THINKING ABOUT YOU, WORRYING ABOUT ME: SELF-OTHER DIFFERENCES IN RISK PERCEPTION AND THE INFLUENCE OF NUMERACY AND EMOTIONS

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ABSTRACT

LINDSAY KENNEDY: Thinking About You, Worrying About Me: Self-Other Differences in Risk Perception and the Influence of Numeracy and Emotions
(Under the direction of Lawrence J. Sanna)

Research on numeracy – the ability to make sense of numbers and statistics – has focused on the relationship between numeracy and *general, other-focused* risk estimates – with numeracy resulting in more accurate risk estimates – while less is known about numeracy and *personal* risk estimates. Because individuals view themselves as less at risk than their peers (Weinstein, 1982, 1987) and emotions play an important role in risk-related decisions (e.g., Loewenstein et al., 2001), it was hypothesized that worry would have a greater effect than numeracy on personal risk estimates, and numeracy would have a greater effect than worry on other-focused risk estimates. In Studies 1a and 1b, and in Study 2, participants were provided health statistics and estimated risk for themselves and an average other, and, in Studies 1b and 2, provided behavioral intentions for the self and behavioral recommendations for others. Worry and numeracy were measured in all studies, and manipulated in Study 2. Overall, worry was a better predictor of self-focused outcomes, while numeracy and worry were found to predict other-focused outcomes. Implications for the usefulness of numeracy training programs and patient-provider interactions are discussed.

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CHAPTER 1

INTRODUCTION

With health care costs continually rising (Kaiser Family Foundation, 2007), it is more important than ever to understand the psychological factors that promote a healthy lifestyle. One such factor is personal health risk perception. Given the positive relationship between personal perceptions of risk and health-protective behaviors (e.g., Harrison, Mullen, & Green, 1992; McCaul, Bransetter, Schroeder, & Glasgow, 1996; Brewer, Chapman, Gibbons, Gerrard, McCaul, & Weinstein, 2007), understanding the factors that influence personal risk perception can be an important step toward increasing the likelihood of individuals engaging in preventative behaviors, rather than seeking treatment after it is too late. In this dissertation, I focus on two important factors related to personal risk perception: (a) understanding statistical concepts; and (b) affective experiences such as worry and fear.

Numeracy and Risk Perception

To begin with the first factor, *numeracy* is defined as the ability to make sense of numbers and statistics (e.g., Peters, 2008; Peters, Vastfjall, Slovic, Mertz, Mazzocco, & Dickert, 2006). According to Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, and Woloshin (2008), there exists a widespread inability to understand numbers and statistics. They argue that this difficulty with numerical information can negatively affect perceptions of risk, and, ultimately, result in negative mental and physical health consequences, such as experiencing undue hope or worry, or choosing a suboptimal treatment option. For example, when presented with the Basic Numeracy Assessment Scale (BNAS; Schwartz, Woloshin, Black, & Welch, 1997), a sample of older female veterans struggled to convert 1% to 10 in 1,000 (46% incorrect); struggled to convert 1 in 1,000 to 0.1% (80% incorrect); and struggled to correctly estimate the number of times a coin would come up heads in 1,000 flips (46% incorrect). Scores on the BNAS showed a strong linear relationship with accuracy in interpreting health-related risk information, such that those scoring lower in numeracy struggled to understand the risk reduction benefits provided by mammography screening (Schwartz et al., 1997). Additional studies have shown similar effects, with numeracy predicting accuracy in the health domain, such that those low in numeracy were less accurate in providing risk estimates (Black, Nease, & Tosteson, 1995; Davids, Schapira, McAuliffe, & Nattinger, 2004; Weinstein, Atwood, Puleo, Fletcher, Golditz, & Emmons, 2004; Woloshin, Schwartz, Black, & Welch, 1999; Wright, Whitwell, Takeichi, Hankins, & Marteau, 2009).

Further exacerbating this problem is the finding that this inability to make proper sense of numbers is not restricted to the average Joe and Jane; the highly educated (Lipkus, Samsa, & Rimer, 2001), medical providers, journalists, politicians, and the like have also been shown to struggle with accurately interpreting numerical information (Gigerenzer et al., 2008). For example, when given base-rate information about the prevalence of breast cancer in a particular region, and the sensitivity and false-positive rate of mammograms, the majority of gynecologists sampled greatly overestimated the probability of a woman having breast cancer, given a positive mammogram. Although the most accurate choice was approximately a 10 percent chance, most chose either 81 or 90 percent, which is a huge overestimation. Findings such as these are especially disconcerting given the nature of the patient-doctor relationship and the recommendations and emotions that would likely follow such an inaccurate estimate. However, after the gynecologists were given numeracy training, in which they learned how to translate complicated statistics into more understandable numbers, accuracy greatly improved. In the case of the gynecologists, accuracy jumped from 21 percent (less than chance) to 87 percent (Gigerenzer et al., 2008).

Given this improvement following numeracy training, Gigerenzer and colleagues (2008) offer two general recommendations to combat collective statistical illiteracy. First, a stronger emphasis should be placed on numeracy training in education systems. They argue that it is imperative to begin teaching statistics as early as elementary school, alongside reading and writing, and as late as medical school. By doing so, they believe that societal numeracy levels can improve, thus providing individuals with the tools necessary to accurately interpret information about things such as prescription drugs, the effectiveness of treatment options, and personal risk levels. With this improved accuracy, we can not only make more rational health-related decisions and judgments, but also reduce the amount of money spent on unnecessary health care (e.g., surgical options, suboptimal prescription drugs, etc.).

Second, all risk information should be presented in straightforward, transparent ways. By this, Gigerenzer and colleagues (2008) mean that risk information should be presented in terms of absolute risks (risk reduces from 5 out of 1,000 to 4 in 1,000) instead of relative risks (risk reduces by 20%), and natural frequencies (10 out of 1,000 women have breast cancer; of these 10 women, 9 will have a positive mammogram) instead of conditional probabilities (probability of breast cancer is 1%; probability of a positive mammogram given breast cancer is 90%), for example. Gigerenzer et al. (2008) note that most numerical information found in medical journals, pamphlets, and websites is presented in nontransparent, confusing ways, thus making an accurate interpretation even more difficult, especially for those already low in numeracy.

Taking this evidence into consideration, the importance of numeracy in risk perception cannot be understated. However, demonstrations of the beneficial effects of high numeracy, numeracy training, and transparent presentation of numerical information on health-related judgments have been mixed for *self-focused* judgments, or restricted to *other-focused* judgments. Although studies have found evidence for high numeracy resulting in more accurate *personal* health judgments (Black, Nease, & Tosteson, 1995; Davids et al., 2004; Woloshin et al, 1999; Wright et al, 2009), these effects are not consistent across judgments. For example, numeracy significantly predicted probability estimates of dying from breast cancer in the next 10 years, but not estimates of the relative risk reduction from undergoing breast cancer screening (Black, Nease, & Tosteson, 1995), while numeracy also significantly predicted comparative perceived risk, but not numerical estimates of risk (Woloshin et al., 1999). Similarly, Weinstein et al. (2004) found that numeracy significantly predicted personal risk perceptions *before* receiving numerical risk information, but not personal risk perceptions after receiving this information.

Additional demonstrations of the benefits of numeracy, numeracy training, and transparent presentation of information on health-related judgments have been restricted to other-focused judgments. For example, in the case of the gynecologists, they were asked to provide estimates for a hypothetical patient (Gigerenzer et al., 2008). Focal judgments for other studies include breast cancer risk estimates for the average woman (Fagerlin, Zikmund-Fisher, & Ubel, 2004), likelihood estimates of a mental patient committing an act of violence after discharge (Slovic, Monahan, & MacGregor, 2000; Peters et al., 2006), and general health judgments about hypothetical others (Keller & Siegrist, 2009; Garcia-Retamero & Galesic, 2010). Similarly, when Galesic, Garcia-Retamero, and Gigerenzer (2009) presented participants with icon arrays used to visually and transparently depict health-related statistics, the task of the participant was to answer a numeric question about another person (e.g., "How many of 1,000 people with symptoms of arterial disease might have a stroke or heart attack if they do not take aspirin?"). In all cases, participants were more accurate when they either (a) had higher levels of numeracy; (b) were trained to better understand statistics; or (c) were presented with understandable, transparent statistics – all of which make a strong case for the benefits of numeracy on other-focused judgments.

What is still unclear, however, is whether or not numeracy levels, numeracy training, and/or straightforward presentation of numerical information are powerful enough to overcome personal biases and experiences that may contribute to *self-focused* risk perceptions, such as a person's emotions. Certainly presenting numerical risk information in a manner that is easily interpreted, like using absolute risks instead of relative risks, along with incorporating better statistical training into the education system are good – even great – improvements, but might the effects of numeracy and numeracy training be overshadowed by such biases and phenomena as unrealistic optimism, subjective interpretations of numerical risk, and experiences of emotions, such as worry and fear, when making judgments about the self? As Henry Clay (1777-1852) once wrote, "Statistics are no substitute for judgment." Here, Clay is directly contrasting statistics and judgment. Perhaps individuals value their own intuition or subjective interpretations over numbers, making one's level of numeracy simply less important when thinking about the self. To this point, self-other differences and the possibility that numeracy and numeracy training may differentially influence self- and other-focused perceptions of risk has been neglected in the literature, which leaves open the question of whether or not numeracy and numeracy training are as important for predicting self-focused perceptions of risk, as it is for predicting other-focused perceptions of risk. If numeracy and numeracy training are less important for judging self-focused perceptions of risk – the perceptions of risk that influence behavior – then the enthusiasm over and investment in numeracy training to improve health would not be justified. Addressing this important gap in the literature is the main objective of my dissertation.

Self-Other Differences In Risk Perception

That judgments about the self often differ from judgments about others is a pervasive and well-known finding in social psychological literature, dating back to classic actor-observer differences in attributions (Jones & Nisbett, 1972; Ross, 1977). For example, Taylor and Brown (1988) have demonstrated that the majority of people believe that they are above average in most domains, which is, of course, statistically impossible. In addition, individuals are much more inclined to see cognitive biases operating in the judgments of others than in their own judgments, a phenomenon known as the bias blind-spot (Pronin, Lin, & Ross, 2002). Furthermore, as compared to others, people tend to view themselves as less susceptible to media influence (Douglas & Sutton, 2004); less influenced by alcohol in incidents of aggression (Graham & Wells, 2001); less likely to endure long periods of negative affect (Igou, 2008); and less vulnerable to victimization (Perloff & Fetzer, 1986), just to name a few.

Most relevant to my dissertation, differences in risk perception have been found when estimating levels of risk for the self versus levels of risk for others. Weinstein (1982, 1987) found that most people rate themselves as less at risk than their peers for a wide array of health problems. This discrepancy was most pronounced when the focal health problem was preventable in nature, presumably because individuals were better able to think about behaviors they could engage in – more easily than thinking about the behaviors of others – that would improve the possible outcome (Weinstein, 1980, 1987).

The tendency for people to believe they are more likely to experience positive events and less likely to experience negative events than their peers has been labeled *unrealistic optimism* (Weinstein, 1980). Like many other biases in reasoning, researchers have searched for ways to overcome unrealistic optimism; however, these attempts have only been successful in producing slight reductions in this bias. When provided with information about a peer relevant to the judgment at hand (e.g., factors influencing risk of developing lung cancer), participants narrowed the gap between estimates of the self and peer, but the self-other differences remained significant (Weinstein, 1980). In addition, Weinstein and Klein (1995) attempted to reduce unrealistic optimism using four different debiasing interventions, including asking participants to generate lists of personal factors that would likely increase their risk of a health problem, only to find that an optimistic bias remained in all four cases. One mode of information presentation that has been found to be effective in reducing the optimistic bias – by way of raising *personal* risk perceptions – is the use of personal testimonials or narratives. Personal narratives conveying health information have been found to be more effective at increasing a sense of personal risk, and thus resulting in a greater likelihood of engaging in health-protective behaviors, than objective statistics conveying health information (de Wit, Das, & Vet, 2008), again suggesting possibly important self-other differences.

Experienced Affect or Emotions and Risk Perception

There are still other ways in which judgments about the self are likely to differ from judgments of others. In particular, when making judgments about the self, experiences of affect or specific emotions are likely to be salient and used as information. For example, one prominent approach to understanding the relationship between affect or specific emotions and judgments is the feelings as information hypothesis (Schwarz & Clore, 1983, 2003). According to this hypothesis, general mood states, specific emotions, or simply general subjective states (Schwarz & Clore, 2007) are often relied upon as meaningful sources of information when making judgments, even if the source of the feeling is unrelated to the judgment at hand (Schwarz, 1998; Schwarz & Clore, 1983). For example, individuals were more likely to report being happy and satisfied in their lives after just recalling a happy memory versus an unpleasant memory (Schwarz & Clore, 1983).

