, numbers, ovals, and pie charts (2000). They find that vertical bar graphs not only produce the most accurate results but they also take the least amount of processing time to understand the information that is being communicated (Ibid). Davis, McNair, Brigic, Clarke, Brookes, Thomas, and Blazeby find similar results when they look at the presentation of cancer surgery survival data and discover that bar graphs lead to accurate understanding for over 90% of the participants (2010). Waters, Weinstein, Colditz, and Emmons compare the visual display of bar graphs with the presentation of numbers or words alone (2006). They also find that participants who receive the information visually in bar graphs have

more accurate responses than those who receive the information in text (without visual displays). Bar graphs are shown to be effective in communicating information so that it is understood correctly.

Lipkus suggests that bar graphs are good tools for making comparisons, and he states that “individuals are sensitized to graphs that use height to signify risk likelihood or to make comparisons among events” (2007: 703). Bar graphs provide a visual representation of information that is user friendly.

Alternatively, Schapira, Nattinger, and McHorney find less favourable results for bar graphs within their study (2001). The participants find that “bar graphs were perceived as analytical, as difficult to understand, and as having less impact” (Ibid: 462). In this study, bar graphs are not a preferred visual presentation format.

Timmermans, Molewijk, Stiggelbout, and Kievit assess presentation formats and their perceived threat (2004). They find that compared to pictographs, percentages, and frequencies, bar graphs are found to have the greatest perceived threat. Therefore, based on this study, if the goal of a communication message is to maximize risk perception, bar graphs are an effective presentation format.

Bar graphs are a familiar visual presentation format, and are shown to be effective in some studies and less effective in others. They are assessed in the current research for understanding and perception by being included on the risk information handouts.

Numbers

Although there is ample evidence that visual displays are both preferred and produce greater understanding, there is an equal amount of evidence that suggests numbers have

the same effects. Parrott, Silk, Dorgan, Condit, and Harris report on differences between risk information being presented verbally (through text and numbers) and visually (through graphs) (2005). Participants perceive verbal forms of statistical evidence to be higher in quality than visual forms. Even more importantly, the participants not only find the verbal statistics to be of greater quality, but they also understand the risk that is being communicated through numbers and text better than when explained via graphs (Ibid). The authors express caution when using visual displays and state that “not only [do] visual forms do little to enhance understanding to promote accurate genetic health risk appraisals, but also that the general public suffers deficits in this regard” (Ibid: 447). These researchers not only support the use of numbers as presentation formats, but they also warn against using visual displays as a substitute.

Miron-Shatz, Hanoch, Graef, and Sagi compare the presentation formats of frequencies (one out of every x), 1-in-N (written as 1:x), and the visual displays of pictographs (drawings of blank and shaded circles to represent frequencies) in communicating the risks of having a fetus with Down syndrome (2009). The frequency format is found to be the most effective format in that participants understand the risk that is being communicated and therefore produce accurate results (Ibid). In addition, this format has the lowest perceived risk when compared to the 1-in-N format and visual displays (Ibid). This study is important in that it reduces risk while preserving the truth of the information being communicated; that is, participants demonstrate accurate understanding of the information as well as perceiving the risk to be lower.

Feldman-Stewart, Kocovski, McConnell, Brundage, and MacKillop look at different formats to communicate treatment risks and benefits (2000). Detailed-level

information is most accurately perceived when presented in numbers rather than any of the graphical formats (bar graphs, ovals, and pie charts) (Ibid). Numbers allow for the specifics of information to be identified.

Timmermans, Molewijk, Stiggelbout, and Kievit assess presentation formats and their perceived threat (2004). They find that compared to pictographs and bar graphs, numbers in the form of frequencies and percentages, have the lowest perceived levels of threat. Based on this research, numbers are more effective than visual displays in minimizing risk.

Gigerenzer, Gaissmaier, Kurz-Mileke, Schwartz, and Woloshin emphasize a need for statistical literacy and state that “patients have a right to learn how big benefits and harms of a treatment are” (2008: 86). They discuss the use of qualitative terms and in their opinions, these words are not clear, and a term such as “unlikely” or “low” can be interpreted in many different ways. They discuss transparent representations of numbers and recommend using frequency statements rather than single-event probabilities, absolute risks rather than relative risks, mortality rates rather than survival rates, and natural frequencies rather than conditional probabilities (Ibid). Connelly and Knuth agree with the risks of using qualitative information and find in their study that a quantitative presentation of risk with numbers is more effective than a qualitative presentation of risk using words such as “low”, “moderate”, and “high” (1998).

An important numeric concept that arises when assessing presentation formats is numeracy. Schwartz, Woloshin, Black, and Welch discuss the presentation of numbers and the role of numeracy in understanding the benefits and risks of screening mammography (1997). The construct of numeracy is explained as, “quantitative

information [only being] meaningful to the extent that patients have some facility with basic probability and numerical concepts” (Ibid: 966). Schwartz, Woloshin, Black, and Welch find that participants who have higher numeracy scores also achieve more accurate responses in assessing and understanding risk (1997). Therefore, numbers are effective in communicating risk so long as they are understood; if numeracy can be improved, comprehension of risk information may also be improved.

Keller and Siegrist echo this importance in numeracy as they state that “different communication formats may produce different risk perceptions, but the effect is qualified by patients’ numeracy skills” (2009: 483). This is not just applicable to numeric presentation formats, but includes visual presentation formats as well. An individual’s level of numeracy in turn affects the perception and understanding of information.

For example, Miron-Shatz, Hanoch, Graef, and Sagi find that “high numeracy levels were associated with a better ability to judge risk likelihood” (2009: 439). Numeracy proficiency plays a role in the overall level of understanding of the information. They also comment that those individuals with lower numeracy abilities are able to achieve more accurate responses when the risk information is communicated through frequencies rather than other presentation formats (Ibid). Therefore, these researchers support the use of numbers regardless of the level of numeracy proficiency, as they produce the most accurate level of understanding.

Waters, Weinstein, Colditz, and Emmons find in their study that the majority of participants indicate that their preferred format to receive information is through words or pictures, whereas the smallest group of individuals indicates their preference is through numbers (2006). However, it is interesting to note that despite this preference, those

individuals who prefer receiving information through numbers are the most accurate in perceiving the risk, regardless of the format it is presented in. In light of this fact, if more people are educated on how to work with numbers, risk information, regardless of the format it is presented in, may be better understood. This finding can be linked back to numeracy. Individuals who prefer to receive information through numbers rather than words or visual displays, demonstrate a level of comfort and knowledge of numeracy proficiency. This groups' higher level of numeracy proficiency results in a higher level of understanding in turn suggesting that as numeracy proficiency increases, so does the level of understanding.

As the concept of numeracy and its relationship with understanding arise frequently in the literature, numeracy is assessed within the current research. It is important to recognize if there are other factors impacting the perception of presentation formats. Numeracy proficiency is shown to have an impact on understanding in other studies and may also show such an impact in the current research.

Presentation preference is mentioned in the above study by Waters, Weinstein, Colditz, and Emmons and is found to not relate to level of understanding (2006). That is that an individual's preferred presentation format does not necessarily produce the most accurate understanding. Feldman-Stewart, Kocovski, McConnell, Brundage, and MacKillop comment on presentation preference as well and also indicate that participants' perceived preference does not result in accurate results (2000). Therefore, an individual's choice for format does not necessarily reflect whether or not they understand that information. As presentation preference does not appear to have an influence on understanding, it is not included in the current research.

Based on this research, numerical presentation formats are used within the risk information handouts and are assessed for effective communication of information to recovering cardiovascular patients. Further details of these numeric presentation formats are outlined below.

Tables

Tables provide a way to present numbers in a visual format. Numbers can be organized into rows and columns, rather than just being written out in sentence form. Gigerenzer, Gaissmaier, Kurz-Mileke, Schwartz, and Woloshin outline the benefits of using tables to show comparisons such as drug performance (2008). They state that “by being given data outcomes side by side, readers are reminded that understanding an effect entails comparing what would happen with and without the drug. Similarly, presented with information about benefit and harm on the same page, readers are reminded that judging whether a drug is ‘worth it’ means comparing good and harmful effects” (Ibid: 86). They find that tables are an effective presentation format to make comparisons.

In other research, Hawley, Zikmund-Fisher, Ubel, Jancovic, Lucas and Fagerlin find tables to be effective in communicating precise numbers (2010). They also report that participants deem the table to be the most trustworthy and scientific, while the pie chart is perceived to be the least trustworthy and scientific (Ibid). Tables are effective presentation formats and have positive attributes assigned to them.

Spence and Lewandowsky also look at presentation format and find that when precise numbers need to be communicated, the textual style of tables demonstrates such information more effectively than visual displays of bar graphs or pie charts (1991). A

table can give precise numbers and values, whereas a visual display may not relay this information as clearly.

Tables are shown to be effective presentation formats in communicating information effectively. They are therefore included within the risk information handouts to display numbers, and are assessed for their understanding and perception.

Frequencies and Percentages

Two very common numeric presentation formats are frequencies and percentages, and they have been compared to one another in a number of studies. Siegrist studies the differences between probabilities (ex: 0.0006) and frequencies (ex: 600 in 1,000,000) when communicating risk information (1997). He finds that participants are willing to pay a higher amount of money for a “safer medication” when the risks comparing the safer medication and the old medication are presented as frequencies instead of probabilities (Ibid). Siegrist states “the frequency format emphasizes the threat of risk” (Ibid: 509). Therefore, frequencies appear to have a persuasive effect and increase the perception of the risks for not taking the safer medication. If the goal of the risk communication message is to maximize risk, frequencies are more effective than percentages.

Gigerenzer, Gaissmaier, Kurz-Mileke, Schwartz, and Woloshin discuss the benefits of using natural frequencies to display risk rather than conditional probabilities (2008). Conditional probabilities provide risk information in percentages while natural frequencies provide information in the form of one number, x, out of a total number, y. The statements that, “the probability that a woman has breast cancer is 1%” and “if a

woman has breast cancer, the probability that she tests positive is 9%” are conditional probabilities (Ibid: 55). The equivalent information expressed in natural frequencies is “ten out of every 1,000 women have breast cancer” and “of these 10 women with breast cancer, 9 test positive” (Ibid: 55). This information (along with a scenario and question) is provided to a group of physicians first in the form of conditional probabilities, and then in the form of natural frequencies. When conditional probabilities are provided, only 21% of the physicians are able to answer the corresponding question correctly (which is slightly less than chance) (Ibid). However, when the information is provided in natural frequencies, 87% of the physicians are then able to identify the correct answer (Ibid). The researchers explain that “natural frequencies represent the way humans encoded information before mathematical probabilities were invented in the mid-17th century and are easy to ‘digest’ by our brains” (Ibid: 55). This research demonstrates that the frequency format enhances understanding. Gigerenzer, Gaissmaier, Kurz-Mileke, Schwartz, and Woloshin test these statistics with medical professionals. It is important to observe that the presentation of risk information can have varying effects even for highly educated individuals who work within the field of medicine.

Waters, Weinstein, Colditz, and Emmons explore medical tradeoff decisions and look at differences between percentages and frequencies as well (2006). They look at how risk is interpreted when participants were presented with the concept of taking a drug that would cut the risk of one thing, while increasing the risk of something else such as side effects. Their results differ from the research above in that it is found that percentages result in more accurate responses than the frequencies (Ibid). Individuals understand the information better when it is presented as percentages.

Concerning preferences for receiving risk information, Ozanne, Wittenberg, Garber, and Weeks find in their study that 48% of participants prefer to receive risk information as percentages, followed by 23% as a comparison of their risk to that of an average woman, and finally 19% through frequencies (2009). This study demonstrates that more people prefer to receive risk information as percentages rather than as frequencies.

Schapira, Nattinger, and McHorney held focus groups and find that both percentages and frequencies each have their own positive attributes when it comes to communicating risk information (2001). Individuals report frequencies as having ease of interpretation, simplicity, and the ability to provide a human contextual quality when used with graphics (Ibid). Percentages are found to include an association with personal risk estimation and as having a mathematical quality (Ibid). The participants in this study acknowledge advantages in using percentages and advantages in using frequencies.

All together, this research demonstrates that both percentages and frequencies are used to communicate risk information, and have done so resulting in different perceptions and understandings. Both percentages and frequencies are assessed within the current research to assess understanding and perception of information communicated to cardiovascular patients.

Frequency Denominator

Another numeric presentation format variation involves manipulating the denominator when presenting frequencies. First off, it is important that the presentation of frequencies in risk communication always show both the numerator and the denominator (Lipkus,

2007). Presenting a numerator without its respective denominator greatly affects risk perception (Ibid). Lipkus reports that “graphically emphasizing only the numerator of a risk (e.g., showing only those affected) increases risk-avoidant behaviors, whereas attending to both the numerator and denominator decreases risk-avoidant behaviors” (2007: 702). For example, if the number “1” is presented, the perception of risk could range from very risky to not risky at all. If the reader assumes a denominator of “2”, then this risk is perceived as high. On the other hand, if the denominator is assumed to be high such as “1000”, the risk is perceived as low. This research leads to the decision that any frequencies that are presented within the current research will show both the numerator and the denominator.

Yamagishi examines frequencies in his research, and how manipulating the size of these numbers creates discrepancies in the perception of risk (1997). The participants perceive the data to be of greater risk when the numbers are larger. For example, $1286/10000$ is perceived to be of greater risk than $24.14/100$ when discussing cancer death rates (Ibid). If the participants convert these frequencies to percentages, they will learn that $1286/10000$ is equivalent to 12.86%, whereas $24.14/100$ is equivalent to 24.14%, thus resulting in the latter being of greater risk. However, the larger number of 1286 results in individuals perceiving that more people died of cancer, thus indicating that the denominator is not taken into account.

Other work involving manipulations of the denominators is done by Zikmund-Fisher, Fagerlin, Roberts, Derry and Ubel, and they too find a misunderstanding among perception (2008). Respondents report that frequencies with a denominator of 1000, compared to frequencies with a denominator of 100 (equivalent in value), are more

worrisome and seen as being of greater risk. In another study, Zikmund-Fisher, Ubel, Smith, Derry, McClure, Stark, Pitsch, and Fagerlin look at which denominator, 100 or 1000, results in a better understanding of the information (2008). They find that the denominator of 1000 significantly increases knowledge compared to the denominator of 100.

These manipulations of denominators demonstrate that larger denominators are perceived as being a greater risk as they are thought to be larger in quantity. Although larger denominators appear to be more risky, it is also shown that the risk is better understood than with a smaller denominator.

One final study that looks at denominator size finds contradictory results in that “subjects focused on the denominator, noting that more figures were presented without disease when the larger denominators were used (i.e., 100 or 1000 compared to 10)” (Schapira, Nattinger & McHorney, 2001: 463). The perception of risk is therefore less with the larger denominators as there are a greater number of individuals who are not affected by the disease.

The research demonstrates that manipulations in the size of a frequency denominator changes how people perceive and understand the information that is being communicated. Large and small denominators are assessed in the current research to determine their effectiveness in communicating risk to recovering cardiovascular patients.

Message Framing: Loss and Gain

In addition to visual presentation formats and numeric presentation formats, differences in message framing are another way to vary the presentation of information. Gore and Campanella Bracken look at fear appeals and explain the differences between danger control processes and fear control processes (2005). Essentially, if the perceived threat of a message is high, and the perceived efficacy is also high, this results in a danger control process. This is a positive response as it allows individuals to “focus cognitively on dealing with the threat and possible solutions to avert the threat” (Ibid: 30). The fear control process on the other hand, occurs when the perceived threat of the message is again high, but the efficacy is low. This results in a negative response and emotions tend to take over, often leading to denial or avoidance (Ibid).

Gore and Campanella Bracken’s research discovers the importance of an efficacy component in risk message preparation (2005). An increase of efficacy in the messages results in individuals experiencing danger control processes, whereas a decrease of efficacy, results in fear control processes (Ibid). Although the efficacy component is crucial in risk message preparation, Gore and Campanella Bracken acknowledge the importance of threat as well (2005). If there is no perceived threat, then the individual will not feel a need to engage in any new behaviour. There needs to be a balance of threat and efficacy in risk message preparation, so that the individual both recognizes the importance of the threat and their ability to engage in behaviours that reduce that threat.

A division of fear appeals involves the perception of loss-framed versus gain-framed messages. Edwards, Elwyn, Covey, Matthews, and Pill discuss loss-framed and gain-framed messages in risk communication (2001). Loss-framed messages are found to

be more effective than gain-framed messages. For example, messages stating the risks of not being screened for breast cancer are more effective than messages stating the benefits of being screened (Ibid). This example is a detection behaviour which is shown to have greater effects with loss-framing rather than prevention behaviours (Ibid). However, both prevention and detection behaviours demonstrate superior results with loss-framing as opposed to gain-framing.

Rivers, Salovey, Pizarro, Pizarro, and Schneider also look at gain and loss framing when communicating information about Pap tests (2005). They find that loss-framed messages used for detection framing and gain-framed messages used for prevention framing, result in more individuals engaging in the behaviour of getting a Pap test (Ibid). Therefore they determine that depending on what type of message is being conveyed, prevention or detection, will in turn affect whether gain or loss framed messages are more effective.

Halpern, Blackman, and Salzman use a variation of gain and loss-framing when discussing oral contraceptive safety (1989). They find that using “the number who will not die” results in a lower perceived risk than using “the number who will die” (Ibid). In this context, the gain-framed message, that is the number who will not die, results in a lower perceived risk, which if related to the study by Edwards, Elwyn, Covey, Matthews, and Pill could be interpreted as not as effective (lower risk). However, this is just speculation, as effectiveness is not studied, only risk perception.

Risk messages can create a sense of threat as well as a sense of efficacy. Determining the appropriate balance is crucial when framing a risk communication message. Gain-framed messages and loss-framed message are used within the risk

information handouts and are assessed for effectiveness in terms of understanding and perception.

All of the presentation formats discussed are included on the risk information handouts: visual displays of bar graphs, pie charts, and pictographs, numeric displays of table, frequencies, and percentages, and message framing variations of loss-framed and gain-framed messages. These formats are assessed for effectiveness of risk communication through measures of understanding and perception. Max Weber's rationality is integral in understanding how the messages are created and how thoughts are formed as individuals digest and process information. Rationality involves absorbing information, determining a desired result, and figuring out the steps to achieve that desired result. The theories of social judgment theory and the heuristic-systematic model build off of this core concept of rationality and provide a deeper understanding of the importance of message preparation. Both of these theories provide insight into how individuals perceive information and make decisions based on this perception. Rationality is also intertwined into expected utility theory, protection motivation theory, and the extended parallel process model. These theories provide insight into how risk is perceived, how threat and efficacy are appraised, and ultimately how thoughts turn into active decisions. All of these theories come together within the current research to guide how messages are created for the risk information handouts, and help to explain how messages may be perceived in regards to understanding and perception. It is evident that there are many different ways to present the same information, and it is of the utmost importance to determine how to do so effectively.

Chapter 3

Methodology

The review of the literature guides the development of the methodology for the current research. Various presentation formats are used to present risk information to recovering cardiovascular patients and are assessed for their understanding and perception.

Concepts and Operationalization

There are several key concepts that are integral to this research, and these terms provide the framework for understanding how to effectively communicate risk messages to cardiovascular patients. These concepts are: risk, motivation, protection, message preparation, understanding, and perception.

