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Cognitive and Affective Perceptions of Vulnerability as Predictors of Exercise Intentions among People with Type 2 Diabetes

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Abstract

Most conventional measures of risk perception such as perceived likelihood address largely deliberative or cognitive perceptions of vulnerability. Nevertheless, *affective* perceptions of vulnerability such as worry may have different antecedents and consequences than do these conventional measures, serve as stronger predictors of behavior, and qualify effects of conventional deliberative risk perceptions on behavior. In this study, we assessed how worry – the most common measure of affective perceptions of vulnerability compared with three conventional measures of risk (absolute risk, comparative risk, and conditional risk) in predicting behavioral intentions. Participants were 83 adults with type 2 diabetes who assessed their risk of heart disease and reported their intentions to increase physical activity (which reduces heart disease risk). As predicted, worry was the only significant predictor of exercise intentions such that higher worry was associated with higher intentions. Importantly, this relationship was stronger among individuals who perceived their absolute risk to be relatively higher and those who perceived their comparative risk to be relatively lower, demonstrating that cognitive and affective perceptions interact. These findings highlight the importance of not conflating affective and cognitive perceptions of vulnerability when assessing perceived risk, and suggest the need for more research on how to best conceptualize perceived risk in different samples and settings.

Keywords

Risk perception; Worry; Cognitive; Affective; Exercise; Diabetes

1. Introduction

According to many models of health behavior, people must perceive that they are at risk if they intend to change a health-related behavior (Janz and Becker 1984; Rogers and Prentice-Dunn 1997). Researchers and interventionists seeking to develop and test the influence of

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[2]The analyses employing the absolute, comparative and conditional risk perceptions scales were also performed using each of the individual absolute, comparative and conditional risk perception items in the place of the scales. The level of significance and pattern of results was identical to the analyses using the risk perception scales.

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psychological constructs such as risk perception on intentions and behavior change base their work on the presumption that the perception of threat is a necessary precondition to behavior change (e.g., Walker et al. 2007). Several meta-analyses demonstrate that perceived risk can be a reliable predictor of behavioral intentions at least under some circumstances (Floyd and Prentice-Dunn 2000; McCaul et al. 1996). This has led some scholars to claim that risk perceptions are "rightly placed as core concepts in theories of health behavior" (Brewer et al. 2007, 136). From this research one may conclude that low risk perceptions are unlikely to promote intentions or subsequent precautionary behavior.

The relationships among risk perceptions, intentions and behavior are complicated by two important findings – that risk perceptions are often inaccurate, and that traditional cognitive measures of risk perception do not always capture the way in which people think about their personal risk. With respect to the first issue, individuals often over- or under-estimate their risk compared to actual or calculated objective risk. One study found that participants' risk perceptions were significantly differed from their objective risk across nine different health outcomes (Rothman, Klein, and Weinstein 1996). A recent study in a nationally-representative sample found that only about one-third of women held reasonably accurate breast cancer risk perceptions relative to the Gail model, which produces an objective assessment of breast cancer risk (Waters et al. 2011).

The second problem centers on how risk perception is best measured and conceptualized. Risk perception is often measured using a single item assessing absolute risk perception – typically defined as the perceived likelihood that the outcome will occur. However, risk perceptions and their measurement are not monolithic; people may interpret and understand their risk in a variety of ways (Dillard et al. 2012). For example, risk perceptions may refer to the *absolute risk for the self* (e.g., What is your risk of heart disease?), the perceived risk for the *self as compared to a social target* (e.g. Is your risk of heart disease higher, lower, or about the same as someone of the same age and sex?), or perceptions of risk *conditional* on an event occurring or changing a specific behavior (e.g. Would your risk of heart disease increase, decrease, or stay the same if you were to quit smoking?).

These various measures of risk perception have been shown to be only moderately related (Lipkus et al. 2005; Radcliffe and Klein 2002; Ranby et al. 2011; Zajac, Klein, and McCaul 2006) and in some studies predict behaviors differentially (Gerrard et al. 2008). This suggests that each measure may represent a slightly different kind of risk perception, as evidenced by only a moderate correlation between the constructs (Dillard, Ferrer, Ubel, and Fagerlin 2012; Ferrer et al. 2011; Lipkus, Klein, Skinner, and Rimer 2005; Zajac, Klein, and McCaul 2006). The selection of a measure of risk perception may be determined by the population studied, or the research questions asked. However that selection may limit findings emerging from other measures especially if they interact with each other or other variables of interest in different ways (Kreuter 1999). Thus, inclusion of multiple measures of risk perception can lead to different conclusions than using single measures. Exploration of how these different measures of risk perception predict behavior is warranted.