Of particular relevance to my dissertation, the risk as feelings hypothesis (Loewenstein, Weber, Hsee, & Welch, 2001) posits that reactions to risk possibilities are either cognitive or emotional in nature, an approach akin to the Common Sense Model of illness self-regulation (Leventhal, Meyer, & Nerenz, 1980). Although cognitive and emotional reactions may influence one another, they may also lead to differing conclusions. A useful example provided by Loewenstein and colleagues (2001) involved changes in probability of winning the lottery, and how a change in probability impacts cognitive appraisals, but not emotional ones. The authors suggest that when the odds of winning the lottery change from 1 in 10,000,000 to 1 in 10,000 this change in probability is unlikely to change the personal feeling associated with the possibility of winning (e.g., how much better they feel their life would be). Applying this reasoning to the health context, a change in the likelihood of contracting genital herpes may change the cognitions regarding the magnitude of the risk, but this change in likelihood probably does not change the negative affective reaction that accompanies the thought of having genital herpes. Furthermore, when cognitive and emotional reactions to risk diverge, Loewenstein et al. (2001) suggest that behavior is primarily driven by the emotional reactions.

In terms of specific emotions, worry is one emotion that is commonly present when talking about risk perception. As defined by Borkovec, Robinson, Pruzinsky, and DePree (1983), worry is a "chain of thoughts and images, negatively affect-laden and relatively uncontrollable. The worry process represents an attempt to engage in mental problem solving on an issue whose outcome is uncertain but contains the possibility of one or more negative outcomes. Consequently, worry relates closely to fear process" (p. 10).

Regarding health, worry has been found to be a significant predictor of health-related and protective behaviors, and sometimes operates upon beliefs and behaviors in ways independent of risk perceptions. For example, Cameron and Diefenbach (2001) found that the desire to undergo genetic testing was significantly predicted by worry about developing breast cancer, such that higher levels of worry were associated with a greater willingness to undergo genetic testing; however, perceived risk of developing breast cancer did not significantly predict the same outcome. Moreover, worry was positively associated with the belief that genetic testing could have a negative emotional impact, while risk perception was negatively associated with the same beliefs. Similarly, Chapman and Coups (2006) found that anticipated worry better predicted vaccination behavior than perceptions of risk, and even mediated the effect of perceptions of risk on vaccination behavior.

Given its relationship to worry (Borkovec, et al., 1983), fear has also been found to influence risk estimates. Specifically, fear has been linked to increases in estimates of risk (Lerner, Gonzalez, Small, & Fischhoff, 2003), which speaks to the popularity of fear appeals in public health campaigns. Fear appeals have the ability to influence attitudes and behaviors through an emotional pathway, and are thought to be an effective means to influencing health-related behavioral intentions and behaviors because the arousal of fear also activates the need to manage this fear (Leventhal, 1971). If the fear appeal contains efficacious information on how to avoid the threat, then recipients of the appeal are likely to manage their fear through the adoption of the message's recommendations (Witte, 1992). Fear appeals can also be effective if they increase vulnerability felt by the recipient (Witte & Allen, 2000). The effectiveness of such an emotional approach has yet to be compared to the effectiveness of the more cognitively based numeracy training approach. And, given that fear appeals are commonly used in public health campaigns and that the popularity of numeracy training is growing rapidly, a direct comparison between these two approaches could prove very useful in terms of determining which approach to improving health-related behaviors is more effective and efficient.

CHAPTER 2

THE PRESENT RESEARCH

In sum, extant research on numeracy has focused on the relationship between numeracy and *general* assessments of risk, which tend to be other-focused, while less is known about the relationship between numeracy and *personal* assessments of risk. This is a gap in the numeracy literature, given that individuals consistently view themselves as less at risk than their peers, and that affect and specific emotions play an important role in risk-related decision making. Because personal risk perceptions may be more affectively driven, and may be relatively unaffected by one's level of numeracy, it is possible that the benefits of numeracy training have been overstated and that societal efforts to teach statistical reasoning may not result in the positive health outcomes that many are hoping for (e.g., Gigerenzer et al, 2008). For example, if numeracy and numeracy training don't influence personal risk perceptions, then these factors may also be unlikely to influence personal health behaviors, which greatly reduces the importance of this cognitively driven approach.

The studies outlined in my dissertation aim to integrate research on numeracy, self-other differences in risk perception, and emotions in order to better understand the importance of cognitive and emotional factors in differing types of risk perceptions. If numeracy and numeracy training are found to influence other-focused perceptions of risk, but not self-focused perceptions of risk, as I hypothesize, then it may be the case that the benefits of numeracy training are restricted to populations that regularly estimate risk for other people, such as medical providers and counselors, and may not be the most effective approach for improving the health of the general public. By having a better understanding of the roles of both numeracy and emotions in personal risk perception, in particular, we may better know how to intervene – cognitively or emotionally – to influence personal risk perceptions, and thus behavioral outcomes.

In the first pair of studies (Studies 1a and 1b), I examine the hypothesis that numeracy levels are more important than worry on other-focused risk estimates, whereas worry is more important than numeracy levels on self-focused risk estimates is tested using an online survey. In this survey, worry and numeracy were measured and participants were asked to estimate risk for both themselves and the average college student. In the second study, I build upon the initial study by incorporating behavioral measures to see which factor – numeracy or worry – is more predictive of behavioral intentions and behavioral outcomes. Finally, Study 2 attempts to manipulate levels of numeracy and worry – through a numeracy training intervention and the use of fear appeals, respectively – and will again measure self- and other-focused perceptions of risk, behavioral intentions, and behavioral outcomes.

CHAPTER 3

STUDY 1A

The main purpose of this study was to provide an initial examination of the influence of experienced emotion (in particular, worry) and numeracy levels on judgments of risk for the self versus others. To address one of the recommendations to improve risk perceptions made by Gigerenzer et al. (2008), risk-relevant numerical information was presented using either transparent (e.g., absolute risks) or nontransparent (e.g., relative risks) framing; this difference in framing of risk information, or transparency, was a between-subjects variable. Focus of the judgment was a within-subjects variable, such that all participants provided risk estimates for the self and the average college student on four different health scenarios: melanoma, car accident, genital herpes, and type 2 diabetes. I hypothesized that numeracy level would have a greater effect than worry on other-focused risk estimates, whereas worry would have a greater effect than numeracy level on self-focused risk estimates.

Method

Participants

Participants were 75 undergraduates from the University of North Carolina at Chapel Hill who were enrolled in an introductory psychology course. In exchange for their participation, participants received credit toward partial fulfillment of a class research requirement. Given that the health data presented to the participants were applicable up to age 29, participants aged 30 and above were not included in the analyses. This inclusion criterion resulted in a final sample size of 70, ranging in age from 18 to 29, with an average age of 20 years.

Procedure

The general procedure for this study was as follows: Participants accessed an online Qualtrics survey via the University's participant pool website, and were randomly assigned to one of two conditions: *nontransparent* vs. *transparent* presentation of information (referred to from this point as *transparency*). Following standard informed consent procedures, participants answered questions about four different health-related events: melanoma, type 2 diabetes, genital herpes, and getting into a car accident. Participants responded to questions aimed to assess their worry about each of the four events and, following a short filler-task, their perception of risk for the self and others for each of the events. They also answered a set of questions about their subjective interpretation of their level of risk and how at risk they believed themselves to be relative to the average college student for all four events. Next, they answered a set of questions that assessed their numeracy level. Finally, participants responded to some demographic questions. The precise measures used are presented and described below. The average college student was chosen as the target of the other-focused condition, so as to provide a comparison group that was similar to the participants and pose a more stringent test of self-other differences.

Materials

Worry

The survey began by asking participants to indicate how *bothered* they were by thinking about and how *worried* they were about experiencing each of the four health-related events (McCaul, Mullens, Romanek, Erickson, & Gatheridge, 2007). Responses to each question were provided using a 7-point scale, ranging from 0 (*Not at all*) to 6 (*Extremely*).

Numerical Risk Estimates

In order to assess numerical perceptions of risk, all participants read the same four scenarios containing factual information about preventable health-related events. Statistical information gathered from the Skin Cancer Foundation (melanoma; 2010a), the Virginia Tech Transportation Institute (car accident; 2009), the Centers for Disease Control and Prevention (genital herpes; 2007), and the National Diabetes Education Program (type 2 diabetes; 2004) and was presented in either a nontransparent or transparent manner. The scenarios are presented in their entirety in Appendix A. Below is a sample scenario, presented transparently and nontransparently, respectively, with differences bolded:

> *Melanoma (the most serious type of skin cancer) is the most common form of cancer for young adults 25-29 years old and the second most common form of cancer for adolescents and young adults 15-29 years old.* ***One in 55*** *people will be diagnosed with melanoma during their lifetime. A person's risk for melanoma* ***doubles*** *if he or she has had five or more sunburns at any age.*
>
> *Melanoma (the most serious type of skin cancer) is the most common form of cancer for young adults 25-29 years old and the second most common form of cancer for adolescents and young adults 15-29 years old.* ***Approximately 1.8%*** *of people will be diagnosed with melanoma during their lifetime. A person's risk for melanoma* ***increases by 100%*** *if he or she has had five or more sunburns at any age.*

Each of the four scenarios was presented twice, and all eight presentations were randomized. For one presentation of each scenario, participants were asked to provide their perception of risk for themselves; for the other presentation, participants were asked to provide their perception of risk for the average college student. These estimates were provided by answering questions that tapped into the three dimensions of perceived risk: likelihood, susceptibility, and severity (Brewer, et al., 2007).

The first question addressed perceived likelihood and asked, for example, "What is the likelihood of you [the average college student] being diagnosed with melanoma in your lifetime?" Following this estimate, participants were asked, "How susceptible do you think you are [the average college student is] to developing melanoma in your lifetime?" For these two questions, participants were asked to provide an estimate ranging from 0% (*Not at all*) to 100% (*Extremely*). A final question assessed severity by asking, "How serious a disease do you think melanoma is?" Participants provided an estimate between 0 (*Not at all*) and 100 (*Extremely*).

Subjective and Relative Risk Estimates

Subjective risk was measured through questions such as, "How at risk do you think you are for developing melanoma in your lifetime?" Responses were provided using a seven-point scale, ranging from 0 (*Not at all at risk*) to 6 (*Very much at risk*). Participants responded to one question per event.

Risk level relative to the average college student was also measured through one question for each event. For example, participants were asked the question, "How do you think your chance of getting melanoma in your lifetime compares with that of the average college student?" Responses were provided using a seven-point scale, ranging from *much lower than average* to *much higher than average*, with *average* as the midpoint.

Numeracy Level

Numeracy level was assessed through a series of 11 questions developed by Lipkus, Samsa, and Rimer (2001). A sample question reads as follows, "If Person A's risk of getting a disease is 1% in 10 years, and Person B's risk is double that of A's, what is B's risk?" An individual's numeracy level reflected how many questions were answered correctly, with a possible range of 0 to 11; the actual range of scores was 4 to 11, with an average score of 9.09 questions correct. This full measure is presented in Appendix B.

Data Analysis

Multivariate multiple regression in Mplus (Muthen & Muthen, 1998) was used to estimate the effects of transparency (framing of information), worry, numeracy level, and all of the two- and three-way interaction terms on the estimates of self- and other-focused risk. Worry was calculated by averaging responses to worry questions for the melanoma, car accident, and type 2 diabetes scenarios ($\alpha = .79$). Similarly, self- and other-focused risk estimates were calculated by averaging risk estimates from the melanoma, car accident, and type 2 diabetes scenarios (αs = .62 and .84, respectively).[1]

Four different models were tested for the data: one containing only main effects, one containing main effects plus the interactions between transparency and numeracy level and transparency and worry, one containing main effects plus all two-way interaction terms, and one containing the above plus the three-way interaction term. Chi-square difference tests were used to identify the best fitting model for the data. Results are presented for the best fitting model only. In addition, a hierarchical linear regression analysis was used to analyze

[1] The genital herpes scenario was dropped from analyses, because it did not react in the same way as the other three scenarios. When analyzing the genital herpes scenario separately, there were no significant effects of transparency, worry, or numeracy level on self-focused numerical or subjective risk, and there was only a marginally significant effect of numeracy on other-focused numerical risk. In addition, there were significant two-way interactions between condition and worry (self-focused numerical and subjective risk) and condition and numeracy (self-focused subjective risk) that did not replicate in any other scenarios. Given that the correlation between how *worried* participants were about getting genital herpes, and how *bothered* they were by thinking about getting genital herpes was low and only marginally significant, with ratings of the latter being much higher than the former, it is possible that this different pattern of results were found due to low levels of sexual activity in this sample.

the effects of transparency, worry, numeracy level, and all of the interaction terms for the aforementioned variables on subjective risk.

Although no specific predictions were made for two- and three-way interactions among transparency, numeracy level, and worry, these interaction terms were included in all regression analyses for exploratory purposes, and were retained if they significantly contributed to explained variance.

Results and Discussion

Descriptive statistics and bivariate correlations for all variables of interest are presented in Table 1. Numeracy level and worry were centered for all regression analyses. Although not central to my hypothesis, there was an optimistic bias present, such that self-focused numerical risk estimates were significantly lower than other-focused numerical risk estimates, t (69)= -7.74, $p < .001$, and the average relative risk estimate was lower than average (lower than the midpoint of 4 on the scale), $M = 3.17$, $SD = .81$.

Effects on Numerical Risk Estimates

Again, multivariate multiple regression was used to examine the effects of transparency, worry, numeracy level, and the two- and three-way interactive effects of transparency, worry, and numeracy level on both self- and other-focused estimates of risk. The results from the best-fitting model – the model containing only main effects – are presented in Table 2.