Risk

The first key concept is that of risk, and it is the core theme of this research. Risk can be understood as uncertainty between different outcomes and involving an assessment of danger. Maule states that “risk” is conceptualized in many different ways but that “formally, risk is usually defined as the product of the likelihood of some event and the impact, value or utility of its outcome” (2004: 19). For this research, risk is defined as the potential of uncertainty of a presented circumstance.

Risk is measured through the use of a questionnaire which poses questions assessing whether or not the information being communicated scares the patient. Each presentation format has a corresponding risk assessment question. The risk questions

make use of the Likert Scale. The Likert scale involves the expression of “attitudes or other responses in terms of ordinal-level categories (e.g., agree, disagree) that are ranked along a continuum” (Neuman, 2007: 233). This format allows for mutually exclusive and exhaustive categories. The scale used for this questionnaire ranges from “Strongly Disagree” to “Strongly Agree” and also contains an “I don’t know” option. Patients are required to read the risk information handout and indicate the extent to which the information scares them. As these questions assess the perception of risk, there are no correct or incorrect answers. The responses provide information on how the information and presentation format is perceived with regards to risk.

Motivation

Motivation is the desire and drive to engage in a particular behaviour that will assist with protection and the avoidance of risky situations. Efficacy is strongly intertwined with motivation. Should the individual feel that he or she can do something to protect his or herself from the risk, the individual can feel motivated to engage in protective behaviours (Tanner, Hunt & Eppright, 1991). Motivation is measured within the questionnaire through questions assessing whether or not the information being communicated motivates the patient. Several of the presentation formats have a corresponding motivation question, and these questions again make use of the Likert Scale. Patients are required to read the risk information handout and indicate the extent to which the information motivates them to engage in the particular behaviour (ex: following the recommended number of food servings). As these questions assess motivation, there are no correct or incorrect answers. Responses will provide information on whether or not the

information and presentation format has an effect on motivating the individual to engage in a behaviour.

Protection

Protection is a combination of risk and motivation and involves perceiving the risk or severity of something, assessing the need to protect oneself from this risk, and having the motivation to engage in a protective behaviour. This “need to protect” is directly related to the extended parallel process model in that there are two different ways to protect oneself. The danger control process means protecting oneself through changing behaviours and taking external control (Witte, 1994). The fear control process on the other hand means protecting oneself through emotions such as avoidance and denial (Witte, 1994). Danger control processes are the goal when it comes to protection. Should the need to protect oneself be acknowledged, the concept of motivation arises.

Message Preparation

These concepts lead to the idea of message preparation. Message preparation involves how the information is framed and includes manipulations in wording, statistics, and graphical displays. Essentially, the same message with equivalent information can be presented in many different ways. Manipulations in framing can make a person more likely to engage in a behaviour or more likely to avoid a behaviour. A message can be presented to raise the perception of risk, or to reduce the perception of risk. It is important that these manipulations in presentation only occur if the truth of the information is still

being preserved. Therefore, risk perception and risk accuracy work hand in hand, and a level of ethics is weaved into the risk presentation development. Gigerenzer, Gaissmaier, Kurz-Mileke, Schwartz, and Woloshin state that there is a great deficit in this regard and express their concerns quite strongly (2008). They believe that “we face a large-scale ethical problem for which an efficient solution exists yet which ethics committees, focusing their attention instead on stem cells, abortion, and other issues that invite endless debates, have not yet noticed” (Ibid: 56). Communicating information involving risk is of the utmost importance. It requires finding the perfect balance so that the presentation of risk is perceived to be appropriate while ensuring that the information is relayed accurately. Schapira, Nattinger, and McHorney provide a succinct summary when they state that “risk formats should be chosen to optimize patient understanding and ability to use the information effectively, rather than for the purpose of persuasion (2001: 466). Therefore, it is important to recognize that effective risk communication is centered on the concept of accurate understanding.

Understanding

Understanding is of the utmost importance. Understanding refers to whether or not the recipients of the risk information comprehend what the message is telling them.

Understanding is measured through questions assessing whether or not the patient comprehends the information that is being communicated. Each presentation format has a corresponding comprehension question. As previously mentioned, effective risk communication not only requires a level of sensitivity to communicate the information, but it also requires that the information be conveyed accurately. The understanding

questions use two different formats: the Likert scale (which was described above) and multiple choice. Multiple choice questions ask a question about something on the risk information handout and provide four answers to choose from, as well as the “I don’t know” option. There is a correct answer, as comprehension is being assessed. These questions allow for the determination of whether or not that particular presentation format conveys the information accurately. Dressel and Schmid explain these types of questions as “problems [that] involve one right answer and, in a very real sense, other proffered responses are purely distracters chosen on the basis of hunches or of actual evidence on the kinds of errors, misunderstandings, or misinformation concomitant to the problem” (1953: 575). There is one correct answer, which determines whether or not the participant understands the material for that question.

As previously outlined, understanding can be broken down into two categories called verbatim understanding and gist understanding. Verbatim understanding refers to the ability to identify specifics of the information. Hawley, Zikmund-Fisher, Ubel, Jancovic, Lucas, and Fagerlin provide the example of correctly identifying numbers from graphs (2008). Alternatively, gist understanding refers to the ability to provide the general idea or essential point of the information (Ibid). These are two different types of understanding and are assessed using two questions within the questionnaire. One question asks for a specific value to be identified (verbatim understanding), while the other question asks about a comparison (gist understanding). These questions are included to see if there is a difference among presentation format and the type of understanding achieved.

Perception

Perception is the last key concept and involves how an individual interprets given information. For the purposes of this study, perception corresponds directly with the interpretation of risk and motivation. Therefore, a message may be perceived to be more risky or motivating or less risky or less motivating depending on how the messages are framed and presented.

All of these concepts are integrated into the research through the use of risk information handouts and the questions that are then posed within the questionnaire. Risk is woven into every element involved with the presentation of the information. It is shown through visual displays, numbers, and words. Protection and motivation are assessed through questions in the questionnaire addressing what a reaction would be or what behaviour the individual would employ. For example, gain-framed and loss-framed messages may experience different outcomes as to how people would protect themselves.

Message preparation is central to how the information is presented and includes differences in denominators, frequencies versus percentages, gain-framed versus loss-framed messages, and numbers versus visual displays. By using one format on one risk information handout, and the other format on a different risk information handout, the most effective format in terms of perception and understanding is determined.

Perception and understanding are addressed within the questionnaire through both comprehension questions, ensuring that the information is properly understood, and comparison questions. For example, the study by Yamagishi (mentioned above) demonstrates how errors are made when individuals are faced with two different statistics and have to choose the one that is less risky (1997). Perceptions and understanding vary

depending on how the content is presented. These core concepts are woven into the design of the research, which is elaborated on below.

Research Design: Experimental Research

The experimental research is deductive, moving from the general to the particular (McLeod & Tichenor, 2007). As outlined in the Literature Review, there are many different presentation formats and explanations of how these formats function with regards to understanding and perception in various contexts. The current research uses this prior knowledge in helping to formulate the risk information handouts and questionnaires so that it can be applied to the context of health and risk communication to recovering cardiovascular patients at the University of Ottawa Heart Institute.

Quantitative techniques such as the structuring of questions, the development of categories and variables, and counting responses and observations, are used within this design (Nardi, 2007). In addition, a microscopic conceptual approach is adopted since “the emphasis is primarily on the individual as a unit of analysis” (McLeod & Tichenor, 2007: 14). Individual behaviours and motivations are gathered from the research, which are key characteristics of the microscopic approach (McLeod & Tichenor, 2007). This research targets a specific group of patients: recovering cardiovascular patients at the University of Ottawa Heart Institute.

Experimental research is employed for the current study using a between-subjects experimental design. This design involves “three crucial elements of the classical experiment: control over extraneous variables, methods of dealing with pre-treatment

similarity of groups, and manipulation of a treatment” (Jackson & Verberg, 2007: 299). Extraneous variables such as demographics, numeracy proficiency, and prior knowledge of cardiovascular disease are controlled for within the research, similarity of groups is established through stratified sampling, randomization, and precision matching, and manipulation of treatments is accomplished through variations in presentation formats. These elements are discussed in further detail throughout the methodology.

Variables

There are several dependent variables involved in this research design. A dependent variable is classified as “the phenomenon measured in order to determine if any change has taken place as a result of some experimental intervention” (Jackson & Verberg, 2007: 295). The dependent variables include the subject’s understanding of the material, the subject’s perceived riskiness of the material, and the subject’s perceived motivation of the material. Each of these dependent variables is assessed separately within the questionnaire.

In addition to dependent variables, there are several independent variables involved in this research. Jackson and Verberg indicate that “independent variables include all the variables taken into account, or manipulated, by the researcher that can influence the dependent variable” (2007: 295). The independent variables within this research are the manipulations of the presentation format. These manipulations include information presented as frequencies, percentages, numbers, pie charts, pictographs, bar graphs, small or large denominators, tables, loss-framed messages, and gain-framed messages. These different presentation formats are assessed in terms of their

understanding, perceived riskiness, and motivation as experienced by the subjects of this study.

Control variables are also present in the research. Control variables involve any major factors that could influence the dependent variables, not including the independent variables (Jackson & Verberg, 2007). These control variables include demographic information such as gender, age, marital status, annual household income, highest level of education completed, and stage of rehabilitation. Demographics allow for insight into characteristics of the participants. Mutually exclusive and exhaustive categories are provided for each question, and the participants are required to check off the box that applies to them. These questions are very important to the study, as they will provide insight into which groups of individuals respond which way. For example, perhaps the majority of males over the age of 70 who have a University degree score 100% on the comprehension questions while the majority of females over the age of 70 who have a University degree only score 50% on the comprehension questions. Gender could therefore play a role on influencing the dependent variables. In addition, the demographics allow for the creation of equal groups of participants. This means that there is an individual who fills out risk information handout A, and then a similar individual who fills out risk information handout B. This allows for more accurate comparisons to take place.

Two additional control variables are prior knowledge of cardiovascular disease and numeracy proficiency. It is important to assess what knowledge the participants have of cardiovascular disease since their level of knowledge could influence their responses. Some individuals may be experts on the topic while others are not aware of the basics.

Zikmund-Fisher, Fagerlin, Roberts, Derry, and Ubel control for differences in prior knowledge within their research (2008). They ask participants to indicate on a 5-point scale how much they know about their topic, tamoxifen (Ibid). The use of a 5-point scale, ranging from “I don’t know anything about cardiovascular disease” to “I know everything about cardiovascular disease”, is used within the questionnaire to assess for prior knowledge. This question allows for the determination of whether or not there is a relationship among knowledge of the disease and comprehension and perception of the risk information handout and questionnaire.

Numeracy proficiency is another control variable. It is important to assess an individual’s ability to work with, and understand, numbers. Some individuals are naturally more mathematically inclined than others. Schwartz, Woloshin, Black, and Welch assess numeracy in their study’s tests of participants’ understanding of the benefits of screening mammography (1997). They use three questions to complete their assessment, and numeracy is scored as the total number of correct responses (Ibid). These same questions (with slight wording variations) are used in the study by Sheridan, Pignone, and Lewis to assess patients’ understanding of number needed to treat (2003). These questions are included on the questionnaire to assess numeracy for the current research participants. Participants are given five answers to choose from plus an “I don’t know” option. They must check off the box that they feel is the correct answer. These questions do have correct and incorrect answers. The numeracy questions will allow for the determination of whether or not there is a relationship between an individual’s numeracy and the comprehension and perception of the risk information handout and questionnaire. All of these variables allow for a greater degree of control to ensure that

the independent variables are responsible for any effect on the dependent variables, rather than outside factors.

Finally, confounding variables are present in the research, as they are variables “that can unintentionally obscure or enhance a relationship” (Jackson & Verberg, 2007: 295). These variables include things such as timing (i.e. the patient is getting ready to leave the Heart Institute for the day and rushes through the questionnaire) or language (the risk information handouts and questionnaires are in English and this may not be the first or preferred language for all participants).

Reliability and Validity

Such manipulations are central to the research and are implemented using reliable and valid means. Reliability is ensured through having consistent conditions where similar results occur under similar manipulations (Nardi, 2007). Structured and identical risk information handouts and questionnaires are distributed to each participant, which allows for consistent conditions to be maintained. In addition, the same methodology is implemented for all questionnaire distributions, including factors such as explanations and time of distributions. Equal representations of participants are achieved for each grouping, Risk Information Handout A and Risk Information Handout B, which is explained in further detail below. Finally, during the analysis, the same manipulations are done to all of the data using the statistical software, SPSS.

Validity is ensured through the creation of constructs to accurately represent what occurs in the real world (Nardi, 2007). Risk messages are communicated every day, resulting in the receiver taking in and processing the information. Messages are

understood or not, risk is assessed, and in some cases motivation is also assessed. Using this experienced knowledge with support from the literature, validity is ensured.

Sampling: Creating Equivalent Groups

There are two different groups within this design; an experimental group and a control group. As Jackson and Verberg outline, “the control group is established so that comparisons can be made between the experimental group and the control group” (2007: 300). Essentially, the two different groups (control and experimental) are exposed to the same information but in different presentation formats. The variations in presentation are assessed for comprehension, perceived riskiness, and motivation as experienced and reported by the patients. For example, one group may have information presented in the form that 20% of heart disease patients experience clinical depression, whereas in the other group that same information is presented as 1 out of 5 heart disease patients experience clinical depression. This particular manipulation in the presentation assesses the differences in perception of percentages versus frequencies. The different presentation formats used are determined based on the findings of similar studies presented in the literature review and the information received from the Cardiovascular Rehabilitation Centre at the University of Ottawa Heart Institute.

A critical element that leads to the success of such a research design is that the two groups be made as equivalent as possible. This is achieved within the research through a combination of stratified sampling, randomization, and precision matching. The sampling strategy adopted for this research is probability sampling, and more specifically, stratified sampling. Stratified sampling first involves dividing the population

into subpopulations based on certain criteria (Neuman, 2007). The groups are determined based on demographic information. When the researcher distributes the two different risk information handouts, he or she is ideally aiming for equivalent representations of the individuals who fill out the questionnaires. For example, if only women under the age of 50 who did not finish high school answered the questionnaires for risk information handout A, while only men over the age of 50 who all had university educations filled out the questionnaires for risk information handout B, it would be difficult to pinpoint what factor is responsible for differences in perception. Therefore, the stratified approach is adopted so as to make sure the groups have equal representations of different types of people.

Randomization is defined as “a process of assigning subjects to a treatment or a control group so that each subject has an equal chance of being assigned to either group” (Jackson & Verberg, 2007: 300). Randomization is applied to this research design through the alternate availability of the two versions of the risk information handouts: version A and version B follow one after the other in the pile. Should a patient choose to participate, he or she will pick up a questionnaire from the pile which is version A. The next patient will pick up version B. The A-B cycle continues so that every second person gets the same version.

Precision matching is also used within the research to achieve equal control and experimental groups. Precision matching is defined as “a method of achieving equivalence between control and experimental groups by ensuring that the groups are matched on certain key variables” (Jackson & Verberg, 2007: 302). Within this research the key variables are the demographics. For example, a similar representation of females

and males needs to receive both versions of the Risk information handouts. Precision matching is used after the questionnaires are collected to make sure that there are comparable participants (with regards to demographics) in both groups. Data is collected until these equal groups are achieved.

Hypotheses

This research holds one primary hypothesis and three sub-hypotheses which are outlined below.

Primary Hypothesis

- There is a relationship between the presentation format of information (frequencies, percentages, denominator size, gain/loss-framing, graphs, and tables) and the effectiveness of risk communication (levels of understanding, risk perception, and motivation) of recovering cardiovascular patients.

Sub-Hypotheses

- There is a relationship between the presentation format and the level of understanding of cardiovascular information among recovering patients.
- There is a relationship between the presentation format and the level of risk perception of cardiovascular information among recovering patients.

- There is a relationship between the presentation format and the level of motivation of cardiovascular information among recovering patients.

The responses provided on the questionnaires are used to determine what the relationships are between these presentation formats and effective risk communication.

The information learned from these relationships can help in determining how to present information to these patients in the future so as to maximize understanding while maintaining an appropriate level of perceived risk.

Data Collection and Analysis

Ethical Considerations

Due to the nature of the research and the methodology of distributing questionnaires to human subjects, ethical considerations are made. An expedited review takes place at the Human Research Ethics Board at the University of Ottawa Heart Institute. This review involves submitting a full application which includes the protocol, the risk information handouts, the questionnaire, the information sheet and consent form, and the thesis committee approval letter. Approval is granted, and this approval is then submitted to the Research Ethics Board at the University of Ottawa. The University of Ottawa Research Ethics Board also reviews the application and grants approval of the study.

One of the primary ethical considerations is informed consent. Informed consent consists of the participant's capacity to make a rational and mature decision, knowledge of what is to occur, comprehension of the possible effects, and freedom from coercion or undue pressure (Greenberg, Eastin & Garramone, 2007). The questionnaires contain a

cover page addressing these elements as well as confidentiality, anonymity, and the right to not participate. All participants receive the same introduction to the research provided by the primary researcher and are invited to pick up a risk information handout/questionnaire package if they are interested in participating. They can then complete the questionnaire and submit the document to a return box located in the centre. This approach is important so participants do not feel pressure to participate since they are picking the package up and returning it to an object (table or box) as opposed to a person (primary researcher).

Demographics of Respondents

Once the risk information handouts and questionnaires are distributed, completed, and returned, the information is collected and analyzed. 200 completed questionnaires are divided into two equal groups: 100 for Risk Information Handout A and 100 for Risk Information Handout B. Both groups have similar representations of participants in all six categories of demographics. 109 males and 91 females completed the questionnaires, and equal numbers of each are represented in Handout A and Handout B. The majority of participants are over the age of 50, married, in a medium or high bracket of income, have a medium or high level of education, and are in the early stages of rehabilitation. *Table 1* outlines the details of the demographics.

Table 1: Demographics of Respondents

		Number of Participants		
Demographic	Category	Risk Information Handout A	Risk Information Handout B	Total
Gender	Male	54	55	109
	Female	46	45	91
Age	<20	0	0	0
	20-<40	2	3	5
	40-<50	11	13	24
	50-<60	29	30	59
	60-<70	34	30	64
	70+	24	24	48
Marital Status	Single	7	10	17
	Married	62	66	128
	Common-Law	4	1	5
	Divorced	15	17	32
	Widowed	11	3	14
	Other	1	3	4
Income	Low	4	2	6
	Medium	41	37	78
	High	52	56	108
Education	Low	26	18	44
	Medium	39	39	78
	High	30	38	68
	Very High	5	4	9
Stage of Rehabilitation	Early	60	53	113
	Middle	25	28	53
	Late	15	19	34

Both risk information handouts have comparable groups of participants. The greatest difference between the two groups is 4%. This 4% provides a confidence level of 96% which is greater than the minimum required confidence level for this research of 95%.

The Risk Information Handout

There are two key instruments that are used for data collection within this research: risk information handouts and questionnaires.