Importantly, recent evidence suggests that these largely cognitive perceptions of risk may not be as important as affective states about risk, such as worry, in predicting intentions and behavior (Janssen et al. 2011; Janssen et al. 2012). These affective states about risk refer to how worried, fearful, or anxious a person is about a disease or condition (Dolcini et al. 1996; Ferrer, Portnoy, and Klein 2013; Sjöberg 1998). These types of affective states have traditionally not been included in studies of risk perception and may represent a more intuitive way of thinking about risk (Loewenstein et al. 2001), and may represent more experiential processing of risk information. (Janssen, van Osch, de Vries, and Lechner 2011). In recent years, there has been a sharp increase in researchers recognizing the

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importance of affective states and affective risk perceptions (e.g., Dillard, Ferrer, Ubel, and Fagerlin 2012; Ferrer, Bergman, and Klein 2012; Janssen, van Osch, de Vries, and Lechner 2011; Janssen, van Osch, Lechner, Candel, and de Vries 2012). This intuitive reaction (which cognitive measures of risk perceptions only approximate) is potentially more predictive of intentions, (Dillard, Ferrer, Ubel, and Fagerlin 2012). For example, cognitive perception of the likelihood that the event will happen may not be totally related to the worry one feels about it (Barlow 2004; Janssen, van Osch, Lechner, Candel, and de Vries 2012; Lazarus and Folkman 1984; MacGregor 1991; McCaul and Mullens 2003). However, worry is thought to inform cognitive risk perceptions (Loewenstein, Weber, Hsee, and Welch 2001).

Worry and similar constructs are included or referenced in some models of health behavior, but how these constructs are defined and predict outcomes varies. Expectancy-value theories, such as the Health Belief Model (HBM) and Protection Motivation Theory, propose that a person's subjective probability of an outcome (expectancy) and views on how positive or negative that outcome is (value) interact to predict behavioral intentions and subsequently behavior. In the HBM, a person's feelings about the seriousness of a health threat, or perceived severity, is thought to be more affective in nature (Becker 1974; Janz and Becker 1984). An extension of HBM, the Protection Motivation Theory, proposes a more indirect role of emotional arousal on attitude and behavior change through its influence on perceived severity (Prentice-Dunn and Rogers 1986; Rogers 1975). Other models posit that cognitive and emotional processes are, at least, partially independent processing systems (Leventhal, Diefenbach, and Leventhal 1992). The Extended Parallel Process Model specifies potential determinants of these two separate cognitive and affective reactions to fear (Popova 2012). In general, most theories of health behavior do not include an affective component either alone or in addition to cognitive risk perceptions. When affect is included in such models, the distinctions between and potential ways in which affective states and cognitive perceptions of risk are interrelated are often not addressed.

There is strong empirical evidence for the independent effects of cognitive and affective reactions of risk. There is some evidence that such affective reactions to risk operate in parallel with cognitive risk perceptions (Slovic et al. 2004). A recent study concluded that worry is a determinant of behavioral intentions, and that when accounting for worry in a statistical model perceived risk is not a significant predictor of intentions (Schmiege, Bryan, and Klein 2009). Similarly, Cameron and Diefenbach (2001) found that worry, but not risk perceptions, was a significant predictor of interest in genetic testing, and that risk perceptions and worry were only moderately correlated. This suggests that both cognitive risk perceptions and worry are important, but distinct determinants of health intentions. In addition, affective measures such as worry may also be more predictive of health behavior (Ferrer, Bergman, and Klein 2012; Weinstein et al. 2007). Taken together, these findings suggest that cognitive risk perceptions and more affective reactions should be examined together.

Making matters more interesting, there may be a more complex interplay between cognition and affect (Wang et al. 2007). Recent evidence has demonstrated that cognitive and affective responses, such as worry, have interactive effects. These studies have sometimes demonstrated a counterintuitive pattern – although high risk perception and high worry might each predict greater intentions to change behavior, the combination of the two has been associated with *lower* intentions. For example, among those high in worry about cancer, higher levels of risk perception were associated with lower engagement in exercise and in fruit and vegetable consumption (Ferrer, Portnoy, and Klein 2013). In another study with smokers, quitting intentions were lower among individuals with both high worry and high risk perception for lung cancer (Klein, Zajac, and Monin 2009). A recent meta-analysis

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shows that risk perceptions and worry may be influenced differently in response to specific kinds of risk information (Portnoy et al. 2013). Taken together, these results suggest that risk perceptions alone cannot account for health behaviors and that there may be a more complicated relationship to disentangle.

Beyond theoretical discrepancy in how cognition and affect predict health behavior, there is also much variation in the measurement of risk perception and affect in the literature. When both cognitive and affective states are measured, it is often using a single item for each construct which cannot capture the multidimensional nature of risk perceptions (Loewenstein, Weber, Hsee, and Welch 2001). Use of a single measure also precludes comparisons of the relative influence of risk perception and affective responses to risk in terms of predicting intentions and behavior. Notably, Janssen (2011) attempted to parse the various factors of perceived likelihood by measuring skin cancer-relevant conditional and unconditional absolute risk perceptions, as well as direct and indirect comparative risk perceptions predicting sunscreen use. That study found that absolute risk perceptions and indirect comparative risk perceptions predicted sunscreen use, and that conditional measures were generally better than unconditional measures. That study also included affectively-based perceived severity measures; those measures showed somewhat greater predictive validity than the cognitive-based measures.