After controlling for all variables, the relationship between self- and other-focused risk estimates remained significant, $B = 106.93$, $SE = 27.11$, $p < .001$. Beginning with self-focused risk estimates, there was a significant effect of worry, such that a 1-unit increase in worry resulted in a 4.51-unit increase in self-focused risk. There was also a marginally significant effect of numeracy level, $p = .10$, such that a 1-unit increase in numeracy level – getting one additional question correct on the numeracy measure – resulted in a 1.36-unit decrease in self-focused risk estimates. There was no significant effect of transparency. Although a marginal effect of numeracy level was not expected, the finding that worry *was* a significant predictor for self-focused numerical risk estimates supports my hypothesis. Also supporting my hypothesis, for other-focused risk estimates, there was a significant effect of numeracy level, such that a 1-unit increase in numeracy level resulted in a 2.46-unit decrease in other-focused risk, but there were no significant effects of transparency or worry.

Effects on Subjective Risk Estimates

Hierarchical linear regression was used to test the effect of transparency, worry, numeracy level (Step 1), the two-way interactions between all three variables (Step 2), and the three-way interaction term (Step 3) on subjective risk estimates. Linear regression was used in this case, instead of multivariate multiple regression, because subjective risk was only asked the self, and not for the self *and* the average college student. Only results from Step 1 are reported, as the change in R^2 beyond Step 1 was not significant. Results from Step 1 are presented in Table 3.

For subjective estimates of personal risk there was a significant effect of worry, such that a 1-unit increase in worry resulted in a .26-unit increase in subjective risk. There were no significant effects of transparency or numeracy level. The significant effect of worry, coupled with the nonsignificant effect of numeracy level, supports my hypothesis.

Summary

The results from Study 1a are strongly supportive of my hypothesis that the effect of worry would be greater than the effect of numeracy level on self-focused risk estimates, while the effect of numeracy level would be greater than the effect of worry on other-focused risk estimates. Worry, but not numeracy level, significantly predicted both self-focused numerical and subjective risk estimates, whereas numeracy level, but not worry, significantly predicted other-focused numerical risk estimates. Interestingly, transparency did not play a significant role in predicting any of the three types of risk estimates. It should be noted, however, that the degree to which the data were perceived by participants to be transparent or nontransparent was not measured, so strong conclusions should not yet be drawn about the general lack of effect of the transparency manipulation.

Overall, it does not appear to be the case that the potentially beneficial effects of numeracy level on risk perceptions extend to perceptions of risk for the *self*, nor does it appear to be the case that the transparency, or lack thereof, of numerical data played an influential role on either type of risk perception. Taken together, the data from Study 1a call into question whether or not the recommendations made by Gigerenzer and colleagues (2008) are universally applicable. As Study 1a highlights an important boundary condition to the effects of numeracy level – a restriction to *other*-focused risk estimates – it seems that efforts to increase numeracy levels may be more important and influential for those individuals who regularly estimate risk for other people, such as medical providers and counselors. In addition, given that *personal* risk estimates are likely to influence personal health behavior more than other-focused risk estimates, it is unlikely that numeracy levels will have beneficial effects on behavior as suggested by Gigerenzer, et al. (2008). To test this, behavioral intentions and behavioral outcomes were added to the next study.

CHAPTER 4

STUDY 1B

Study 1b was conducted as a revision and extension of Study 1a. The general procedure was largely unchanged, though several key changes were made, some of which address potential shortcomings of Study 1a. These changes include modifications of the scenarios used (only melanoma and type 2 diabetes; both presented in terms of lifetime risk), an additional pilot test of the transparency manipulation, the addition of measures, such as other-focused subjective risk and behavioral intentions and recommendations for others, and an increase in the sample size.

Scenario Changes

The first important change was in regard to the presented scenarios. Study 1a presented participants with data for four different health-related events, and these data differed in terms of time frame. For example, while participants were asked to estimate their risk of developing melanoma over their lifetime, they were asked to estimate their risk of contracting genital herpes over the next year. In Study 1b, the scenarios for each topic referenced the same time frame: lifetime risk. This time, only the melanoma and type 2 diabetes scenarios were used. The car accident scenario was dropped because it was not directly health-related, and the genital herpes scenario was dropped, because of the possibility that the data did not apply to a sizeable number of participants (i.e., those who are not sexually active).

Additional Pilot Test of Transparency

Given the lack of significant effects for transparency in Study 1a, a pilot test was run to test whether or not this manipulation is producing the intended effect on the interpretability of health data, in order to draw more confident conclusions from significant – or a lack of significant – effects upon the dependent measures. To test this manipulation, a sample of 34 undergraduates from the UNC Participant Pool were provided with either transparent or nontransparent statistics regarding melanoma and type 2 diabetes and asked to compare their risk for developing each to their risk for developing hypertension by both indicating which risk was higher and numerically estimating how much higher they believed that risk to be. In the case of melanoma, the risk of developing hypertension (18.38%) was greater than the risk of developing melanoma (2.72%); in the case of type 2 diabetes, the risk of developing type 2 diabetes (30.83%) was greater than the risk of developing hypertension (18.38%).

Although no significant differences in accuracy were found between the two conditions for either scenario (using logistic regression and *t*-tests), the percentages and means were in the expected directions. Regarding participants' choices of which risk was higher, 62.50% of participants in the transparent condition versus 44.44% of participants in the nontransparent condition provided correct responses for the melanoma scenario, while 56.25% participants in the transparent condition versus 44.44% of participants in the nontransparent condition provided correct responses for the type 2 diabetes scenario. Regarding their numerical estimates of the differences between the two risks, the mean estimates for each scenario were more accurate when the data was presented transparently.

For melanoma, the mean error in the transparent condition was 22.84, while the mean error in the nontransparent condition was 25.02. For type 2 diabetes, the mean error in the transparent condition was 12.36, while the mean error in the nontransparent condition was 25.58.

Despite the fact that there were no significant differences in participant accuracy based on how transparently the information was presented, the scenarios used in the pilot study were retained for the full study. This was because the framing of the scenarios was highly representative of the transparent-nontransparent distinction made by Gigerenzer and colleagues (2008), and because the inability to find significant effects of transparency in the first study and in follow-up pilot studies may be reflective of a real lack of effect for this transparent-nontransparent distinction. The final version of each scenario framing is presented in Appendix C.

Added Measures

Several new measures were also included in this follow-up study. Other-focused subjective risk estimates were added to more fully examine the impact of numeracy level and worry on subjective interpretations of risk estimates, and how these factors may differentially impact estimates for the self versus other. Also, because level of perceived control or preventability has been found to increase the magnitude of self-other differences in risk perception (e.g. Weinstein, 1980), questions assessing perceived controllability of each health-related event were also included. Although all of the events included in Study 1a were considered relatively preventable in nature, participants' perceptions of controllability were not explicitly measured. The mood clarity subscale of the Trait Meta-Mood Scale (Salovey, Mayer, Goldman, Turvey, & Palfai, 1995) was also included in order to test whether or not the ability to understand emotional experiences would affect the relative influence of numeracy level and worry on the outcome measures.

In addition, questions aimed to assess participants' specific behavioral intentions related to each disease were included after participants provided self and other risk estimates for both health-related events. Participants responded not only to questions about protective and detective behaviors, but also to questions about willingness to pay for treatment and willingness to undergo genetic testing. For each group of questions, participants provided responses for themselves, as well as behavioral recommendations for the average American. The inclusion of these important questions was to allow for the examination of the influence of numeracy level and worry on behavioral intentions and behavioral recommendations for others. It was also to allow for the simple comparison of the predictive value of numerical risk estimates and subjective risk estimates on health-related behaviors, intentions, and recommendations. In other words, analyses will be able to reveal which type of risk perception is more closely related to behavioral intentions and recommendations: a numerical estimate, or a subjective interpretation of that estimate. Given previous research (e.g., Brewer & Hallman, 2006), it is expected that subjective risk estimates will be more predictive of behavioral intentions and recommendations than numerical risk estimates.

At the conclusion of the survey, participants were provided with relevant information about how to protect against melanoma and type 2 diabetes, and how to detect melanoma early through skin cancer self-examinations. Participants were then recontacted one month later to collect self-report data on performance of protective behaviors.

Increase in Sample Size

Finally, in order to increase power, the sample size was more than doubled. To accomplish this goal, data was collected using Amazon's Mechanical Turk, an online service that allows businesses and researchers to post tasks for workers to complete for monetary compensation.

Similar to Study 1a, the main hypothesis for Study 1b is that numeracy level will have a greater effect than worry on other-focused numerical and subjective risk estimates and behavioral recommendations for others, whereas worry will have a greater effect than numeracy level on self-focused numerical and subjective risk estimates, as well as on personal behavioral intentions, and self-reported behavior one month later. Additionally, it was hypothesized that any effects of numeracy level on behavioral intentions or recommendations would result in *fewer* intentions and recommendations.

Method

Participants

One hundred fifty participants were recruited through Amazon's Mechanical Turk website, with the restriction that participants must live in the United States (as the "other" that was used for the study was the average American) and be over the age of 18. Participants were compensated with $0.75 for completing the first part of the study and an additional $0.25 for completing the follow-up portion of the study one month later. One participant was dropped from analyses, and thus not compensated, for not providing a valid completion code through Mechanical Turk, resulting in a final sample size of 149. The age range of this sample was 18 to 82, with an average age of 33.52-years old, with 62.4% female and 77.2% Caucasian.

For the behavioral follow-up 87 participants were retained from the first part of the study. The age range of this sample was, again, 18 to 82, with an average age of 35.81-years old. This sample was 66.3% female and 80.2% Caucasian.

Procedure

As with Study 1a, participants were randomly assigned to one of two conditions: *nontransparent* vs. *transparent* presentation of information. Participants then followed procedures nearly identical to Study 1a. Participants began by answering two questions aimed to assess their level of worry about each health event ($\alpha = .78$) and, following a short filler-task, their perception of numerical risk for the self ($\alpha = .61$) and others (the average American; $\alpha = .82$) for each of the events. They then answered questions about their subjective interpretation of their level of risk ($r = .17, p = .04$) and the level of risk for the average American ($r = .43, p < .001$) for both scenarios. New to this study, participants then answered questions about how much they were willing to pay for treatment related to each scenario, as well as how much they were willing to undergo genetic testing for each scenario. They then made payment and genetic testing recommendations for the average American for each scenario.

Also new to this study, participants then answered a series of questions aimed to assess the extent to which they believed they would engage in protective and detective behaviors related to each scenario. And, again, they made behavioral recommendations for the average American. Perceived control over experiencing each event was then measured, followed by numeracy level, and then mood clarity. Participants finished by answering basic demographic questions. Measures not present in Study 1a are described below.

Materials

Other-Focused Subjective Risk

Other-focused subjective risk was measured using modified versions of the subjective risk questions used in Study 1a (e.g., "How at risk do you think the average American is for developing melanoma in their lifetime?"). Responses were provided using a seven-point scale, ranging from 0 (*Not at all at risk*) to 6 (*Very much at risk*). Participants responded to one question per event.

Behavioral Intentions and Recommendations

Willingness to Pay for Treatment

Willingness to pay for treatment, as well as payment recommendations for the average American were measured for each scenario using variations of the following question: "How much would you be willing to [recommend the average American] pay for treatment related to being diagnosed with melanoma [type 2 diabetes]? Please provide a dollar amount in the box below."

Willingness to Undergo Genetic Testing

Willingness to undergo genetic testing, as well as genetic testing recommendations for the average American were measured for each scenario using variations of the following question: "How much would you be willing to [recommend the average American] undergo genetic testing for melanoma [type 2 diabetes] susceptibility?" Responses were provided using a seven-point scale, ranging from 0 (*Not at all*) to 7 (*Very much*).

Protective Behaviors

To measure behavioral intentions related to protecting against melanoma, participants were asked to indicate how often they would do each of the following in the next month when going outside on a sunny day for more than 15 minutes: stay in the shade; wear a hat; wear a long sleeved shirt and long skirt, long shorts, or long trousers; and, apply sunscreen regularly (adapted from the Sun Protective Behaviors Index; Cokkindides et al., 2001; Cameron, 2008). These same questions were used to indicate how often participants believed that the average American should engage in the aforementioned behaviors. Ratings were provided using a five-point scale, ranging from 1 (*never*) to 5 (*always*).

Also adapted from the Sun Protective Behaviors Index (Cokkindides, et al., 2001; Cameron, 2008), to measure behavioral intentions related to protecting against type 2 diabetes, participants were asked to indicate both how often they would do each of the following in the next month: engage in 30 minutes of moderate exercise five times per week; smoke cigarettes (reverse scored); eat three or more servings of whole grains (wheat bread, whole grain pasta, brown rice, oatmeal, etc.) per day; eat colorful fruits and vegetables (National Diabetes Education Program, 2004). These same questions were used to indicate how often participants believed that the average American should engage in the aforementioned behaviors. Ratings were provided using a five-point scale, ranging from 1 (*never*) to 5 (*always*).

Detective Behaviors

To measure behavioral intentions related to detecting melanoma, participants were asked to indicate the extent to which they would do each of the following in the next month: carry out a skin self-examination, talk to a friend or family member about their potential risk for skin cancer, go for a clinical skin examination, check someone else's skin for symptoms, and find out more about skin cancer. These same questions were used to indicate how often participants believed that the average American should engage in the aforementioned behaviors. Responses were provided using a five-point scale, ranging from 1 (*not at all*) to 5 (*very much*).