Two versions of the risk information handout are created, version A and version B. These versions present the same information yet differ in the format in which the information is presented. The information that is presented on these sheets is information that is given out at the University of Ottawa Heart Institute. Some of the information comes directly from handouts that are given to the patients during their rehabilitation classes, while other information comes from the website to which they are referred for additional information on heart disease. The information to include on the questionnaires is chosen based on several criteria: patients having access to the information, a range of different material including nutrition, exercise, and illness, and the information's ability to be presented in two different formats. Each risk information handout is one page (front and back) and contains nine different presentations of information. *Table 2* outlines the presentation formats that are used on the risk information handouts:

Table 2: A Comparison of Presentation Formats on Risk Information Handouts A and B

INFORMATION SHEET A	INFORMATION SHEET B
Frequency	Percentage
Percentage	Pie Chart
Frequency	Pictograph
Bar Graph	Numeric Statement
Small Denominator	Large Denominator
Bar Graph	Pie Chart
Pictograph	Bar Graph
Table	Bar Graph
Loss-Framed Message	Gain-Framed Message

These variations in presentation format are assessed for understanding, perception of risk, and motivation through the use of a questionnaire.

The Questionnaire

The questionnaire is a two page (front and back) document consisting of 33 questions. Participants are required to refer to the attached risk information handout when responding to the questions. The questionnaire consists of six different components which were described within the concepts and variables: understanding, risk perception, motivation, demographics, assessment of prior knowledge, and level of numeracy proficiency.

Context of Data Collection

The risk information handouts and questionnaires are distributed to recovering cardiovascular patients at the Cardiovascular Rehabilitation Centre at the University of Ottawa Heart Institute. There are approximately 40 new patients each week, and the questionnaires are distributed on site. Patients come in to the centre to meet with doctors, engage in exercise, and participate in workshops. The questionnaires are distributed to the patients during the exercise classes, and patients are given the choice as to whether or not they would like to participate. Distribution of the questionnaires continues until the sample size of 200 is met. This size of 200 consists of two groups of 100 participants with comparable demographics in each.

Statistical Analysis

Once the questionnaires are distributed, completed, and returned, the data is entered into SPSS software for analysis. All of the responses to the questions, once entered into SPSS, can be used for many modes of analysis.

Frequencies

Frequencies are performed on the data to determine different groupings and the overall numbers associated with the research. Nardi provides the following definition; “A *frequency table* or *distribution* shows how often each response (a *value*) was given by the respondents to each item (a *variable*)” (2007: 472). Frequencies are ideal to show the demographics of respondents as was outlined in *Table 1*.

Chi-Square Analyses

Chi-square analyses are the primary tests that are employed to determine if significant relationships are present among variables. Chi-square analysis is chosen due to the levels of measurement in the research: nominal and ordinal. Nominal level measurement is defined as “a difference in type only among the categories of a variable” (Neuman, 2007: 225). An example of this is gender, where the categories are male or female. Ordinal level measurement is defined as “a level of measurement that identifies a difference among categories of a variable and allows the categories to be rank ordered” (Ibid). An example of this is rating risk perception on a scale from strongly disagree to strongly agree. The chi-square test measures how independent two variables are and asks whether what is found is significantly different from what is expected to occur by chance alone (Nardi, 2007). Due to the presence of nominal and ordinal levels of measurement, the chi square test is an effective assessment to determine the significance of relationships (Ibid).

Statistical Significance

Statistical significance is calculated for each relationship, and a relationship is considered significant “if the probability of obtaining a statistic by chance alone is less than 5 percent” (Ibid: 485). Or, in other words, a relationship is considered significant if there is a confidence level of 95% or greater. *Table 3* outlines the confidence levels used for this research.

Table 3: Confidence Levels

Significance Level	Probability of Obtaining the Statistic by Chance	Confidence Level
$p \leq 0.05$	5 in 100 or 5%	95%
$p \leq 0.01$	1 in 100 or 1%	99%
$p \leq 0.001$	1 in 1000 or 0.1%	99.90%

Contingency Coefficients

Contingency coefficients are also calculated for the relationships found in the research as they indicate the strength of the associations (Nardi, 2007). A contingency coefficient is a value from 0.0 to 1.0, and the closer the value is to 1.0, the stronger the relationship. If a relationship is shown to be significant, the contingency coefficient shows the strength of that relationship.

Data Recoding

In some instances data is recoded into categories such as low, medium, and high. This is done to achieve different groupings based on the ways certain questions are answered. For example, understanding is measured by correct responses, and the more correct responses, the greater the overall understanding. Therefore, the number of correct responses for each participant is counted and the data is recoded to indicate a low, medium, or high level of understanding.

Chapter 4

Findings and Discussion

Completion of the experimental research design, as outlined in the methodology, yields important findings for effective risk communication to recovering cardiovascular patients. These findings for understanding, risk perception, and motivation are illustrated below.

Level of Understanding and Presentation Format

The first sub-hypothesis for this research is as follows:

- There is a relationship between the presentation format and the level of understanding of cardiovascular information among recovering patients.

All of the presentation formats produce accurate understanding for the majority of participants. *Table 4* outlines the presentation format pairs and their impact on understanding.

Table 4: Presentation Format Pair Comparisons and Understanding

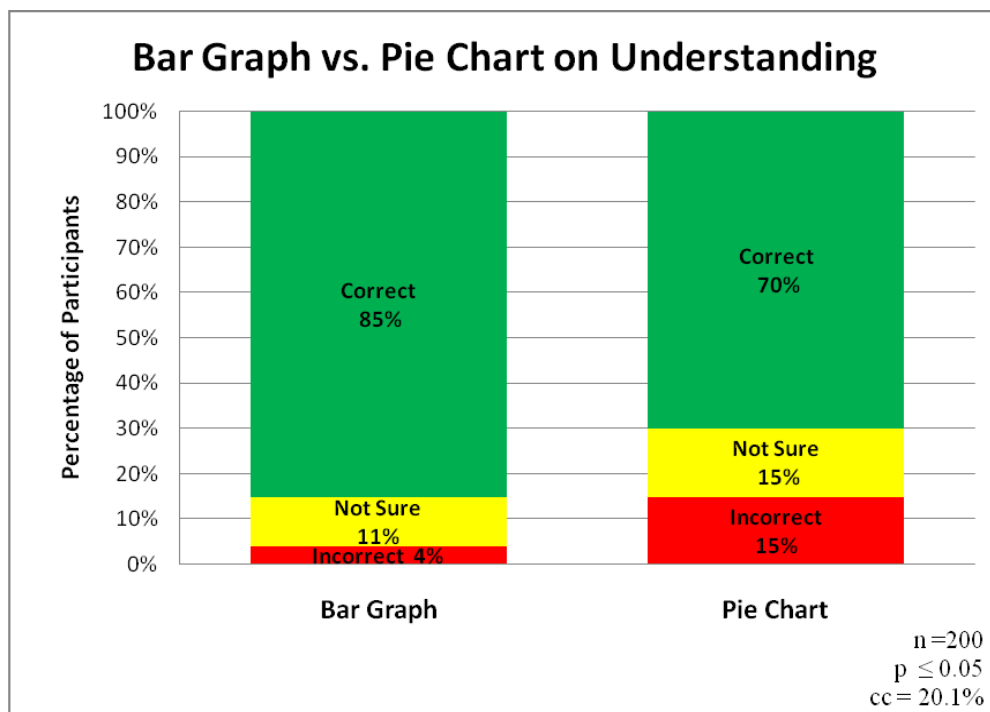
Presentation Format Pair	Level of Understanding (% of Participants with the Correct Response)
Loss-Framed Message	91%
Gain-Framed Message	93%
Frequency	89%
Percentage	85%
Percentage	83% and 84%
Pie Chart	91% and 90%
Bar Graph	82%
Numeric Statement	86%
Small Denominator	91%
Large Denominator	88%
Pictograph	68% and 78%
Bar Graph	74% and 77%
Bar Graph	85%
Pie Chart	70%
Frequency	88%
Pictograph	69%
Table	92% and 91%
Bar Graph	79% and 82%

The presentation formats produce accurate understanding for anywhere from 69% to 93% of participants. In fact, due to this high level of understanding, the majority of presentation format comparisons do not have significant relationships. In other words, the majority of presentation format comparisons produced similar numbers of participants who understood the information correctly and participants who did not understand the information correctly. These presentation format pairs are: loss-framed and gain-framed messages, frequencies and percentages, percentages and pie charts, bar graphs and numeric statements, small denominators and large denominators, and pictographs and bar

graphs. This leaves three presentation format pairs which do produce significant relationships with regards to understanding.

When comparing the two visual displays of a bar graph and a pie chart, both formats result in the majority of participants understanding the information. However, a difference is found in the number of incorrect and uncertain responses as the pie chart produces more responses in both of these categories compared to the bar graph ($p \leq 0.05$, $cc = 20.1\%$).

Figure 1: Bar Graph vs. Pie Chart on Understanding

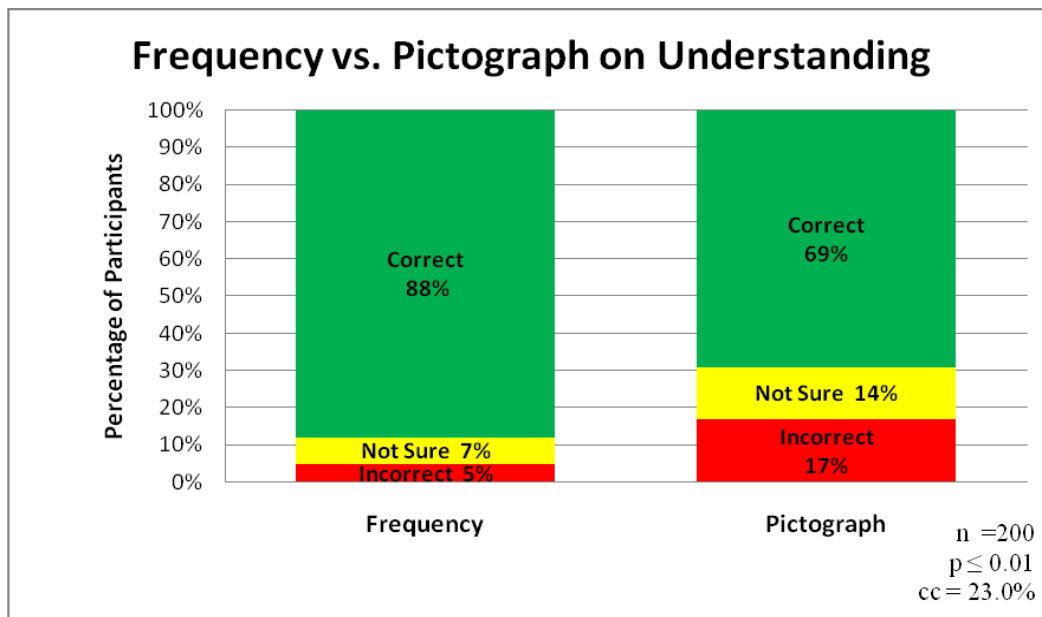


As shown in *Figure 1*, 85% of the participants exposed to the bar graph choose the correct answer, 11% are not sure, and 4% choose the incorrect answer. Alternatively, 70% of participants exposed to the pie chart choose the correct answer, 15% are not sure, and 15% choose the incorrect answer. Pie charts produce twice as many uncertain and

incorrect responses than bar graphs ($p \leq 0.05$, $cc = 20.1\%$). Therefore, based on understanding alone, the bar graph is a more effective presentation format than the pie chart.

Another presentation format pair which produces a significant relationship is the comparison of frequencies and pictographs. Both presentation formats result in the majority of participants understanding the information. However, there is a notable difference as the pictograph results in more incorrect and uncertain responses than the frequency format ($p \leq 0.01$, $cc = 23.0\%$).

Figure 2: Frequency vs. Pictograph on Understanding

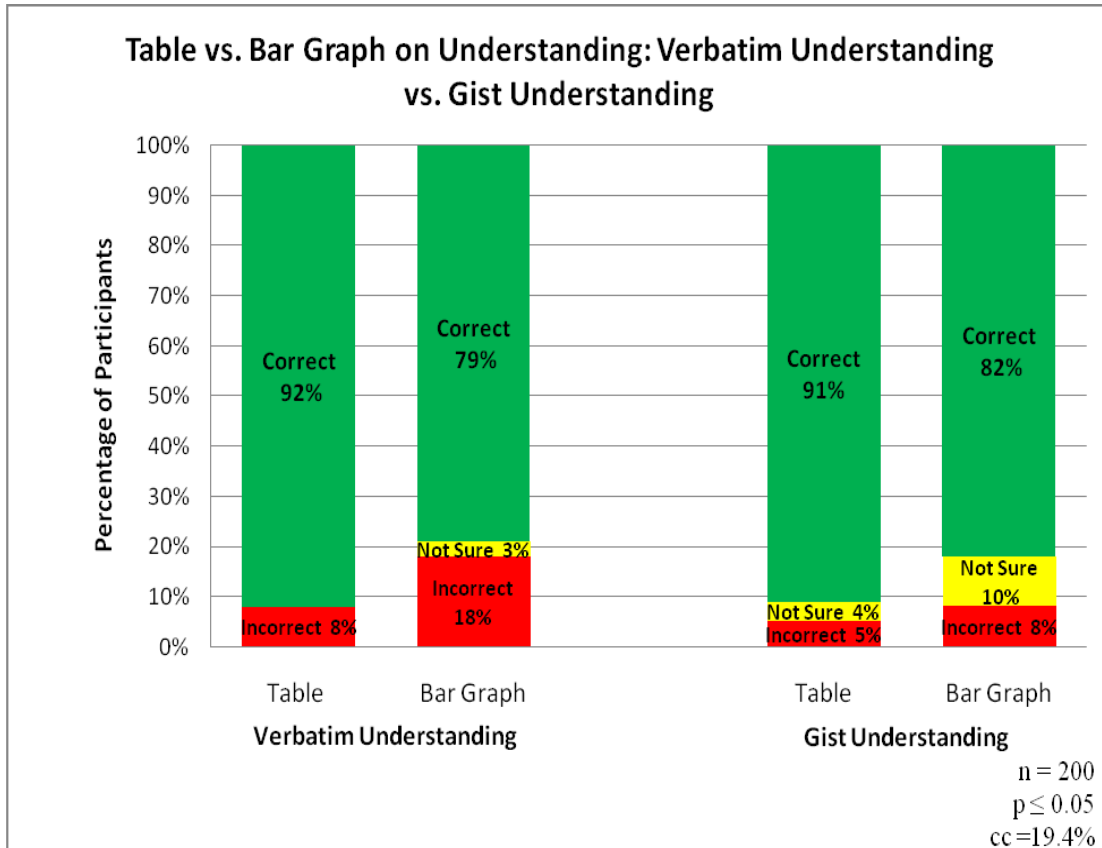


As shown in *Figure 2*, 88% of the participants exposed to the frequency choose the correct answer, 7% are unsure, and 5% choose the incorrect answer. Alternatively, 69% of the participants exposed to the pictograph choose the correct answer, 14% are unsure, and 17% choose the incorrect response. Pictographs produce more uncertain and

incorrect answers than frequencies ($p \leq 0.01$, $cc = 23.0\%$). Therefore, based on understanding, a frequency is a more effective presentation format than a pictograph.

One presentation format pair, tables and bar graphs, is used to assess differences in the type of understanding: verbatim understanding and gist understanding. Verbatim understanding asks for a specific number to be sought, while gist understanding asks for a comparison to determine if two values are equal. When comparing the table and bar graph formats, in relation to gist understanding, both formats result in the majority of participants understanding the information. Neither format, table nor bar graph, result in a greater or lesser level of understanding. Verbatim understanding, on the other hand, results in both formats producing correct responses for the majority of participants. However, the bar graph has more incorrect and uncertain responses than the table ($p \leq 0.05$, $cc = 19.4\%$).

Figure 3: Table vs. Bar Graph on Understanding: Verbatim Understanding vs. Gist Understanding



As seen in *Figure 3*, the table produces more correct answers than the bar graph for both verbatim and gist understanding. Verbatim understanding, though, is the only one to have a significant relationship due to the number of incorrect and uncertain answers. The bar graph in the verbatim understanding question leads to more incorrect answers than the table. The gist understanding question produces similar numbers of incorrect and uncertain answers for both the table and bar graph, resulting in a relationship without significance. Therefore, if the information being communicated uses gist understanding, either format, table or bar graph, is an acceptable presentation format. However, if the

information being communicated uses verbatim understanding, a table is more effective than a bar graph.

Risk Perception and Presentation Format

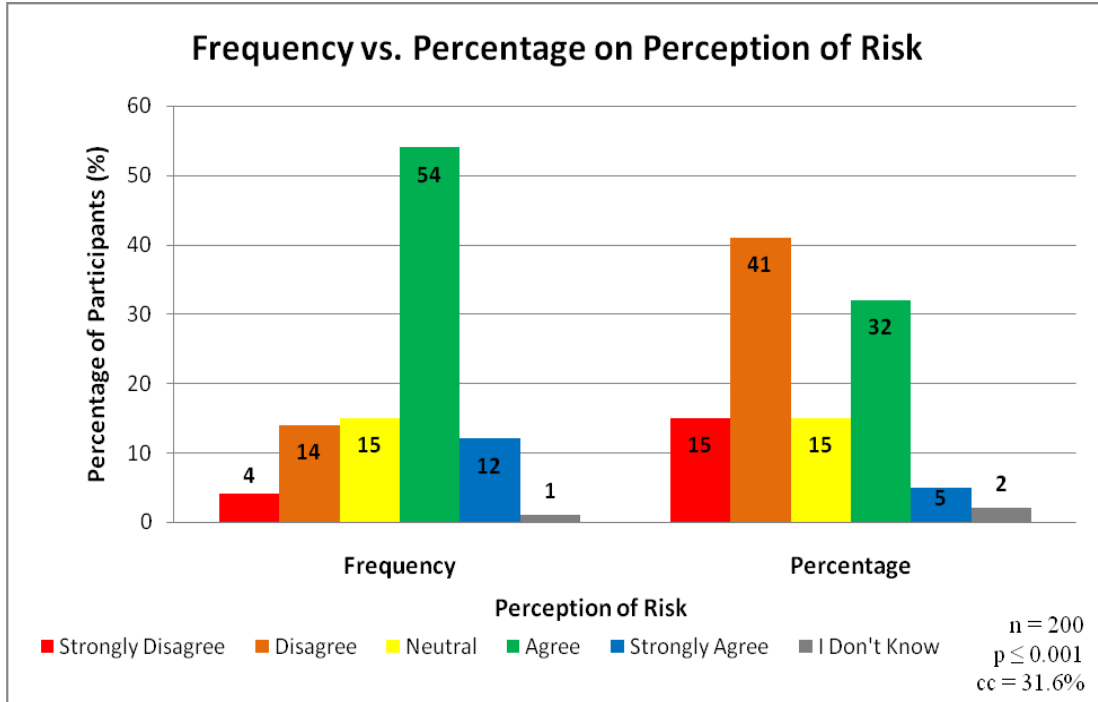
The second sub-hypothesis for this research is as follows:

- There is a relationship between the presentation format and the level of risk perception of cardiovascular information among recovering patients.

Each presentation format pair demonstrates a significant relationship with regards to risk perception and these results are outlined in the discussion below.

When frequencies and percentages are compared, frequencies are perceived to be risky by the majority of participants, while percentages are perceived to be less risky ($p \leq 0.001$, $cc = 31.6\%$).