Even when measures of risk perception and worry are both included, many studies use healthy convenience samples (e.g., Woloshin et al. 1999), or a healthy, but high-risk sample assessing risk perceptions of developing the disease for which they are at risk (Meiser and Halliday 2002). One study in which both cognitive risk perceptions as well as feelings of vulnerability were measured found that only comparative risk perceptions and affective reactions, in this case worry, predicted intentions to get a mammogram (Lerman et al. 1991).

This study will enhance our knowledge about the distinction among various types of risk perception as well as examine how worry and risk perceptions jointly influence behavioral intentions within a sample of participants with type 2 diabetes mellitus (T2DM), who are also at risk for heart disease. Importantly, few studies have tested how worry and risk perceptions about a health condition operate in a population affected by another related medical condition (McKenzie and Skelly 2010). Most focus on risk perceptions *between* diseases (Gerend et al. 2004). Thus the context for this study is people with diabetes, who are also at risk for heart disease. Diabetes affects approximately 8.3% of the United States population; the vast majority of cases are type 2 diabetes mellitus (T2DM). Nearly two million adults were newly diagnosed in 2010 (CDC 2011a). In addition to the direct health effects of diabetes, diabetes is also a risk factor for coronary heart disease (CHD) (CDC 2011b; Egede and Zheng 2002; Turner et al. 1998). Although T2DM confers increased risk for CHD, there are behavioral factors known to reduce that risk, including exercise. Sedentary lifestyle behaviors increase the risk of developing T2DM (Hu et al. 2001) as well as hypertension and ultimately CHD (Matthews et al. 1989). Lack of exercise is a risk factor for CHD as well as reduced glycemic control in people with T2DM (Boule et al. 2001; Tanasescu et al. 2003). Because exercise is related to both the development and control of T2DM as well as development of CHD, it is an apt target for behavior change in people with T2DM. However, many people with T2DM do not perceive themselves to be at risk for CHD (McKenzie and Skelly 2010) and thus do not engage in risk reducing behaviors. As such, it is unclear if people with T2DM view their risk of CHD as meriting effort to change their behavior. This population may have heightened awareness about associated health outcomes and thus different levels of risk perceptions and worry about CHD than the general population. Although individuals with T2DM may recognize that they are at more susceptible to CHD (Gerend, Aiken, West, and Erchull 2004), they may not be motivated to take appropriate actions, such as increase exercise, to help offset these risks.

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The current study sought to fill gaps in prior studies that often include only a single type of risk perceptions measure (not taking into account the complex nature of risk perceptions), not including an affective component, such as worry, and generally focusing only on health samples. The current study examines worry and risk perceptions about CHD among people with T2DM, using multiple measures of risk perception (absolute, comparative, and conditional) and a multi-item measure of worry, and an epidemiologically-derived calculated measure of CHD risk. We examined how these cognitive, affective, and objective measures of risk predicted intentions to engage in exercise. We predicted that: 1. Neither cognitive risk perceptions nor worry would be related to calculated risk estimates, 2. Worry would be a significant predictor of exercise intentions over and above all types of risk perception measures, 3. High worry would only be associated with higher intentions when risk perception was low, leading to a risk perception by worry interaction.

2. Methods

2.1. Participants

Adults with T2DM (N = 83, Table 1) were recruited through university-based, primary care and endocrinology clinics in Eastern Ohio (n = 55) and Western Pennsylvania (n = 28). Additionally, recruitment mailings were sent to members of local diabetes mailing lists. Participants were eligible if they (a) were age 18 or older, (b) were diagnosed with T2DM for at least one year, (c) had not experienced any recent cardiac events (d) had no history of heart disease, and (e) did not have any health problems which would prevent them from engaging in regular exercise.

2.2. Procedure

Participants provided informed consent and were screened for inclusion/exclusion criteria. Participants recruited from the Ohio site completed questionnaires and other study materials through the mail. Participants from the Pennsylvania site completed questionnaires and other study materials within a laboratory setting as part of another larger, ongoing study. Participants were paid $10 for their participation.

2.3. Measures

2.3.1 Absolute self risk perceptions—Four items assessed participants' perceptions of their chances of developing/dying from heart disease in 10 years/someday (α=.94). For example, they were asked "What do you think the chance is that you will someday develop heart disease?" Responses were recorded using a graduated log percentage scale. This scale, anchored by *no chance* at 0% and *certain to happen* at 100%, also included a range of possible responses, increasing from 0% to 1% by 0.1% increments, then 1% increments from 1% to 20% and 10% increments from 20% to 100% with instructions to use any value between 0% and 100%. Use of this scale attunes participants to the possibility of responding below 1%, and has been used successfully in previous research with diverse populations (Gurmankin et al. 2005; Radcliffe and Klein 2002, 28; Rothman, Klein, and Weinstein 1996, 26).

