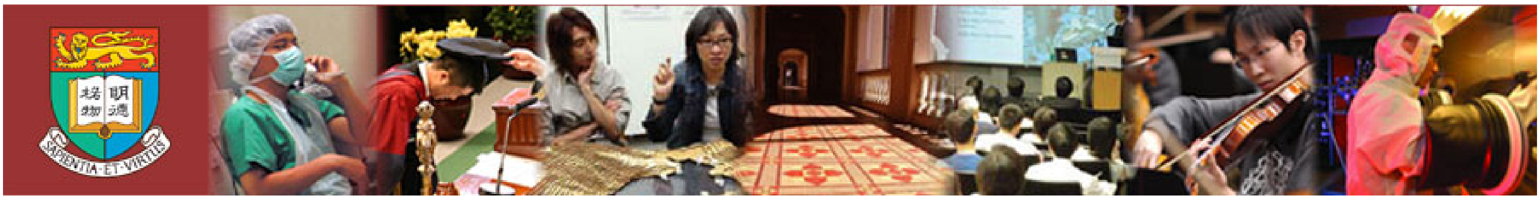

Title	**The Effect of Self-Control on the Construction of Risk Perceptions**
Author(s)	**Jia, SJ; Khan, U; Litt, A**
Citation	**Management Science, 2015, v. 61 n. 9, p. 2259-2280**
Issued Date	**2015**
URL	**http://hdl.handle.net/10722/217306**
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The Effect of Self-Control on the Construction of Risk Perceptions

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The authors would like to thank Christopher Hsee, David Hardistry, Jianmin Jia, and seminar participants at Stanford University for their feedback at various stages of this research, and Yuval Rottenstreich, the Associate Editor, and three anonymous reviewers for their guidance during the review process. We would like to dedicate this paper in the memory of Ab Litt.

ABSTRACT

We show that the way decision makers construct risk perceptions is systematically influenced by their level of self-control: low self-control results in greater weighting of probability and reduced weighting of consequences of negative outcomes in formulating overall threat perceptions. Seven studies demonstrate such distorted risk construction in wide-ranging risk domains. The effects hold for both chronic and manipulated levels of perceived self-control and are observed only for risks involving high personal-agency (e.g., overeating, smoking, drinking). As an important implication of our results, we also demonstrate that those lower (higher) in self-control show relatively less (more) interest in products and lifestyle changes reducing consequences (e.g., a pill that heals liver damage from drinking) than those reducing likelihood of risks (e.g., a pill that prevents liver damage from drinking). We also explore several possible underlying processes for the observed effect and discuss the theoretical and managerial relevance of our findings.

1. Introduction

Self-control failures during risky choice impose myriad costs on both individuals and society. In the United States, poor eating habits have contributed to two-thirds of adults being overweight (half of whom are obese) and 26 million suffering from type-two diabetes (Centers for Disease Control and Prevention 2011). Worldwide, alcohol abuse results in approximately 2.5 million deaths each year (World Health Organization 2011). Tobacco smoking kills 6 million people globally every year, incurs half a trillion dollars of economic damage annually, and may kill as many as one billion people over this century (World Health Organization 2013). A broad spectrum of addictive disorders cost $590 billion annually in lost productivity and government-funded medical treatment in the United States (Forbes 2006). The prevalence and persistence of such risky behaviors, despite knowledge of their potential harm, often stems from difficulties individuals face in exercising self-control.

Extensive research related to judgment and decision-making has examined the relationship between self-control and risk-taking to understand the motivational, emotional, and behavioral consequences of low self-control (e.g., Bruyneel et al. 2009; Faber and Vohs 2012; Freeman and Muraven 2010; Hoch and Loewenstein 1991). However, little attention has been paid to how reduced self-control may distort peoples' basic formulations of risk itself. By this, we mean not simply the overall salience of risks, or the mis-estimation of the absolute level of risk associated with one's behavior. Rather, we are referring to how self-control differences may alter the relative importance, or weighting, of specific constituent factors that construct overall perceptions of risk. Typically, decision theory decomposes overall risk perception into two basic components: the probability of negative outcomes occurring, and the consequences of those negative outcomes (Cunningham 1967; Peter and Ryan 1976; Kahneman and Tversky 1979). The current research explores whether risk-consequences or risk-probabilities matter more for people with different levels of self-control. Thus, our focus is on how self-control affects the relative *weighting* of these two components and the extent to which they each predict and influence overall perceived risk. For example, if a person who under-weights consequences relative to probability is told that the consequences of heart disease are twice as bad as previously believed, their perceptions of overall threat will rise by less than if they are told that their probability of contracting heart disease is twice as high. Hence, their constructions of overall risk perceptions are more responsive to the probability than consequences of a negative outcome.