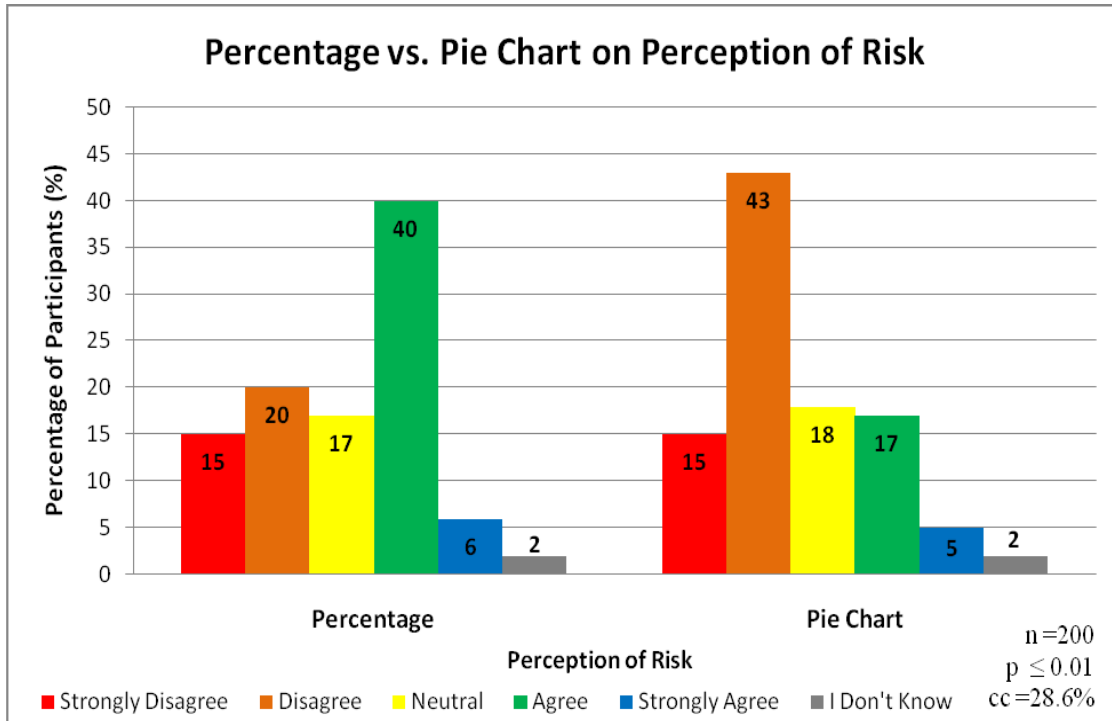
Figure 4: Frequency vs. Percentage on Perception of Risk



As shown in *Figure 4*, the majority of participants exposed to frequencies agree or strongly agree that the information scares them (66% of participants), while a small group disagree that the information scares them (18%). On the other hand, 46% of participants exposed to percentages disagree or strongly disagree that the information scares them, while 37% of participants agree that the information scares them. Percentages have a more varied response in terms of risk perception, while frequencies lead the majority to perceive the information as scary.

Comparing percentages and pie charts reveals that percentages are perceived to be risky, while pie charts are perceived not to be risky ($p \leq 0.01$, $cc = 28.6\%$).

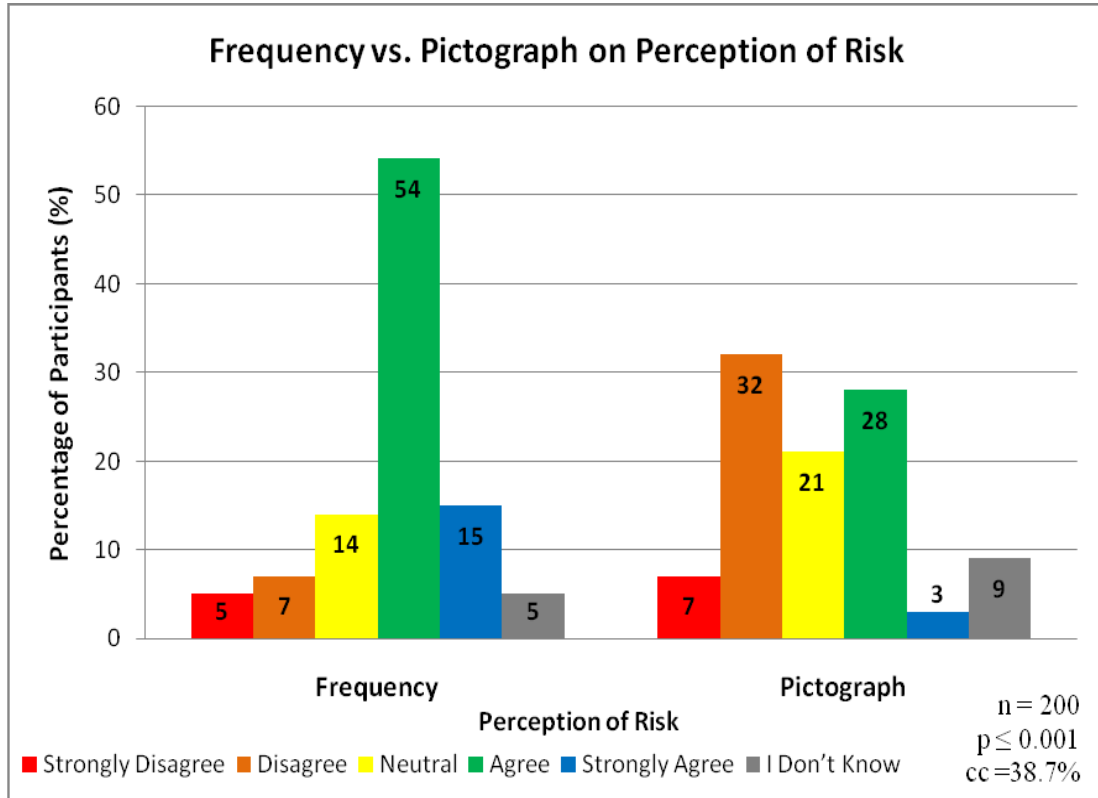
Figure 5: Percentage vs. Pie Chart on Perception of Risk



As shown in *Figure 5*, the majority of participants exposed to pie charts disagree or strongly disagree that the information is risky (58%). Percentages, on the other hand, have 35% of participants who disagree or strongly disagree that the information is risky, while 46% of participants agree or strongly agree that the information is risky. More participants agree that the information is risky.

The comparison of frequencies and pictographs indicates that frequencies are perceived to be risky, while pictographs are perceived to be less risky ($p \leq 0.001$, $cc = 38.7\%$).

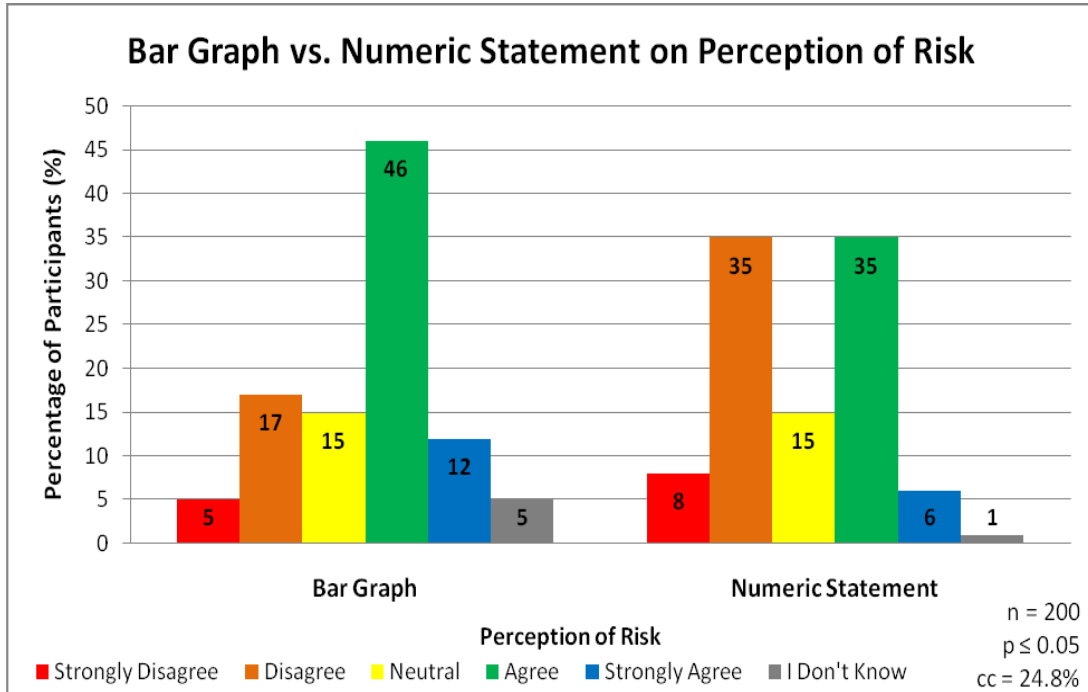
Figure 6: Frequency vs. Pictograph on Perception of Risk



As shown in *Figure 6*, the majority of participants exposed to frequencies agree or strongly agree that the information scares them (69% of participants). The participants who are exposed to the pictograph, on the other hand, have a more varied response. 31% agree or strongly agree that the information scares them, 30% are neutral or unsure, and 39% disagree or strongly disagree that the information scares them. More participants disagree that the information is risky.

Comparing the presentation formats of bar graphs and numeric statements reveals that bar graphs are perceived to be risky, while numeric statements have relatively equal numbers who perceive the information to be risky and not risky ($p \leq 0.05$, $cc = 24.8\%$).

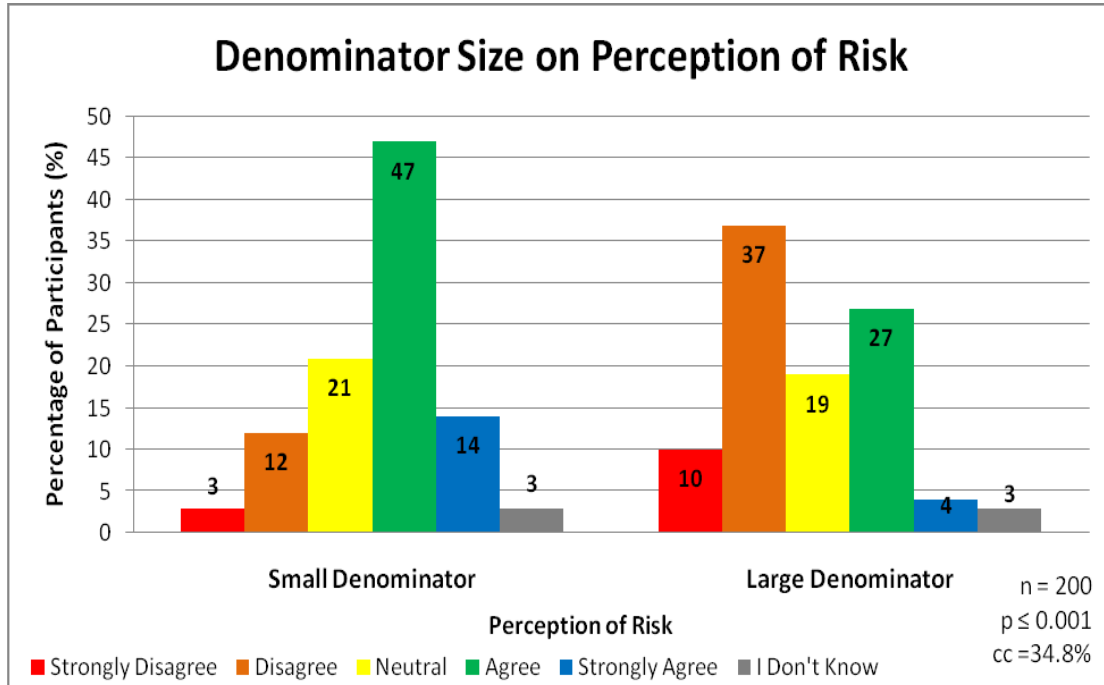
Figure 7: Bar Graph vs. Numeric Statement on Perception of Risk



As shown in *Figure 7*, the majority of participants exposed to bar graphs perceive the information to be risky (58% of participants). A relatively equal number of participants exposed to numeric statements perceive the information to be risky (41%) and not risky (43%).

Comparing denominator size, small denominators are perceived to be risky by the majority of participants, while large denominators are perceived to be less risky ($p \leq 0.001$, $cc = 34.8\%$).

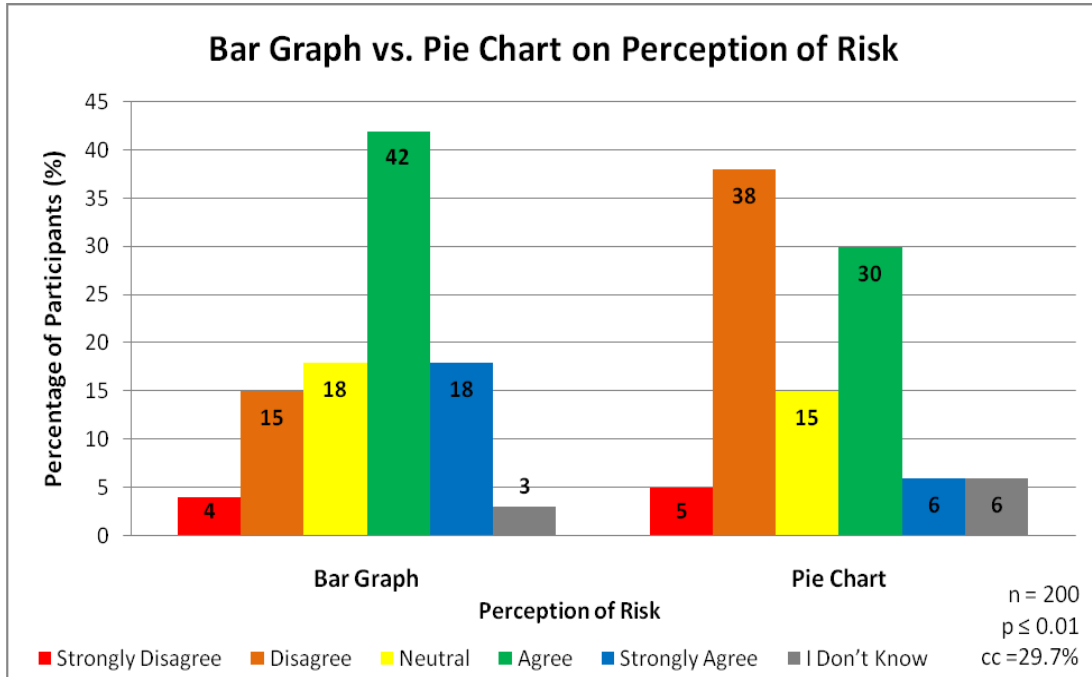
Figure 8: Denominator Size on Perception of Risk



As shown in *Figure 8*, the majority of participants exposed to the smaller denominator perceive the information to be risky (61% of participants). 31% of participants exposed to the larger denominator agree or strongly agree that the information is risky. 47% disagree or strongly disagree that the information is risky. More participants disagree than agree that the information is risky.

In terms of bar graphs versus pie charts, the majority of participants perceive the bar graph format to be risky, while the pie chart format is perceived not to be as risky ($p \leq 0.01$, $cc = 29.7\%$).

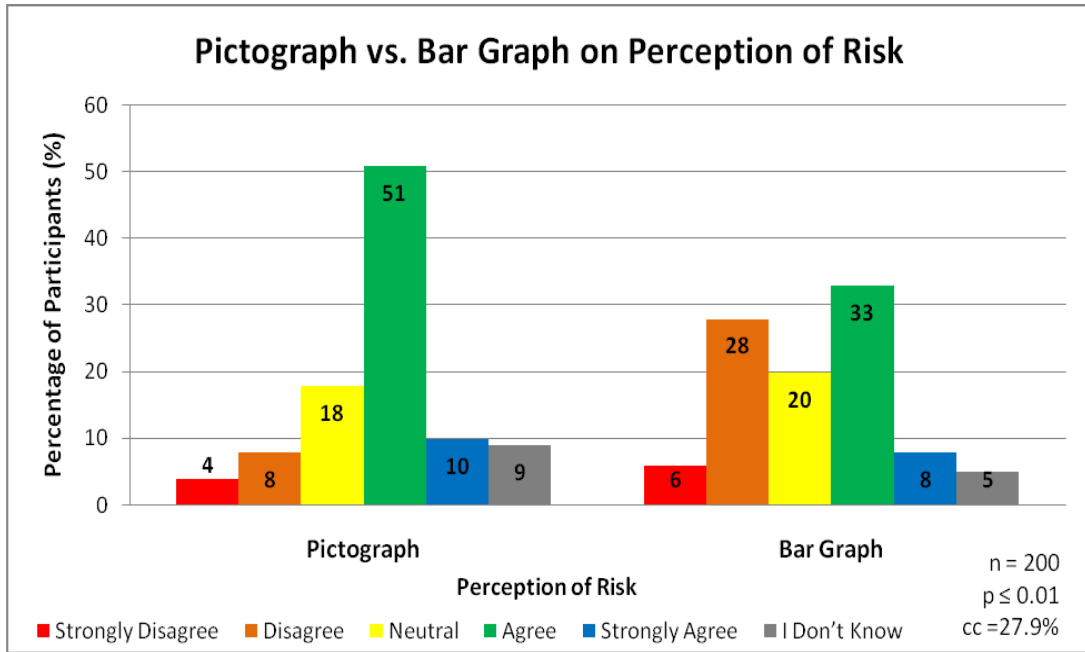
Figure 9: Bar Graph vs. Pie Chart on Perception of Risk



As shown in *Figure 9*, the majority of participants exposed to bar graphs perceive a high level of risk (60% of participants). In terms of pie charts, 36% of the participants perceive the information as risky while 43% perceive it as being not risky. More participants find the information not to be risky.

The comparison between the pictograph and bar graph formats indicates that pictographs are perceived as risky by the majority of participants, while bar graphs are perceived as not risky by a greater number of participants than those who do find it risky ($p \leq 0.01$, $cc = 27.9\%$).