And, also adapted from Cameron (2008), to measure behavioral intentions related to detecting type 2 diabetes, participants were asked to indicate the extent to which they would do each of the following in the next month: assess their type 2 diabetes risk, talk to a friend or family member about their potential risk for type 2 diabetes, go for a clinical type 2 diabetes test, assess someone else's type 2 diabetes risk, and find out more about type 2 diabetes. These same questions were used to indicate how often participants believed that the average American should engage in the aforementioned behaviors. Responses were provided using a five-point scale, ranging from 1 (*not at all*) to 5 (*very much*).

In order to examine the effects of worry, numeracy level, transparency, and the two-way and three-way interactive effects of these variables on behavioral intentions and recommendations, generally, responses to the above questions were standardized and averaged to create a composite behavioral intentions measure ($\alpha = .85$) and a composite behavioral recommendations measure ($\alpha = .90$).

Perceived Controllability

For each event, participants were asked a series of nine questions for each scenario tapping into control risk beliefs (adapted from Cameron, 2008). These nine questions represent three factors of control, including personal control over prevention (e.g., "There is a lot I can do to prevent melanoma."), personal control over cure (e.g., "If I get melanoma, the course of the illness will depend on me."), and treatment control ("If I get melanoma, then it can be controlled or cured through medical treatment."). Responses were provided using a five-point Likert-type scale, ranging from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*) and averaged to form a composite control score ($\alpha = .82$).

Mood Clarity

Mood clarity was assessed using the mood clarity subscale of the Trait Meta-Mood scale (Salovey et al., 1995). Sample questions include, “I am rarely confused about how I feel” and “I can’t make sense out of my feelings” (reverse scored). Responses to all 11 questions were provided using a five-point Likert-type scale, ranging from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*) and averaged to form a mood clarity score ($\alpha = .91$).

Information on Protecting Against Melanoma and Type 2 Diabetes

At the conclusion of the online survey, participants were presented with resources related to the prevention and detection of melanoma and the prevention of type 2 diabetes. These resources included links to websites detailing how to prevent against melanoma (http://www.skincancer.org/year-round-sun-protection.html; Skin Cancer Foundation, 2010b) and type 2 diabetes (http://ndep.nih.gov/publications/PublicationDetail.aspx?PubId=76; National Diabetes Education Program, 2004) that participants were encouraged to follow and bookmark, as well as a handout describing how to do a skin cancer self-examination that participants were encouraged to save and print (Rigel & Carucci, 2000). The skin cancer self-examination handout can be found in Appendix D.

Self-Reported Behavior – One Month Follow-Up

One month after completing the initial survey, participants were recontacted via e-mail (containing a link to the follow-up survey) to assess the degree to which they engaged in protective and detective behaviors related to each disease. Questions about intentions to engage in protective and detective behaviors from the initial survey were readministered, but modified to ask about the extent to which each behavior was performed over the past month. They were also asked to report on their worry about each scenario to see whether or not their engagement in protective and detective behaviors over the past month affected their current levels of worry.

Data Analysis

The data analytic approach from Study 1a (multivariate multiple regression) was also used in Study 1b to examine the effects of transparency, worry, numeracy level, and the two- and three-way interactive effects on estimates of self- and other-focused numerical and subjective risk, as well as behavioral intentions and recommendations across the average of the two scenarios. Perceived controllability and mood clarity were included as additional covariates. Again, for each set of dependent variables, four different models were tested for the data: one containing only main effects, one containing main effects plus the interactions between transparency and numeracy level and transparency and worry, one containing main effects plus all of the two-way interaction terms, and one containing main effects and all interaction terms. Chi-square difference tests were used to identify the best fitting model for each scenario. Results are presented for the best fitting models only.

In addition, linear regression analyses were used to test the effects of each of the aforementioned predictor variables, along with self-focused numerical and subjective risk estimates, on self-reported behavior one month later. Linear regression was also used to test the effects of protective and screening behaviors on current levels of worry.

Results and Discussion

Descriptive statistics and bivariate correlations for all variables of interest are presented in Table 4. Worry, numeracy level, control, and mood clarity were centered for all regression analyses. Self- and other-focused numerical and subjective risk were centered for behavioral regression analyses.

Again, multivariate multiple regression was used to examine the effects of transparency, worry, numeracy level, and the two- and three-way interactive effects of transparency, worry, and numeracy level on both self- and other-focused numerical and subjective estimates of risk, as well as behavioral intentions and recommendations. The results from the best-fitting models – for all outcome variables, the model containing only main effects – are presented in Table 5.

Effects on Numerical Risk Estimates

After controlling for all variables, the relationship between self- and other-focused numerical risk estimates remained significant, $B = 134.88$, $SE = 31.86$, $p < .001$. Beginning with self-focused risk estimates, there was a significant effect of worry, such that a 1-unit increase in worry resulted in a 5.03-unit increase in self-focused risk. There were no significant effects of transparency, numeracy level, control, or mood clarity. These findings support my hypothesis that worry would be more predictive of self-focused risk estimates than numeracy level.

For other-focused numerical risk estimates, there was a significant effect of numeracy level, such that a 1-unit increase in numeracy level resulted in a 3.88-unit decrease in other-focused risk. There was also a marginally significant effect of control, $p = .07$, such that a 1-unit increase in feelings of control resulted in a 5.94-unit increase in other-focused numerical risk estimates. There were no significant effects of transparency, worry, or mood clarity. These findings support my hypothesis that numeracy level would be more predictive of other-focused risk estimates than worry.

Effects on Subjective Risk Estimates

After controlling for all variables, the relationship between self- and other-focused subjective risk estimates remained significant, $B = .37$, $SE = .10$, $p < .001$. Beginning with self-focused risk estimates, there was a significant effect of worry, such that a 1-unit increase in worry resulted in a .52-unit increase in self-focused risk. There were no significant effects of transparency, numeracy level, control, or mood clarity. As with numerical risk estimates, the hypothesis that worry, but not numeracy level, would be predictive of self-focused risk was supported.

For other-focused risk estimates, there was a significant effect of numeracy level, such that a 1-unit increase in numeracy level resulted in a .15-unit decrease in other-focused risk. There was also a significant effect of worry, such that a 1-unit increase in worry resulted in a .15-unit increase in other-focused subjective risk estimates. There were no significant effects of transparency, control, or mood clarity. Although worry was not expected to be predictive of other-focused risk estimates, the significant effect of numeracy level on other-focused subjective risk supports my hypothesis.

The results for both types of risk estimates are, again, strongly supportive of my hypotheses. Worry was a significant predictor of self-focused numerical and subjective risk estimates, but numeracy level was not. This lack of significant effect of numeracy level on self-focused risk estimates again suggests that the potential benefits of numeracy on risk perception may be restricted to those who estimate risk for others. For other-focused risk estimates, numeracy level was a significant predictor of both types of estimates, whereas worry only significantly predicted other-focused subjective risk. Given the nature of subjective risk – that it is more of a gist-like representation of numerical risk – it makes intuitive sense that worry would play a role in other-focused subjective risk but not other-focused numerical risk. And, given that transparency did not play a significant role in predicting any of the four types of risk estimates, there is more evidence to suggest that transparent versus nontransparent framing of numerical information may be less important in terms of risk perception than previously suggested (e.g., Gigerenzer et al., 2008).

Effects on Behavioral Intentions and Recommendations

After controlling for all variables, there was no relationship between personal behavioral intentions and behavioral recommendations for the average American, $B = .01$, $SE = .02$, $p = .41$. As a reminder, responses to behavioral measures were standardized before creating the composite measures, so results are presented in terms of standard deviations.

Beginning with personal behavioral intentions, there was a significant effect of worry, such that a 1-unit increase in worry resulted in a .13 standard deviation increase in behavioral intentions. There was also a significant effect of numeracy level, such that a 1-unit increase in numeracy level resulted in a .12 standard deviation *decrease* in behavioral intentions. The significant (positive) effect of worry supports my hypothesis regarding its effect on personal behavioral intentions. It was also hypothesized that if numeracy level was predictive of behavioral intentions, this effect would be negative – the data also support this hypothesis. In addition, there was a marginally significant effect of transparency, such that behavioral intentions were higher when information was presented transparently, $M = .09$, $SD = .54$, versus nontransparently, $M = -.05$, $SD = .42$. This finding is the first piece of evidence that suggests transparent framing of health information may be more beneficial than nontransparent framing, specifically in terms of behavioral intentions. Interestingly, there were no significant effects of self-focused numerical or subjective risk – subjective risk was expected to be predictive of behavioral intentions – nor were there significant effects of control or mood clarity.

For behavioral recommendations for the average American, the pattern was very similar. There was a significant effect of numeracy level, such that a 1-unit increase in numeracy level resulted in a .08 standard deviation decrease in behavioral recommendations. In this case, numeracy level *was* hypothesized to be predictive of behavioral recommendations, and was, again, negatively predictive. There was also a significant effect of worry, such that a 1-unit increase in worry resulted in a .14 standard deviation increase in recommendations. This effect does not support my hypothesis. The effect of transparency was also significant, such that behavioral recommendations were higher in the transparent condition, $M = .07$, $SD = .51$, versus the nontransparent condition, $M = -.10$, $SD = .60$. This finding also provides support for using transparent framing of health information over nontransparent framing in order to improve health outcomes, here, behavioral recommendations for others. Finally, there were also significant effects of other-focused subjective risk and feelings of control, such that a 1-unit increase in each resulted in a .16 and .29 standard deviation increase in behavioral recommendations, respectively. There were no significant effects of other-focused numerical risk or mood clarity.

The results for behavioral intentions and recommendations also generally support my hypotheses. While worry was expected to be predictive only of personal behavioral intentions, in reality, it was predictive of both personal intentions and recommendations for others, suggesting the powerful role that emotions play in various kinds of decision-making processes, regardless of the subject of the decision. Numeracy level was also predictive of both intentions and recommendations; however, as predicted, the effect of numeracy level was to *reduce* behavioral intentions and recommendations. Although this was the only effect of numeracy level on self-focused judgments in this study, it is a very important one: higher numeracy levels are reducing participant desires to engage in protective and detective behaviors related to two common diseases. Given that higher numeracy levels are making numerical risk estimates for self and other more accurate by *reducing* these estimates (although not significantly so for the self), it logically follows that higher numeracy levels may reduce behavioral intentions and recommendations. However, the risk data provided to the participants reveal that the risk for each of these diseases is quite substantial (approximately 2.72% and 30.83% for melanoma and type 2 diabetes, respectively); the finding that higher numeracy levels are reducing behavioral intentions suggests that these participants are not sensitive to what levels of risk may warrant taking action. Therefore, if we are to increase societal numeracy levels – and thus make people more accurate in their perceptions of risk – through numeracy training, a necessary component to that training will be providing individuals with the proper context in which to interpret these risks, so as not to result in a lack of important protective and detective health behaviors.

Also regarding behavioral intentions and recommendations, neither numerical nor subjective risk estimates predicted behavioral intentions; however, subjective risk estimates did predict behavioral recommendations for others. This finding is only partially supportive of my hypothesis that subjective risk would be more predictive of personal behavioral intentions *and* behavioral recommendations for others, relative to numerical risk, given that we are more likely to use gist-like, intuitive information when making decisions involving risk (i.e., Fuzzy-Trace theory; Reyna, 2004). It is currently unclear as to why subjective risk was not predictive of personal intentions. This relationship – or possible lack thereof – will be explored again in Study 2.

Emerging for the first time in this study were significant effects of transparency. The marginal effect of transparency on personal intentions and significant effect of transparency on behavioral recommendations revealed that receiving information in a transparent, straightforward manner resulted in higher behavioral intentions and recommendations than receiving information in a nontransparent, less straightforward manner. Although numerical risk perceptions were more accurate (lower) in the transparent condition, it is unlikely that this trend relates to the increases in intentions and recommendations. Not only was the effect of transparency on numerical risk estimates nonsignificant, but also the effect of numeracy level on intentions and recommendations was such that more accurate risk estimates *reduced* these behavioral measures, instead of increasing them as transparency did. Instead, drawing from the fluency literature, perhaps it is the case that the mere ease with which the transparent information was processed made the risks seem more plausible. Given that more fluent information is believed to be truer (e.g., Reber & Schwarz, 1999), it is possible that participants were more motivated to engage in behaviors related to these risks, because the risks felt more real to them. Thus, it may be that receiving information in a transparent manner served to increase feelings of worry, and therefore behavioral intentions and recommendations; however, this possibility cannot be confirmed as worry was only measured *before* the health information was presented.

Effects on Self-Reported Behavior – One Month Follow-Up

Again, hierarchical linear regression was used to examine the effects of transparency, worry, numeracy level, control, mood clarity, self-focused numerical and subjective risk estimates (Step 1), the two-way interactions between transparency, worry, and numeracy level (Step 2), and the three-way interaction term (Step 3) on self-reported behaviors at the one month follow-up. Because participants were not asked about genetic testing or willingness to pay at the follow-up, the behaviors measure was calculated by averaging responses (not standardized) to questions regarding the extent to which they engaged in protective and detective behaviors. Only results from Step 1 are reported, as the change in R^2 beyond Step 1 was not significant. Results from Step 1 are presented in Table 6. As a reminder, 87 out of 149 participants were retained from the first part of the study.