Across multiple studies our approach reveals that low self-control (whether chronic or situationally induced) leads to systematically greater weighting of probabilities and reduced weighting of consequences in forming risk perceptions. That is, low self-control results in a smaller marginal impact of risk consequence, and a greater marginal impact of risk probability, on overall threat perceptions. The findings are not only theoretically insightful but have important practical relevance as differences in relative weighting of risk-components reflect differences in their relative importance to the individual decision maker. For example, as one implication of our model, we show that level of self-control predicts relative preferences for risk mitigation strategies that are probability-reducing (e.g., a pill that prevents damage) versus consequence-reducing (e.g., a pill that heals damage). Thus, in addition to offering important theoretical insight into the interplay between self-control and risk perception, our research also provides pertinent practical insights for behavior under risk and the strategies people adopt to mitigate such behaviors' concomitant risks.

2. Risk Perception

2.1. Background

While risk perceptions can reflect an underlying stable set of attitudes (Weber and Milliman 1997), they are often affected by a range of individual differences as well as contextual factors (Slovic 1987). For example, changes in mood and affect can shift risk perceptions: people in better moods are more optimistic, and people in worse moods are more pessimistic (Loewenstein, Weber, Hsee, and Welch 2001). Social factors such as the presence of peers can result in lower risk perceptions of risky group undertakings (Clark 1971). Furthermore, cultural differences can also affect perceptions and evaluations of risky choices; Weber and Hsee (1998) found that American and Chinese respondents indicated divergent risk perceptions for financial options.

Besides impacting the perception of overall risk, external factors can also influence the perception of individual risk components - probability and consequences of an outcome (Kahneman and Tversky 1979). Because probability and consequence judgments are formulated via different cognitive and affective processes (Rottenstreich and Hsee 2001; Slovic, Fischhoff, and Lichtenstein 1981; Tversky and Kahneman 1973), one might expect external factors to differentially affect perceptions of one risk component versus the other. This difference may manifest in two ways: in absolute differences or weighting differences. The most basic phenomenon is for some factor to affect absolute judgment of one risk component more than the other component. Indeed, previous risk perception literature largely focuses on biases in absolute judgments of risk components (e.g., Claster 1967; Bauman and Siegel 1987; Ditto et al. 2006; Strecher, Kreuter, and Kobrin 1995). For example, a nuclear safety expert might provide very accurate judgments of consequences of a nuclear plant meltdown, but still underestimate the probability of it occurring (Slovic, Fischhoff, and Lichtenstein 1981).

It is also possible for some factor to affect only how the probability and consequence judgments are weighted to construct overall perceived risk. Weighting differences tell us how much each risk component influences overall risk perceptions whatever their absolute level may be. As one example, previous work directly examining the weighting of risk components suggests that for Western populations, risk-probability has slightly greater influence on overall risk perceptions than risk-consequences (Bontempo, Bottom, and Weber 1997; Milne, Sheeran, and Orbell 2000) whereas Asian populations have relatively more balanced weighting. Critically, this is different from saying that Asian populations have higher absolute judgments of one risk-component or the other. In fact, Bontempo, Bottom, and Weber (1997) find that Asian populations have similar absolute risk-component judgments as Western populations, but are differently influenced by (or weight) each. Similar to how factors like culture impact the relative influence or weight of risk-consequences versus risk-probabilities, we posit that self-control might also change the relative influence and weighting of these fundamental components of risk.