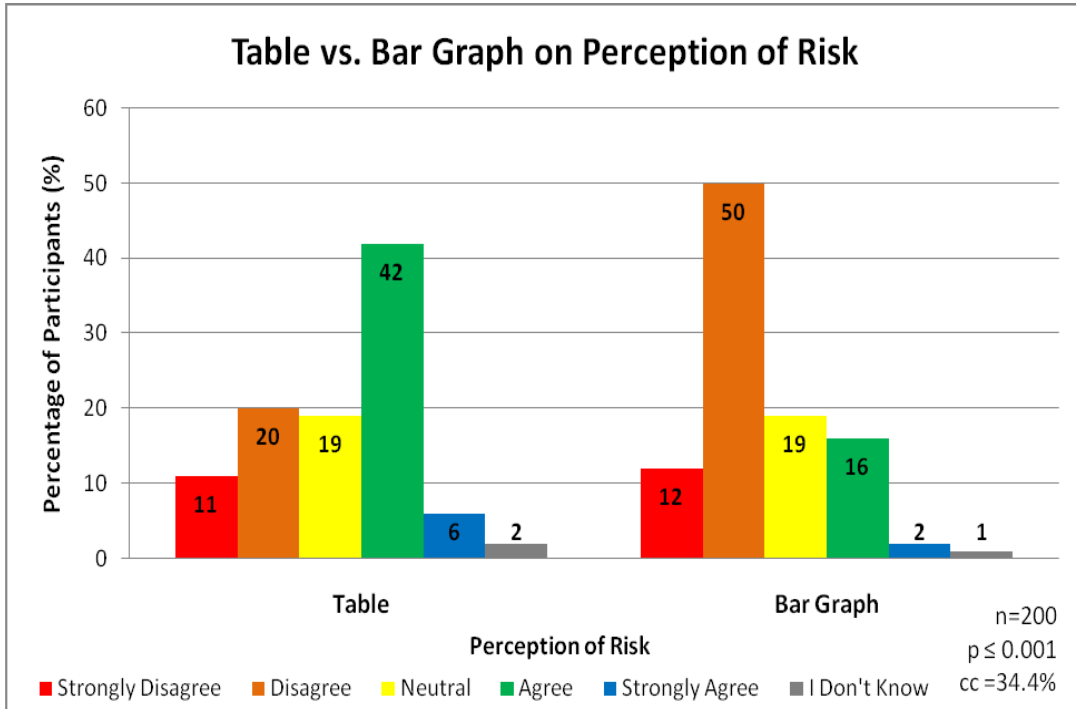
Figure 10: Pictograph vs. Bar Graph on Perception of Risk



As shown in *Figure 10*, the majority of participants exposed to pictographs perceive the information to have a high level of risk (61% of participants). On the other hand, 41% of participants exposed to bar graphs find the information to have a high level of risk. 34% find the information to have a low level of risk.

A comparison of tables and bar graphs shows that tables are perceived to be risky by almost half of the participants, while bar graphs are perceived not to be risky by the majority of participants ($p \leq 0.001$, $cc = 34.4\%$).

Figure 11: Table vs. Bar Graph on Perception of Risk

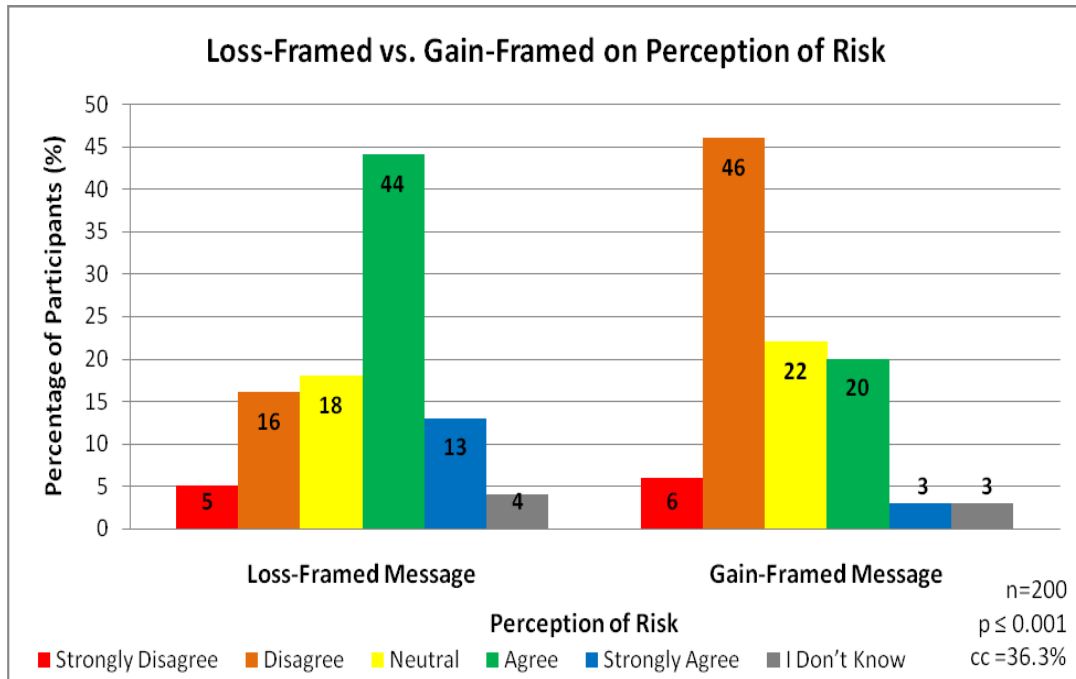


As shown in *Figure 11*, almost 50% of participants exposed to the table presentation format agree or strongly agree that the information is risky. 31% of the participants disagree or strongly disagree that the information is risky, while 21% of the participants are unsure whether the information is risky or not. On the other hand, the majority of participants exposed to bar graphs disagree or strongly disagree that the information is risky (62% of participants). Only 18% of participants disagree or strongly disagree that the information is risky, and 20% of participants are unsure whether the information is risky or not.

Loss-framed and gain-framed message comparisons reveal that loss-framed messages are perceived to be risky by the majority of participants, while gain-framed

messages are perceived not to be risky by the majority of participants ($p \leq 0.001$, $cc = 36.3\%$).

Figure 12: Loss-Framed Message vs. Gain-Framed Message on Perception of Risk



As shown in *Figure 12*, the majority of participants exposed to loss-framed messages perceive the information to be risky (57% of participants). By comparison, the majority of participants exposed to gain-framed messages perceive the information not to be risky (52% of participants).

Motivation and Presentation Format

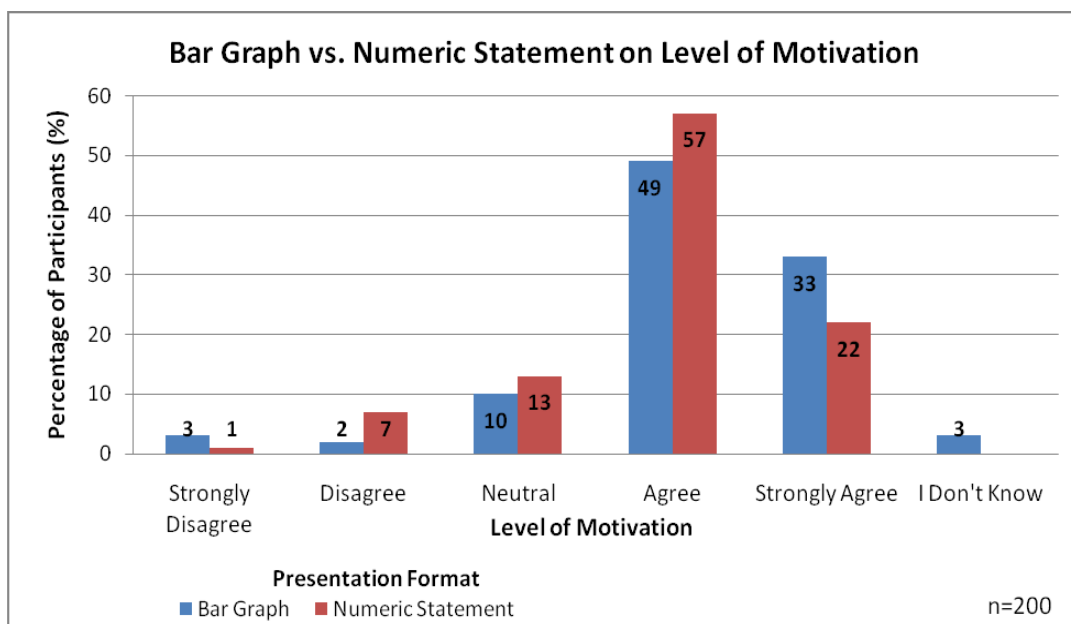
The third sub-hypothesis for this research is as follows:

- There is a relationship between the presentation format and the level of motivation of cardiovascular information among recovering patients.

Only two presentation format pairs are assessed for level of motivation. The content presented on the risk information handouts does not always provide an opportunity for participants to indicate intention to engage in a behaviour, and therefore only the questions that do can be assessed for motivation.

The first presentation pair assessed for motivation involves a bar graph and a numeric statement. Both presentation formats are perceived to be motivating by the majority of participants.

Figure 13: Bar Graph vs. Numeric Statement on Level of Motivation

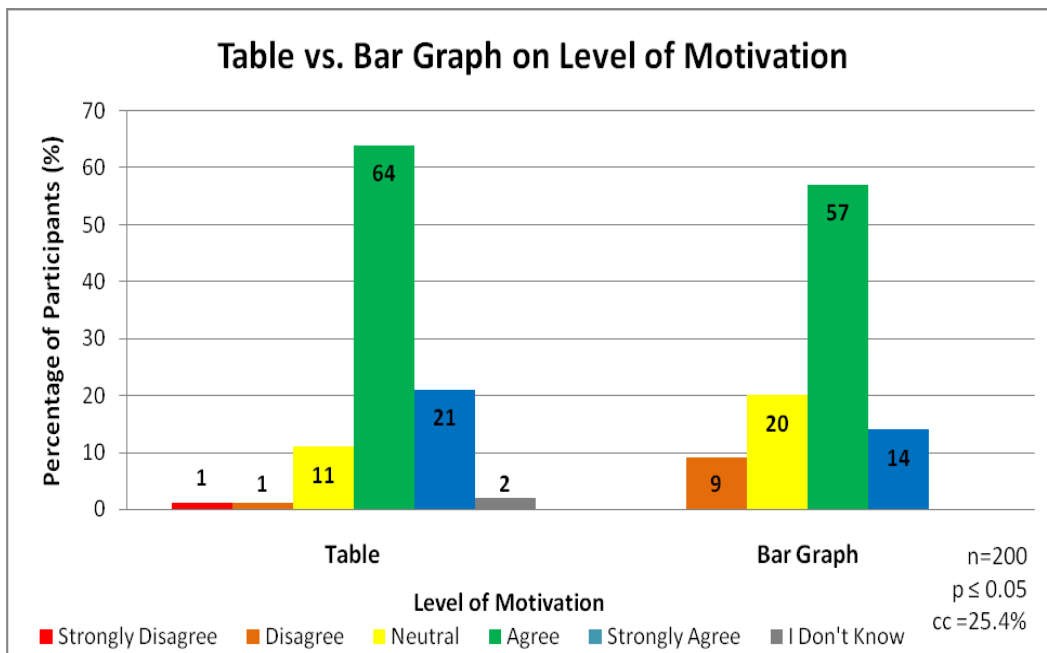


As shown in *Figure 13*, the majority of participants in both groups perceive the information to be motivating, regardless of presentation format. The majority of participants agree or strongly agree that the information is motivating (82% of participants exposed to bar graphs, and 79% of participants exposed to numeric statements). This relationship is not significant, as similar results are produced by both

presentation formats. They both produce high levels of motivation. Therefore, both bar graphs and numeric statements effectively elicit motivation.

Alternatively, the comparison of tables and bar graphs does produce a significant relationship. Both presentation formats see the majority of participants agreeing or strongly agreeing that the information is motivating. However, a greater number of participants respond to the bar graph by disagreeing, or strongly disagreeing, that the information is motivating, or are unsure of how they feel, than they do to the table ($p \leq 0.05$, $cc = 25.4\%$).

Figure 14: Table vs. Bar Graph on Level of Motivation



As shown in *Figure 14*, the majority of participants agree or strongly agree that the information is motivating regardless of presentation format (85% for the table and 71% for the bar graph). However, the bar graph has almost double the number of participants

who disagree that the information is motivating or are uncertain whether the information is motivating than the table (29% compared to 15%).

Effective Presentation Formats

The primary hypothesis for this research is:

- There is a relationship between the presentation format of information (frequencies, percentages, denominator size, gain/loss-framing, graphs, and tables) and the effectiveness of risk communication (levels of understanding, risk perception, and motivation) of recovering cardiovascular patients.

Combining the results of the sub-hypotheses, the overall effectiveness of different presentation formats is assessed. Effective risk communication involves two central components: understanding of information and perception of risk. In order for effective risk communication to take place, understanding must be accurate. The information being communicated needs to be understood correctly. Risk, on the other hand, does not have an accurate or inaccurate outcome. In effective risk communication, risk can either be communicated so that the information is perceived as having a high level of risk or as having a low level of risk. One does not supersede the other when it comes to producing effective risk communication. The content and purpose of the message determines whether a high level of risk or a low level of risk is desired.

Table 5 summarizes the different presentation formats and their results in terms of understanding and perception of risk.

Table 5: Effective Risk Communication: A Summary of Presentation Formats

Presentation Format Pair	Percentage of Participants with Accurate Understanding (%)	Percentage of Participants Who Found the Information to be Risky (%)	Percentage of Participants Who Found the Information Not to Be Risky (%)
Frequency	89	66	18
Percentage	85	37	46
Percentage	83 and 84	46	35
Pie Chart	91 and 90	22	58
Frequency	88	69	12
Pictograph	69	31	39
Bar Graph	82	58	22
Numeric Statement	86	41	43
Small Denominator	91	61	15
Large Denominator	88	31	47
Bar Graph	85	60	19
Pie Chart	70	36	43
Pictograph	68 and 78	61	12
Bar Graph	74 and 77	41	34
Table	91 and 92	48	31
Bar Graph	82 and 79	18	62
Loss-Framed	91	57	21
Gain-Framed	93	23	52

A third component that comes into play with certain risk communication messages is motivation. These communication messages are designed to not only show a level of risk, but also to assess whether or not an individual perceives the information to be motivating. It is important to note that this is an acknowledgement of motivation and that the actual engagement in a behaviour is not known. Only a couple of the risk messages contain an element of motivation and these are outlined in *Table 6*.

Table 6: Risk Communication Messages: Presentation Format and Motivation

Presentation Format Pair	Percentage of Participants with Accurate Understanding (%)	Percentage of Participants Who Found the Information to be Risky (%)	Percentage of Participants Who Found the Information to be Motivating (%)
Bar Graph	82	58	82
Numeric Statement	86	41	79
Table	91 and 92	48	85
Bar Graph	82 and 79	18	71

Combining the results of understanding, risk perception, and in some cases motivation, overall effective presentation formats are determined. These comparisons are outlined and explained below.

Frequency vs. Percentage

Both frequencies and percentages produce accurate understanding for the majority of individuals, 89% and 85% respectively. Therefore, either format is an acceptable format to convey the information properly. A review of the literature shows that there is considerable research in support of frequencies over percentages, but there is also substantial research in support of percentages over frequencies. Schapira, Nattinger, and McHorney, however, similar to the current research, acknowledge that both formats have positive attributes (2001). In their research, individuals report frequencies as having ease of interpretation, simplicity, and the ability to provide a human contextual quality when used with graphics, while percentages are found to include an association with personal

risk estimation and as having a mathematical quality (Ibid). Both presentation formats are found to produce accurate understanding.

The two formats differ when it comes to their effect on risk perception. Frequencies are perceived to be risky by 66% of participants and not risky by 18% of participants. This is consistent with Siegrist's statement that "the frequency format emphasizes the threat of risk" (1997: 509). Percentages, on the other hand, are perceived as risky by 37% of participants and not risky by 46% of participants. Therefore, if the goal of the risk communication message is to maximize the perception of risk, frequencies should be used rather than percentages. An example of this might be communicating the risks of not exercising to heart disease patients; it could be beneficial to have a risky message so as to stress the importance of engaging in physical activity. If the goal of the risk communication message is to minimize risk perception; however, percentages should be used rather than frequencies. An example of this might be when communicating potential minimal risks associated with a beneficial medication.

Percentage vs. Pie Chart

Both percentages and pie charts produce accurate understanding for the majority of individuals, 83% and 84% for percentages, and 91% and 90% for pie charts. Either format is therefore an acceptable choice to communicate the information to ensure understanding. The two formats differ when it comes to their effects on risk perception. Percentages are perceived to be risky by 46% of participants and not risky by 35% of participants. There is only an 11% gap between finding the information risky and not. Pie charts, on the other hand, are perceived to be risky by 22% of participants and not risky

by 58% of participants. There is a clear majority who find the information portrayed in a pie chart not to be risky. Lee, Lin, Tseng, Cassidy, and Hor look at the risk perception of pie charts in their research as well (2009). Contrary to the current research, they find that more participants perceive the pie chart to be risky than not risky. This difference, though, is less than 7%. Their research has a more split response from the participants, whereas the cardiovascular patients at the University of Ottawa Heart Institute have a definite view that the pie chart is not risky. Therefore, if the goal of the risk communication message is to minimize the perception of risk, pie charts should be used. If the goal of the risk communication message is to maximize the perception of risk, a percentage is more effective than a pie chart but may still be perceived as being not risky to a significant group of people. A different format all together may be a better choice to maximize risk perception.

Frequency vs. Pictograph

The frequency and pictograph formats produce accurate understanding for the majority of individuals, 88% and 69% respectively. However, a significant relationship is present in that there are almost 20% more individuals who understand the information correctly when communicated as a frequency than when communicated as a pictograph. The pictograph produces more inaccurate and unsure responses than the frequency. Therefore, the frequency is a more effective presentation format than a pictograph to enhance understanding. Miron-Shatz, Hanoach, Graef, and Sagi find similar results in their comparison of frequencies and pictographs (2009). The frequency format is found to produce a greater level of understanding, as participants understand the risk that is being

communicated more so than with the pictograph format (Miron-Shatz, Hanoach, Graef & Sagi, 2009).

The two formats also differ when it comes to their effect on risk perception. Frequencies are perceived to be risky by 69% of the participants and not risky by 12% of the participants. Pictographs have a more split response. They are perceived to be risky by 31% of participants and not risky by 39% of participants. Tait, Voepel-Lewis, Zikmund-Fisher, and Fagerlin find similar results in their study. They find that when information is conveyed through pictographs, the perception of risk is lower than when communicated through numbers (2010). Therefore, if the goal of the risk communication message is to maximize the perception of risk, frequencies are more effective than pictographs. If the goal of the risk communication message is to minimize the perception of risk, pictographs are more effective than frequencies. However, pictographs may still be perceived as risky to a significant group of people since there is only an 8% difference between the number of participants who perceive the pictograph as risky and those who perceive it as not risky. Furthermore, their level of understanding is not as effective as that of frequencies. As a result, pictographs are not the best presentation format choice for effective communication, regardless of the risk goals.

Bar Graph vs. Numeric Statement

Bar graphs and numeric statements both produce accurate understanding for the majority of individuals, 82% and 86% respectively. Parrott, Silk, Dorgan, Condit, and Harris emphasize the benefit of numeric text in their research. They find that participants not only understand the information better than when displayed visually, but there is a

perception that the numeric statements are higher in quality (2005). Similar support is found for bar graphs in the research of Waters, Weinstein, Colditz, and Emmons, who find that participants who receive the information visually in bar graphs have more accurate responses than those who receive the information in text (2006). There is support in the literature for both presentation formats, and, based on the results of the current research, both formats are acceptable formats to communicate information.

The two formats differ when it comes to their effect on risk perception. Bar graphs are perceived to be risky by 58% of the participants and not risky by 22% of the participants. Numeric statements have a more split response. They are perceived as risky by 41% of participants and not risky by 43% of participants. Timmermans, Molewijk, Stiggelbout, and Kievit find similar results in their research where they assess presentation formats and the perceived level of threat (2004). They too find that, compared to numbers, bar graphs have a greater perceived level of threat. Therefore, if the goal of the risk communication message is to maximize the perception of risk, bar graphs are more effective than numeric statements. If the goal of the risk communication message is to minimize the perception of risk, numeric statements are more effective than bar graphs. However, it is important to note that although numeric statements are better than bar graphs at minimizing risk perception, they are not necessarily the ideal choice. Numeric statements produce almost equal numbers of participants who find the information risky as those who find the information not risky.

