A Close Examination of the 1-in-X Effect and Its Impact on Health Risk Perceptions

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ABSTRACT

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Research has shown that when communicating a medical risk in the 1-in-X format, people perceived the probability of being affected by the risk to be higher than when communicating the risk in the N-in-N*X format. Numerous heuristics have been examined to see whether they can explain this 1-in-X effect. However, a theoretical explanation for the 1-in-X effect has still not been determined. In this thesis, I first aimed to test whether the 1-in-X effect occurs when utilizing the 1-in-X numerical format in a fear appeal message that promotes healthy behavior and whether the 1-in-X effect can help consumers initiate behavioral change more effectively. Secondly, I aimed to find a viable explanation for the 1-in-X effect. In two experiments, I found that when communicating a health risk in the 1-in-X format, participants perceived the probability of being affected by the risk significantly higher, were significantly more worried and more willing to take actions to reduce the risk than when communicating the risk in the N-in-N*X format. In addition, I found that the 1-in-X effect occurs because it was easier for people to imagine the risk than when communicating the risk in the 1-in-X format than in the N-in-N*X format. This ease of imagination ultimately heightens the perceived probability when risk is presented in the 1-in-X format. These findings contribute to various aspects of consumer psychology, social psychology, and medical decision making literature and provide substantial implications for social marketing.
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1. Introduction

Societies worldwide are facing increasing health challenges (Grier and Bryant, 2005). Some consumers make decisions or behave in a way that is not good for their health. For example, many consumers do not meet the physical activity recommendations of doing at least 30 minutes of physical activity a day (U.S. Dept. of Health and Human Services, 2001; Wurtele and Maddux, 1987), resulting in heart disease and problems to the cardiovascular system (Wurtele and Maddux, 1987); many consumers overeat from stress and do not exercise enough to burn the extra calories, resulting in obesity (Adam and Epel, 2007; Kumanyika et al., 2008); and many consumers do not consume enough fruits and vegetables, resulting in imbalanced nutrition, cardiovascular disease, and cancer (Lock et al., 2005).

To combat these public health problems, social marketing plays an important role (Grier and Bryant, 2005). Social marketing is a discipline that utilizes marketing techniques to promote desirable behavior and reduce risky behavior (Grier and Bryant, 2005). In order to change or prevent consumers from risky unhealthy behavior, social marketers utilize various persuasion techniques, one of which is fear appeal (Solomon, Zaichkowsky, and Polegato, 2011).

According to the protection motivation theory, one important aspect that contributes to the success of fear appeal is the consumer’s perceived probability of being affected by the threat (Rogers, 1983). Research has shown that a higher perceived probability of a threat happening leads to a higher intention to change risky behavior (Maddux and Rogers, 1983; Tanner, Day and Crask, 1989; Wurtele, 1988; Wurtele and Maddux, 1987). In previous research, manipulations of perceived probability of threat were only implemented by changing the probability of the threat – either through providing different supporting evidence or directly changing the probability (Maddux and Rogers, 1983; Tanner, Day and Crask, 1989; Wurtele, 1988; Wurtele and Maddux, 1987). For example, Maddux and Rogers’s (1982) manipulated how likely smoking leads to lung
cancer and heart disease by providing participants with different citations from research (e.g., citations that either supported or questioned smoking as a likely cause of lung cancer and heart disease). In another study, Tanner, Day, and Crask (1989) assigned the probability of being affected by STDs as a function of participants’ sexual activity frequency. In these studies, individuals were most likely to change behavior when there was a high probability that the event would occur. However, sometimes, when social marketers need to communicate a fact, the probability of being affected by a threat cannot be changed. For example, if social marketers would like to communicate that there is a 12% chance that a smoker might develop lung cancer, the 12% probability cannot be changed to keep this information factual. Then, how should social marketers display this information in a style that is effective in changing behavior?

Recently, in the medical decision making literature, various numerical communication styles have been tested (Pighin et al., 2011; Sirotta et al., 2014; Zikmund-Fisher, 2011, 2013). These styles include the percentage format, the 1-in-X format, and the N-in-N*X format (the frequency format). It is found that when the probability of being affected by a medical risk is communicated using the 1-in-X format, people perceive the probability to be higher than when the same risk is communicated using the N-in-N*X format or the percentage format (the 1-in-X effect). One possible explanation for this finding is that when a medical risk is communicated in the 1-in-X format, people can more easily imagine the risk (Oudhoff and Timmermans, 2015) and this ease of imagination will, in turn, lead to an increased perceived probability of being affected by the risk (Sherman, et al., 1985).

The purpose of this research is to first test whether the 1-in-X effect occurs when utilizing the 1-in-X numerical format in a fear appeal message that promotes healthy behavior and whether the 1-in-X effect can help consumers initiate behavioral change more effectively.
The second aim is to examine whether ease of imagining the risk is a viable explanation that mediates the relationship between numerical format and the perceived probability of being affected by a risk.
2. Theoretical Background

In this section, I present research in the social psychology and medical decision making literature on how numerical formats lead to different perceptions of probability of an uncertain event occurring and how they can help the persuasiveness of fear appeal messages.

2.1. Fear Appeal in Social Marketing

Fear appeal, a type of persuasive communication which arouses fear, has been the interest of many researchers since 1953 (Witte and Allen, 2000). According to the protection motivation theory (Rogers, 1975, 1983), the effectiveness of fear-arousing communication in changing people’s behavior depends on four variables – (1) the perceived severity of the threat, (2) the perceived probability of its occurrence, (3) whether there is an effective way to prevent or deal with the threat – coping response efficacy, and (4) whether one can initiate the behavior change – self-efficacy. Among these variables, the perceived probability of being affected by the threat is considered to be an important aspect of fear-arousing communication. According to the extended parallel process model (EPPM), in order for people to take actions to control a threat, they first need to be scared of the threat. This is done by making people believe that there is a possibility that they can be affected by the threat (Witte, 1992). Both the protection motivation theory and the EPPM suggest that the higher the perceived probability of being affected by the threat, the more likely consumers will change their risky behavior.

Empirical studies based on the protection motivation theory and the EPPM have manipulated the perceived probability of being affected by a threat to test the effectiveness of fear appeal in changing health-related behavioral intentions or behavior (Maddux and Rogers, 1983; Tanner, Day and Crask, 1989; Wurtele, 1988; Wurtele and Maddux, 1987). However, manipulations of perceived probability have been limited to changes in message content or actual
probability. For example, Maddux and Rogers (1983) manipulated the perceived probability of developing lung cancer and heart disease with different citations from research. To create a high perceived probability of threat, they included citations which supported that smoking was a likely cause of lung cancer and heart disease in an essay provided to participants. In the low perceived probability condition, they included citations which supported that smoking was an unlikely cause of lung cancer and heart disease. Results showed that a high level in perceived probability led to a higher intention to change smoking behavior.

Another study that manipulated perceived probability of being affected by the threat was conducted by Wurtele and Maddux (1987). In their study, they asked participants to read an essay designed to highlight the importance of exercise. The perceived probability variable was either present or absent in the essay. When the variable was present in the essay, the essay contained the following statement: “Because you do not exercise regularly, your cardiovascular system has already begun deteriorating, which puts the health of your body in jeopardy”. Results showed that the presence of the perceived probability variable led to a higher intention to exercise and marginally changed participants’ amount of exercise.