2.2. Self-Control and Biased Risk Perceptions

Previous research on self-control and risky behavior has typically focused on demonstrating when and how lower self-control leads to sub-optimally risky decisions. For example, it has been shown that lower self-control resulting from proximity to a temptation (Prelec and Bodner 2003; Khan and Dhar 2007), limited cognitive resources (Shiv and Fedorikhin 1999), or hot affective states such as hunger and sexual arousal (Hoch and Loewenstein 1991; Prelec 2004; Tal and Wansink 2013) can lead people to choose options that may put their long term interest at risk over options that are beneficial in the long-run. Such myopic and deleterious decisions may not transpire simply because people ignore risks when self-control falters under the grips of temptation (e.g., Ditto et al. 2006; Faber and Vohs 2012). Rather, lower self-control may actually distort how risky people perceive their courses of action to be.

Indeed those with poor self-control are usually less able or willing to objectively evaluate the riskiness of their actions. For example, reduction of regulatory ability via disruption of the brain's executive control functions is shown to not only result in decreased risk aversion in gambling but also in lower perceptions of risk (Verbruggen, Adams, and Chambers 2012). Similarly, smokers holding a cigarette not only felt more tempted to smoke it, but also rated negative consequences of smoking (e.g., heart disease, lung cancer) as lower than smokers without cigarettes in hand (Sayette et al. 2001). These findings are ironic since from a normative perspective, one might expect people with lower self-control, who are presumably more vulnerable to numerous self-control related risks (e.g. lung cancer due to smoking, heart disease due to over-eating), to be more incentivized to accurately appraise these threats (Floyd, Prentice-Dunn, and Rogers 2000). However in reality, the opposite seems to be the case whereby individuals low in self-control are more likely to distort judgments of risk and underplay their negative consequences.

In fact, prior research has demonstrated that the individuals most vulnerable to particular risks are more likely to be biased in their risk perceptions (Taylor and Brown 1988) and such biases grow stronger when the individual is under greater threat. For example, promiscuous men underestimate HIV infection risks (Bauman and Siegel 1987), juvenile delinquents underestimate the chances of being caught or receiving punishment relative to non-delinquents (Claster 1967), and smokers underestimate the chances of contracting smoking-related diseases (Strecher, Kreuter, and Kobrin 1995); Thus, prior research has uncovered that people show a greater propensity to bias processing of risk information when their self-control is poor and when they are faced with greater threat (Ditto and Lopez 1992; Kunda 1990; Pyszczynski, Greeberg, and Holt 1985). However, this literature has primarily focused on how self-control can bias absolute risk judgments.

In the current research we take the general notion–that lower self-control can lead to greater risk-taking or can bias perceptions of overall risk–a crucial step further, and test a novel and specific form in which lower self-control might distort risk construction: through changes in the relative weighting of the constituent components of risk perceptions. Our research approach allows us to investigate whether biased risk processing comes about not simply as mis-estimating absolute risk judgments, but instead in how risk perceptions are constructed from its constituent components.

2.3. Self-control and Biased Weighting of Risk Components

Prior research has shown that the components of risk are independently subject to weighting distortions stemming from both individual and situational differences (Dowling and Staelin 1994; Diamond 1988). If the weightings of consequence and probability of risk are indeed malleable, an important question is whether low self-control biases risk component weighting and which factor–consequence or probability–would be weighted relatively more or less. While no prior work has directly examined this question, indirect insight into this issue comes from previous research suggesting that increased perceived control over an outcome can result in risks' probability being ignored (Rottenstreich and Kivetz 2006; Koehler, White and John 2010). For example, successful executives often ignore probability statistics (March and Shapira 1987; Shapira 1995) and judge risk by outcome value rather than by likelihood and value. Presumably this tendency arises since they believe that probabilities in life do not apply to them (Weinstein 1980) and thus see risk as something they can control or reduce (Jeske and Werner 2008) by using skill to mitigate the dangers (Strickland, Lewicki, and Katz 1966; Keyes 1985). Hence as managers move up in the corporate hierarchy and gain greater sense of control, risk-taking tendencies and an inclination to encourage others to take risk increases (Shapira 1986; MacCrimmon, and Wehrung 1986). The idea also underscores the finding that executives who encourage risk-taking at the same time frown upon gambling (March and Shapira 1987), which is less conducive to illusions of personal control.