This presentation format comparison also includes an assessment of motivation. In terms of motivation, 82% of participants exposed to bar graphs perceive the information to be motivating, and 79% of participants exposed to numeric statements

perceive the information to be motivating. The majority of participants see both presentation formats as motivating. Therefore, it is important to note that regardless of the level of risk perception, high risk or low risk, the information is perceived to be motivating. The level of risk does not have an effect on the level of motivation. In this case, regardless of whether risk is high or low, motivation prevails and protection ensues.

Small Denominator vs. Large Denominator

Both small denominators and large denominators produce accurate understanding for the majority of individuals, 91% and 88% respectively. Either format is therefore acceptable for communicating the information. This information is contradictory to the work of Zikmund-Fisher, Ubel, Smith, Derry, McClure, Stark, Pitsch, and Fagerlin, who find that the larger denominator of 1000 significantly increases knowledge compared to the denominator of 100 (2008). The current research finds both denominator sizes to be effective at communicating the information.

The two formats differ when it comes to their effect on risk perception. Small denominators are perceived to be risky by 61% of the participants and not risky by 15% of the participants. Large denominators, on the other hand, are perceived to be risky by 31% of the participants and not risky by 47% of the participants. Schapira, Nattinger & McHorney find similar results in their research. They find that larger denominators are perceived to be less risky than smaller denominators (2001). They also find that the larger denominators lead individuals to translate such information into a greater number of individuals who are not affected by the disease as opposed to the smaller denominator (Ibid). Therefore, if the goal of the risk communication message is to maximize risk,

small denominators are more effective than large denominators. Alternatively, if the goal of the communication message is to minimize risk, large denominators are more effective than small denominators but may still be perceived as risky to a significant group of people.

Bar Graph vs. Pie Chart

The comparison of bar graphs and pie charts indicates that both formats produce accurate understanding for the majority of individuals, 85% and 70% respectively. These results are similar to the findings of Spence and Lewandowsky, who find that for simple tasks, such as identifying a larger component, bar graphs and pie charts are comparable in communicating the information effectively (1991). However, a significant relationship is present. The bar graph produces accurate understanding for 15% more individuals than the pie chart. The pie chart produces more inaccurate and unsure responses than the bar graph. Therefore, the bar graph is a more effective presentation format than the pie chart due to the increased number of unsure and incorrect responses from the pie chart.

Feldman-Stewart, Kocovski, McConnell, Brundage, and MacKillop echo this preference for the bar graph, finding that bar graphs produce the most accurate results when compared to other visual presentation formats, including the pie chart (2000). Similar results are put forth by Davis, McNair, Brigic, Clarke, Brookes, Thomas, and Blazeby. They report that bar graphs lead to accurate understanding for over 90% of the participants (2010). The results of the current research prove to have similar findings, as bar graphs lead to accurate understanding for 85% of the participants. The pie chart leads to accurate understanding for 70% of the participants.

The two formats also differ when it comes to their effect on risk perception. Bar graphs are perceived to be risky by 60% of the participants and not risky by 19% of the participants. Timmermans, Molewijk, Stiggelbout, and Kievit also find that bar graphs elicit a high level of perceived threat when compared to other presentation formats (2004). Pie charts, by comparison, are perceived to be risky by 36% of participants and not risky by 43% of participants. Lee, Lin, Tseng, Cassidy, and Hor look at the risk perception of pie charts in their research and find almost opposite values with 41.7% of participants perceiving high risk and 35.5% perceiving low risk (2009). However, it is vital to look at the percentage difference between the low risk and high risk perceptions. Both the current research and the research conducted by Lee, Lin, Tseng, Cassidy, and Hor have a 6-8% difference between the number of participants who perceive a high level of risk and the number of participants who perceive a low level of risk. This is a small margin and shows that there is not an overwhelming conclusion about the level of risk for this presentation format.

If the goal of the risk communication message is to maximize risk, bar graphs are more effective than pie charts. Alternatively, if the goal of the communication message is to minimize risk, pie charts are more effective than bar graphs. However, pie charts have almost equal groups of participants who find the information risky and not risky. Therefore, although a pie chart may be a better choice than a bar graph to minimize the perception of risk, another format all together may be a better choice. Furthermore, the pie chart also has a greater number of participants who do not understand the information, making the pie chart a less favourable presentation format.

Pictograph vs. Bar Graph

Both the pictograph and bar graph formats produce accurate understanding for the majority of individuals, 68% and 78% for pictographs and 74% and 77% for bar graphs. Either format is therefore acceptable for communicating information. Hawley, Zikmund-Fisher, Ubel, Jancovic, Lucas, and Fagerlin find the pictograph to be an effective presentation format in their research (2008). The pictograph produces adequate results in both verbatim and gist knowledge and is perceived by participants to be scientific and trustworthy (Ibid). Bar graphs have similar support by virtue of their ability to yield accurate understanding. Davis, McNair, Brigid, Clarke, Brookes, Thomas, and Blazeby find that bar graphs lead to accurate understanding for over 90% of the participants in their research (2010).

The two formats differ when it comes to their effect on risk perception. Pictographs are perceived to be risky by 61% of participants and not risky by 12% of participants. Bar graphs also have more participants who perceive the information to be risky than not risky, but it was a more split result with 41% and 34% respectively. Therefore, for this research and group of patients, if the goal of the risk communication message is to maximize risk perception, pictographs are more effective than bar graphs. If the goal of the risk communication message is to minimize risk perception, although bar graphs are more effective than pictographs, an entirely different presentation format is recommended. Timmermans, Molewijk, Stiggelbout, and Kievit assess presentation formats and perceived threat and find results that are contradictory to the current findings (2004). They find that compared to pictographs, percentages, and frequencies, bar graphs have the greatest perceived threat (Ibid). In the current research, although bar graphs do

have more participants who perceive the information to be risky rather than not, the pictograph produces higher risk responses than the bar graph.

Table vs. Bar Graph

The comparison of tables and bar graphs indicate that both formats produce accurate understanding for the majority of individuals, 91% and 92% for tables and 82% and 79% for bar graphs. Two different types of understanding are assessed by these presentation formats. For one type of understanding, there is a more effective presentation format than the other. In the verbatim understanding question where a particular number is being sought, a significant relationship is present. Although both the table and bar graph produce accurate responses for the majority of participants, the bar graph produces more uncertain and incorrect responses than the table. This difference is enough to make the relationship a significant one, and the table is thus rendered a more effective presentation format than a bar graph for these particular types of questions. Spence and Lewandowsky find similar results in that when precise numbers need to be communicated, the textual style of tables demonstrates such information more effectively than visual displays of bar graphs or pie charts (1991).

The gist understanding question, which asks if two values are equal, does not have a significant relationship. Therefore, contrary to the case with verbatim understanding, either format, table or bar graph, is acceptable for communicating the information. Lipkus supports this effectiveness of bar graphs, stating that they are good tools for making comparisons (2007).

With regards to risk perception, tables are perceived to be risky by 48% of participants and not risky by 31% of participants. Bar graphs, on the other hand, are perceived to be risky by 18% of participants and not risky by 62% of participants. Therefore, if the goal of the risk communication message is to maximize risk perception, tables are more effective than bar graphs. If the goal of the risk communication message is to minimize risk perception, bar graphs are more effective than tables. Timmermans, Molewijk, Stiggelbout, and Kievit find different results in their research. They find that bar graphs have the greatest perceived threat compared to other presentation formats (2004). However, tables are not among these presentation formats. If they were included, they may have been found to have a greater perceived threat than bar graphs.

Even though bar graphs are more effective than tables at minimizing risk information, they yield a lower level of verbatim understanding compared to the table. As a result, they are an ineffective presentation format for minimizing risk when using verbatim understanding material. Tables should therefore be used for these questions instead of bar graphs, regardless of the risk goals, in order to avoid compromising understanding.

This particular comparison also involves information that can be assessed for motivation. The concept of motivation paired with risk perception is important and is explained with fear appeals. Gore and Campanella Bracken explain that if the perceived threat of a message is high, and the perceived efficacy is also high, a danger control process results (2005). This is a positive response, as it allows individuals to “focus cognitively on dealing with the threat and possible solutions to avert the threat” (Ibid: 30). The fear control process, on the other hand, occurs when the perceived threat of the

message is again high, but the efficacy is low. This results in a negative response, and emotions tend to take over, often leading to denial or avoidance (Ibid).

In terms of motivation, 85% of participants exposed to tables perceive the information to be motivating and 71% of participants exposed to bar graphs perceive the information to be motivating. The majority of participants find both presentation formats to be motivating. However, a significant relationship is present where the bar graph produces a greater number of participants who disagree or are unsure whether or not the information is motivating. Therefore, a table is a more effective format than a bar graph to increase motivation. This is consistent with the danger control process in that the table is perceived to be riskier than the bar graph. However, this risk is appropriately paired with efficacy, resulting in participants perceiving the information as motivating as well. The risk does not overwhelm the participants, a high level of motivation is perceived, and protection ensues.

Loss-Framed Message vs. Gain-Framed Message

Both loss-framed and gain-framed presentation formats produce accurate understanding for the majority of participants, 91% and 93% respectively. Either format is therefore acceptable to communicate information. The two formats differ when it comes to their effect on risk perception. Loss-framed messages are perceived to be risky by 57% of participants and not risky by 21% of participants. Similar findings occur in the study by Edwards, Elwyn, Covey, Matthews, and Pill where they too find that loss-framed messages are perceived to be riskier than gain-framed messages (2001). Gain-framed messages, on the other hand, are the opposite of loss-framed messages in that they are

perceived to be risky by 23% of the participants and not risky by 52% of the participants. This finding is consistent with the research conducted by Halpern, Blackman, and Salzman. They also find that gain-framed messages result in a lower perceived risk than loss-framed messages (1989). Therefore, if the goal of the risk communication message is to maximize risk perception, loss-framed messages are more effective than gain-framed messages. However, if the goal of the risk communication message is to minimize risk perception, gain-framed messages are more effective than loss-framed messages.

Control Variables and Understanding

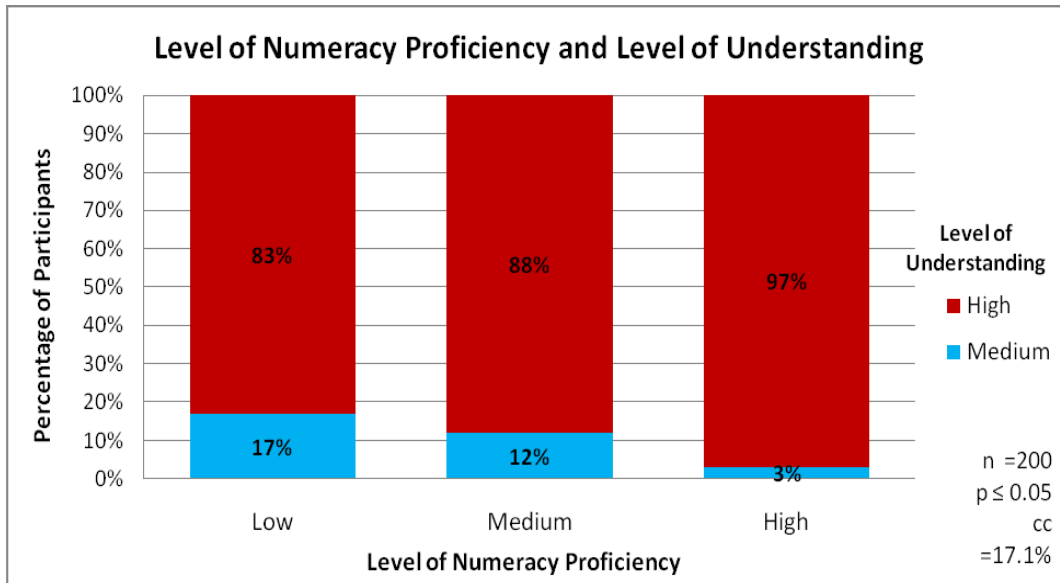
As mentioned in the methodology, factors aside from presentation format can affect understanding and are therefore controlled for within the current research. These factors include numeracy proficiency, prior knowledge of cardiovascular disease, and demographics.

Numeracy Proficiency

The concept of numeracy proficiency and its impact on understanding is identified frequently in the literature (Schwartz, Woloshin, Black & Welch, 1997, Keller & Siegrist, 2009, Miron-Shatz, Hanoch, Graef & Sagi, 2009, Waters, Weinstein, Colditz & Emmons, 2006). Research demonstrates that the level of numeracy proficiency affects the level of understanding. Individuals who are more proficient with numbers demonstrate a greater level of understanding (Ibid). In the current research, a significant relationship is also found between the level of numeracy and the level of understanding. As the level of

numeracy proficiency increases, the level of understanding also increases ($p \leq 0.05$, $cc = 17.1\%$).

Figure 15: Level of Numeracy Proficiency and the Level of Understanding



As shown in *Figure 15*, the participants with a high level of numeracy proficiency also have a high level of understanding. Those participants with medium and low levels of numeracy proficiency do not have as high a level of understanding. The level of understanding increases as numeracy proficiency increases. It is therefore possible that numerically proficient individuals have a higher level of understanding due to their understanding of numbers and apply this knowledge to their interpretation of the risk information handouts.

It is important to note that understanding is high for the majority of participants. Zero participants demonstrate a low understanding of the material, 21 participants demonstrate a medium level of understanding, and the remaining 179 participants demonstrate a high level of understanding. In other words, less than 11% of the

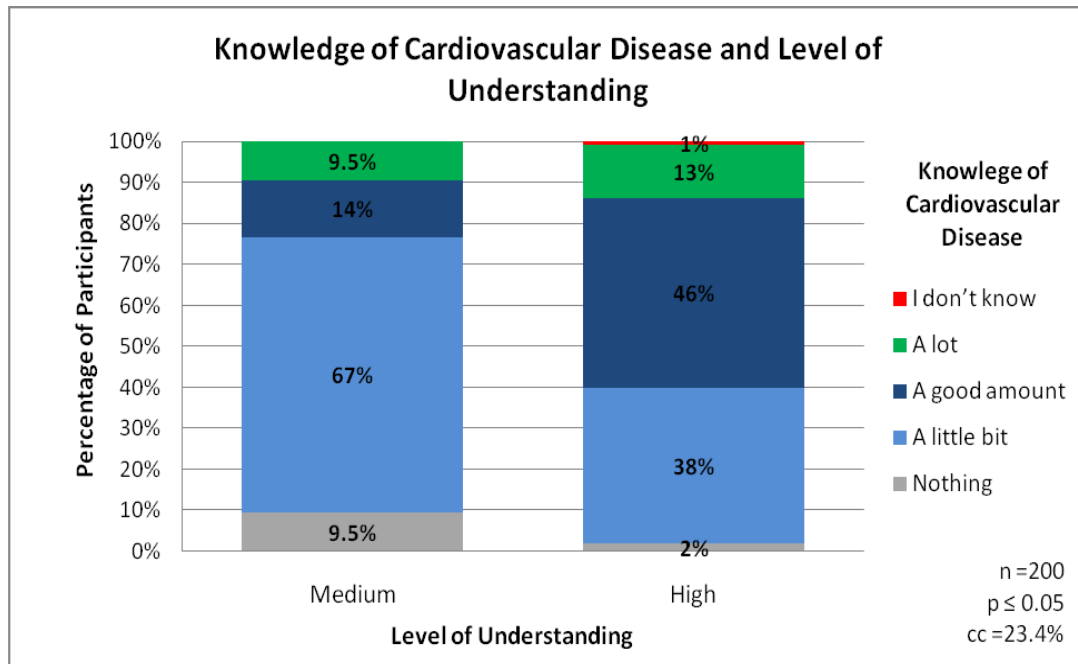
participants have a lower level of understanding (medium). Therefore, of that 11% of individuals, there is a significant relationship because a greater number of participants with lower understanding also have a lower level of numeracy proficiency. It is important to recognize this relationship and its consistency with what is found in the literature. However, due to the overwhelmingly high level of understanding in the current research, 89% of participants, the level of numeracy proficiency does not greatly impact the overall results. Essentially, due to the fact that the majority of the participants have a high level of understanding, regardless of their level of numeracy proficiency, this proficiency does not overshadow presentation format on the effects on understanding. It is a relationship to be aware of, but it is not as though all participants with a high level of understanding also have high levels of numeracy proficiency.

Prior Knowledge of Cardiovascular Disease

Prior knowledge of cardiovascular disease is another factor that can affect the level of understanding and is reported by each participant on the questionnaire. The participants' level of knowledge on the subject is important since it can impact the understanding of the information in addition to the presentation format itself. Zikmund-Fisher, Fagerlin, Roberts, Derry, and Ubel assess prior knowledge in their research as well, and no significant relationship is found between knowledge of the material (tamoxifen) and understanding (2008). In the current research, a different result occurs. A significant relationship is found between the knowledge of cardiovascular disease and the level of understanding. The participants with a high level of understanding also indicate they have

a greater prior knowledge of cardiovascular disease than the participants with a lower level of understanding ($p \leq 0.05$, $cc = 23.4\%$).

Figure 16: Knowledge of Cardiovascular Disease and Level of Understanding



As shown in *Figure 16*, the majority of individuals, regardless of their level of knowledge, have a high level of understanding of the material. However, more participants who have less knowledge of cardiovascular information have a lower level of understanding than those with a greater knowledge of cardiovascular information. Therefore, it is possible that prior knowledge of cardiovascular disease enhances understanding. If the participants are already familiar with the material, they may know the correct answers regardless of the presentation format.