Wurtele (1988) also manipulated the perceived probability variable in his study. In his research, participants were asked to read an essay regarding osteoporosis. The perceived probability variable was manipulated as either high or low. In the high perceived probability condition, the essay described recent incidences of bone loss in young women and provided several reasons for why young women may be at risk. The essay asserted that based on the evidence, it was almost certain that there was a high risk for the participants to get osteoporosis or the participants already had some form of osteoporosis. In the low perceived probability condition, the essay claimed that osteoporosis was a disease for older women and offered several
reasons for why young women had low risk of getting osteoporosis. Results showed that a high (vs. low) perceived probability of having osteoporosis led to a higher intention to increase calcium intake and an actual increase in calcium intake after two weeks.

In all of the above examples, researchers manipulated the perceived probability variable by varying the message content between the low and high perceived probability conditions (e.g., use of evidence either supporting or opposing risk). In addition to this type of manipulation, other researchers have used different probabilities when manipulating the perceived probability variable. For example, Tanner, Day, and Crask (1989) conducted a study on preventing sexual diseases (STDs). In their study, the probability of being affected by STDs depended on participants’ own sexual activity and was stated in a percentage. The highest probability of being affected by STDs was assigned to participants who reported having more than 5 partners in the last year; the moderate probability of being affected by STDs was assigned to participants who had 2-5 partners; and the lowest probability was assigned to participants who had only 1 partner or no sexual activity. The results showed that as the probability of being affected by STDs increased, the intentions to use condoms increased.

In summary, the research on fear appeal suggests that the perceived probability of being affected by a threat is an important component in changing consumers’ risky health behavior (Rogers, 1975, 1985; Witte, 1992). Manipulations of perceived probability of being affected by a threat, however, have only been limited to changes in message content or actual probability (Maddux and Rogers, 1983; Tanner, Day and Crask, 1989; Wurtele, 1988; Wurtele and Maddux, 1987). In some cases, social marketers may not be able to manipulate the perceived probability of being affected by a threat in either way because the information communicated needs to be factual. Thus, the question remains as to how social marketers can display the probability
information without altering factual information such that consumers perceive the threat as being important to them. In the following section, I present how the research on numerical formats (e.g., 1-in-X vs. N-in-N*X) in social psychology and medical decision making can help address this question.

2.2. The Impact of Numerical Formats on Perceptions of Probability

2.2.1. N-in-N*X Format Increases Perceived Probability

In the social psychology literature, it is found that when the probability of an uncertain event happening is expressed in the N-in-N*X format, people perceive the event to more likely occur than when the same probability is expressed in the 1-in-X format. Miller, Turbull, and McFarland (1989) found that when telling participants that a child who likes chocolate chip cookies drew a chocolate chip cookie from a jar that contained 1 chocolate cookie and 19 oatmeal cookies, participants became more suspicious that the child had peeked at the jar when drawing the cookie than when they were told that the jar contained 10 chocolate cookies and 190 oatmeal cookies. Miller and colleagues explained that drawing from the jar that has only 1 desired cookie is more abnormal than drawing from a jar that has 10 desired cookies. According to the Norm theory, events are normal if the thoughts, images and scenarios evoked by the event are similar to the event, while events are abnormal if the thoughts, images and scenarios evoked by the event are dissimilar to the event. When there was only 1 chocolate chip cookie, there was only one way the event could occur. In contrast, when there were 10 chocolate-chip cookies, there were 10 similar ways that the event could occur. Therefore, participants were less suspicious that the child had cheated in the latter situation than the former.

However, there were alternative explanations for this finding. Kirkpatrick and Epstein (1992) suggested that participants are more suspicious that the child cheated when the child
successfully drew the chocolate chip cookie from the jar that contained only 1 chocolate chip cookie because people perceive the event to be less likely than drawing a chocolate chip cookie from a jar that contains 10 chocolate chip cookies. According to the cognitive-experiential self-theory (CEST), Kirkpatrick and Epstein suggested that expressing the probability of an event happening in different numerical formats may trigger different perceived probability even if the probabilities are mathematically equivalent. Kirkpatrick and Epstein (1992) found in their studies that when asking participants to choose from drawing a winning ticket from a bowl that contained 1 winning ticket and 9 blank tickets or drawing a winning ticket from a bowl that contained 10 winning tickets and 90 blank tickets, more participants were willing to draw tickets from the bowl that contained 10 winning tickets. They were also willing to pay for the privilege of drawing from this bowl. Additionally, Kirkpatrick and Epstein found that participants made comments such as they knew their behavior was irrational, but in the winning condition, they felt that they had a better chance of drawing a winning ticket when there were more of them, even though the probability of drawing a red jelly bean was the same for both bowls.

Denes-Raj and Epstein (1994) extended Kirkpatrick and Epstein’s (1992) study. They found that when asking participants to choose from drawing a winning ticket from a bowl that contained 10 tickets in total, of which 1 of them was a winning ticket, or drawing a winning ticket from a bowl that contained 100 tickets in total, of which 5 to 9 of them were winning tickets, more participants were willing to draw tickets from the bowl that contained 100 tickets. The researchers concluded that different numerical formats triggered different perceived probability, and this difference in perception was so prevalent that it led people to make non-optimal choices.

The research that was conducted by Kirkpatrick and Epstein (1992) and Denes-Raj
(1994) shows that when the probability of a positive event occurring is presented in large numbers (i.e. 10-in-100), people perceive the probability to be greater than when the probability is presented in small numbers (i.e. 1-in-10). This difference in perception is referred to as the ratio-bias (RB) phenomenon (Pacini and Epstein, 1999). Building on the research by Kirkpatrick and Epstein (1992) and Denes-Raj (1994), Pacini and Epstein investigated the underlying principles of the RB phenomenon. They find that three principles are involved in the RB phenomenon. First, according to CEST, the experiential system comprehends numbers better than ratios. Therefore, people prefer to process and compare numbers rather than think about ratios (numerosity effect). Secondly, the experiential system comprehends smaller numbers better than larger numbers because smaller numbers are more concrete (small-number effect). Therefore, the RB phenomenon only exists when the probability of a positive uncertain event occurring is small (i.e. 1-in-10 vs. 10-in-100), but does not exist when the probability becomes large (i.e. 9-in-10 vs. 90-in-100). Lastly, the affirmative representation principle suggests that affirmation is more concrete than negation, making positive representations easier to comprehend than negative representations. Therefore, if an uncertain event is a negative event (i.e. the probability to lose a game is 1-in-10 vs. 10-in-100), people will transfer it into a positive event (i.e. the probability of not losing the game is 9-in-10 vs. 90-in-100).

In addition to the previous research, Alonso and Fernandez-Berrocal (2003) found that there is a relationship between need for cognition and the RB phenomenon. They suggested that people’s degree of rationality affects whether they use the rational or the experiential system in understanding the probability information. The greater their need for cognition is (i.e., the more they enjoy and engage in effortful cognitive activity), the less likely the RB phenomenon will occur.
In summary, research in social psychology found that when the probability of an uncertain positive event occurring is expressed in the N-in-N*X format, people perceive the event to be more likely to occur than when the same probability is expressed in the 1-in-X format (Alonso and Fernandez-Berrocal, 2003; Denes-Raj and Epstein, 1994; Kirkpatrick and Epstein, 1992; Pacini and Epstein, 1999). This is because people process information with two different systems – experiential and rational (Denes-Raj and Epstein’s, 1994; Pacini and Epstein, 1999). When people process information using the rational system, different numerical formats do not lead to differences in perceived probability if the probabilities are mathematically equivalent. However, when people process information using the experiential system, the RB phenomenon occurs due to the numerosity effect, small-number effect, and the affirmative representation principle (Pacini and Epstein, 1999). In addition, it is found that the extent to which the RB phenomenon occurs depends on an individual’s degree of rationality (Alonso and Fernandez-Berrocal, 2003).