To the extent that low self-control is conceptually opposite to perceived control over a situation, the weighting of risk-components may also occur in the opposite direction for low self-control people.

That is, individuals with lower self-control may put more weight on probability of an outcome relative to its consequences. In other words, people with low self-control might think that probabilities are more relevant for them because they have worse control over their future behavior. For example, a low self-control individual might think: "I know I overeat unhealthy foods, so the chances of getting heart disease are something I need to pay extra attention to." The opposite effect could occur for high self-control individuals who might think that probabilities are relatively less relevant to them (since they are better able to control future outcomes) and subsequently weight probability less than consequence.

A mechanism based on perceived control over a situation predicts that the effect should depend on the degree to which personal agency (the capacity of an individual to act on the world) can affect a risky outcome. Risks that can be affected by a person's degree of self-control (e.g., health issues from poor diet) are high in personal agency, whereas risks that are not affected by a person's degree of self-control (e.g., electrical failure causing a plane crash) are low in personal agency. Moreover, the effect should be more likely to arise in more threatening situations. For risks with inconsequential outcomes, low self-control individuals might not bother extending greater weight and attention to the risk's probability as the result of doing so is insignificant.

2.3.1. Other potential drivers of Biased Weighting of Risk Components

If low self-control indeed results in over-weighting of probabilities relative to consequences, it is important to consider what other psychological mechanisms may explain this predicted direction of effect.

Motivated Reasoning: One possible explanation for the predicted effect is that individuals low in self-control might feel more threatened and therefore particularly motivated to reduce risks. Past research has shown that people's active motivations can ex ante distort perceptions and evaluations to make desired courses of action more attractive and justifiable (Kunda 1987). One key factor in motivated reasoning is ambiguity of evidence and whether it can be molded to fit different goals (Balcetis and Dunning 2006). Between probability and consequences, the former is more ambiguous and pliable. For example, even when presented with a 99% chance of an unfavorable event, one can motivationally believe to be part of the lucky 1%; whereas even with strong motivation, it is difficult to view heart attack as a positive event. Hence, we may expect that when threatened by a risk, low (versus high) self-control individuals should put more weight on probability, which allows them to hold optimistic views about their susceptibility to the risk, rather than on consequences that are relatively more unambiguous.

If the effects are driven by a goal to reduce threat, we should also expect lower absolute estimates of risk since this is the most straightforward way to reduce perceived threat (Bauman and Siegel 1987; Claster 1967; Strecher, Kreuter, and Kobrin 1995). A motivational process may also predict the effect to reverse in the positive domains of risk where people are driven by a goal to achieve a positive risky outcome rather than avoid a negative risky outcome. Furthermore, a motivational process does not require self-agency (Budescu and Bruderman 1995) and can operate in situations where people have no control over the outcome such as sports team performances (Sherman and Cohen 2002) or gambles (Budescu and Bruderman 1995). Hence if a motivational process is driving the effect we should expect to see the proposed weighting distortions in domains without any personal agency.

General Weighting Bias: Another possible reason why low self-control individuals may put more weight on probability of a risk rather than its consequences could be some general weighting bias that affects the basic valuation of chance versus size of risk among low self-control individuals. In other words, low self-control individual may be in general more sensitive to probabilities than consequences. If the predicted distortion is due to some general weighting bias that operates differently among low versus high self-control individuals, then we should expect this bias to impact risk weighting in all domains of risk and across all situational contexts. Thus if a general decision heuristic or bias is guiding the effect then the effect should occur regardless of size of the threat and relevance of agency.

Past experience: If individuals low in self-control indeed put more weight on probability than consequence of a potential outcome, the tendency may reflect accuracy of prediction given past experience. Specifically, based on past experience high self-control individuals may predict that they will successfully abstain from risky activities whereas low self-control individuals may accurately predict that they will not be able to abstain from risky activities. Subsequently, the probabilities of negative outcomes arising from the activities in question are in fact more relevant for low self-control people than for high self-control people. This account predicts a similar pattern of boundary conditions as the perceived control account, but the two differ in process. Critically, the past experience account suggests that low self-control does not directly lead to biased risk perceptions; but that it is the different experiences and behaviors caused by self-control differences that lead to differences in risk perception. There are several ways of testing the viability of this mechanism. This account would suggest that a direct manipulation of the feeling of self-control should not induce the proposed effect (since little experiential and learning differences occur due to an experimental manipulation). Furthermore, this account suggests that the hypothesized effect should not occur if we statistically control for the history and experience of risky activities.