2.3.2 Absolute risk perceptions of others—Eight items assessed participants' perceptions of the risk of an average person with/without diabetes of the same age, gender, and race as them for developing/dying from heart disease in 10 years/someday (Cronbach's α=.94). For example "What do you think the chance is that the average person with diabetes of the same age, gender and race as you will develop heart disease within the next ten years?" These items also used the graduated log percentage response scale.

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2.3.3 Comparative risk perceptions—Comparative risk perceptions were computed as the absolute risk perceptions of others subtracted from the absolute self risk perception. This was done for each combination of outcome (developing/dying from CHD) and time frame (10 years/lifetime) for average others with and without diabetes resulting in eight comparative risk perceptions, which were then collapsed into one measure (Cronbach's α=. 88). Higher values reflect higher risk perceptions for the self as compared to others, also known as comparative pessimism (Radcliffe and Klein 2002, 28).

2.3.4 Conditional risk perceptions—Six items assessed participant's perceived CHD risk if their level of physical activity increased/stayed the same over the next ten years. For example, "Imagine you started exercising more than you do now, and continue to do so in the future. How likely do you think you would be to die from coronary heart disease within the next ten years?" (Cronbach's α=.86). Responses were on a 7-point Likert-type scale from 1 = *not at all likely*/*much lower* to 7 = *much higher*/*extremely likely*.

2.3.5 Worry—Four items measured different affective states related to developing CHD (Cronbach's α=.93). These items assessed how worried, anxious, fearful, and concerned the participant was about developing CHD. For example, "How worried are you about getting coronary heart disease?" Responses were on a 7-point Likert-type scale ranging from 1 = *not at all* to 7 = *extremely*. We refer to this measure as "worry," although other similar constructs are included.

2.3.5 Calculated risk—To calculate participants' objective risk for developing and dying from CHD, demographic and other medical data from the questionnaire (Pennsylvania sample) or through medical record review (Ohio Sample) were entered into the risk engine developed as part of the United Kingdom Prospective Diabetes Study (http://www.dtu.ox.ac.uk/riskengine; Stevens et al. 2001). This risk engine calculates 10-year and lifetime risk estimates for CHD and fatal CHD specifically for people with T2DM.

2.3.6 Demographic and medical variable—Demographic information collected included age, ethnicity, income, and educational status. Measures also included variables necessary for the UKPDS risk engine including blood pressure, history of atrial fibrillation, cholesterol, smoking status, and HbA1C, a measure of average blood glucose control over the three-month period prior to the study.

2.3.7 Exercise intention—The main outcome was a single item that asked participants "Do you plan to increase the amount of exercise you get over the next three months?" Responses were on a 7-point Likert-type scale from 1 = *not at all* to 7 = *definitely plan to do so*. Single intentions items have been shown to be satisfactory predictors of future behavior in a number of contexts. Although multiple intentions measures would have been optimal, the data for this analysis were drawn from a larger study which did not use intentions as a main outcome, thus only a single item was included and available for analysis.

2.4. Analysis

Three main analyses were performed. To test hypothesis 1, the associations between the measures of perceived and calculated risk, worry, and exercise intentions were examined using bivariate correlations.

Next to test hypothesis 2, an omnibus stepwise linear regressions model predicting exercise intentions was performed including each of the risk perception scales, the worry scale, and demographic factors. Demographics were entered in the first step, measures of risk perception were entered in the second step, and worry was entered in the third step.

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To test hypothesis 3, interaction terms between worry and each measure of risk perceptions were entered in the fourth step of the regression. Scores for worry and each measure of risk perception were mean-centered to enhance interpretation of model estimates. In the presence of a significant interaction, simple slopes were generated to examine the association between worry and exercise intentions at one standard deviation above and below the centered mean of the risk perception measure.

3. Results

Table 1 shows the descriptive demographic statistics for the sample. The sample was largely female (64%), White (87%), and low in education and income (42% high school education or below; 44% household income < $20,000). There were no significant demographic differences between recruitment sites, therefore all analyses were collapsed across the two sites and site of recruitment is not discussed further.

3.1. Psychological Variables and Calculated Risk

Consistent with the first hypothesis, calculated risk estimates derived from the UKPDS risk engine for CHD risk or fatal CHD risk were not significantly related to the risk perception scales, the worry scale, nor exercise intentions (Table 2). The correlation between calculated measures of risk and perceived risk of CHD were generally negative and smaller than $r < -.16$, and none were statistically significant ($p > .19$). These findings suggest that participants did not hold accurate perceptions of their CHD risk. Given the lack of association, calculated risk was not included in subsequent analyses and is not discussed further[1].