2.2.2. 1-in-X Format Increases Perceived probability

Contrary to what has been found in the social psychology literature, in the medical decision making literature, researchers have found a 1-in-X effect — when the probability of being affected by the risk is communicated using the 1-in-X format, people perceive the probability to be higher than when the same risk is communicated using the N-in-N*X format or the percentage format (Pighin, et al., 2011; Sirotta, et al., 2014; Zikmund-Fisher, 2011, 2013). Pighin and colleagues were first to investigate the 1-in-X effect in the medical field (Pighin et al. 2011). Pighin and colleagues found that when participants were asked to imagine that they had bought a trip to Kenya but just learned that there was a 1-in-200 (or 5-in-1000) risk of contracting malaria while traveling to Kenya. Participants rated the subjective probability of
contracting malaria to be significantly higher when the risk was 1-in-200 than when it was 5-in-1000.

Several explanations for the 1-in-X effect have been explored. Pighin and colleagues (2011) suggested that the 1-in-X effect occurred when the difference in the number of digits between the numerator and denominator was higher in the N-in-N*X format than in the 1-in-X format. However, they found that when a risk was expressed in 1-in-12 vs. 10-in-120, the 1-in-X effect still occurred. In both 1-in-12 and 10-in-120 formats, the numerator had 1 less digit than the denominator. Therefore, they ruled out this explanation.

The second explanation they ruled out was numerator neglect. Pighin and colleagues (2011) suggested that because the denominator of the 1-in-X format was always smaller than the denominator of the N-in-N*X format, people might focus on the denominator and neglect the numerator resulting in the 1-in-X effect. However, when they tested 3-in-48 vs. 10-in-160, the 1-in-X effect did not occur. This finding showed that when people looked at ratios, they did not neglect the numerator.

Apart from these two explanations, Sirota and colleagues have ruled out a few other explanations. Sirota and colleagues explained that 1-in-X effect was not caused by denominator neglect (Sirota et al. 2014). Denominator neglect suggests that when looking at ratios, people only focus on the numerator and compare ratios by contrasting numerators (Denes-Raj and Epstein, 1994; Kirkpatrick and Epstein, 1992; Miller, et al. 1989, Pighin et al., 2011). According to this theory, when risk is presented in 1-in-X or N-in-N*X, people will only focus on the numerator 1 or N. Since N is more than 1, people will perceive the probability to be higher when the risk is presented as N-in-N*X than when it is presented as 1-in-N. However, this tendency predicts the opposite of the 1-in-X effect. Therefore, Sirota and colleagues concluded that
denominator neglect was not a viable explanation.

Sirota and colleagues also suggested that the group diffusion effect was not a viable explanation for the 1-in-X effect (Sirota et al. 2014). The group-diffusion effect suggests that the bigger the reference class, the smaller the perceived probability (Price and Matthews, 2009; Yamaguchi, 1998). However, Sirota and colleagues found that when asking participants to rate perceived probability when a risk is presented in 1-in-12, 5-in-60, or 10-in-120, participants who saw the risk presented as 1-in-12 rated the perceived probability to be significantly higher than participants who saw the risk presented as 5-in-60 or 10-in-120. In addition, there was no difference in perceived probability between 5-in-60 and 10-in-120. This finding contradicts the group diffusion effect. If the 1-in-X effect is caused by the group diffusion effect, presenting risk in 5-in-60 should lead to a perceived probability that falls in between 1-in-12 and 10-in-120 because the reference class for 5-in-60 is 60 which falls in between the reference classes 12 and 120. Therefore, Sirota and colleagues concluded that the group diffusion effect could not explain the 1-in-X effect.

Another explanation suggested by Sirota and colleagues was the difference in individual numeracy and cognitive reflection (Sirota et al., 2014). However, Sirota and colleagues found that the 1-in-X effect was not more prevalent among participants with a low level of numeracy or cognitive reflection. Therefore, individual numeracy and cognitive reflection were found to be irrelevant to the 1-in-X effect. Furthermore, Sirota and colleagues found that the mechanism of 1-in-X effect was not culturally or linguistically specific after testing the effect across different populations and finding similar results.

In addition to the studies conducted by Pighin et al. (2011) and Sirota et al. (2014), Zikmund-Fisher claimed that because 1-in-X is usually used to express small risk, what is
communicated is not the probability of risk but rather whether the risk will occur (Zikmund-Fisher 2011, 2014). He argued that 1-in-X creates a gist meaning that the risk can occur, but N-in-N*X creates a gist meaning that the risk is unlikely to occur. However, whether people actually perceive them this way was not empirically tested in his studies.

In more recent research, Oudhoff and Timmermans (2015) found that the 1-in-X effect occurs when the denominator of the 1-in-X format is as small as 3.4 up to as big as 700. As the denominator became bigger, the difference in perceptions of probability between 1-in-X and N-in-N*X became smaller. However, the difference remained significant. They also found that when the risk was a fictional lottery instead of medical risk, the 1-in-X effect still occurred. In addition, they found that when the probability was presented in the 1-in-X format, participants took less time to respond, and reported that the risk could be imagined more easily. However, they did not conduct a systematic investigation on whether these are viable explanations of the 1-in-X effect. Oudhoff and Timmermans (2015) suggested that participants took less time to respond because the risk information was easier to be comprehended when the probability was presented in the 1-in-X format. Therefore, I would focus on testing whether ease of imagining the risk is a viable explanation because ease of comprehension leads to ease of imagining the risk as suggested by Denes-Raj and Epstein (1994). However, I would not focus on testing whether less processing time explains the 1-in-X effect because less processing time can be seen as a result of ease of comprehension or imagination (Oudhoff and Timmermans, 2015).

In summary, research in the medical decision literature suggests that when a risk is communicated in the 1-in-X format, people perceive the risk to be more likely to happen than when it is communicated in the N-in-N*X format or the percentage format (Oudhoff and Timmermans, 2015; Pighin et al., 2011; Sirota et al., 2014). However, a theoretical explanation
for the 1-in-X effect has still not been determined. Explanations that have been ruled out include relative number of digits, numerator neglect, denominator neglect, group diffusion effect, individual numeracy and cognitive reflections (Pighin et al., 2011; Sirota et al., 2014). The possibility that the mechanism of 1-in-X effect is culturally or linguistically specific has also been ruled out (Sirota et al., 2014). A possible explanation suggested by Oudhoff and Timmermans (2015) is that the 1-in-X format triggers ease of imagining the risk and this ease of imagination heightens the perceived probability of being affected by the risk. However, this explanation has not been empirically tested. For my thesis, I investigated the role of ease of imagination in risk communication.
3. Hypotheses Development

3.1. Direct Effect of 1-in-X format on Perceived Probability

In the social psychology literature, it is found that when the probability of an uncertain event occurring is expressed in the N-in-N*X format, people perceive the event to more likely occur than when the same probability is expressed in the 1-in-X format (Alonso and Fernandez-Berrocal, 2003; Denes-Raj and Epstein’s, 1994; Kirkpatrick and Epstein, 1992; Pacini and Epstein, 1999). However, contrary to this finding, in the medical decision making literature, it is found that when a risk is presented in the 1-in-X format, people perceive the probability of the risk to be higher than when the same risk is presented in the N-in-N*X format (Oudhoff and Timmermans, 2015; Pighin et al., 2011; Sirota et al., 2014). The opposite findings in the literature raise the question to why the 1-in-X numerical format leads to different perceived probability. I speculate that this happens because in the social psychology literature, the uncertain events were either positive events or were treated as non-negative events due to the affirmative representation principle. For example, participants automatically transferred the 1-in-10 probability of losing a game into a 9-in-10 probability of not losing the game. This may be because that, in the studies, participants were given a sum of money at the beginning of the experiment, making participants more optimistic that losing money in the game was not much of a risk.