Differential Temporal Discounting: It is also possible that people with different levels of self-control discount future consequences differently. In other words, since the consequences of poor self-control are often displaced in the future (e.g., liver failure resulting from excessive drink; weight gain from over-eating), the hypothesized effect could occur simply because low self-control individuals have higher rates of temporal discounting and subsequently underweight the future consequences of their actions. The notion is consistent with prior research showing that low self-control individuals value more proximate outcomes and discount future consequences (Frederick, Loewenstein, and O'Donoghue 2002). Related research has also documented that impatient (vs. patient) individuals discount future consequences, such as monetary outcomes of inter-temporal trade-offs and values of future gambles (Prelec 2004). Since low self-control often corresponds with greater impatience (Ditto et al. 2006), low self-control individuals might underweight the future consequences relative to its probability. Such an account would suggest that the predicted risk weighting difference should be attenuated if risks are situated in the near future, where there is less scope for temporal discounting. Moreover, a mechanism based on temporal discounting does not predict any difference in agency versus non-agency risks.

Next, we briefly discuss our modeling approach and then present a series of studies to demonstrate how self-control might bias the weighting of risk components. We hypothesize that lower self-control may lead to less weighting of a risk's consequence and greater weighting of a risk's probability. In addition to documenting the predicted effect, we explore and test the tenability of the psychological processes discussed above from which the predicted pattern of results may arise.

3. Perceived Risk Model and Self-Control

There is a long history of modeling perceived risk, *R*, as a function of two components: probability, *p(x)*, and consequences, *v(x)* (see Mitchell 1998 for review). Although early perceived risk research mostly assumed a multiplicative relationship between probability and consequence (e.g., Cunningham 1967; Peter and Ryan 1976), there is also a substantial literature that favors an additive relationship (e.g., Bettman 1973; Horton 1976; Laurent and Kapferer 1985; Stone and Winter 1987). The appropriateness of different models is largely determined by the relationship between the two risk components in specific risk contexts. We adopt a multiplicative model for several reasons. Firstly, a multiplicative relationship has the advantage of capturing situations where consequences and probabilities are independent, i.e., $R = 0$ when $p(x) = 0$ or $v(x) = 0$. Secondly, from a theoretical perspective, we are using a utility-based measurement of risk (e.g., Jia, Dyer, and Butler 1999), for which a standard utility or prospect theory multiplicative framework would be appropriate and capture the interactive relationship between the two components (Kahneman and Tversky 1979). Thirdly, as outlined below in (4), a multiplicative model allows us to make direct comparisons of the effects of self-control on each individual component (without having to normalize). Based on these factors, we adopted a multiplicative approach (which we later empirically verify as more appropriate than an additive model), and modeled perceived risk as:

$$R = kv(x)^a p(x)^b \tag{1}$$

where *R* is the overall perceived risk of a negative outcome *x*, *v(x)* the negative consequences of *x, p(x)* the probability of *x* occurring, and *k* a scaling constant. The weightings of probability and consequences in determining overall risk are represented by *a* and *b*, respectively. Note that in contrast to classic formulations of risk, this formulation does not assume that the two components of risk have equal weighting, and thus has the benefit of being able to capture differences in that weighting (Peter and Ryan 1976). This basic risk model makes no assumptions on cognitive process, and only implies that probability and consequences are considered to some degree (reflected by their weightings) in the construction of overall risk perceptions. A log-linear transformation of model (1) yields:

$$\ln(R) = \ln k + a \ln v(x) + b \ln p(x) \quad (2)$$

(2) above may be used as the basic regression model to calculate the relative elasticities of the risk-component weights – in other words, how much a one-percentage change in probability or consequence perception changes overall risk perception. To capture how self-control impacts risk perceptions, we added a self-control term and its interaction terms with probability and consequence to (2), which yields the following perceived risk model:

$$\ln(R) = \ln k + a \ln v(x) + b \ln p(x) + c \ln(SC) + d \ln v(x) * \ln(SC) + e \ln p(x) * \ln(SC) \quad (3)$$