3.2. Cognitive Risk Perceptions and Worry

The three risk perception scales were significantly related to each other (see Table 2). Worry in the sample was near the scale midpoint, $M = 3.85$ (SD = 1.75), as were absolute self risk perceptions $M = 40.95$ (SD = 28.01) and conditional risk perceptions $M = 3.77$ (SD = 1.13). Average comparative risk perceptions indicated a small difference in the direction of higher risk for themselves compared to similar others, $M = 5.40$ (SD = 16.20).

The worry scale was significantly positively related to each risk perception scale: absolute self r (80) = .497, $p < .01$, comparative r (77) = .413, $p < .01$, and conditional r (81) = .490, $p < .01$. Higher risk perceptions for the self were related to greater worry.

3.3. Predictors of Exercise Intentions

An omnibus stepwise linear regression was performed to test hypothesis 2 – that worry about CHD would be a stronger predictor of exercise intentions than each measure of cognitive risk perception (Table 3). None of the variables in the first step of the model, that included demographics, were significant predictors of exercise intentions. In the second step, none of the three measures of risk perceptions were significantly predictive of exercise intentions, nor did the addition of these measures add significantly to the model, F_{change} (3, 64) = 1.58, $p = .203$. In step 3, when worry was added it emerged as a significant predictor. In that step, worry was the only significant predictor of exercise intentions, $\beta = .167$, $p = .001$. As predicted, greater worry about CHD was associated with higher exercise intentions.

Our third hypothesis was that there would be significant interactions between cognitive risk perceptions and worry. Interaction terms between absolute, comparative and conditional risk perceptions and worry were entered in step 4 of the regression. Interactions between all three

[1]Controlling for calculated risk in the analyses employing risk perceptions and worry to predict exercise intentions did not change the pattern or level of significance of the results.

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measures of risk perception and worry emerged and explained significantly more variance than the model without those terms, $r^2 = .410$ F_{change} (3, 60) = 6.14, $p = .001$. In addition, in that step worry remained a significant predictor of intentions ($\beta = .194$, $p < .001$).

The interaction between *absolute* self risk perceptions and worry ($\beta = .197$, $p = .007$; Figure 1) showed that high absolute self risk perceptions bolstered the relationship between worry and exercise intentions. Among those reporting high absolute risk perceptions, high worry was associated with *higher* exercise intentions (simple slope = 1.14, $t = 1.85$ $p = .06$) compared to those who reported low worry. For individuals who held low absolute self risk perceptions, the relationship between worry and exercise intentions was attenuated (simple slope = .07, $t = .114$, $p = 0.91$).

The opposite pattern emerged for the interaction between *comparative* risk perceptions and worry ($\beta = -.201$, $p = .001$; Figure 2). For individuals who held low comparative risk perceptions (e.g. those who perceived their risk as *lower* than others), higher worry was associated with *greater* exercise intentions (simple slope = 1.25, $t = 8.89$, $p < .001$) compared to those who reported low worry. For individuals who held high comparative risk perceptions (e.g. those who perceived their risk as *higher* than others), the relationship between worry and exercise intentions was attenuated (simple slope = −0.0448, $t = 0.33$, $p = .741$).

The interaction between *conditional* risk perceptions and worry ($\beta = -.137$, $p = .007$; Figure 3) exhibited a pattern similar to that for the interaction of comparative risk perceptions and worry. For those who held low conditional risk perceptions, higher worry was associated with *greater* exercise intentions (simple slope = 0.978, $t = 4.80$, $p < .001$) compared to individuals who reported low worry. For individuals who held high conditional risk perceptions, there was no difference in their exercise intentions by amount of worry (simple slope = .228, $t = 1.27$, p = 0.2095).

4. Discussion

In the first study to examine cognitive risk perceptions and worry among individuals with T2DM, we found that worry was a significant predictor of intentions to exercise whereas more conventional cognitively based measures of risk perception were not. This finding builds on a small but emerging literature demonstrating similar relationships on intentions (e.g., Dillard, Ferrer, Ubel, and Fagerlin 2012) and behavior (Ferrer, Portnoy, and Klein 2013; Magnan et al. 2009) in healthy populations.

Consistent with our first hypotheses, calculated risk estimates of CHD among people with T2DM (10-year and lifetime risk estimates for CHD and fatal CHD) were not significantly related to cognitive risk perceptions or worry. This lack of association between objective and subjective measures of risk suggests that, in this sample, participants held inaccurate perceptions about their heart disease risk.