Contrary to these experiments in the social psychology literature, in the medical decision making literature, the uncertain events communicated to participants were all negative events (i.e. risks). In such cases, how participants process the information may be different from how participants process positive or non-negative uncertain events. When researchers communicate a risk, participants could view the information as a non-negative event, similar to how participants
respond to the jelly bean and tickets game. For example, when communicating the risk of contracting malaria is 1-in-200, participants could view this information as 199-in-200 people not affected by the disease. However, research has shown that participants did not interpret the risk information this way (Oudhoff and Timmermans, 2015; Pighin, et al., 2011; Sirota, et al., 2014; Zikmund-Fisher, 2011, 2013) rather they comprehended the risk information directly. One possible explanation to this finding is that the risks used in the medical decision making literature were more severe and relevant to the participants compared to “returning” money to the researchers in the social psychology experiments. Therefore, participants focused more on comprehending the risks instead of transferring the risk information into non-negative information. Oudhoff and Timmermans’ (2015) research further corroborates this speculation. Oudhoff and Timmermans used a lottery as the context of their research, which is mechanically similar to drawing jelly beans or tickets in the social psychology studies. However, Oudhoff and Timmermans asked participants to imagine paying for the ticket from their own pocket. Therefore, participants would have seen the lottery as more of a risk. Because in this thesis, I am interested in looking at how numerical formats (i.e. 1-in-X and n-in-N*X) affect perceived probability of health risks, I hypothesize that my findings will be consistent with the findings of the medical decision making literature – presenting a risk in the 1-in-X format will increase the perceived probability of being affected by health risks. Therefore, I hypothesize:

H1: When 1-in-X format is used to present a health risk in a fear appeal message, consumers will perceive the probability of being affected by the risk to be higher than when the risk is presented in the N-in-N*X format.
3.2. *Indirect Effect of 1-in-X format on Perceived Probability*

The explanation proposed by Oudhoff and Timmermans (2015) suggests that the 1-in-X format leads to ease of imagining a threat. This ease of imagination further leads to a heightened perceived probability of the threat. In the following section, I will first discuss literature that supports that the 1-in-X format leads to ease of imagination. I will then discuss literature that supports that ease of imagining an event heightens the perceived probability that the event will happen.

3.2.1. *1-in-X Leads to Ease of Imagining the Risk*

According to the concreitive principle of CEST, information is more comprehensible if it is more concrete (Epstein, 1998). As the psychological magnitude of a number follows a power function with an exponent in the range of 0.7-0.8 (Schneider, et al., 1974), small numbers are more likely to be concrete than large numbers because the psychological magnitude of the number becomes smaller as the number becomes bigger, meaning that the perceived difference in numbers become smaller as the number becomes larger. This suggests that because smaller numbers are more easily comprehended, they can help people imagine the risk information more easily (Denes-Raj and Epstein, 1994).

In addition to the concreteness of small numbers, retrieval fluency can help people imagine risk presented in 1-in-X more easily than in N-in-N*X. Research has shown that images of future experiences are generated from existing autobiographical memory (D’Argembeau and Van der Linden, 2004). It is easier to retrieve 1 person (when 1-in-X format is used) than N people (when N-in-N*X format is used) from memory (Schwarz et al., 1991). These findings support the prediction that it is easier for people to imagine a risk when it is presented in the 1-in-X format compared to the N-in-N*X format. In addition, people would focus on retrieving 1
person out of X people and N people out of N*X people due to figure-ground relations (Pacini and Epstein, 1999). The 1 person or the N people that are affected by the threat stand out as figures against the background of healthy people. One person as a figure in the background of X people is likely to be more salient than N people in a background of N*X people. Moreover, previous findings by Oudhoff and Timmermans (2015) show that when a risk is presented in the 1-in-X format, participants reported they could imagine the event more easily.

Together, the aforementioned research lend support to the notion that people will imagine risk that is communicated in the 1-in-X format more easily than when it is communicated in the N-in-N*X format.

3.2.2. Ease of Imagination Leads to Heightened Perceived Probability

The simulation heuristics suggest that if an uncertain event is mentally constructed or imagined, people tend to think that there is a higher probability that it happens (Tversky and Kahneman, 1982). Therefore, if it is easier for consumers to imagine the risk when the risk is expressed in the 1-in-X format, consumers will perceive this risk to have a higher probability.

Several researchers have investigated how ease of imagining an uncertain event impacts perceived probability of the event happening. For example, Sherman, Cialdini, Schwartzman, and Reynolds (1985) investigated people’s perceived probability of contracting a disease (Hyposcenia-B) when presenting participants with easy-to-imagine symptoms or hard-to-imagine symptoms. They found that participants who were required to imagine experiencing the easy-to-imagine symptoms perceived that the probability of contracting the disease to be higher than participants who only read about the disease, whereas participants who were required to imagine experiencing the difficult-to-imagine symptoms perceived that the probability of contracting the disease to be lower than participants who only read about the disease. This research suggests that
if it is easy to imagine being affected by a health risk when the risk is expressed in the 1-in-X format and if it is difficult to imagine being affected by the risk when the risk is expressed in the N-in-N*X format, consumers will perceive the probability of being affected by the health risk is higher if the risk is expressed in the 1-in-X format than if the risk is expressed in the N-in-N*X format.

3.2.3. Ease of Imagination as a Mediator

In the present research, I argue that when a health risk is presented in the 1-in-X format, it is easier for consumers to imagine being affected by the risk, and the ease of imagination will lead to a higher perceived probability of the risk. On the other hand, when the same risk is presented in the N-in-N*X format, it is difficult for consumers to imagine being affected by the risk, and the difficulty in imagining the event occurring would lead to a lower perception of the risk in comparison. Therefore, I hypothesize:

H2: Ease of imagining being affected by a health risk will mediate the effect of communication format on perceived probability of the risk.
4. Study 1

Study 1 aimed to first test when communicating a fear appeal message, whether there is a direct effect of numerical format on perceived probability of being affected by a health risk. More specifically, I aimed to test whether consumers perceive the probability of being affected by a risk to be higher when the risk is presented in the 1-in-X format than when it is presented in the N-in-N*X format.

I also aimed to test an indirect effect – whether ease of imagining the risk mediates the effect of numerical format on the perceived probability of being affected by the risk. More specifically, I aimed to test whether it is easier for consumers to imagine being affected by the risk when the risk is presented in the 1-in-X format compared to when the risk is presented in the N-in-N*X format and whether ease of imagining the risk leads to a higher perceived probability of being affected by the risk.