The new term *SC* is the variable for self-control, and *c* is its associated weight; *d* is a parameter that captures the interaction between self-control and perceived consequences, and *e* captures the interaction between self-control and perceived probability. In order to more clearly interpret the meanings of these parameters, we can rewrite model (3) as follows:

$$\begin{aligned} \ln(R) &= \ln k + [a + d * \ln(SC)] \ln v(x) + [b + e * \ln(SC)] \ln p(x) + c \ln(SC) \\ &= \ln k + \alpha \ln v(x) + \beta \ln p(x) + c \ln(SC) \end{aligned}$$

which has the following equivalent multiplicative form:

$$R = k v(x)^{\alpha} p(x)^{\beta} SC^{c} \quad (4)$$

where $\alpha = a + d * \ln(SC)$ and $\beta = b + e * \ln(SC)$ are the revised weights for risk-consequences and risk-probabilities, respectively, when self-control is considered. This rearrangement highlights that the original parameters *a* and *b* are no longer individually interpretable, and by themselves do not represent the weights of consequence and probability respectively. To calculate the total weight of each risk component, one must also take into account *d* and *e*, the interaction terms for self-control/consequence and self-control/probability, respectively. The total weight of consequence is now α instead of *a*, and the total weight of probability is β instead of *b* only.

Model (4) allows us to test how self-control might affect overall risk perceptions. For example, as a special case of model (4), if the parameter *c* is not significant and the parameters *a* and *b* are significant, then self-control only has an interaction effect on overall risk perception through the weights of consequence and probability. Consequently, the coefficients *d* and *e* of the regression model are our main measures of interest in this research. Positive coefficients imply heavier weighting of that component by individuals relatively higher in self-control, whereas negative coefficients indicate heavier weighting by individuals relatively lower in self-control.

We stress that this model, and our focus on its interaction coefficients, reflects our interest specifically in how probability and consequences are *relatively weighted* in constructing overall risk, rather than in their means or absolute levels. It is certainly possible, perhaps even likely, that absolute ratings of perceived probability or consequences of a risk might vary greatly between people low and high in self-control, or depending on whether an individual actually engages in or has experienced the focal risky behavior being evaluated (e.g., smoking, overeating). However, our approach in this research is to discern whether self-control changes how subjective judgments of probability and consequence predict and contribute to overall conceptions of perceived risk, whatever their precise absolute levels. This approach has the potential to be a stronger predictor of actual behavior than simple measures of absolute judgments. Even when an individual gives a high rating for one risk-component, they may not necessarily make use of that information (i.e., weight it heavily). Our approach allows us to measure how much decision-makers care about probability versus consequence judgments during overall processing of risk information. Of particular practical importance, this allows to make useful predictions of choice behavior. By learning what risk components different individuals care more about, we also learn their relative preferences for different risk prevention strategies, such as types of insurance policies (reduce probability of loss more or reduce consequence of loss more) or dietary and pharmaceutical preferences (reduce chance or consequence of health issues more). The extraction of differences in risk-component weighting thus allows for the design of risk-prevention strategies that most appeal to different sub-populations of at-risk and low self-control individuals.

It is important to point out that a more simplistic alternative method to investigating our research question is to directly ask individuals how much weight they put on probability and consequences when forming their overall risk perceptions. Such an approach could be problematic for several reasons. For instance, people might not be able to accurately gauge and report such weightings, in line with well-documented limitations in people's direct introspective access to their own cognitive processes (Nisbett and Wilson 1977). Furthermore, such overt responses might be distorted by how much different people think they ought to weight probability and consequences for various risks. Our method indirectly extracts individuals' actual weightings of these risk components as predictors of their overall threat perceptions, and so avoids these problems while still allowing us to make testable behavioral predictions.