The only significant effects to emerge from the above predictors were effects for worry and numeracy level. Replicating the effects for behavioral intentions and supporting my hypothesis, a 1-unit increase in worry resulted in a .15 unit increase in self-reported protective and detective behaviors, whereas a 1-unit increase in numeracy level resulted in a .07-unit *decrease* in these same behaviors. Interestingly, and not in support of my hypothesis, there were no significant effects of self-focused numerical or subjective risk estimates. There were also no significant effects of transparency, control, or mood clarity.

Regarding the effect of engaging in protective and detective behaviors on current levels of worry, the results were surprising: engaging in these behaviors resulted in a significant *increase* in feelings of worry, $B = .88$, $SE = .18$, $p < .001$, above and beyond the significant effect of worry from part 1 of this study, $B = .54$, $SE = .07$, $p < .001$. Specifically, a 1-unit increase in self-reported protective and detective behaviors resulted in a .88-unit increase in feelings of worry. Although no hypotheses were made about the effects of engaging in protective and detective behaviors on current levels of worry, this effect was somewhat counterintuitive, in that it seems more likely that engaging in healthy behaviors would *reduce* levels of worry, because protective action had been taken. Following from self-perception theory (Bem, 1967), however, it is also plausible that participants used their recent performance (or lack thereof) of these health behaviors to infer their level of worry. In other words, participants may have viewed their protective and detective behaviors as an indicator of their level of worry, with those performing more behaviors reporting more worry.

Summary

Overall, the results of Study 1b again suggest that numeracy level is not an important factor when making risk assessments about the self. And, in terms of behavior, numeracy level is playing a negative role by reducing motivations to engage in protective and detective behaviors. These data suggest the possibility that numeracy training programs will not only be restricted in impact to *other*-focused perceptions of risk, but also may discourage people from engaging in important, healthy behaviors. Conversely, this study has shown that feelings of worry *increase* motivations to engage in these health-related behaviors, making a more emotionally-based intervention beneficial in terms of increasing healthy behaviors. These two approaches – numeracy training versus emotional appeals – are directly compared in Study 2.

CHAPTER 5

STUDY 2

The goal of Study 2 was to explicitly examine the recommendation of Gigerenzer et al. (2008) to improve health through implementing numeracy training in order to change perceptions of risk. Therefore, this study compares the effects of a numeracy training intervention and an emotional intervention on risk estimates for the self and risk estimates for others, as well as on behavioral intentions and recommendations, and self-reported behavior. As stated previously, changes in risk estimates that have been demonstrated following a numeracy training intervention have only tested participants on their perceptions of risk for *others* (Gigerenzer et al., 2008). Unlike prior research, Study 2 not only examines the effects of a numeracy training intervention on perceptions of risk for the *self*, but also compares the effects of the numeracy training intervention to the effects of an emotionally-based intervention – specifically, the use of personal narratives and fear appeals – on self- and other-focused estimates of risk, as well as behavioral intentions and recommendations, and self-reported behavior. Again, with so much recent attention being turned to numeracy training programs and the potential benefits of numeracy training on health, it is important to know how such an approach compares to existing approaches (i.e., the use of fear appeals and personal narratives), especially when the former approach is more involved, likely more costly than existing approaches, and may, in fact, reduce engagement in healthy behaviors (as demonstrated in Study 1b).

While the numeracy training intervention was aimed at increasing numeracy levels, the emotional intervention was aimed at increasing worry. Increasing worry was chosen as an intervention goal, because of the potential to increase health-protective behaviors by *increasing* personal risk perceptions, which was also supported by Study 1b. This 3 (Intervention: numeracy training vs. emotional vs. control; between-subjects) x 2 (Focus of judgment: self vs. other; within-subjects) mixed design allows for a direct comparison between two specific risk communication strategies on important health-related outcomes.

Similar to Studies 1a and 1b, I hypothesized that numeracy levels would have a stronger effect than worry on other-focused numerical and subjective estimates of risk and behavioral recommendations, while worry would have a stronger effect than numeracy levels on self-focused numerical and subjective estimates of risk, as well as behavioral intentions and self-reported behavior one month later across all three intervention conditions. Specific to this study, I hypothesized that the emotional intervention would produce significantly higher levels of self-focused numerical and subjective risk estimates, behavioral intentions, and self-reported behavior one month later, relative to the numeracy training and control interventions. Conversely, I hypothesized that the numeracy training intervention would produce significantly lower levels of other-focused numerical and subjective risk estimates and behavioral recommendations, as well as significantly lower levels of behavioral intentions and self-reported behavior one month later (as indicated by Study 1b) relative to the emotional and control interventions, but will not significantly differ from the control condition on *self*-focused numerical or subjective estimates of risk.

Method

Participants

Participants were 96 undergraduates from the University of North Carolina at Chapel Hill who were enrolled in an introductory social psychology course. In exchange for their participation, participants received extra credit toward their final course grade. Given that the health data presented to the participants were applicable up to age 29, participants aged 30 and above were not included in the analyses. In addition, participants were asked to verify that they had watched the video manipulation in full before moving on. Those who admittedly did not watch the video in full were not included in the analyses. These inclusion criteria resulted in a final sample size of 91, ranging in age from 18 to 22, with an average age of 19.73 years. The sample was 84.6% female and 61.50% Caucasian.

For the behavioral follow-up 71 participants were retained from the first part of the study. The age range of this sample was, again, 18 to 22, with an average age of 19.76-years old. This sample was 87.3% female and 66.2% Caucasian.

Procedure

As in Study 1b, melanoma and type 2 diabetes were used as the focal health events, and the dependent measures were largely unchanged. Participants accessed the survey via Qualtrics and were assigned to one of three conditions: numeracy training intervention, emotional intervention, or control intervention. For each condition, participants first watched one of three 15-minute lecture interventions (recorded using PowerPoint and narrated by an individual who was blind to the hypotheses), with intervention topic serving as the manipulation. Intervention topics included: 1. How to interpret health statistics (numeracy training), 2. Personal testimonials about melanoma and type 2 diabetes (emotional), and 3.

Understanding the Affordable Health Care Act (health-related control). All interventions were pilot tested before being implemented using a sample of 30 undergraduates recruited through an introductory social psychology class. After watching one of the three interventions, participants responded to the o, questions about the content of the intervention, worry about melanoma and type 2 diabetes, and the numeracy measure.

Regarding emotional reactions to the interventions, the emotional intervention elicited significantly higher levels of guilt, sadness, and fear, relative to the numeracy training and control interventions. The emotional intervention also elicited significantly higher levels of worry, relative to the other two interventions. Although a significant effect was not detected, the numeracy training intervention resulted in higher numeracy levels ($M = 9.10$) than the emotional condition, ($M = 8.5$) and the control condition ($M = 8.90$). Importantly, there were no significant differences between any of the conditions on the extent to which participants found the interventions to be effective in conveying information, enjoyable to watch, vivid, interesting, understandable, engaging, or likeable. There were also no differences in the extent to which participants reported paying attention, caring about the information presented, or learning from the interventions. Detailed information regarding each intervention is presented in the next section.

Following the interventions, all participants completed a general emotion inventory – the mDES – to assess the overall emotional effects of each intervention, and then reported on their worry about melanoma and type 2 diabetes. Following a short filler task, participants were presented with scenarios and data similar to those that were used in Study 1b (the specific scenarios are presented in Appendix E), and asked to provide numerical and subjective risk estimates for both the self and the average college student. They were then asked about perceived controllability, behavioral intentions and recommendations, and mood clarity. The last measure participants completed was, again, the numeracy assessment. At the end of the session, they were presented with the same take-home health information used in Study 1b. Finally, participants were recontacted one month later to assess self-reported protective and detective behaviors.

Materials

Interventions

Although the use of established and published interventions was sought and preferred, extensive literature searches produced little success. Therefore, the following interventions were created expressly for the purposes of this study. At the end of each intervention, participants were presented with information about melanoma and type 2 diabetes, along with information about how to protect against each in order to make the emotional intervention appropriately effective, as providing participants with information on how to alleviate their fear is a critical component of an effective fear appeal (Witte, 1992), and to account for the fact that the emotional intervention provided information about these two diseases, while the other two lectures did not.

Numeracy Training Intervention

This lecture presented concepts taught in previous numeracy training courses led by Gerd Gigerenzer, including “the illusion of certainty, single-event probabilities versus frequencies, conditional probabilities versus natural frequencies, [and] relative versus absolute risks” (personal communication, August 24, 2010). According to Gigerenzer, the most important message of his training sessions was that “the reason for their lack of understanding of health statistics is not inside their heads (or in their genes), but in the misleading way information is framed" (personal communication, August 24, 2010). In other words, the goal of this intervention was to teach the participants how to translate nontransparent health data into a transparent format upon which they can then more accurately operate. The exact information presented in this intervention is based upon Gigerenzer (2002) and Sedlmeier and Gigerenzer (2001).

Emotional Intervention

Drawing upon the fear appeals literature and the effectiveness of personal testimonials (e.g., de Wit, Das, & Vet, 2008), this intervention presented stories from individuals diagnosed with melanoma or type 2 diabetes, paired with general information about each disease, in order to arouse worry in the participants. The personal testimonials presented in this intervention came from websites hosted by the Australian Government Department of Health and Ageing (2010), and Health.com (2010).

Control Intervention

In order to provide a strong comparison condition, the control intervention was also 15 minutes long and focused on a health-related topic: understanding the new Affordable Health Care Act. The exact information contained in this intervention was based upon the explanatory materials provided by the U.S. Department of Health and Human Services (2010).

Modified Differential Emotions Scale (mDES) and Manipulation Checks

After the interventions, participants completed the mDES to serve as a manipulation check of the emotions evoked via the interventions. It was intended that the emotional intervention would evoke more fear-related emotions than either of the other two interventions. Participants were asked to indicate how much of each emotion (25 total) they were experiencing while watching the intervention. Responses were provided using a 5-point rating scale, ranging from 0 (*Not at all*) to 4 (*Extremely*). Also included were 10 questions from the pilot study to ensure that these interventions were not differing on the extent to which they were effective in conveying information, enjoyable, vivid, interesting, understandable, engaging, and likeable, and the extent to which participants learned from the intervention, cared about the information presented in the intervention, and paid attention to the intervention. Responses to these 10 questions were provided using a 7-point rating scale, ranging from 1 (*Not at all*) to 7 (*Extremely*).

Data Analysis

The data analytic approach for Study 2 was identical to the approach proposed for Study 1b (multivariate multiple regression for numerical risk, subjective risk, and behavioral intentions and recommendations; linear regression for self-reported behavior one month later), with the exception that transparency was no longer an included variable (all information was presented nontransparently), while intervention type was added as a predictor variable. Also added for this study were manipulation checks to compare differences in emotions evoked by each intervention, as well as mean numeracy and worry levels across conditions.

Results and Discussion

Descriptive statistics and bivariate correlations for all variables of interest are presented in Table 7. Worry, numeracy level, control, and mood clarity were centered for all regression analyses. Self- and other-focused numerical and subjective risk estimates were centered for behavioral regression analyses.

Manipulation Checks

To begin, one-way analysis of variance tests were used to test the effect of intervention type on emotions experienced during the video. Similar to the pilot study, there was a significant effect of intervention type on feelings of fear, $F(2, 88) = 4.52$, $p = .01$, such that fear was significantly higher while watching the emotional intervention, $M = 1.73$, $SD = .74$, relative to the numeracy training, $M = 1.24$, $SD = .79$, $t(57) = 2.48$, $p = .02$, and control interventions, $M = 1.28$, $SD = .58$, $t(60) = 2.69$, $p = .01$, which did not differ from one another, $t(59) = -.23$, $p = .82$. Contrary to the pilot study, significant effects of intervention type emerged on additional reported emotions. There was a significant effect of intervention type on feelings of sadness, $F(2, 88) = 5.45$, $p = .01$, such that the emotional, $M = 1.80$, $SD = .96$, *and* numeracy training, $M = 1.48$, $SD = 1.06$, interventions induced significantly more sadness than the control intervention, $M = 1.09$, $SD = .39$, ts > 1.94, ps $< .05$, but did not differ from one another, $t(57) = 1.21$, $p = .23$. There was also a significant effect of intervention type on feelings of awe, $F(2, 88) = 3.76$, $p = .03$, such that the numeracy training intervention, $M = 1.69$, $SD = .93$, induced marginally significantly more awe than the emotional intervention, $M = 1.33$, $SD = .55$, $t(57) = -1.80$, $p = .08$, and significantly more awe than the control intervention, $M = 1.22$, $SD = .55$, $t(59) = 2.43$, $p = .02$; the emotional and control interventions did not differ from one another, $t(60) = .82$, $p = .42$. Finally, there was a significant effect of intervention type on feelings of rejection, $F(2, 88) = 3.23$, $p = .04$, such that the numeracy training intervention, $M = 1.38$, $SD = .98$, induced marginally significantly more rejection than the control intervention, $M = 1.06$, $SD = .25$, $t(59) = 1.77$, $p = .08$, and the emotional intervention, $M = 1.03$, $SD = .18$, $t(57) = -1.90$, $p = .06$; the emotional and control interventions did not differ from one another, $t(60) = -.53$, $p = .60$.

In addition, unlike the pilot study, one significant difference emerged regarding intervention qualities: There was a significant effect of intervention type on the extent to which participants understood the information presented in the intervention, $F(2, 88) = 5.92$, $p = .004$, such that understanding was significantly higher in the emotional intervention, $M = 6.00$, $SD = 1.26$, than the numeracy training, $M = 4.86$, $SD = 1.60$, $t(57) = 3.04$, $p = .004$, and control, $M = 4.97$, $SD = 1.38$, $t(60) = 3.07$, $p = .003$, interventions, which did not differ from one another, $t(59) = -.28$, $p = .78$.