4.1. Methodology

4.1.1. Participants and Design

A total of 124 participants (58.9% were male, mean age 33) participated in the study in exchange for $0.50. They were recruited on Amazon Turk. They were randomly assigned to one of the two conditions: the 1-in-9 condition and the 12-in-100 condition.

4.1.2. Stimuli

To test the two hypotheses, I focused on a problem that many people face, a lack of exercise, and its risks. It has been shown that people who do not meet the physical activity recommendations of doing at least 30 minutes of moderate physical activity 5 days a week have a chance of developing heart disease (i.e. coronary artery disease) (Park, 2012).

In the study, participants were asked to read an essay that promotes a regular program of
physical exercise (Appendix 1). The essay first described coronary artery disease and the severity of the disease. Then the essay provided an effective way to prevent contracting the disease – by doing a regular program of exercise. Next, the essay emphasized that starting to do exercise may seem difficult, but it actually is not because all they needed was 30 minutes of moderate physical activity. This helped participants to identify an effective means to prevent the risk. Lastly, the essay provided the probability of contracting coronary artery disease if they do not meet the physical activity recommendation. The probability was presented as either 1-in-9 or 12-in-100. These two conditions were selected because they represent the actual probability of contracting coronary artery disease resulting from lack of exercise (Park, 2012). In addition, the probability of 1-in-9 is mathematically greater than the probability of 12-in-100. It might be interesting to investigate whether the 1-in-X effect was strong enough that despite the difference, people still perceived the risk to be greater in the 1-in-9 condition.

4.1.3. Dependent Measures

Two attention check questions were included in the instrument to check whether participants took time to read the essay (Appendix 2). Both questions were related to the content of the essay.

Five dependent variables were measured in this study (Appendix 3). The first three dependent variables were the perceived probability of contracting coronary artery disease, the severity of coronary artery disease, and how worried participants were regarding the 1-in-9 (12-in-100) chance of contracting coronary artery disease. The first three dependent variables were adapted from Pighin et al. (2011). In addition to these three measures, I added another two dependent variables to capture participants’ intentions to exercise in the future. The two dependent variables were how likely they are going to exercise in the future and how frequent
they are going to exercise in the future. All of the dependent variables used a 7-point Likert scale.

The mediator of ease of imagining the risk was measured using three items (Appendix 4). These three items were adapted from Johnson et al. (1988). They measured the clarity, visual details, and vividness of participants’ imagined thoughts. All the items used a 7-point Likert scale.

4.1.4. Procedure

Before participants began, they were provided with information regarding the study but the information did not reveal the true purpose of the study. If participants agreed to participate, they could proceed to the next page which presented the essay on coronary artery disease. After reading the essay, participants were asked to complete the attention check questions. Then they were asked to respond to the dependent variable measures and items of the ease of imagining the risk construct. Lastly, participants were asked to answer a few demographic questions (Appendix 5). The demographic questions included basic demographics such as gender and age. There were also questions regarding whether participants had medical or family history of heart-related problems. People who have medical or family history of heart-related problems may not be subject to the manipulations as they may generally be worried about heart diseases. In addition, a question of how often they exercise each week was also included. People who exercise every day may not find the stimuli relevant. At the end of the study, the participants were thanked and debriefed.
4.2. Results and Discussion

4.2.1. Attention Check

For both of the attention check questions, the accuracy rates were above 90%. 97.5% of the participants responded to the first attention check question correctly and 92.7% of the participants responded to the second attention check question correctly. Therefore, I concluded that participants read the essay and understood what they read.

4.2.2. Dependent Variables

The mean values for each dependent variable in the two conditions (the 1-in-9 and the 12-in-100 condition) were calculated and one-way ANOVAs were performed to test whether the differences in the mean values between the two conditions were significant. The mean values are shown in Figure 4.1 and the ANOVA results are summarized in Table 4.1.

![Figure 4.1: Mean Values of Dependent Variables](image)

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>F statistic</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived probability of contracting coronary artery disease</td>
<td>10.974</td>
<td>.001</td>
</tr>
<tr>
<td>Severity of coronary artery disease</td>
<td>3.701</td>
<td>.057</td>
</tr>
<tr>
<td>Worrisomeness</td>
<td>6.733</td>
<td>.011</td>
</tr>
<tr>
<td>Likelihood of future exercise</td>
<td>6.874</td>
<td>.010</td>
</tr>
<tr>
<td>Future exercise frequency</td>
<td>1.044</td>
<td>.309</td>
</tr>
</tbody>
</table>
The results suggest that participants perceived the probability to be significantly higher \[ F(1, 122) = 10.974, p=0.001 \] when the chance of contracting coronary artery disease was described as 1-in-9 \( (M = 4.20, \text{SD} = 1.427) \) than when it was described as 12-in-100 \( (M = 3.42, \text{SD} = 1.197) \). Participants were more worried \[ F(1,120) = 6.733, p=0.011 \] in the 1-in-9 condition \( (M = 4.41, \text{SD} = 1.766) \) than in the 12-in-100 condition \( (M = 3.64, \text{SD} = 1.483) \). Participants were also more willing to start to exercise in the future \[ F(1, 122) = 12.056, p=0.010 \] in the 1-in-9 condition \( (M = 5.89, \text{SD} = 1.223) \) than in the 12-in-100 condition \( (M = 5.27, \text{SD} = 1.425) \). In addition, severity of coronary artery disease is marginally significant \[ F(1, 121) = 5.047, p=0.057 \], meaning that numerical formats also marginally affected how people perceived the severity of coronary artery disease. Participants who read the risk being 1-in-9 perceived the disease to be marginally more severe \[ F(1, 121) = 5.047, p=0.057 \] than participants who read the risk being 12-in-100 \( (M = 6.02, \text{SD} = 1.120 \text{ vs. } M = 5.61, \text{SD} = 1.218) \). However, the mean value of future exercise frequency (per week) in the 1-in-9 condition \( (M = 5.41, \text{SD} = 1.231) \) was not significantly different \[ F(1, 122) = 1.044, P=0.309 \] than the mean value in the 12-in-100 condition \( (M = 5.17, \text{SD} = 1.380) \). The mean difference was only 0.24. A possible explanation to this finding could be that the essay described exercising 5 times a week could effectively prevent coronary artery disease. Therefore, participants in either condition might have a tendency to report that they were likely to exercise around 5 times a week \( (1\text{-in-9 condition: } M = 5.41, \text{SD} = 1.231 \text{ vs. } 12\text{-in-100 condition: } M = 5.17, \text{SD} = 1.380) \).

In addition to the above findings, a closer examination of the data revealed that there was evidence suggesting that a general 1-in-X effect existed regardless of whether the participants met the physical exercise recommendations or not. A summary of how frequently participants reported exercising per week is shown in Figure 4.2 below.
Among the 124 participants, 27 of them exercised 5 times or more per week. The mean values of each condition of the study are shown in Figure 4.3.

Among participants who did not meet the physical exercise recommendation, participants who were in the 1-in-9 condition rated the perceived probability (M = 4.31, SD = 1.432) to be significantly higher (D = 0.80, t = 3.077, p =0.003) than participants in the 12-in-100 condition (M = 3.51, SD = 1.120). For participants who met the physical exercise recommendation, the mean perceived probability of participants in the 1-in-9 condition (M = 3.88, SD = 1.408) was
0.88 higher than participants in the 12-in-100 condition (M = 3.00, SD = 1.483). However, there was not enough number of participants in each group to make a scientific conclusion on whether the mean difference was significant. However, this mean difference was similar to the mean difference between groups that did not meet physical exercise recommendation.