4. Experiment 1

This experiment documented the basic effect and examined whether individuals varying in self-control differentially weight probability and consequences of negative outcomes in constructing overall threat perceptions. We tested this across risk domains varying in personal agency over the occurrence of the negative outcome. Having this situational dichotomy allows us to test some of the possible psychological accounts previously discussed. For example, the effect should occur for both agency and non-agency risks if it arises due to motivated reasoning, some general weighting bias, or differential temporal discounting. However, if the effect is guided by differences in perceived control then the effect should only occur for risks involving personal agency. In general, if self-control per se plays a causal role in the formation of biased risk perceptions, we would not expect any weighting distortions to occur for non-agency risks (where self-control is irrelevant).

4.1. Method

In exchange for $5 gift-cards, participants (N = 124; 74f) from a national on-line pool[1] responded to risk perception measures across low personal agency and high personal agency risk domains. High-agency risks included those related to consumption behaviors (heart disease and diabetes from overeating unhealthy foods, smoking-related lung cancer, and illness from choosing to eat genetically modified foods) as well as other risky behaviors, such as the risk of a car crash from frequent speeding. Low-agency risks included being in a plane crash, contracting avian flu from required business-travel, having one's car break down randomly, and computer hard-drive damage from a power-surge. A pre-test (N = 34) confirmed that the high-agency risks were indeed seen as more controllable ("How much can good self-control reduce the following risks?" 1 = "Not at all", 7 = "Greatly") than low-agency risks ($M_{\textit{high-agency risks}} = 5.74$ vs. $M_{\textit{low-agency risks}} = 2.96$, $p < .05$).

Participants indicated their subjective perceptions of the consequences of each risk (1 = "Not serious at all" to 10 = "Extremely serious"), probability of the risk's occurrence (1 = "Extremely unlikely" to 10 = "Extremely likely"), and the overall threat of each risk to themselves if they engaged in the relevant risky behavior (1 = "Not threatening at all" to 10 = "Extremely threatening"). Question order was counterbalanced to avoid order effects. We also measured general self-control with a six-item scale of cognitive restraint and ability to resist temptation (adapted from Tangney, Baumeister, and Boone 2004), yielding index scores where higher values indicate higher self-control ($\alpha = .79$, M = 13.4, SD = 3.76).

4.2. Results and Discussion

To calibrate our perceived risk model (3), we used a step-wise backward elimination procedure for model selection (Burnham and Anderson 1998). We began by submitting the measures of self-control, risk-

[1] The pool consists of 7000 US residents who participate in online studies for Stanford University. The pool is managed by full time research lab staff that recruits a demographically representative sample of participants and removes participants who have participated in over 50 studies as well as participants who have participated in more than 7 studies involving deception.

consequence, risk-probability, and overall threat perception for the high-agency risks to the full regression model (3). We found that the parameter for the main effect of self-control, *c*, was not a statistically significant predictor for any of the risks (*p's* > .1). Hence, we dropped the non-significant self-control term '$c\ln(SC)$' from the full regression model to obtain:

$$\ln(R) = \ln k + a \ln v(x) + b \ln p(x) + d \ln v(x) * \ln(SC) + e \ln p(x) * \ln(SC) \qquad (5)$$

The corresponding multiplicative form of this model is a special case of model (4) without the independent term for self-control, *SC*. We then submitted the risk and self-control measures to the new regression model (5) and obtained improved results relative to the original regression model (3) with lower Bayesian Information Criterion (BIC) scores for all risks, and improved p-values for parameters (see Table 1). BIC offers a relative measure of information lost when a given model is used to describe a reality, thus a lower BIC score is more desirable in model selection. The improved BIC scores also corresponded with relatively large adjusted R-squared values for all risks: adjusted R-squared was between .39 and .77 for all risks, and between .44 and .77 for high-agency risks.

In (5), as previously in (3), the key coefficients of interest were the interaction terms between self-control and consequence (*d*) and self-control and probability (*e*). These two parameters were significant for all high-agency risks ($p < .05$). As Table 1 shows, for high-agency risks, *d* and *e* had oppositely signed coefficients. Specifically, for all five high-agency risks, consequences and self-control had a significant positive interaction coefficient, while probability and self-control had a significant negative interaction coefficient. Thus, for high-agency risks, lower self-control was associated with higher weighting of probability and reduced weighting of consequences in forming overall risk perceptions.