Regarding worry, there was a significant effect of intervention type on worry, $F(2, 88) = 3.84$, $p = .03$, such that those in the emotional intervention, $M = 4.22$, $SD = 1.16$, reported significantly more worry than those in the numeracy training intervention, $M = 3.37$, $SD = 1.16$, $t(57) = 2.80$, $p = .01$, but did not differ from those in the control intervention, $M = 3.84$, $SD = 1.20$, $t(60) = 1.27$, $p = .21$; the numeracy training and control interventions also did not differ in terms of worry, $t(59) = -1.54$, $p = .13$. Regarding numeracy level, there were no significant differences among any of the interventions, $F(2, 87) = .29$, $p = .75$. Unlike in the pilot, the means were not in the expected directions, with numeracy level being highest in the control intervention, $M = 9.19$, $SD = 1.75$, followed by the emotional intervention, $M = 8.93$, $SD = 2.12$, and then the numeracy training intervention, $M = 8.79$, $SD = 2.41$.

Taken as a whole, it appears that the emotional intervention produced the intended effects on worry, but the effectiveness of the numeracy training intervention was not confirmed. Given the emotional reactions to the numeracy training intervention (elevated levels of awe, rejection, and sadness) combined with the lower numeracy levels and understanding, it is possible that these feelings of awe may have been the result of the depth of knowledge displayed in the video, whereas the feelings of rejection may have been the result of their difficulty understanding the information. These data, then, suggest that the online video format may not be the most efficient means of providing numeracy training, and thus is not likely to produce any of the intended effects. Because the interventions were not fully effective, intervention type has been included as a predictor in all analyses, but the primary focus will be on internal analyses aimed at addressing the relative effects of worry and numeracy on self- versus other-focused judgments.

As before, multivariate multiple regression was used to examine the effects of intervention, worry, numeracy level, and the two- and three-way interactive effects of intervention, worry, and numeracy levels on both self- and other-focused numerical and subjective estimates of risk, as well as behavioral intentions and recommendations. The results from the best-fitting models – for all outcome variables, the model containing only main effects – are presented in Table 8.

Effects on Numerical Risk Estimates

After controlling for all variables, the relationship between self- and other-focused numerical risk estimates remained significant, $B = 150.64$, $SE = 37.37$, $p < .001$. Beginning with self-focused risk estimates, and supporting my hypothesis, there was a significant effect of worry, such that a 1-unit increase in worry resulted in a 4.86-unit increase in self-focused risk. There was also a significant effect of mood clarity, such that a 1-unit increase in mood clarity resulted in a 6.31-unit increase in self-focused risk. There were no significant effects of intervention type, numeracy level, or control.

Also supporting my hypothesis, there was a significant effect of numeracy level on other-focused numerical risk estimates, such that a 1-unit increase in numeracy level resulted in a 2.08-unit decrease in other-focused risk. This time, there was a marginally significant effect of mood clarity, such that a 1-unit increase in mood clarity resulted in a 5.35-unit increase in other-focused risk. There were no significant effects of intervention type, worry, or control.

Effects on Subjective Risk

After controlling for all variables, the relationship between self- and other-focused subjective risk estimates remained significant, $B = .39$, $SE = .11$, $p < .001$. Beginning with self-focused subjective risk estimates, there was a significant effect of worry, such that a 1-unit increase in worry resulted in a .49-unit increase in self-focused subjective risk. There was also a significant effect of control, such that a 1-unit increase in feelings of control resulted in a .66-unit decrease in self-focused subjective risk. There were no significant effects of intervention type, numeracy level, or mood clarity. The significant effect of worry, along with the nonsignificant effect of numeracy level on self-focused subjective risk, supports my hypothesis.

For other-focused subjective risk estimates, there was a marginally significant effect of worry, $p = .08$, such that a 1-unit increase in worry resulted in a .15-unit increase in other-focused subjective risk. There were no significant effects of intervention type, numeracy level, worry, control, or mood clarity.

The results for risk estimates – both numerical and subjective – are very supportive of my hypotheses. Worry significantly predicted both self-focused risk estimates, but neither was predicted by numeracy level. For other-focused estimates, numeracy level only significantly predicted other-focused numerical risk estimates, demonstrating the narrowest range of numeracy effects of all reported studies. Worry was, again, a marginally significant predictor of other-focused subjective risk, replicating the effect of Study 1b and again highlighting the importance of emotional factors in the decision-making process, even if these decisions are about others.

Although the numeracy training video did not appear to work, as indicated by the manipulation checks, when only including intervention type in the model as a predictor, there was a marginally significant effect of intervention type, $B = -.25$, $SE = .15$, $p = .10$, on self-focused subjective risk, such that subjective risk in the emotional intervention, $M = 4.02$, $SD = 1.21$, was significantly higher than the numeracy training intervention, $M = 3.18$, $SD = 1.07$, and marginally higher than the control intervention, $M = 3.52$, $SD = 3.14$. The numeracy training and control interventions did not differ from one another. Because this effect is not present in the full model, it suggests that intervention type is not having an effect on self-focused subjective risk above and beyond the effect of worry (as the emotional intervention was expected to operate through elevated levels of worry). When only including intervention type in the model predicting numerical risk estimates, there were no significant effects.

Interestingly, there were also significant effects of mood clarity on risk estimates. For self- and other-focused numerical risk, increases in mood clarity resulted in increases in risk estimates. Perhaps it is the case that the ability to make sense of one's feelings may make general feelings and reactions to health-related information seem more real and/or informative when making judgments about personal and other-focused risk. It should be noted, however, that these participants are not likely relying more on their personal feelings of *worry*, specifically, as the result of higher mood clarity; post-hoc analyses did not reveal a significant interaction between mood clarity and worry on either self- or other-focused numerical risk. Regardless, these effects of mood clarity were not present in Study 1b, nor were they further demonstrated in Study 2, so they should be interpreted with caution until replicated.

Effect on Behavioral Intentions and Recommendations

After controlling for all variables, the relationship between personal behavioral intentions and behavioral recommendations for the average American remained significant, $B = .12$, $SE = .03$, $p < .001$. As a reminder, responses to behavioral measures were standardized before creating the composite measures, so results are presented in terms of standard deviations.

Beginning with personal behavioral intentions, and supporting my hypothesis, there was a significant effect of worry, such that a 1-unit increase in worry resulted in a .15 standard deviation increase in behavioral intentions. Contrary to my predictions there was also a marginally significant effect of self-focused numerical risk, such that a 1-unit increase in numerical risk resulted in a -.01 standard deviation *decrease* in behavioral intentions, but no significant effect of self-focused subjective risk. Finally, there was also a significant effect of control, such that a 1-unit increase in feelings of control resulted in a .53 standard deviation increase in intentions. There were no significant effects of intervention type, numeracy level, or mood clarity.

For behavioral recommendations for the average American, there was, again, a significant effect of worry that was not predicted, such that a 1-unit increase in worry resulted in a .12 standard deviation increase in behavioral recommendations. There was also a marginally significant effect of control, such that a 1-unit increase in feelings of control resulted in a .29 standard deviation increase in behavioral recommendations. There were no significant effects of intervention type, numeracy level, mood clarity, other-focused numerical risk, or other-focused subjective risk. As a note, when only including intervention type in the model as a predictor, there were no significant effects on behavioral intentions or recommendations.

For behavioral intentions and recommendations, the data pattern from Study 2 differed from Study 1b. This time, there were no significant effects of numeracy level on either intentions or recommendations; however, the significant effects of worry did replicate. Across these two studies, it can be seen that *if* numeracy level plays a role in predicting these intentions and recommendations, then it does so negatively, suggesting that numeracy training programs that successfully increase numeracy levels may not be useful, or may actually be harmful in terms of engaging in everyday healthy behaviors.

Regarding the predictive value of numerical versus subjective risk estimates on behavioral intentions and recommendations, the results did not support the hypothesis: subjective risk estimates did not significantly predict behavioral intentions or recommendations, while numerical risk estimates were marginally significant for personal intentions. So, while Study 1b suggests that subjective risk may be more important in determining behavior than numerical risk, Study 2 did not replicate this effect. Again, this inconsistent pattern of effects warrants further investigation, as determining which type of risk perception is more predictive of intentions and recommendations remains important and may help inform what types of interventions may best be suited for increasing healthy behaviors: those that influence numerical risk, or those that influence more gist-like representations of risk.

Effects on Self-Reported Behavior – One Month Follow-Up

Again, hierarchical linear regression was used to examine the effects of intervention type, worry, numeracy level, control, mood clarity, self-focused numerical and subjective risk estimates (Step 1), the two-way interactions between transparency, worry, and numeracy level (Step 2), and the three-way interaction term (Step 3) on self-reported behaviors at the one month follow-up. Because participants were not asked about genetic testing or willingness to pay at the follow-up, the behaviors measure was calculated by averaging responses (not standardized) to questions regarding the extent to which they engaged in protective and detective behaviors. Only results from Step 1 are reported, as the change in R^2 beyond Step 1 was not significant. Results from Step 1 are presented in Table 9. As a reminder, 71 out of 96 participants were retained from the first part of this study.

The only significant effect to emerge from the above predictors was the effect of mood clarity. Similar to the effect on self- and other-focused numerical risk, a 1-unit increase in mood clarity resulted in a .14 unit increase in self-reported behaviors. It is again possible that this is because those who are higher in mood clarity are better able to make sense of their feelings – their general reactions to the risks of melanoma and type 2 diabetes – which are then used as information when making judgments; however, as in the first part of Study 2, post-hoc analyses did not reveal an interaction between mood clarity and worry on self-reported behavior. It is important to note that this effect of mood clarity was not replicated in Study 1b.

Replicating the effects for behavioral intentions and supporting my hypothesis, there was a marginal effect of worry, such that a 1-unit increase in worry resulted in a .08 unit increase in self-reported protective and detective behaviors. There was also a marginally significant effect of control, such that a 1-unit increase in feelings of control resulted in a .22-unit increase in self-reported behaviors. Unlike Study 1b, there was no significant effect of numeracy level on self-reported behaviors in Study 2, again suggesting the limited effects of numeracy level on self-focused outcomes. Finally, contrary to my hypothesis, but replicating the findings of Study 1b, there were no significant effects of self-focused numerical or subjective risk estimates. There were also no significant effects of intervention type.

Also replicating the findings of Study 1b, engaging in protective and detective behaviors resulted in significantly *higher* feelings of worry, $B = .53$, $SE = .25$, $p = .04$, above and beyond the significant effect of worry from part 1 of the study, $B = .67$, $SE = .09$, $p < .001$. Specifically, a 1-unit increase in self-reported protective and detective behaviors resulted in a .53-unit increase in feelings of worry. Again, as suggested in Study 1b, this finding is likely reflective of self-perception effects (Bem, 1967).

Summary

Although the results of this study replicate the general effects of studies 1a and 1b, namely the limited beneficial effects of numeracy levels, these results are not fully supportive of the hypotheses unique to Study 2. While the emotional intervention appeared to be working as expected, especially in regard to self-focused subjective risk, the numeracy training intervention did not have an effect on numeracy levels, risk estimates, behavioral intentions, or behavioral recommendations. The numeracy training intervention produced emotional effects that were not present in the pilot study, and thus not expected in the full study. Specifically, the numeracy training intervention produced greater levels of awe than both the emotional and control interventions, and also produced significantly more feelings of rejection than the control intervention, although these ratings did not differ from those in the emotional intervention. Again, I believe that these elevated levels of both awe and rejection may suggest that participants were in awe of the statistical knowledge presented in the numeracy training intervention, but doubted their own ability to implement this knowledge, which could explain why mean numeracy levels and understanding were lowest in the numeracy training intervention.

Regardless, it is clear that this numeracy training intervention was not working as intended, and requires additional editing for future studies. Specifically, it seems as though format would be the best starting point in terms of editing, such that an in-person, longer, and interactive format may be better equipped to improve levels of numeracy than an online video, making it more akin to the numeracy training program reported by Gigerenzer et al. (2008). Improvement of this manipulation is an important pursuit, as the results from Studies 1a and 1b have demonstrated the need to directly compare numeracy training and emotional interventions on self- and other-focused judgments and decisions.

Overall, however, Study 2 adds to the evidence of the previous two studies that suggests limitations to the effects of numeracy levels on health-related judgments, and even shows the most limited effect of numeracy level of all three studies – here, restricted to other-focused numerical risk only. And, again, Study 2 showcases the importance of emotions – namely, worry – in the decision-making process about not only the self, but others as well.

CHAPTER 6

GENERAL DISCUSSION

Through the work in my dissertation, significant progress was made toward better understanding the roles that numeracy level and worry play in both self- and other-focused health judgments. Not only was the effect of worry demonstrated across all studies and, occasionally, across both types of judgments, the *narrow* range of the effect of numeracy level was also demonstrated.