In addition, there was also evidence suggesting that a general 1-in-X effect existed regardless of whether the participants had family history of heart disease. A summary of whether participants had medical or family history is shown in Figure 4.4.

Among all the participants, 8 of them had medical history of heart disease and 47 of them reported that they had family history of heart disease. There was insufficient number of participants who had medical history of heart disease for a further analysis. However, a more detailed analysis was made on whether participants had family history of heart disease x conditions. Findings are shown in Figure 4.5.
There were not enough participants to conclude that the mean differences between the two conditions were significant for participants who had family history of heart disease or participants who did not. However, for participants who had family history of heart disease, the mean perceived probability of participants who read the risk as 1-in-9 (M = 4.50, SD = 1.295) was greater than the mean perceived probability of participants who read the risk as 12-in-100 (M = 3.53, SD = 0.990). For participants who did not have a family history of heart disease, the mean perceived probability of the 1-in-9 condition (M = 3.91, SD = 1.510) was also greater than the mean perceived probability of the 12-in-100 condition (M = 3.38, SD = 1.267).

From the analysis, there is support for people perceiving the probability of contracting the disease is significantly higher when presenting the risk of contracting coronary artery disease is displayed as 1-in-9 than when presenting the risk as 12-in-100. People were also more worried and more willing to exercise regularly in the future when seeing the risk as 1-in-9 instead of 12-in-100. Therefore, Hypothesis 1 is supported. Additionally, despite that the actual probability of 12-in-100 is mathematically greater than 1-in-9, the perceived probability of 1-in-9 was still higher than the perceived probability of 12-in-100. This implies that the 1-in-X effect is powerful.
enough that it can override the actual difference between the two ratios. In addition, there was evidence suggesting that the 1-in-X format was powerful enough to affect everyone regardless of exercise frequency or family history.

4.2.3. Mediator: Ease of Imagining the Risk

To examine whether the difference in ease of imagining the risk is significant between the two conditions, first a correlation matrix was generated to determine whether the three items of the construct were highly correlated with each other. The correlation matrix is shown in Table 4.2.

<table>
<thead>
<tr>
<th></th>
<th>Clarity of imagined thoughts</th>
<th>Visual detail of imagined thoughts</th>
<th>Vividness of imagined thoughts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarity of imagined thoughts</td>
<td>1</td>
<td>.666**</td>
<td>.670**</td>
</tr>
<tr>
<td>Visual detail of imagined thoughts</td>
<td>.666**</td>
<td>1</td>
<td>.856**</td>
</tr>
<tr>
<td>Vividness of imagined thoughts</td>
<td>.670**</td>
<td>.856**</td>
<td>1</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation matrix shows that all three items are highly correlated – the items achieve convergent validity. Cronbach’s Alpha was also generated to examine the reliability of the items in measuring the construct. As the Cronbach’s Alpha is 0.891, it implies that these three items are reliable in measuring the ease of imagining the risks construct. Therefore, the three items are averaged and the average was used to represent the ease of imagining the risk construct.

A one-way ANOVA analysis was performed to examine whether ease of imagining the risk was significantly different between the two conditions. Results showed that the mean value of the 1-in-9 condition (M = 5.4167, SD = 1.10315) was not significantly different [F (1, 121) = 1.981, p = 0.162] than the mean value of the 12-in-100 condition (M = 5.1073, SD = 1.33109). In
other words, how easy it was to imagine the risk did not differ when the risk was presented as 1-in-9 or when the risk was presented as 12-in-100. However, this insignificance could also be caused by participants not focusing on reporting how they felt about the ratios. In the essay that was presented to the participants, there were imagery descriptions on what coronary artery disease is, such as “cholesterol-laden plaque builds up on the inner side of the artery walls ... narrows the arteries, slowing the flowing of blood ... flows to your heart.” Participants may have reported the ease of imagining these descriptions. Therefore, in Study 2, we tried to avoid this problem by using a stimulus that contained minimal descriptions of the risk.
5. Study 2

Study 1 found that people perceived the probability of contracting coronary artery disease to be higher when they read the risk was 1-in-9 than when they read the risk was 12-in-100. Participants who were assigned to the 1-in-9 condition were also more worried and more willing to exercise regularly in the future than participants who were assigned to the 12-in-100 condition. However, the imagery descriptions of coronary artery disease may have interfered with how participants reported the ease of imagining the risk information. Therefore, in this study, to avoid participants reporting on imagery descriptions, we used a stimulus that was employed by various researchers in the medical decision making literature (Pighin et al., 2011; Siroti et al., 2013).

5.1. Methodology

5.1.1. Participants and Design

82 Canadian and American adults took part in the study (45.1% female, mean age 34) in return for $25. They were recruited on Amazon Turk. Participants were randomly assigned to one of the two conditions: the 1-in-200 condition and the 5-in-1000 condition.

5.1.2. Stimuli

The stimulus that participants read was

“Imagine that you have bought a trip to Kenya and you have just read that the risk of being affected by malaria while traveling to Kenya is [1 in 200; 5 in 1000].”

Within this stimulus, except for providing the probabilities, a minimal description was provided about the disease.
5.1.3. Dependent Measures

Participants were asked to rate the subjective probability of contracting malaria, how severe malaria is and how worried they were regarding the risk information (Appendix 6). These dependent variables were adopted from Pighin et al. (2011). All three dependent variables used 7-point Likert scales.

In addition, participants were asked to respond to the ease of imagining the risks’ items. The mediator, ease of imagining the risk, was measured using three items (Appendix 7), similar to ones used in Study 1. These three items were adapted from Johnson et al. (1988). They measure the clarity, visual details and vividness of participants’ imagined thoughts. All the items used a 7-point Likert scale.

5.1.4. Procedure

Before participants began the study, they were provided information about the study. If participants agreed to participate, they could proceed to the next page which showed the stimulus. Participants were then asked to respond to the dependent variable measures and the items of the ease of imagining the risk construct. Then they were asked to answer basic demographic questions (gender and age), and they were thanked and debriefed.

5.2. Results and Discussion

5.2.1. Dependent Variables

The mean values for each dependent variable in the two conditions (the 1-in-200 and the 5-in-1000 condition) were calculated and one-way ANOVAs were performed to test whether the differences in the mean values between the two conditions were significant. The mean values are shown in Figure 5.1 and the ANOVA results are summarized in Table 5.1.
The results for the dependent variables showed that the mean value of the perceived probability for the 1-in-200 condition (M = 4.35, SD = 1.460) was significantly higher \([F (1, 80) = 26.154, p=0.000002]\) than the mean value for the 5-in-1000 condition (M = 2.71, SD = 1.436). The mean value of worrisomeness for the 1-in-200 condition (M = 5.23, sd = 1.310) was also significantly higher than the mean value for the 5-in-1000 condition (M = 3.90, SD = 1.543). These findings suggest that when the chance of contracting malaria was presented as 1-in-200, participants perceived the probability to be higher and felt more worried than when the chance was presented as 5-in-1000. However, the mean value of severity of malaria for the 1-in-200 condition (M = 5.50, SD = 1.198) was not significantly higher \([F (1, 80) = 2.225, p=0.14]\) than the mean value for the 5-in-1000 condition (M = 5.83, SD = 0.794), meaning that how the probability was presented did not affect how severe people thought malaria was. These results
are similar to what was found by Pighin and colleagues (2011).