Absolute self, comparative, and conditional risk perceptions were significantly associated with each other, but were not statistically significantly related to exercise intentions when controlling for demographic variables. Further, when included in regressions along with worry, cognitively-based risk perception measures were not significant predictors of intentions. Consistent with our second hypothesis, worry predicted exercise intentions such that those who reported greater worry about CHD reported greater intentions to exercise in the future. These results dovetail with theory and research on the affect heuristic (for an overview see Slovic et al. 2007), as well as the risk as feelings model (Loewenstein, Weber, Hsee, and Welch 2001). These theories suggest that affect is influential in judgments about risk. This does not suggest that cognitive risk perceptions are not important or do not have

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predictive power in certain circumstances (McCaul, Branstetter, Schroeder, and Glasgow 1996, 15). Rather it speaks to the multidimensional nature of risk judgments, which can have interactive effects. Of note, the literature linking risk perceptions to behavior is somewhat conflicting, varying by measurement and type of behavior under study (e.g., Brewer, Chapman, Gibbons, Gerrard, McCaul, and Weinstein 2007). This suggests a need to identify more systematic measures of risk perception to better predict health behavior.

One implication may be that some health behavior researchers have overly focused on how people *think* rather than how people *feel*. This is evidenced by the many health behavior theories that are missing an affective or emotional component. However, research demonstrates that affect appears to be more predictive of behavioral intentions than cognitive risk perceptions (Dillard, Ferrer, Ubel, and Fagerlin 2012; Farley and Stasson 2003). The decision making literature – as illustrated by the research noted above on the affect heuristic and risk-as-feelings model – shows that affect does not necessarily interfere with cognition but complements, and perhaps augments, the effect of cognition. Thus, affect may aid in the decision making process to engage in behavior.

The interactive effects found in the current study lend support to this idea. Prior research has shown that high risk perceptions paired with high worry were paradoxically related to *lower* behavioral intentions for smoking cessation (Klein, Zajac, and Monin 2009) and lower levels of exercise and fruit/vegetable consumption (Ferrer, Portnoy, and Klein 2013) compared to low worry. Although we found significant interactions, they were not in the direction predicted in our third hypothesis. Differences in the pattern of the interactions between cognitive risk perceptions and worry differed due to the type of risk perception measure used. In particular, individuals who held *high* absolute risk perceptions reported higher intentions when they also exhibited high worry, whereas those who held *low* comparative risk perceptions reported higher intentions when they exhibited high worry. It should be noted that the paradoxical pattern of high cognitive risk perceptions and high worry being associated with lower intentions that has been previously reported was not found in this study. One methodological difference that might partially explain this difference is that the present study used an absolute numerical risk perception item whereas the previous study used an absolute verbal risk perception measure. Absolute numerical risk perceptions may be more subject to biases. Although verbal measures of risk perception may slightly mitigate some of these biases, they may introduce other biases (Kreuter 1999, 1999). In addition when assessing comparison between a risk perception and a known statistic (such as the measure of CHD risk we employed) a numerical scale may be more appropriate whereas if that is not a goal, then a verbal scale may be more appropriate due to response burden (Weinstein and Diefenbach 1997).

This study had several strengths. It is the first to examine multiple measures of risk perception in a sample of people with T2DM, rather than an average risk population. Although this sample was homogenous with respect to disease diagnosis, it was diverse in its representation of individuals with low-income and low education levels. Few prior studies have included multiple measures of risk perception in a single study as this one did, and no studies to date have done so in a sample of individuals with a specific disease who are at increased risk for comorbid negative health outcomes. This study explicitly assessed individual's perceptions of risk for CHD and intention toward a behavior that may mitigate this risk, namely exercise.

These strengths must be considered in light of some limitations. The analyses were based on a small sample and cross-sectional data, so we are unable to determine the directionality and causality of the relationships. Experimental research in which both risk perception and worry are manipulated independently is necessary to establish causation (Portnoy, Ferrer,

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Bergman, and Klein 2013). These findings may not generalize to a general healthy population; however they are informative for prevention efforts among people with T2DM and potentially other high-risk populations. Finally, there were some limitations in the measures included in the study. The current study relied on an indirect, or a calculated, comparative measure of risk perceptions, rather than direct comparative measures. Although there is a debate about which type of measure is more accurate, we focused on indirect measures, in part, because direct measures have often been found to have an egocentric bias. Direct comparative risk perception measures were included in one of the samples, but the sample size was too small to perform analyses using these measures. The outcome of interest in this study was a single intention item and not actual exercise behavior. Research and theory suggest that behavioral intentions consistently predict behavior and can be measured with relatively few items; however future work should employ objective measures of behavior.

The growing body of evidence suggesting that affective reactions of risk play a substantial role in predicting health behaviors also has implications for the design of interventions. Although delivery of numerical risk estimates is often necessary in interventions or warranted in clinical settings, research should include both measures of cognitive risk perceptions as well as affective responses to that risk information. Inclusion of both types of measures will allow for a more complete assessment of the reactions to risk information by researchers and interventionists, as well as further explore the ways in which these constructs overlap and interact in various formats, contexts and settings of the delivery of risk information (Portnoy, Ferrer, Bergman, and Klein 2013).