In Studies 1a and 1b, the effects of existing levels of worry and numeracy were explored on self- and other-focused numerical and subjective risk estimates. In these studies, the effect of numeracy level on risk estimates was restricted to *other-focused* risk estimates, whereas worry consistently predicted *self-focused* estimates, and even spilled over to other-focused estimates on occasion. Regarding behavioral intentions and recommendations in Study 1b, numeracy level and worry predicted both intentions and recommendations. While worry served to *increase* behavioral intentions and recommendations, numeracy level served to *decrease* these same variables. These effects were then replicated on self-reported behavior one month later. These negative effects of numeracy level on behavioral intentions and behavior are quite important, as these were mostly for everyday behaviors that positively contribute to one's health, such as eating fruits, vegetables, and whole grains, and exercising regularly. Overall, Studies 1a and 1b show the beneficial effects of worry on behavioral intentions, recommendations, and self-reported behaviors, while also demonstrating that numeracy level does not affect self-focused risk estimates, but does serve to reduce the degree to which participants believe that they and others should engage in healthy behaviors.

In Study 2, I attempted to manipulate numeracy levels and worry; however the manipulation of numeracy level was not successful. Despite this, the conclusions drawn about the roles of numeracy level and worry on self- and other-focused judgments echoed the conclusions of Studies 1a and 1b: While worry continued to predict all self-focused outcome variables, and even other-focused subjective risk and behavioral recommendations, the only effect of numeracy level to emerge was on other-focused numerical risk.

These results, combined with the results of Studies 1a and 1b suggest that, although numeracy level may sometimes predict other-focused risk estimates, the effects of numeracy level on personal behaviors and intentions and behavioral recommendations for others are either nonexistent or detrimental in terms of healthy behaviors. These data show that relying on numeracy level and numeracy training as avenues through which we can improve health, generally, has earned premature and unwarranted support. Although higher numeracy levels may prevent people from pursuing treatment options that are suboptimal, higher numeracy levels are also serving to reduce motivations to recommend and personally engage in healthy behaviors.

Strengths and Limitations

A major strength of this work is that the general effects of worry and numeracy level were consistent across all studies, and even replicated across differing samples (i.e., a college-aged population versus a community sample). One finding that is particularly noteworthy here is the replication of the effect of worry across all three studies. In Studies 1a and 1b, worry was measured *before* receiving any health-related information, and thus demonstrated the effect of baseline, or existing levels of disease-specific worry regarding these health scenarios on self- and other-focused judgments. In Study 2, however, worry was measured *after* receiving health-related information and produced the same pattern of results. This replication suggests that the demonstrated effect of worry may hold across differing sources of worry.

These studies also addressed current weaknesses in the numeracy literature: the lack of consistent evidence regarding the effect of numeracy level on *self-focused* judgments, and the lack of direct comparison of the effects of numeracy level and worry on self- and other-focused judgments. Given that most of us are likely to make estimates about and recommendations for other people from time to time, such as when we are providing social support, and that professions exist in which people consistently make risk estimates and behavioral recommendations for others (e.g., medical professions), a better understanding of the effects of numeracy level and worry across these different judgments is very important. In terms of patient-provider interactions, specifically, these findings carry great implications. While patients may be more likely to base their perceptions of risk and behavioral intentions on their feelings of worry, with more worry resulting in more behavioral intentions, providers may be more likely to base their recommendations on their understanding of the relevant numerical information – especially if they are taught to control their emotional experiences when doing so – perhaps resulting in fewer recommendations to engage in protective and detective behaviors. Although there remains a great deal more room for additional studies looking at the relative effects of numeracy level and worry on self- and other-focused judgments, these studies represent an important step toward better understanding the role of these cognitive and affective factors in the health-related decision-making process.

However, these studies are not without some weaknesses. Regarding Studies 1a and 1b, the lack of effects of transparency should be interpreted with caution. Despite several rounds of pilot testing, I was not able to find significant differences in accuracy of interpreting numerical information based on whether the information was presented transparently or nontransparently, and it is this difference in accuracy that would be expected to result in differences in risk estimates, behavioral intentions and recommendations, and behaviors. It is still possible, though, that the lack of effects of transparency could be attributed to a true lack of effect: perhaps verbal framing of numerical information *doesn't* matter as much as previously suggested (i.e., Gigerenzer et al., 2008). Given the evidence demonstrating the beneficial effects of more transparent *graphical* representations of health information (e.g., Galesic, Garcia-Retamero, & Gigerenzer, 2009; Wright et al., 2009), a better manipulation for future studies may be whether or not numerical information is accompanied by a straightforward graphical display (e.g., an icon array). Certainly more research regarding the effects of transparency is necessary and important in order to better understand the factors affecting self- and other-focused judgments.

Regarding Study 2, the lack of effect of the numeracy training intervention was a major weakness. Although the emotional intervention appeared to be working as expected, I was unable to compare the effects of this intervention to the effects of a numeracy training intervention. Improving upon the numerical training intervention is an important next step in this program of research. Specifically, I think creating a numeracy training intervention that more closely mirrors that of Gigerenzer and colleagues (2008) is necessary. Given the constraints of the current study design – the online nature and comparison to a fear appeal intervention, in particular – it was not practical at this stage to create a 90-minute, interactive, in-person numeracy training program. Not only would it have required a much greater time commitment from the participants, but also it would have been quite difficult to create an emotional intervention that was analogous in terms of length and active engagement. However, I still strongly believe in the importance of comparing the effects of numeracy training to the effects of fear appeals and personal testimonials directly, and hope to address this issue in future work.

Future Directions

In addition to testing different manipulations of transparency and numeracy levels, there are other interesting next steps that I hope to pursue. Firstly, I am interested in exploring the degree to which numerical and emotional information is *used* in self- versus other-focused judgments by providing participants with either numerical, emotional, or no information about a disease, and then asking them to provide risk estimates and behavioral intentions or recommendations for themselves or an other. Given the results of my dissertation, I would expect numerical information to influence other-focused judgments more than self-focused judgments, and emotional information to influence self-focused judgments more than other-focused judgments. These kinds of findings would again speak to how best to present health information in order to improve health outcomes. I would also like to explore the continuum of self-other overlap in order to locate the point at which numeracy level becomes a significant predictor of other-focused judgments, as I expect the effects of numeracy level to decrease as the degree of self-other overlap increases.

Despite the progress that has been made through this dissertation work, there is still much to be learned about the role of numeracy level and numeracy training in the realm of health-related decision-making across the self and others. Such work carries important implications not only for how risk information is best communicated, but also for understanding and improving patient-provider interactions, where judgments about the self and others are happening concurrently. And, with additional research, perhaps we can come closer to understanding the ways in which we can combat serious societal health issues, such as obesity, by promoting the desire to engage in healthier behaviors on an everyday basis.

APPENDIX A:

EVENT DATA FOR STUDY 1A

Melanoma:

Transparent: **MELANOMA** (the most serious type of skin cancer) is the most common form of cancer for young adults 25-29 years old, and the second most common form of cancer for adolescents and young adults 15-29 years old. One out of 55 people will be diagnosed with melanoma during their lifetime. A person's risk for melanoma increases to 2 out of 55 if he or she has had five or more sunburns at any age.

Nontransparent: **MELANOMA** (the most serious type of skin cancer) is the most common form of cancer for young adults 25-29 years old, and the second most common form of cancer for adolescents and young adults 15-29 years old. Approximately 1.8% of people will be diagnosed with melanoma during their lifetime. A person's risk for melanoma increases by 100% if he or she has had five or more sunburns at any age.

Car Accident:

Transparent: There are more than six million **CAR ACCIDENTS** each year in the United States. Approximately 25 out of 100 drivers will be involved in a car accident in a five-year period. This risk increases to approximately 33 out of 100 for car drivers who use their cell phone while driving.

Nontransparent: There are more than six million **CAR ACCIDENTS** each year in the United States. Approximately 25% of all drivers will be involved in a car accident in a five-year period. Car drivers who use their cell phone while driving are 1.3 times more likely to get into an accident.

Genital Herpes:

Transparent: **GENITAL HERPES** is the most prevalent viral sexually transmitted disease. There are more cases of genital herpes than there are all the other viral STDs combined. Approximately 1,000,000 Americans contract genital herpes annually, with 15-19 year olds making up 250,000 of these new cases, and 20-24 year olds making up 420,000 of these new cases.

Nontransparent: **GENITAL HERPES** is the most prevalent viral sexually transmitted disease. There are more cases of genital herpes than there are all the other viral STDs combined. At least .36% of Americans contract genital herpes annually, with 15-19 year olds making up 25% of new cases, and 20-24 year olds making up 42% of new cases.

Type 2 Diabetes

Transparent: Approximately 50 out of every 10,000 American adults are diagnosed with some form of diabetes each year, with **TYPE 2 DIABETES** accounting for about 45 of these diagnosed cases of diabetes (45 out of 10,000). Type 2 diabetes is a metabolic disorder resulting from the body's inability to make enough, or to properly use, insulin.

Nontransparent: Approximately .5% of American adults are diagnosed with some form of diabetes each year, with **TYPE 2 DIABETES** accounting for about 90 to 95% of all diagnosed cases of diabetes. Type 2 diabetes is a metabolic disorder resulting from the body's inability to make enough, or to properly use, insulin.

APPENDIX B:

NUMERACY MEASURE

1. Imagine that we rolled a fair, six-sided die 1,000 times. Out of 1,000 rolls, how many times do you think the die would come up even (2, 4, or 6)?

2. In the BIG BUCKS LOTTERY, the chance of winning a $10.00 prize is 1%. What is your best guess about how many people would win a $10.00 prize if 1,000 people each buy a single ticket to BIG BUCKS?

3. In the ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets to ACME PUBLISHING SWEEPSTAKES win a car?

4. Which of the following numbers represents the biggest risk of getting a disease?
   1 in 100
   1 in 1,000
   1 in 10

5. Which of the following numbers represents the biggest risk of getting a disease?
   1%
   10%
   5%

6. If Person A's risk of getting a disease is 1% in ten years, and Person B's risk is double that of A's, what is B's risk?

7. If Person A's risk of getting a disease is 1 in 100 in ten years, and Person B's is double that of A's, what is B's risk?

8. If the chance of getting a disease is 10%, how many people would be expected to get the disease:
   Out of 100?
   Out of 1,000?

9. If the chance of getting a disease is 20 out of 100, this would be the same as having what percent (%) chance of getting the disease?

10. The chance of getting a viral infection is .0005%. Out of 10,000 people, about how many of them are expected to get infected?

APPENDIX C:

EVENT DATA FOR STUDY 1B

Melanoma:

Transparent: **MELANOMA** is the most serious type of skin cancer. Approximately 1 out of 55 people will be diagnosed with melanoma during their lifetime. A person's risk for melanoma increases to 2 out of 55 if he or she has had five or more sunburns at any age.

Nontransparent: **MELANOMA** is the most serious type of skin cancer. Approximately 1 out of 55 people will be diagnosed with melanoma during their lifetime. A person's risk for melanoma increases by 100% if he or she has had five or more sunburns at any age.

Type 2 Diabetes:

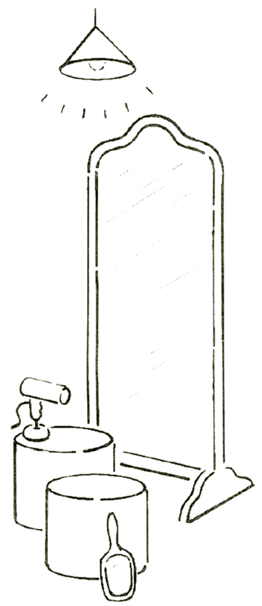
Transparent: Approximately 100 out of 300 Americans will be diagnosed with diabetes in their lifetime, with **TYPE 2 DIABETES** accounting for about 90 to 95 of these diagnosed cases of diabetes. Type 2 diabetes is a metabolic disorder resulting from the body's inability to make enough, or to properly use, insulin.

Nontransparent: Approximately 1 in 3 Americans will be diagnosed with diabetes in their lifetime, with **TYPE 2 DIABETES** accounting for about 90 to 95% of all diagnosed cases of diabetes. Type 2 diabetes is a metabolic disorder resulting from the body's inability to make enough, or to properly use, insulin.

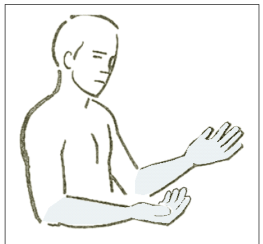
APPENDIX D:

SKIN CANCER SELF-EXAMINATION HANDOUT

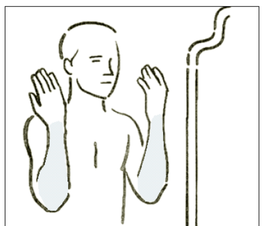
Figure 10
Self-Examination of The Skin



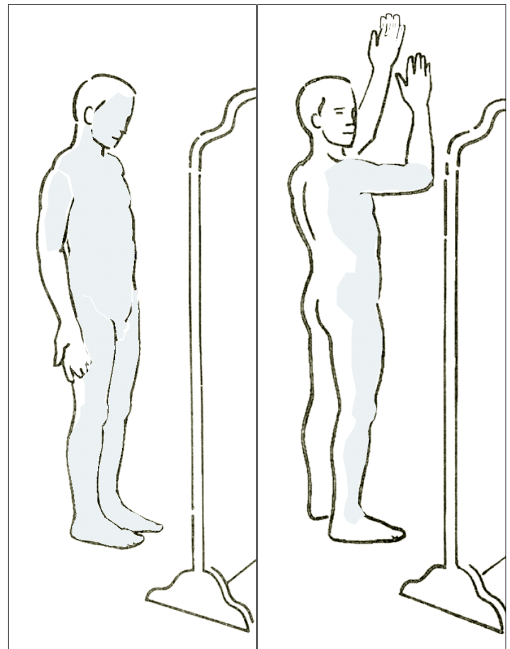
Step 1: Make sure you have good lighting. You will need a full-length mirror, a hand-held mirror, a hand-held blow dryer, and two chairs or stools. Undress completely.