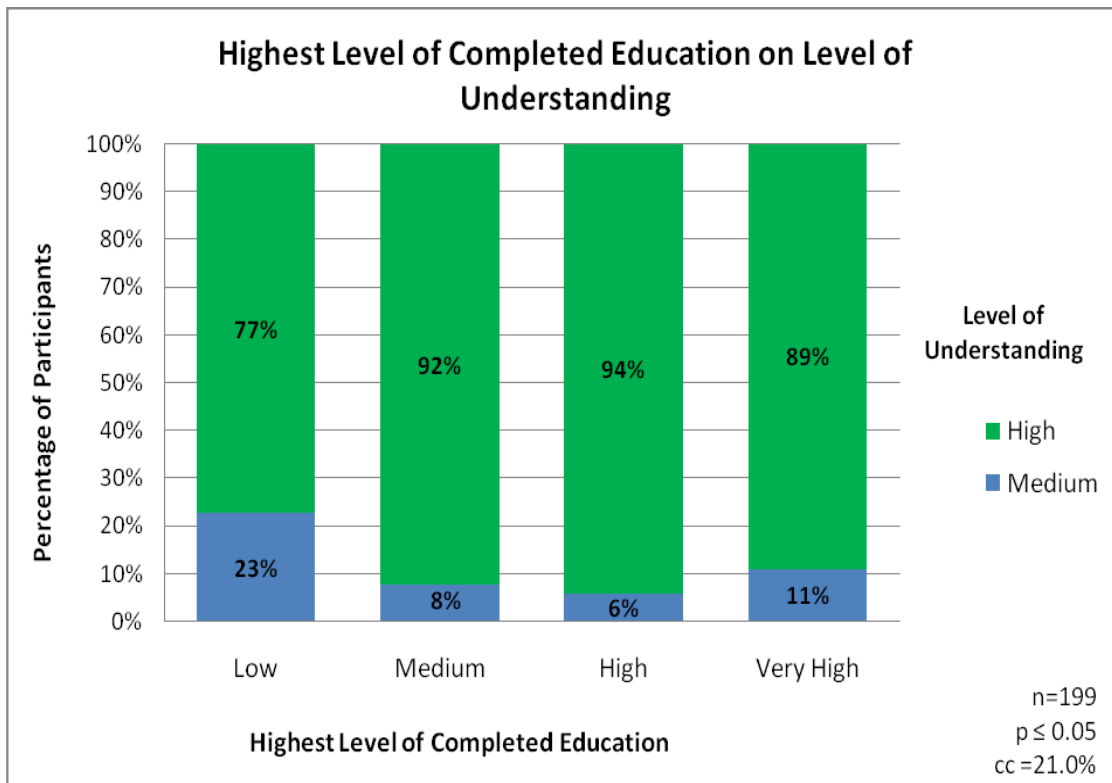
However, as with level of understanding and numeracy proficiency, it is important to note that the majority of participants have high understanding (179 participants) compared to medium understanding (21 participants). These participants

with a high level of understanding report a range of knowledge levels of cardiovascular information. 46% indicate that they know “a good amount” of knowledge on cardiovascular disease, 38% say they know a “little bit” about cardiovascular disease, and the remaining 16% fill in the other categories. Due to the fact that the majority of participants have a high level of understanding, regardless of their level of knowledge on cardiovascular disease, this prior knowledge does not overshadow presentation format on the effects on understanding. It is a relationship to be aware of, but it is not as though all participants with a high level of understanding also are experts on cardiovascular disease.

Demographics

Demographic information is also included on the questionnaire and is assessed for significant relationships in regards to level of understanding. The majority of demographics: gender, age, marital status, annual income, and stage of rehabilitation do not have significant relationships, but one characteristic, highest level of completed education, is found to have a significant relationship with the level of understanding. Participants with a high level of understanding have relatively equal representations of medium, high, and very high education levels. However, when it comes to high understanding and a low level of education, there are fewer participants than there are with higher education levels. Participants with a low level of education demonstrate a lower level of understanding ($p \leq 0.05$, $cc = 21.0\%$).

Figure 17: Highest Level of Completed Education and Level of Understanding

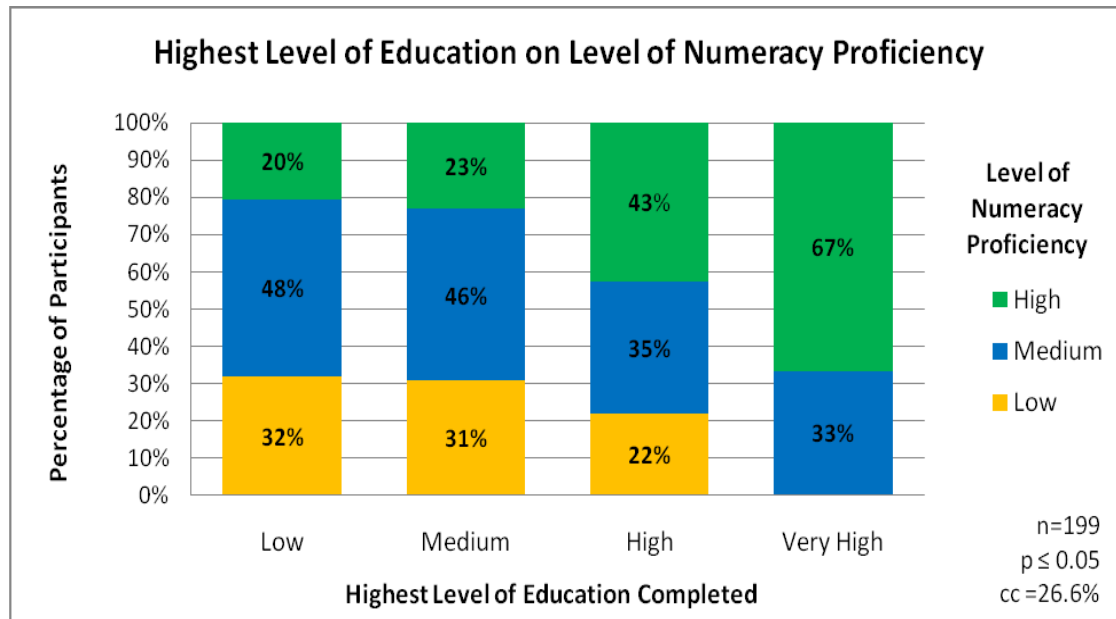


As shown in *Figure 17*, medium, high, and very high levels of completed education have relatively equal representations of medium and high levels of understanding. A low level of education, on the other hand, has a greater representation of a medium level of understanding than the higher education groups. Therefore, understanding may be hindered if an individual has a low level of completed education, compared to higher levels of completed education.

A significant relationship is also found between the highest level of completed education and the level of numeracy proficiency. Participants with higher levels of

education have a higher level of numeracy proficiency than those with lower levels of education ($p \leq 0.05$, $cc = 26.6\%$).

Figure 18: Highest Level of Completed Education on Level of Numeracy Proficiency



As shown in *Figure 18*, as the level of education increases, the level of numeracy proficiency also increases. This suggests that individuals with further education training are also more numerically proficient.

Overall, the results suggest that higher levels of education enhance understanding and numeracy proficiency. Therefore, patients with higher levels of education may have an easier time understanding risk communication messages and may be more numerically proficient than less educated patients. It is important to note that no significant relationships are found for any of the demographics, including highest level of education, and risk perception or motivation.

(CPMP)²: A Communicative Cardiovascular Physician-Patient Model of Message Preparation-Perception

Developing an efficient model of risk communication for recovering cardiovascular patients involves an assessment of the perceptions of various presentation formats. The current research shows that different presentation formats affect understanding, risk perception, and motivation in different ways.

All presentation formats produce accurate understanding for the majority of participants. However, there are three cases when one presentation format produces more inaccurate and uncertain responses than the other. *Table 7* summarizes the results on understanding.

Table 7: A Summary of Presentation Formats on Understanding

Presentation Format	Understanding	Presentation Format
Bar Graph	>	Pie Chart
Bar Graph	=	Numeric Statement
Bar Graph	=	Pictograph
Bar Graph*	=	Table
Bar Graph**	<	Table
Frequency	>	Pictograph
Frequency	=	Percentage
Percentage	=	Pie Chart
Loss-Framed Message	=	Gain-Framed Message
Small Denominator	=	Large Denominator
*Verbatim understanding		
**Gist understanding		

When it comes to effective presentation formats so as to enhance understanding, the bar graph is a better format than the pie chart, the frequency is a better format than the pictograph, and, for gist understanding, the table is a better format than the bar graph. All other presentation format pairs produce equivalent and effective levels of understanding.

In addition to understanding, each presentation format has a different effect on risk perception, and *Table 8* outlines which formats are the most effective in maximizing risk perception.

Table 8: A Summary of Presentation Formats on Maximizing Risk Perception

Presentation Format	Risk	Presentation Format
Frequency	>	Percentage
Frequency	>	Pictograph
Bar Graph	>	Numeric Statement
Bar Graph	>	Pie Chart
Pictograph	>	Bar Graph
Table	>	Bar Graph
Percentage	>	Pie Chart
Small Denominator	>	Large Denominator
Loss-Framed Message	>	Gain-Framed Message

To maximize risk perception, frequencies are more effective than percentages and pictographs, bar graphs are more effective than numeric statements and pie charts, pictographs and tables are more effective than bar graphs, percentages are more effective than pie charts, small denominators are more effective than large denominators, and loss-framed messages are more effective than gain-framed messages.

The goal of certain messages is to maximize risk perception, while the goal for other messages is to minimize risk perception. *Table 9* outlines which presentation formats are the most effective in minimizing risk perception.

Table 9: A Summary of Presentation Formats on Minimizing Risk Perception

Presentation Format	Risk	Presentation Format
Bar Graph	<	Table
Percentage	<	Frequency
Pie Chart	<	Percentage
Pie Chart	<	Bar Graph
Pictograph	<	Frequency
Numeric Statement	<	Bar Graph
Large Denominator	<	Small Denominator
Gain-Framed Message	<	Loss-Framed Message

To minimize risk perception, bar graphs are more effective than tables, percentages and pictographs are more effective than frequencies, pie charts are more effective than percentages and bar graphs, numeric statements are more effective than bar graphs, small denominators are more effective than large denominators, and gain-framed messages are more effective than loss-framed messages.

Finally, certain presentation formats are assessed for their perception of motivation. These formats are outlined in *Table 10*.

Table 10: A Summary of Presentation Formats on Motivation

Presentation Format	Motivation	Presentation Format
Bar Graph	=	Numeric Statement
Table	>	Bar Graph

To enhance motivation, a table is more effective than a bar graph, and a bar graph and numeric statement produce equivalent and effective results.

Effective risk communication involves a combination of accurate understanding and risk perception, high or low, depending on the goals of the message. Combining the findings of understanding and perception, there are several presentation formats which are more effective than others. The most effective presentation formats to maximize risk perception are frequencies over pictographs and percentages, percentages over pie charts, pictographs and tables over bar graphs, bar graphs over pie charts and numeric statements, loss-framed messages over gain-framed messages, and small denominators over large denominators.

The most effective presentation formats to minimize risk perception are pie charts over percentages, percentages over frequencies, numeric statements over bar graphs, bar graphs over tables (for verbatim understanding), gain-framed messages over loss-framed messages, and large denominators over small denominators. The other presentation format pairs may have one format which has a lower perceived risk than the other, but the level of understanding does not match. That is, that the opposing presentation format has a better level of understanding, thus eliminating the low risk format for being an effective one.

Combining the findings of understanding and motivation, tables are more effective than bar graphs, and numeric statements and bar graphs are equally effective. Motivation levels are not known for the remaining presentation formats.

These relationships are brought together in the development of the Communicative Cardiovascular Physician-Patient Model of Message Preparation-Perception (CPMP)² which is outlined in *Figure 19* below.

Figure 19: (CPMP)²: A Communicative Cardiovascular Physician-Patient Model of Message Preparation-Perception

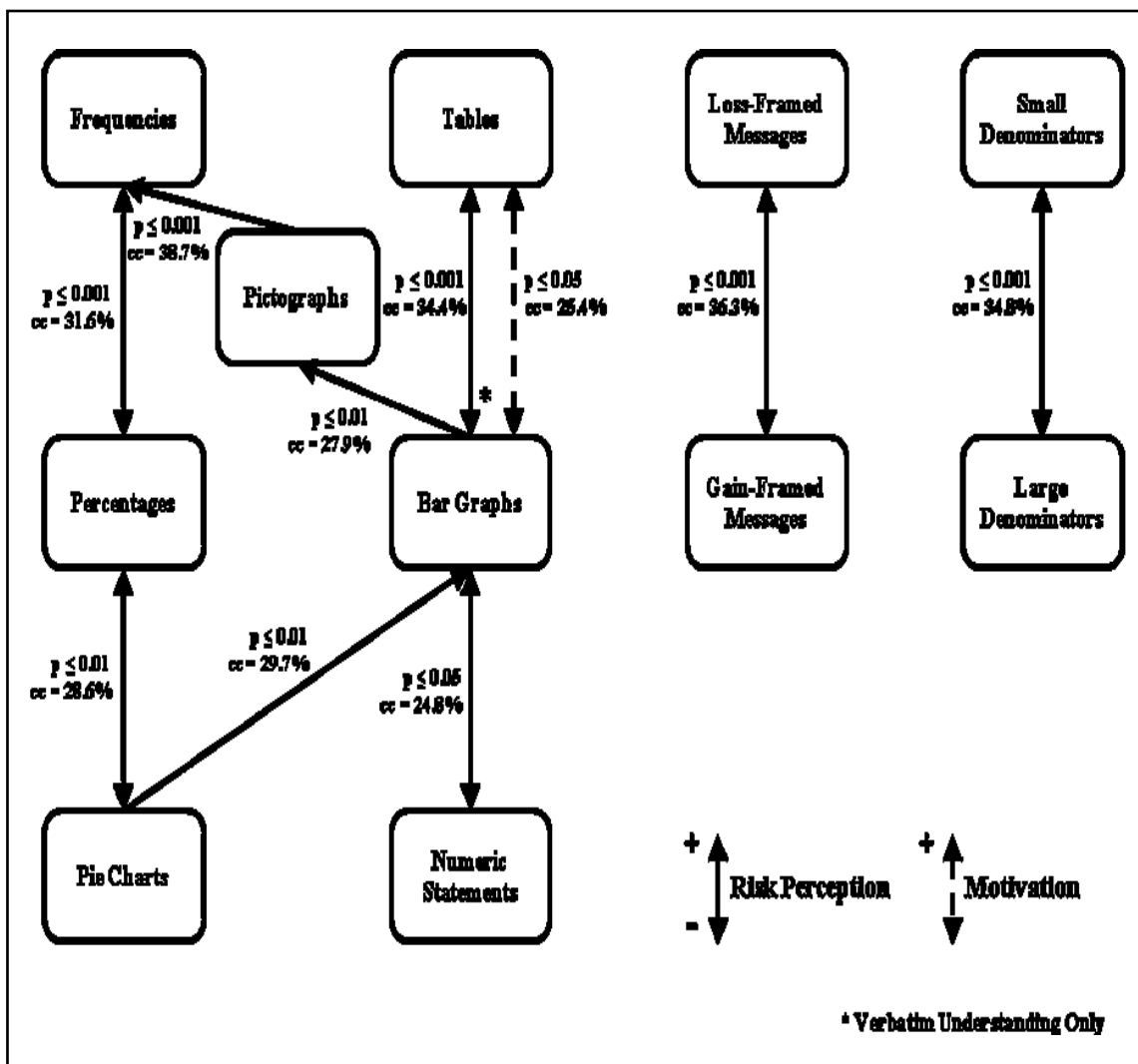


Figure 19 presents (CPMP)², a communicative cardiovascular physician-patient model of message preparation-perception. This model demonstrates which presentation formats are more effective communicating risk information to recovering cardiovascular patients. Physicians communicate various risk messages to cardiovascular patients, and the model provides a guideline for effective message preparation. Message preparation begins with the creation of messages, and two theories, social judgment theory and the heuristic-systematic model, guide this preparation. Essentially, messages should be created with information that is not too extreme. Maintaining relatively neutral messages prevents participants from perceiving the information as being too far off from their own attitudes and beliefs (Cameron, 2009, Trumbo, 2002). Relatable information allows for messages to be accepted by the receivers. Therefore, extreme information is avoided, so participants are comfortable in receiving the information.

Once messages are prepared, the first crucial component of the model arises: understanding. The level of understanding is involved with each of the relationships demonstrated within the model. Understanding must be achieved, regardless of the risk or motivation goals, as the patients must first understand what is being communicated. Therefore, any of the relationships shown in the model involve a presentation format that ensures understanding is achieved. The importance of understanding can be linked back to the core concept of rationality as described by Max Weber. His explanation of rationality suggests that individuals receive information and proceed to engage in logical reasoning to arrive at a specific calculated end (Bolan, 1999). In order to allow rational thought to occur, the information must be understood by the recipient. If the recipient does not understand what he or she is receiving, the rational thought process is based on

faulty information; decisions can be made on incorrect facts. Additional research involving presentation formats is shown to not always place understanding at the forefront. For example, Stones, Yate, and Parker assess levels of persuasion and risk perception but do not take into account whether or not the information is understood correctly (1997). Therefore, a presentation format that is shown to be risky may have been interpreted incorrectly.

An additional crucial element in the model is the level of risk perception. Relationships between different presentation formats are shown in regards to which formats maximize risk perception and which formats minimize risk perception. Depending on the content of the information, the goal may be to maximize risk perception, or the goal may be to minimize risk perception. The model provides insight into which formats are more effective for these different goals. Expected utility theory explains how these goals are achieved through individuals receiving information, calculating the risks associated, and forming decisions based on the calculations (Hellinger, 1989). If the goal of a risk communication message is to maximize risk perception, an individual may receive the information, calculate the risks as being high, and then make a decision based on these high risks.

In the current research, frequencies are shown to maximize risk perception in comparison to percentages, and percentages are shown to minimize risk perception in comparison to frequencies. Research in the field presents similar findings with risk perception. Frequencies are perceived to emphasize the level of threat and increase risk perception to a greater extent than percentages (Siegrist, 1997).

Although percentages minimize risk perception when compared to frequencies in the current research, they are found to maximize risk perception when compared to pie charts. Lee, Lin, Tseng, Cassidy, and Hor find contradictory results for the pie chart in their research, as the pie chart is perceived to have a high level of risk by the majority of participants (2009). Their research does not compare the pie chart with a percentage however, so it is possible that this additional comparison may lead to the pie chart being perceived as less risky than a percentage. Furthermore, Politi, Han, and Col explain that the pie chart is one of the most familiar formats for the presentation of information (2007). It is possible that this level of familiarity has an effect on risk perception. In the current research, perhaps familiarity with the pie chart leads to a level of comfort, causing the pie chart to appear less risky than the less familiar numerical presentation of a percentage.

In the current research, tables are found to maximize risk perception when compared to bar graphs, and bar graphs are found to minimize risk perception when compared to tables, for verbatim understanding only. Other research in the field shows tables to be effective formats in producing accurate understanding, but the impact on risk perception is not known (Hawley, Zikmund-Fisher, Ubel, Jancovic, Lucas & Fagerlin, 2010, Spence & Lewandowsky, 1991). The current research does assess this relationship and finds a table to be more risky than a bar graph. Bar graphs are assessed for risk perception in similar research and are found to be risky when compared to pictographs, percentages, and frequencies (Timmermans, Molewijk, Stiggelbout & Kievit, 2004). Tables are not included in their research. If they were, it is possible they may be perceived to be even riskier than bar graphs.

It is important to note that, in the current research, bar graphs are more effective than tables at minimizing risk perception for verbatim understanding only. This is due to the initial crucial component of understanding. Bar graphs and tables produce equivalent levels of accurate understanding for gist knowledge, but tables produce better understanding than bar graphs when it comes to verbatim understanding. Therefore, regardless of risk perception, understanding is better when information is shown as a table. The bar graph is thus not included as being more effective in minimizing risk perception. Hawley, Zikmund-Fisher, Ubel, Jancovic, Lucas, and Fagerlin find that tables also produce high levels of verbatim understanding in their research (2008). It is possible that tables communicate the specifics of information in a very clear and easily understandable way, thus placing other presentation formats at a lower level of effectiveness.

Although bar graphs minimize risk perception when compared to tables (for verbatim understanding), they maximize risk perception when compared to numeric statements, and numeric statements minimize risk perception when compared to bar graphs. As mentioned above, bar graphs are shown in other research to have a high level of risk when compared to numbers, including percentages and frequencies (Timmermans, Molewijk, Stiggelbout & Kievit, 2004). This is consistent with the findings in the current research.