This study suggests that measures related to worry about developing and dying of disease, such as CHD, may better predict intentions and potentially also self-protective behaviors such as exercise. As indicated by other researchers, health behavior theories based on cognition are lacking important determinants, namely affective constructs, and may need to be modified (Brewer, Chapman, Gibbons, Gerrard, McCaul, and Weinstein 2007). Further research needs to be conducted to clarify the relationships among different types of risk perceptions, affect, optimism, intentions, and ultimately behavior.

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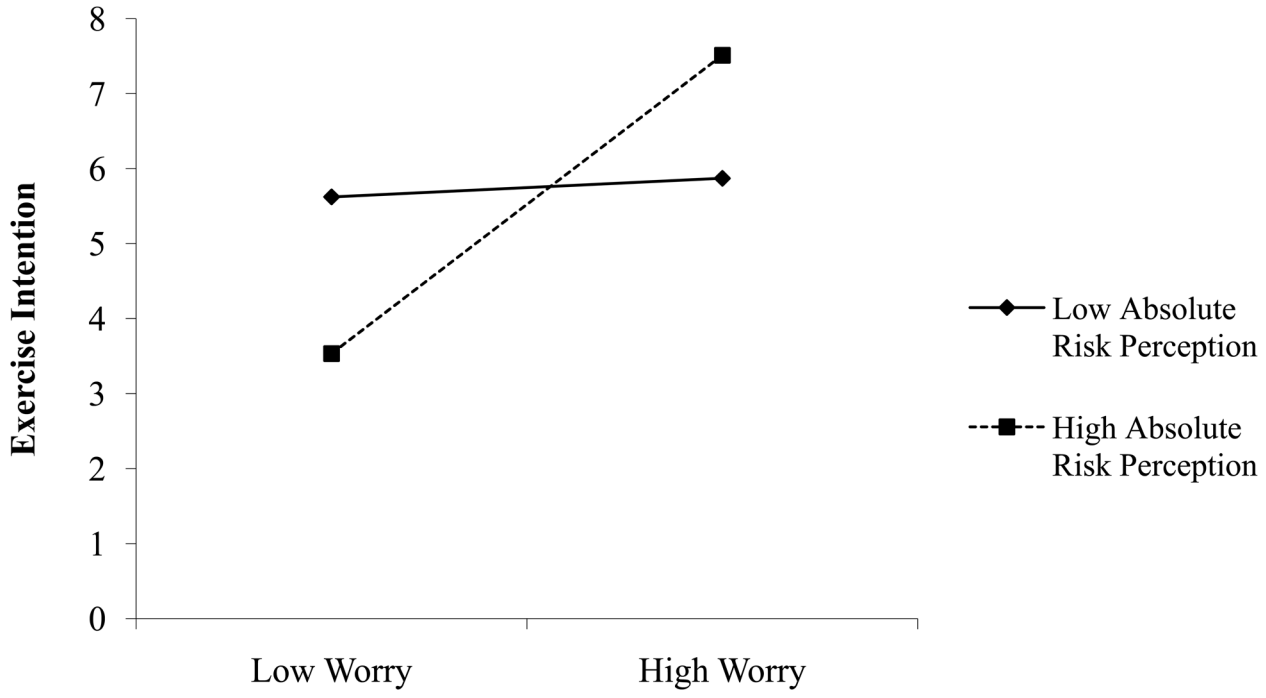

Figure 1.
Interaction between absolute self risk perceptions and worry

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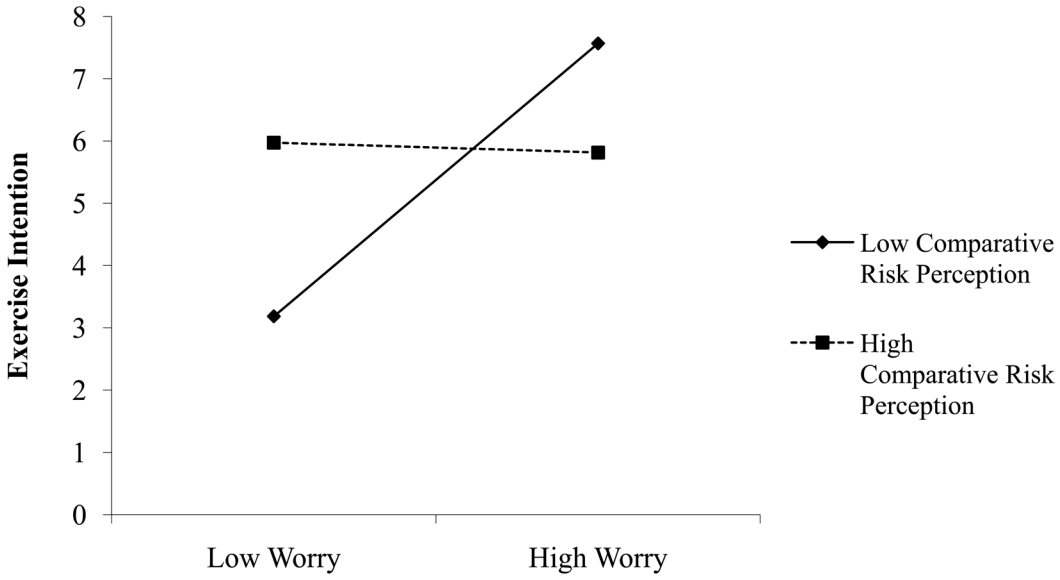