5.2.2. Mediation Analysis

To test whether ease of imagining the risk mediates the relationship between numerical format and perceived probability, I examined the correlation matrix for ease of imagining the risk construct to determine convergent validity. The matrix is shown in Table 5.2.

Table 5.2: Correlation Matrix for the Ease of Imagination Items

<table>
<thead>
<tr>
<th></th>
<th>Clarity of imagined thoughts</th>
<th>Visual detail of imagined thoughts</th>
<th>Vividness of imagined thoughts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarity of imagined thoughts</td>
<td>1</td>
<td>.702**</td>
<td>.604**</td>
</tr>
<tr>
<td>Visual detail of imagined thoughts</td>
<td>.702**</td>
<td>1</td>
<td>.880**</td>
</tr>
<tr>
<td>Vividness of imagined thoughts</td>
<td>.604**</td>
<td>.880**</td>
<td>1</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation matrix shows that all three items were highly correlated. In addition, the Cronbach’s Alpha for the ease of imagining the risk construct is 0.89 meaning that the three items are reliable in measuring the construct. Therefore, I calculated the average of these three items and used the average in the mediation analysis.

Using the two different numerical format conditions as my independent variable, the perceived probability of contracting malaria as my dependent variable, and the average of the three ease of imagining the risk items as my mediator, I ran a mediation analysis with Process Model 4 developed by Preacher and Hayes (2004), with 5000 bootstrapping samples. The results are summarized in Fig. 5.2 and the SPSS output is included in Appendix 8.
As seen in Figure 5.2, how the probability of contracting malaria was presented had a direct effect on the perceived probability of contracting malaria ($\beta=1.637$, SE=0.3198, \(p=0.0000\)). When ease of imagining the risk was added as a mediator, the direct effect of numerical formats on perceived probability became smaller, but remained significant ($\beta=1.4070$, SE=0.3064, \(p=0.0000\)). From bootstrapping 5000 samples, the mediation analysis indicated that the indirect effect (a*b) was significant ($\beta=0.2287$, SE=0.1382) as the bootstrapping confidence interval (0.0145, 0.5654) did not contain 0. These results suggest that ease of imagining the risk mediates the relationship between how the probability of contracting malaria was presented numerically and perceived probability of contracting malaria. However, this mediation is only partial because when the mediator was added as a predictor, the direct effect still remained significant.

In this second study, the results suggest that when the risk of contracting malaria was
presented as 1-in-200, people perceived the probability of contracting malaria to be higher and were more worried than when the risk was presented as 5-in-1000. In addition, ease of imagining the risk partially mediated the relationship between the numerical communication formats and the perceived probability of contracting the disease. Therefore, Hypothesis 2 is partially supported.
6. General discussion

In this thesis, I tested (Hypothesis 1) when 1-in-X format is used to present a health risk in a fear appeal message, consumers will perceive the probability of being affected by the risk to be higher than when the risk is presented in the N-in-N*X format. Results from two experimental studies using two different risk contexts (i.e., coronary heart disease, malaria) and two different ratio pairs (i.e., 1-in-9 vs. 12-in-100, 1-in-200 vs. 5-in-1000) supported this hypothesis.

In Study 1, when the risk of contracting coronary artery disease was presented in the 1-in-X format, participants reported that the perceived probability of contracting the disease to be greater than when it was presented in the N-in-N*X format. Participants were also more worried and more likely to exercise regularly in the future. Additionally, it is worth noting that in Study 1, the pair of ratios used was 1-in-9 and 12-in-100, and the actual probability of 12-in-100 is mathematically greater than 1-in-9. Despite this mathematical difference, the perceived probability of 1-in-9 was still higher than the perceived probability of 12-in-100, implying that the 1-in-X effect is powerful enough to ignore the actual difference between the two ratios. In addition, there was evidence suggesting that the 1-in-X effect is powerful enough to generally affect everyone - regardless of how much participants exercise or whether they have medical or family history of heart disease.

In this thesis, I also aimed to test (Hypothesis 2) ease of imagining the risk information as a mediator on the effect of communication format on perceived probability of being affected by the risk. This hypothesis was also supported. The results from Study 2 suggested that the ease of imagining the risk information partially mediates the relationship between how the probability of the risk occurring was presented numerically and the perceived probability of being affected by the risk.
7. Contribution

7.1. Theoretical contributions

My research offers several contributions to theory. First, I replicated Pighin and colleagues’ study (2011) and confirmed their findings that when 1-in-X is used in presenting a medical risk, people perceive the probability of being affected by the risk to be higher than when the N-in-N*X format is used.

Second, I found that when utilizing the 1-in-X format in fear appeal messages, the 1-in-X effect still exists. In addition, the 1-in-X effect not only heightens the perceived probability of being affected by the health risk, but also more effectively helps consumers form intentions to change their behavior.

Third, the results of Study 2 provide an explanation to why 1-in-X effect occurs. Previously, researchers investigated many heuristics that people might use in processing the 1-in-X numerical formats (Oudhoff and Timmemans, 2015; Pighin, et al., 2011; Sirotta, et al., 2013; Zikmund-Fisher, 2011, 2013). However, none of the heuristics could explain the 1-in-X effect. In this research, we offered a viable explanation to the 1-in-X effect. The 1-in-X effect occurs because when the probability of being affected by the risk is presented in the 1-in-X format, people could imagine the risk information more easily. As the risk information is more easily imagined, people tend to believe that the probability of being affected by the risk is higher.

7.2. Managerial contributions

Each year, to combat health challenges, government of Canada spends billions of dollars on public health (Canadian Institute for Health Information, 2014). The findings of this thesis may help the government and social marketers to communicate health risks more effectively. As people perceive the risks to be higher and are more likely to take actions to reduce the risk when the probability of being affect by the risk is presented in the 1-in-X format, social marketers
should use the 1-in-X format more when aiming to encourage good health behaviors.

In addition, the findings of this thesis also imply the importance of triggering imagination when social marketers aim to reduce consumers’ risky health behaviors. When people imagine that the risk is going to happen to them, they start to feel that it is more likely to happen to them. They start to become more worried and are more likely to take actions. Therefore, marketing campaigns should consider incorporating ways to facilitate imagining the consequences of health risks in their messages to improve the likelihood that consumers will reduce risky behaviors.
8. Limitations and Future research

One limitation of this research is I only measured participants’ intentions to change risky health behavior. Although I found that people are more likely to exercise in the future when the health risk is presented in the 1-in-X format, whether people actually start to do exercise is not measured. In future research, I suggest including both intention measures and behavioral measures.

In addition, future research should also investigate whether the 1-in-X effect is powerful enough that it generally affects everyone regardless of differences in their health. In this research, although we found evidence suggesting this assertion, there was not enough number of participants to make a scientific conclusion. In future research, it would be interesting to recruit more participants and test whether individual differences might moderate the 1-in-X effect.

Future research should also investigate how powerful the 1-in-X format is. In Oudhoff and Timmermans’ research, it has been shown that when the probability becomes smaller, the 1-in-X effect becomes smaller (2015). Although it was still significant when the denominator of the 1-in-X format was as big as 700 (Oudhoff and Timmermans, 2015), there may be a denominator that is so big that the 1-in-X effect no longer exists. If this denominator can be found, social marketers can use this 1-in-X effect more effectively.