Step 2: Hold your hands out in front of you with your palms facing up, as shown. Look at your palms, fingers, the spaces between your fingers, and your forearms. Now turn your hands over and examine the backs of your hands, fingers, the spaces between fingers, your fingernails, and your forearms.

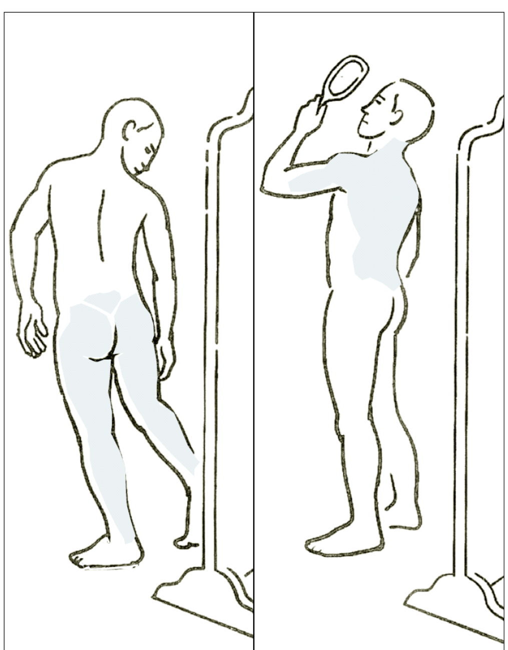


Step 3: Now stand in front of the full-length mirror. Holding your arms up and bent at the elbows, with palms facing you (as shown), examine the backs of your forearms and elbows in the mirror.



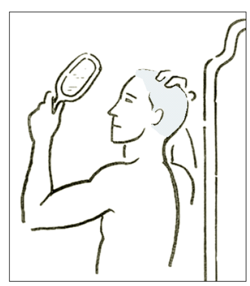
Step 4: Now observe the entire front of your body in the full-length mirror. Examine the front of your face and both sides. Look at your eyes, lips, hairline. Turn your palms toward the mirror and look at your upper arms; your chest; your abdomen; pubic area; thighs; and lower legs.

Step 5: Lift your arms over your head with the palms facing each other. Turn so that you can see your right side in the full-length mirror and look at the entire side of your body—your hands and arms, underarms, sides of your trunk, thighs, and lower legs. Turn and repeat the process, looking at your left side.



Step 6: Turn around and, with your back toward the full-length mirror, look at your buttocks and the backs of your thighs and lower legs.

Step 7: Now, using the hand-held mirror angled to help you see in the full-length mirror (as shown), examine the back of your neck, your back, and buttocks. You may also be able to examine the backs of your arms this way. Some areas are hard to see. You may find it helpful to ask your spouse or a friend to assist you.



Step 8: Continue using the hand-held mirror to look at your ears and scalp. The scalp is difficult to examine, especially if you have thick hair. You may use the hand-held blow dryer to lift the hair from the scalp. While some people are able to hold the mirror in one hand, the dryer in the other, and look in the full-length mirror, many cannot. It may be particularly useful to ask a spouse or friend to assist you with this part of the examination.

Step 9: Sit down and prop one leg up in front of you on a chair or stool, as shown. Using the hand-held mirror, look at the inside of the propped-up leg, beginning at the groin area and moving the mirror down the leg to your foot. Repeat this procedure with your other leg.

Step 10: Still sitting, cross one leg over the other. Use the hand-held mirror to examine the top of your foot, the toes, toenails, and spaces between the toes. Then look at the sole or bottom of your foot. Repeat the procedure for the other foot.

APPENDIX E:

EVENT DATA FOR STUDY 2

Melanoma:

MELANOMA (the more serious type of skin cancer) is the most common form of cancer for young adults 25-29 years old, and the second most common form of cancer for adolescents and young adults 15-24 years old. Approximately 1 out of 55 people will be diagnosed with melanoma during their lifetime. A person's risk for melanoma increases by 100% if he or she has had five or more sunburns at any age.

Type 2 Diabetes:

Approximately 1 in 3 Americans will be diagnosed with diabetes in their lifetime, with **TYPE 2 DIABETES** accounting for about 90 to 95 of these diagnosed cases of diabetes. Type 2 diabetes is a metabolic disorder resulting from the body's inability to make enough, or to properly use, insulin.

Table 1.

Means, Standard Deviations, and Bivariate Correlations Among Variables – Study 1a

	M (SD)	1	2	3	4
1. Numeracy Level	9.09 (1.77)	--			
2. Worry	3.67 (1.20)	.003	--		
3. Self (numerical)	20.60 (13.58)	-.18	.40*	--	
4. Self (subjective)	3.29 (.83)	-.04	.37*	.46*	--
5. Other (numerical)	34.36 (17.39)	-.26*	.14	.56*	-.04

Note. $N = 70$.
*$p < .05$

Table 2.

Unstandardized Multivariate Multiple Regression Estimates of Numerical Risk – Study 1a

	Self-focused risk			*Other-focused risk*		
	B	*SE*	*p*	*B*	*SE*	*p*
Constant	20.73	2.07	< .001**	36.21	2.79	< .001**
Transparency	-.18	2.94	.95	-3.65	3.96	.36
Worry	4.51	1.24	< .001**	2.26	1.68	.18
Numeracy Level	-1.36	.83	.10~	-2.46	1.12	.03*
Residual correlation (self, other)			.54**			

Note. *N* = 140. Transparency was dummy coded (0 vs. 1). Worry and numeracy level were centered at the mean.
~ $p < .10$
* $p < .05$
** $p < .001$

Table 3.

Unstandardized Linear Regression Estimates of Subjective Risk – Study 1a

	B	*SE*	*p*
Constant	3.24	.14	< .001**
Transparency	.09	.19	.63
Worry	.26	.08	.002*
Numeracy Level	-.02	.05	.72

Note. $N = 70$. $R^2 = .14$. Transparency was dummy coded (0 vs. 1). Worry and numeracy level were centered at the mean.
* $p < .01$
** $p < .001$

Table 4.

Means, Standard Deviations, and Bivariate Correlations Among Variables – Study 1b

	M (SD)	1	2	3	4	5	6	7	8	9
1. Numeracy Level	9.17 (1.71)	--								
2. Worry	4.06 (1.45)	-.07	--							
3. Control	3.81 (.46)	.18*	.02	--						
4. Mood Clarity	3.78 (.77)	.09	-.13	.21*	--					
5. Self (numerical)	29.55 (22.41)	-.07	.34**	.04	-.02	--				
6. Self (subjective)	3.65 (1.35)	-.03	.56**	.03	-.10	.63**	--			
7. Other (numerical)	30.80 (18.75)	-.32**	.03	.10	.06	.36**	.09	--		
8. Other (subjective)	4.07 (1.12)	-.22**	.20*	.09	.05	.28**	.36**	.55**	--	
9. Beh. Intentions	.02 (.48)	-.43**	.42**	.01	-.14	.12	.24**	.16	.26**	--
10. Beh. Rec.	-.02 (.56)	-.21*	.39**	.16	-.07	.08	.25**	.16	.35**	.36**

Note. $N = 149$. Behavioral Intentions and Behavioral Recommendations were standardized.
*$p < .05$
**$p < .001$

Table 5.

Unstandardized Multivariate Multiple Regression Estimates – Study 1b

	Numerical Risk		*Subjective Risk*		*Behavioral Intentions and Recommendations*	
	Self	*Other*	*Self*	*Other*	*Self*	*Other*
Constant	27.98 (2.44)**	29.09 (2.03)**	3.74 (.13)**	4.09 (.12)**	.08 (.05)	.06 (.07)
Transparency	3.08 (3.45)	3.27 (2.86)	-.17 (.18)	-.04 (.17)	-.13 (.08)~	-.21 (.09)*
Worry	5.03 (1.20)**	.06 (1.00)	.52 (.06)**	.15 (.06)*	.13 (.03)**	.14 (.03)**
Numeracy Level	-.81 (1.03)	-3.88 (.85)**	.01 (.05)	-.15 (.05)*	-.12 (.02)**	-.08 (.03)*
Control	1.84 (3.89)	5.94 (3.22)~	.09 (.21)	.28 (.20)	.10 (.08)	.29 (.10)*
Mood Clarity	.40 (2.33)	1.27 (1.92)	-.06 (.12)	.09 (.12)	-.04 (.05)	.000 (.06)
Numerical Risk	--	--	--	--	-.002 (.002)	-.002 (.003)
Subjective Risk	--	--	--	--	.03 (.04)	.16 (.05)*
Residual correlation (self, other)	.37**		.31**		.08	

Note. *N* = 298. Transparency was dummy coded (0 vs. 1). All remaining predictor variables were centered at the mean. Standard errors are in parentheses. Behavioral intentions and recommendations were standardized.

~$p < .10$

* $p < .05$

** $p < .001$

Table 6.

Unstandardized Linear Regression Estimates of Self-Reported Behavior – Study 1b

	B	*SE*	*p*
Constant	2.27	.21	< .001**
Transparency	-.06	.12	.63
Worry	.15	05	.003*
Numeracy Level	-.07	.04	.04*
Control	-.08	.13	.54
Mood Clarity	.02	.08	.77
Numerical Risk	.004	.003	.26
Subjective Risk	-.02	.06	.79

Note. $N = 87$. $R^2 = .24$. Transparency was dummy coded (0 vs. 1). All remaining predictors were centered at the mean.
* $p < .05$
** $p < .001$

Table 7.

Means, Standard Deviations, and Bivariate Correlations Among Variables – Study 2

	M (SD)	1	2	3	4	5	6	7	8	9
1. Numeracy Level	8.98 (2.08)	--								
2. Worry	3.81 (1.21)	-.05	--							
3. Control	3.83 (.42)	.20~	-.01	--						
4. Mood Clarity	3.56 (.67)	.06	-.19~	.24*	--					
5. Self (numerical)	28.77 (19.18)	-.13	.27*	-.03	.14	--				
6. Self (subjective)	3.58 (1.18)	-.15	.49**	-.22*	-.04	.59**	--			
7. Other (numerical)	33.33 (19.23)	-.18~	.07	.16	.20~	.49**	.14	--		
8. Other (subjective)	4.03 (1.00)	-.12	.16	.06	.14	.14	.43**	.46**	--	
9. Beh. Intentions	-.03 (.53)	-.22~	.41**	.36**	.13	.11	.16	.24~	.32*	--
10. Beh. Rec.	-.01 (.59)	.03	.27*	.22~	.09	.17	.19	.16	.27*	.60**

Note. $N = 91$. Behavioral Intentions and Behavioral Recommendations were standardized.
~$p < .10$
*$p < .05$
**$p < .001$

Table 8.

Unstandardized Multivariate Multiple Regression Estimates – Study 2

	Numerical Risk		*Subjective Risk*		*Behavioral Intentions and Recommendations*	
	Self	*Other*	*Self*	*Other*	*Self*	*Other*
Constant	27.74 (4.98)**	30.77 (5.05)**	3.88 (.27)**	4.16 (.27)**	-.04 (.14)	.11 (.17)
Intervention Type	.57 (2.29)	1.27 (2.31)	-.15 (.12)	-.06 (.12)	.01 (.06)	-.06 (.08)
Worry	4.86 (1.60)*	1.54 (1.62)	.49 (.09)**	.15 (.09)~	.15 (.05)*	.12 (.05)*
Numeracy Level	-1.02 (.93)	-2.08 (.94)*	-.04 (.05)	-.06 (.05)	-.05 (.03)	.01 (.03)
Control	-2.80 (4.74)	7.59 (4.80)	-.66 (.26)*	.13 (.25)	.53 (.14)**	.29 (.15)~
Mood Clarity	6.31 (2.99)*	5.35 (3.02)~	.21 (.16)	.26 (.16)	.07 (.08)	.07 (.10)
Numerical Risk	--	--	--	--	-.01 (.003)~	.000 (.004)
Subjective Risk	--	--	--	--	.10 (.06)	.06 (.07)
Residual correlation (self, other)	.47**		.42**		.53**	

Note. $N = 182$. Intervention type was coded (1, 2, or 3). All remaining predictor variables were centered at the mean. Standard errors are in parentheses. Behavioral intentions and recommendations were standardized.

~ $p < .10$

* $p < .05$

** $p < .001$

Table 9.

Unstandardized Linear Regression Estimates of Self-Reported Behavior – Study 2

	B	*SE*	*p*
Constant	1.96	12	< .001**
Intervention Type	.04	.06	.45
Worry	.08	.05	.10~
Numeracy Level	-.03	.03	.24
Control	.22	.12	.07~
Mood Clarity	.14	.07	.04*
Numerical Risk	.005	.003	.12
Subjective Risk	-.01	.06	.88

Note. $N = 71$. $R^2 = .28$. Intervention type was coded (1, 2, or 3). All remaining predictors were centered at the mean.
~ $p < .10$
* $p < .05$
** $p < .001$

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