Figure 2.
Interaction between comparative risk perceptions and worry

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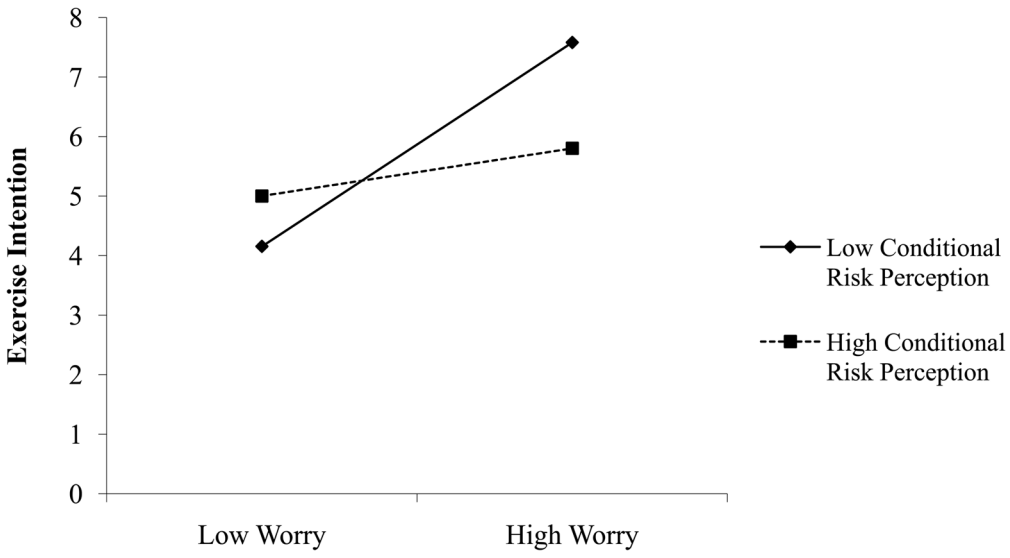

Figure 3.
Interaction between conditional risk perceptions and worry

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Table 1

Demographic characteristics of the sample (N = 83)

Demographic characteristic	Number or Mean	% or (SD)
Number of males (%)	30	36.1%
Mean age, years	57.2	(11.0)
Ethnicity		
White	72	86.7%
Black or African American	1	1.2%
Asian	7	8.4%
American Indian or Alaskan Native	2	2.4%
Other	1	1.2%
Mean age at diagnosis	50.1	(12.8)
Education		
Less than High School	34	41.5%
Technical Education or Some College	22	26.9%
College Degree	14	17.1%
Graduate Degree	10	12.2%
Other	2	2.4%
Income		
Less than $20,000	35	43.8%
$20,000 – $40,000	20	25.0%
$40,000 – $60,000	12	15.0%
$60,000 – $80,000	7	8.8%
$80,000 or more	6	7.6%

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Table 2

Correlation matrix of main study variables

	Exercise Intentions	Worry	Absolute Self Risk Perception	Comparative Risk Perception	Conditional Risk Perception	Calculated CHD risk
Worry	.395 **					
Absolute Self Risk Perception	.157	.497 **				
Comparative Risk Perception	.259 *	.413 **	.754 **			
Conditional Risk Perception	.180	.490 **	.684 **	.564**		
Calculated CHD risk	−.151	−.120	−.009	.043	.002	
Calculated fatal CHD risk	−.161	−.143	.004	.057	−.017	.981 **

Note.

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

* Correlation is significant at the 0.05 level (2-tailed).

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Table 3

	Step 1		Step 2		Step 3		Step 4	
	***F* (3, 68) = .240, *p* = .868 R^2 = .010**		***F* (6, 65) = .941, *p* = .472 R^2 = .080**		***F* (7, 64) = 2.70, *p* = .016 R^2 = .228**		***F* (10, 61) = 4.24, *p* < .001 R^2 = .410**	
Predictor	***B***	***p***	***B***	***p***	***B***	***p***	***B***	***p***
Age	−.078	.724	−.091	.679	.057	.785	.029	.881
Gender	.100	.475	.065	.641	−.016	.902	.073	.538
Income	−.004	.964	.008	.920	−.118	.162	−.153	.056
Absolute Self RP			−.035	.616	−.083	.212	−.022	.742
Comparative RP			.074	.228	.066	.243	.048	.378
Conditional RP			.055	.317	.012	.820	−.043	.373
Worry					**.167**	**.001**	**.194**	**.000**
Absolute Self RP × worry							**.197**	**.007**
Comparative RP × worry							**−.201**	**.001**
Conditional RP × worry							**−.137**	**.007**