In this research, we assumed initially that our results would be consistent with what has been found in the medical decision making literature because both medical and health risks are negative uncertain events. We assumed that our results would be inconsistent with what has been found in the social psychology literature because in social psychology literature, all uncertain events were positive events. The findings of this research supported this assumption. However, it may be interesting to look at this in a more systematical manner. The findings of this research
may suggest that the difference in how people process the numerical formats may relate to verbal and visual information processing (Childers, et al., 1985). When 1-in-X is used to communicate the likelihood of a risk, people actually go through the visual processing - imagining what the risk actually is. However, when 1-in-X is used to communicate the likelihood of a reward, people may not take the time to imagine the likelihood and think through what it actually means. When it is a reward, people may not care as much as if it is a risk. Therefore, they may simply go under a verbal information processing and use heuristics such as denominator neglect to judge the likelihood. In future research, it might be interesting to investigate why people process positive and negative information differently.
References


Appendix 1: Stimuli for Study 1

Coronary artery disease is the most common type of heart disease. It happens when cholesterol-laden plaque builds up on the inner side of the artery walls. The plaque narrows the arteries, slowing the flowing of blood and reducing the amount of blood and thus oxygen that flows to your heart. As the plaque burden builds up over time, it can lead to serious problems, including heart attacks.

To prevent coronary artery disease, a regular program of exercise is proven to be one of the most effective ways. Exercise can lead to higher levels of high-density lipoprotein, lowering the level of cholesterol and thus effectively preventing coronary artery disease.

To be healthy and to prevent coronary artery disease, all you need is 30 minutes of moderate physical activity 5 times a week. Without this regular program of exercise, there is a [1-in-9; 12-in-100] chance that you contract coronary artery disease.
Appendix 2: Attention Checks for Study 1

The cholesterol-laden plague that builds up on the inner side of the artery walls slows the flowing of blood and reducing the amount of blood and thus oxygen that flows to your heart.

- True
- False

How many minutes are recommended to exercise 5 times a week to prevent coronary artery disease?

- 10 minutes
- 20 minutes
- 30 minutes
- 40 minutes
- 50 minutes
- 60 minutes
Appendix 3: Dependent Variables Measures for Study 1

In your opinion, the probability of contracting coronary artery disease is

<table>
<thead>
<tr>
<th>Extremely Low</th>
<th>Neutral</th>
<th>Extremely High</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Coronary artery disease is a disease that is

<table>
<thead>
<tr>
<th>Not severe at all</th>
<th>Neutral</th>
<th>Extremely severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How worried would you be about the probability of [1-in-9; 12-in-100] of contracting coronary artery disease?

<table>
<thead>
<tr>
<th>Not worried at all</th>
<th>Neutral</th>
<th>Extremely worried</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How likely are you going to exercise regularly in the future?

<table>
<thead>
<tr>
<th>Extremely unlikely</th>
<th>Neutral</th>
<th>Extremely likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How often are you going to exercise regularly in the future?

<table>
<thead>
<tr>
<th>Not frequently at all</th>
<th>Neutral</th>
<th>Very Frequently</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>4</td>
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<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 4: Ease of Imagining the Risks Items for Study 1

How clear can you imagine that there is a [1-in-9; 12-in-100] chance that you contract coronary artery disease?

<table>
<thead>
<tr>
<th>Not clear at all</th>
<th>Very clear</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

How detailed are your imagined thoughts?

<table>
<thead>
<tr>
<th>Not detailed at all</th>
<th>Very detailed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
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<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

How vivid are your imagined thoughts?

<table>
<thead>
<tr>
<th>Vague</th>
<th>Vivid</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
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<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 5: Demographic Questions asked in Study 1

What is your gender?

- Male
- Female

What is your age? _____________ years

How often do you exercise per week?

- Zero
- Once
- Twice
- Three times
- Four times
- Five times
- Six times
- Everyday

Do you have any medical history of heart-related problems?

- Yes
- No

Do you have any family history of heart-related problems?

- Yes
- No
Appendix 6: Dependent Variable Measures for Study 2

In your opinion, the probability of being affected by malaria while traveling to Kenya is

<table>
<thead>
<tr>
<th>Extremely Low</th>
<th>Neutral</th>
<th>Extremely High</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
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<tr>
<td>4</td>
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<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
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</tbody>
</table>

Malaria is a disease that is

<table>
<thead>
<tr>
<th>Not severe at all</th>
<th>Neutral</th>
<th>Extremely severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
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<tr>
<td>4</td>
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<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How worried would you be about the probability of [1-in-200; 5-in-1000] of being affected by malaria while travelling to Kenya?

<table>
<thead>
<tr>
<th>Not worried at all</th>
<th>Neutral</th>
<th>Extremely worried</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Appendix 7: Ease of Imagining the Risks Items for Study 2**

How clear can you imagine that there is a [1-in-200; 5-in-1000] chance that you are being affected by malaria?

<table>
<thead>
<tr>
<th>Not clear at all</th>
<th>Very clear</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<td>7</td>
<td></td>
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</tbody>
</table>

How detailed are your imagined thoughts?

<table>
<thead>
<tr>
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<th>Very detailed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td></td>
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</table>

How vivid are your imagined thoughts?

<table>
<thead>
<tr>
<th>Vague</th>
<th>Vivid</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>6</td>
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<td>7</td>
<td></td>
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</tbody>
</table>
Appendix 8: SPSS Output for Study 2 Mediation Analysis

Run MATRIX procedure:

************ PROCESS Procedure for SPSS Beta Release 130612 ************

Written by Andrew F. Hayes, Ph.D.  http://www.afhayes.com

Model = 4
Y = Q10_1
X = conditio
M = imaginat

Sample size
82

Outcome: imaginat

Model Summary

<table>
<thead>
<tr>
<th>R</th>
<th>R-sq</th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>.2128</td>
<td>.0453</td>
<td>3.7952</td>
<td>1.0000</td>
<td>80.0000</td>
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Model

<table>
<thead>
<tr>
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<th>p</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>conditio</td>
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<td>.2789</td>
<td>1.9481</td>
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</tbody>
</table>

Outcome: Q10_1

Model Summary

<table>
<thead>
<tr>
<th>R</th>
<th>R-sq</th>
<th>F</th>
<th>df1</th>
<th>df2</th>
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Model

<table>
<thead>
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<th>coeff</th>
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<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>imaginat</td>
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<td>conditio</td>
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</table>

**************** DIRECT AND INDIRECT EFFECTS ****************

Direct effect of X on Y
<table>
<thead>
<tr>
<th>Effect</th>
<th>SE</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4070</td>
<td>.3064</td>
<td>4.5918</td>
<td>.0000</td>
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</tbody>
</table>

Indirect effect of X on Y

<table>
<thead>
<tr>
<th>Effect</th>
<th>Boot SE</th>
<th>BootLLCI</th>
<th>BootULCI</th>
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</thead>
<tbody>
<tr>
<td>imaginat</td>
<td>.2287</td>
<td>.1387</td>
<td>.0170</td>
</tr>
</tbody>
</table>

************** ANALYSIS NOTES AND WARNINGS

Number of bootstrap samples for bias corrected bootstrap confidence intervals: 5000

Level of confidence for all confidence intervals in output: 95.00

NOTE: Some cases were deleted due to missing data. The number of such cases was: 4

------ END MATRIX ------