Another two-directional relationship in the current research is found as loss-framed messages maximize risk perception when compared to gain-framed messages, and gain-framed messages minimize risk perception when compared to loss-framed messages. This is consistent with the research of Edwards, Elwyn, Covey, Matthews, and

Pill, who find similar results (2001). They find that messages stating the risks of not being screened for breast cancer create a greater sense of risk than messages stating the benefits of being screened (2001). Halpern, Blackman, and Salzman also find the same relationships among loss-framed and gain-framed messages and risk perception (1989).

The final two-directional relationship in the current research is that small denominators are found to maximize risk perception when compared to large denominators, and large denominators are found to minimize risk perception when compared to small denominators. Research in the field has shown both complementary and contradictory results with denominator sizes. Schapira, Nattinger, and McHorney find similar results to the current research, in that small denominators maximize risk perception and large denominators minimize risk perception. Zikmund-Fisher, Fagerlin, Roberts, Derry, and Ubel, however, find the opposite relationship. They find that large denominators are found to maximize risk, while small denominators are found to minimize risk (2008). The current research is in line with the findings of Schapira, Nattinger, and McHorney.

Several one-way relationships are also present in the communicative cardiovascular physician-patient model of message preparation-perception. These relationships have one direction due to levels of understanding. That is, even though a presentation format may minimize or maximize risk effectively compared to another presentation format, the understanding is not as high, thus eliminating the relationship from the model.

In the current research, a bar graph is found to be more effective at maximizing risk than a pie chart. Effective risk maximization for the bar graph is found in the

research by Timmermans, Molewijk, Stiggelbout, and Kievit as well, but a pie chart is not among the formats involved in the comparison. Perhaps if it were, it too would be shown to be less risky than a bar graph. The current research does show this relationship. The pie chart produces a lower level of understanding than the bar graph in the current research, thus eliminating it as being effective at minimizing risk perception. The difficulty of understanding with the pie chart is shown in other research as well, thus strengthening the idea that pie charts produce lower levels of understanding (Feldman-Stewart, Kocovski, McConnell, Brundage & MacKillop, 2000).

A second one-way relationship within the model is that pictographs are shown to be more effective in maximizing risk perception than bar graphs. Additional research in the field both supports and contradicts the current finding. One study demonstrates that pictographs are effective in producing a high level of risk (Stones, Yate, & Parker, 1997). However, contradictory research by Timmermans, Molewijk, Stiggelbout, and Kievit reports that pictographs are seen as less of a threat than bar graphs (2004). For this particular research, pictographs are found to be more effective in maximizing risk than bar graphs.

Although pictographs are shown to be more effective at maximizing risk than bar graphs, frequencies are shown to be more effective at maximizing risk than pictographs in the current research. Once again, this finding is contradictory to the research of Timmermans, Molewijk, Stiggelbout, and Kievit, wherein pictographs are perceived as more risky than frequencies (2004). However, there is research in the field which supports the high level of risk perception associated with frequencies. Siegrist states “the

frequency format emphasizes the threat of risk” (1997: 509). Therefore, frequencies are shown to be effective in maximizing risk, and they have in the current research as well.

The final element included in (CPMP)² is motivation. The two theories, protection motivation theory and the extended parallel process model, help explain how motivation plays a role in risk communication. Essentially, appraisals take place for threat and efficacy. If the perceived threat is within a certain level, not too low and not too high, the individual proceeds to protect him or herself from the threat, and the motivation to engage in a behaviour occurs (Prentice-Dunn, McMath & Cramer, 2009, Witte, 1994). Motivation takes place when one recognizes both the need and ability to protect oneself from the risk. One significant relationship is found in the current research and shows that tables are more effective than bar graphs at producing a sense of motivation. Therefore, if the goal of a risk communication message includes a motivation component, a table is a more effective presentation format than a bar graph. Schapira, Nattinger, and McHorney find in their research that bar graphs are perceived to have “less of an impact” than other presentation formats (2001). This finding, “less of an impact”, can be related to motivation. If a bar graph does not produce much of an impact on individuals, motivation is not likely to occur.

Overall, (CPMP)², provides a visual representation of the presentation formats that are more effective when it comes to understanding, risk perception, and motivation. As medical practitioners communicate risk information to recovering cardiovascular patients, this model can be referred to in order to determine which presentation formats are more effective based on the goals of the message.

Chapter 5

Conclusion

Risk communication is an important branch of communication in general. In the context of a health environment, risk communication occurs daily when individuals attend appointments with physicians, fill prescriptions, or view commercials about medications. One factor affecting the communication of such information is the format in which the material is presented.

Different presentation formats have varying effects on how information is perceived in terms of understanding, risk perception, and motivation. The combination of an individual's understanding and the goals of the message in regards to risk and motivation impacts the effectiveness of a given risk communication message. Whether the goal of the message is to maximize risk perception, minimize risk perception, or produce a sense of motivation, understanding must be accurate in order for the communication to be effective.

The current research assesses different presentation formats and determines which formats are more effective at maximizing risk perception, which formats are more effective at minimizing risk perception, and which formats are effective at creating a sense of motivation.

Most Significant Findings

Existing research shows that the way in which information is presented can greatly affect how that information is perceived and understood. Variations in presentation format can determine the effectiveness of risk communication. The current research assesses popular

risk presentation formats and their effects on understanding, risk perception, and motivation as perceived by recovering cardiovascular patients at the University of Ottawa Heart Institute. Understanding is integral to effective risk communication and is therefore included in all of the presentation format comparisons. Combining the results of understanding and risk perception, ideal presentation formats are presented.

If the goal of the risk communication message is to maximize risk perception, frequencies are more effective than percentages and pictographs, bar graphs are more effective than numeric statements and pie charts, pictographs and tables are more effective than bar graphs, percentages are more effective than pie charts, small denominators are more effective than large denominators, and loss-framed messages are more effective than gain-framed messages. Overall, frequencies, tables, small denominators, and loss-framed messages are the most successful formats for creating effective and risky communication messages. These formats are all perceived as being risky, and no other presentation format that they are compared to exceeds their level of risk. Bar graphs, pictographs, and percentages are perceived to be risky compared to some presentation formats and not risky compared to others. These formats can therefore be effective formats to maximize risk in certain situations. Finally, numeric statements and pie charts have low risk levels in all of their comparisons and are therefore the least effective formats to maximize risk perception.

Alternatively, if the goal of the risk communication message is to minimize risk perception, pie charts are more effective than percentages, percentages are more effective than frequencies, numeric statements are more effective than bar graphs, bar graphs are more effective than tables (for verbatim understanding), gain-framed messages are more

effective than loss-framed messages, and large denominators are more effective than small denominators. Overall, pie charts, numeric statements, large denominators, and gain-framed messages are the most successful formats in creating effective and low risk communication messages. These formats are all perceived as less risky than the presentation formats they are compared to. Frequencies and tables (for verbatim understanding) have higher risk levels in all of their comparisons and are therefore the least effective formats to minimize risk perception. Pie charts, pictographs, and bar graphs (for gist understanding) produce low risk perceptions, but their levels of understanding are also lower, thus eliminating them as effective presentation formats for minimizing risk.

Risk and motivation relate to one another when encouraging or discouraging certain behaviours. If a message is perceived to be risky, it can also be perceived as motivating in that it encourages individuals to engage in a certain behaviour to protect him or herself from the perceived risk. Only two of the pieces of information in the current research have a motivation component, and these formats are assessed for their perception of motivation. The results find that tables are more effective than bar graphs in producing a sense of motivation, and both bar graphs and numeric statements are equivalent in producing perceptions of motivation.

Together, these findings in understanding, risk perception, and motivation work together to create (CPMP)², a communicative cardiovascular physician-patient model of message preparation-perception. (CPMP)² provides a model which presents effective presentation formats for communicating risk to recovering cardiovascular disease patients.

Limitations and Future Research

There are several limitations within the study that are important to recognize. The first limitation involves the study population. The current research is conducted with a specific population, which is the recovering cardiovascular patient population at the University of Ottawa Heart Institute. The findings can be used for future communications with these patients and may be applicable for other recovering cardiovascular patients as well. Cardiovascular disease is the leading cause of death in Canada, and ensuring that these patients receive effective communication is essential. However, what may be effective presentation formats for this group of patients may not be what other groups of patients find effective as well. For example, cardiovascular patients tend to be an older population, whereas cystic fibrosis patients tend to be a younger population. This difference in age may result in different perceptions of presentation formats. A suggestion for future research is to test different groups of cardiovascular patients, perhaps at other institutes around Canada, to see if there are similar results in regards to effective communication formats. It would also be beneficial to test different kinds of patients to see if the presentation formats have the same effects they do on recovering cardiovascular patients.

Another limitation in the research is the content presented through the information handouts themselves. It is important to recognize that the content of the information may influence how the material is understood and perceived. Therefore, certain information may be more difficult to understand than other information, or certain information may be perceived as being riskier, regardless of presentation format. To help eliminate this problem, the same information is presented with two different presentation formats so

that one format can be viewed as more or less effective than another. However, an ultimate list of the most effective and least effective presentation formats cannot be deduced from this research as not every presentation format is assessed with the same content. A suggestion for future research is to break the population into more groups so that more presentation formats can be assessed using the same content. This could help control for content affecting the perception of the material.

One final limitation of the research involves motivation and protection. Motivation and protection are important concepts and are involved in many risk communication messages. However, because not all of the content presented in the information handouts involves eliciting a certain behaviour, the study is limited in its ability to determine motivation. Motivation can only be measured for a limited number of questions. Future research with more motivational information is recommended. Different presentation formats could have varying effects on motivation and protection, and this knowledge would be beneficial for risk communication.

Thesis Summary

Cardiovascular disease is the leading cause of death worldwide, and those afflicted are faced with risk communication messages regarding their health on a consistent basis. It is essential that they understand the information they receive and recognize the level of risk associated. There is evidence in the existing research on risk communication that misperception and misunderstanding can and do occur, and it is therefore vital to ascertain how message framing and different presentation formats impact understanding

and perception in order to maximize the effectiveness of risk communication. The purpose of the research is precisely to determine those ways to present information that communicate risk to recovering cardiovascular disease patients at the University of Ottawa Heart Institute that are effective.

The research has its foundations in Max Weber's concept of rationality. This concept provides insight into how decisions are made from an objective, logical, and reasonable point of view. Practical rationality in particular is integral to this research as it explains how individuals consider end results and decide the best course of action to achieve those results. This can be related to patients observing different presentation formats, formulating perceptions of the material, and then engaging in a behaviour. This conceptual foundation branches into five different theories: social judgment theory, the heuristic-systematic model, expected utility theory, protection motivation theory, and the extended parallel process model. Building on Weber's concept of rationality, the theories examine and explain ideas of message preparation, understanding, perception, risk, and motivation, all of which are involved when receiving information in various presentation formats. Similar research in the field demonstrates how different presentation formats are perceived in various contexts. Both visual displays and numbers are examined in presentation formats including pie charts, pictographs, bar graphs, tables, frequencies, percentages, and denominator size. Message framing is also looked at in regards to loss-framing and gain-framing. The conceptual and theoretical research, as well as the research conducted on the effectiveness of various presentation formats, is used to formulate the design of messages on the risk information handouts as well as the presentation formats included therein.

Following the literature review, the methodology for the research takes place. The key concepts of risk, motivation, protection, message preparation, understanding, and perception are defined and operationalized to clarify how they function within the current research. Questions asking the degree to which a participant agrees or disagrees with a statement, and multiple choice questions asking a participant to choose the correct answer, are used to assess the central concepts of understanding, risk perception, and motivation. An experimental research design is implemented which includes a microscopic conceptual approach, quantitative techniques, establishment of variables, maintenance of reliability and validity, and the creation of equivalent groups for the two risk information handouts. One further key component of experimental research is the formulation of a hypothesis, and the primary hypothesis for this research states that there are relationships between the presentation formats of information and the effectiveness of risk communication for recovering cardiovascular disease patients. The hypothesis is tested through risk information handouts and an associated questionnaire which is completed by patients at the University of Ottawa Heart Institute. Finally, the data collection and analysis takes place through obtaining ethical approval from two research ethics boards, determining the demographics of the respondents, establishing the context of the data collection, and performing a statistical analysis using frequencies and chi square analyses through SPSS software.

The findings reveal that presentation format affects the level of understanding, the level of risk perception, and the level of motivation for recovering cardiovascular patients at the University of Ottawa Heart Institute. Combining the results of understanding, risk

perception, and motivation, the most effective presentation formats are identified. The most effective presentation formats to maximize risk perception are frequencies over pictographs and percentages, percentages over pie charts, pictographs and tables over bar graphs, bar graphs over pie charts and numeric statements, loss-framed messages over gain-framed messages, and small denominators over large denominators. Alternatively, the most effective presentation formats to minimize risk perception are pie charts over percentages, percentages over frequencies, numeric statements over bar graphs, bar graphs over tables (for verbatim understanding), gain-framed messages over loss-framed messages, and large denominators over small denominators. Findings in motivation reveal that tables are more effective than bar graphs, and numeric statements and bar graphs are equally effective. All of this information leads to the creation of (CPMP)²: a communicative cardiovascular physician-patient model of message preparation-perception. This model provides a visual display to identify which presentation formats are effective with which message goals in communicating risk information to recovering cardiovascular patients. Although effective risk communication can be difficult to achieve, as more is learned about how messages are communicated and received, it can be approached with greater ease and confidence. (CPMP)² is a step towards this ultimate goal of effective risk communication.

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Appendices

Appendix A: Ethical Clearance from the Ottawa Hospital Research Ethics Board



Ottawa Hospital Research Ethics Boards / Conseils d'éthique en recherches

Tuesday, June 14, 2011

Re: Protocol # 2011277-01H The Effect of Presentation Format on Risk Communication to Recovering Cardiovascular Patients

Protocol approval valid until - Wednesday, June 13, 2012

I am pleased to inform you that this protocol underwent delegated review by the Human Research Ethics Board (HREB) and is approved. No changes, amendments or addenda may be made to the protocol or the consent form without the HREB's review and approval.

The validation date should be indicated on the bottom of all consent forms and information sheets (see copy attached). If the study is to continue beyond the expiry date noted above, a Renewal Form should be submitted to the HREB approximately six weeks prior to the current expiry date. If the study has been completed by this date, a Termination Report should be submitted.

The Ottawa Hospital Research Ethics Board is constituted in accordance with, and operates in compliance with the requirements of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans; Health Canada Good Clinical Practice: Consolidated Guideline; Part C Division 5 of the Food and Drug Regulations of Health Canada; and the provisions of the Ontario Health Information Protection Act 2004 and its applicable Regulations.

Yours sincerely,

RFD/dw
Encl.

INFORMATION SHEET AND CONSENT FORM



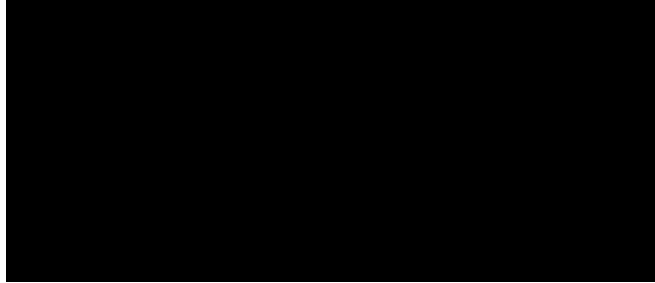
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Faculté des arts
Communication
University of Ottawa
Faculty of Arts
Communication

Ethics Protocol Number: 2011277-01H



Title of Research: The Effect of Presentation Format on Risk Communication to Recovering Cardiovascular Patients



Request to Participate: You are invited to take part in the above mentioned research study. This research is being conducted by [redacted] for the Master's thesis - CMN 6999, Department of Communication, at the University of Ottawa.

Purpose of the Study: From this research I wish to learn how to best communicate risk information to recovering cardiovascular patients.

Participation: If you wish to take part in this study, please use the information sheet to complete the attached survey. The survey should take you roughly 15 minutes to complete. You do not have to answer any questions that you do not want to answer. Once you have filled out the survey, please return it either directly to myself, or to the box labeled "Survey Returns", which can be found on the ledge underneath the message board within the Minto Prevention and Rehabilitation Centre.

Confidentiality and anonymity: The information you share will remain strictly confidential and anonymous. All personal information will be kept confidential, unless release is required by law. Representatives of government regulators such as Health Canada, representatives of the Human Research Ethics Board, as well as the University of Ottawa Heart Institute and the University of Ottawa, may review records for audit purposes.

You will not be identifiable in any publications or presentations resulting from this study. No identifying information will leave the University of Ottawa Heart Institute. All information which leaves the Heart Institute will be coded with an independent study number.

There will be no link between your name and the independent study number. Any link between the information you provide on the survey and the independent study number will only be accessible by [redacted]. The link and study files will be stored separately and



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securely. Both files will be kept for a period of 15 years after the study has been completed. All paper records will be stored in a locked file and office. All electronic records will be stored on the password protected University of Ottawa computer belonging to [REDACTED]

[REDACTED] At the end of the retention period, all paper records will be disposed of in confidential waste or shredded, and all electronic records will be deleted.

Voluntary Participation: You do not have to take part in the study. If you choose to participate, you may choose not to answer questions that you do not want to answer. Completion and return of the survey by you implies consent.

If you have any questions or require more information about the study itself, please contact the [REDACTED]

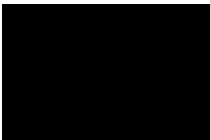
The Human Research Ethics Board (HREB) has reviewed this protocol. The HREB considers the ethical aspects of all research studies involving human subjects at The University of Ottawa Heart Institute. If you have any questions about your rights as a research subject, you may contact the [REDACTED]

The University of Ottawa Human Research Ethics Board has also reviewed this protocol. If you have any questions with regards to the ethical conduct of this study, you may contact the Protocol Officer for Ethics in Research, [REDACTED]

Please keep this form for your records.

Thank you for your time.

Valid until JUN 13 2012



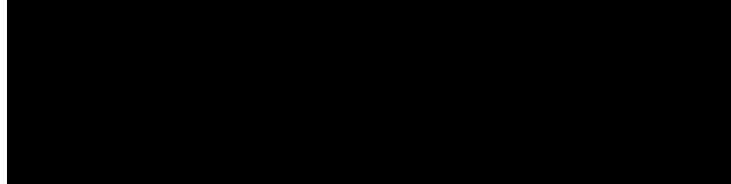
**Appendix B: Ethical Clearance from the University of Ottawa
Research Ethics Board**



Université d'Ottawa University of Ottawa

Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

June 22, 2011



Re: U of O Ethics file no. A 06-11-01- "The Effect of Presentation Format on Risk Communication to Recovering Cardiovascular Patients"



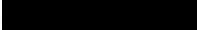
Thank you for the Certificate of Approval from the Ottawa Hospital REB (OHREB file # 2011277-01H) for your project named above.

This is to confirm that, in accordance with the agreement between the University of Ottawa and the Ottawa Hospital, the University of Ottawa has authorized the Ottawa Hospital REB to act as Board of Record for the review and oversight of research involving human subjects conducted at or through the hospital.

Copies of annual reports and renewals of OHREB approvals, as well as certificates and reports for any other study sites must be provided to our office.

We remind you of your obligation to:

- Follow all procedures of the OHREB including reporting and renewal procedures;
- Submit to the authority of the OHREB and that you are subject to OHREB requirements, including, without limitation, the requirement to modify or stop the research on demand of the OHREB.

If you have any questions, please contact our ethics office 

Sincerely yours,