(Insert Table 1 about here)

In contrast, for low-agency risks, we did not observe any differential weighting of risk-components with respect to self-control (i.e., no significant interaction coefficients) for either regression (3) or (5). That is, self-control did not affect the weighting of risk-components for risks where personal agency was low. This result is noteworthy as it suggests that people with lower self-control do not inherently construct all risks differently (as suggested by a general weighting bias account), and that the ability to exercise control over risky outcomes must matter for self-control to distort risk construction. This finding is consistent with research showing that self-positivity biases in risk estimation occur more for controllable than uncontrollable events (Lin, Lin, and Raghubir 2003).

As previously noted, the main effects *a* and *b* should not be individually interpreted with the inclusion of interaction terms *d* and *e*. To compute the overall weight (or 'main effect' value) of any risk component then d and e must also be taken into account. As (4) demonstrates, $\alpha = a + d * \ln(SC)$ and $\beta = b + e * \ln(SC)$ are the revised weights for risk-consequences and risk-probabilities, respectively. Thus, in Table 1 the negative value of a (the parameter of risk-consequence) is not meaningful by itself, and the values of the weights of risk-consequences ($\alpha = a + d * \ln(SC)$) are positive for all high-agency risks. Elasticities for both consequence and probability were convex which suggests greater sensitivity to risk as self-control increases, or declining sensitivity to risk as self-control decreases (Appendix 10). However, this overall elasticity does not provide insight on the relative impact of self-control on each risk component's role in determining overall risk, for which interpreting the interaction coefficients is sufficient. Indeed, it should be noted that the convexity of both components' elasticities is largely determined by the value of d and e.

On dropping the interaction terms from the regression model, predictors a and b of the simple perceived risk model (2) remained significant ($p < .05$) for all risks (and were positive). This means that for both low- and high-agency risks, and across levels of self-control, probability and consequence were significant components predicting participants' overall risk perceptions. This result is important for several reasons. First, it shows that the absence of significant interactions between self-control and probability or consequences for low-agency risks was not simply due to a probability-consequences decomposition being inapplicable for modeling such risks. Similarly, it shows that the same lack of interactions was not due to our probability-consequences decomposition being inapplicable to modeling risk perception by low self-control individuals; which might be the case if their risk constructions involved other risk components that we did not consider, or if they combined probability and consequences in a completely different way (which would demand a different functional form for the overall risk model). Instead we found that the basic probability-consequences deconstruction of perceived risk was valid for all cases, as consistent with previous approaches to modeling risk (e.g., Cunningham 1967; Peter and Ryan 1976).

Earlier, we justified the usage of a multiplicative model conceptually. We also empirically tested its suitability by comparing its performance against an additive model (Appendix 11). Overall, the additive model was a worse fit (seven of the ten interaction terms for all risks in the additive model were significant), but yielded the same basic pattern of results as the multiplicative model. This is an important point as it suggests that our results were not an artifact of the multiplicative model used in our primary analysis.

Although the focus of this research is not on how self-control may bias absolute risk perceptions, an examination of absolute risk perceptions (reported in Appendix 2-4) reveals that for high-agency risks, low and high self-control groups had no systematic differences in absolute judgments (adjusted to control for demographics) of risk-consequences (*p's* > .1), risk probabilities (*p*'s > .1, except for lung cancer from smoking where lower self-control individuals had a marginally lower estimate, $p < .1$), or overall threat (p's $> .1$, except for illness from GM foods where lower self-control individuals had a lower estimate, $p < .05$). For low-agency risks, we found no significant differences in perceptions of consequence, probability, or overall threat. It is important to note that the standard errors for risk perceptions were similar for different levels of self-control – this suggests that it is unlikely that the differential weighting effect arose from simply greater variability in the measurement of one particular risk component.

Experiment 1 provides a first demonstration of differential weighting of probability and consequences in risk construction driven by self-control differences. Furthermore, it seems that self-agency is a necessary condition for the effect. This boundary condition suggests that the effect is unlikely to be due to some general weighting bias, differential temporal discounting or motivated reasoning, all of which should still occur for risks not involving agency. A motivated reasoning process is also unlikely since there were no consistent distortions in absolute risk perceptions, which typically occur with motivated reasoning (e.g., Sherman, Nelson, and Steele 2000). In other words, if people were motivated to reduce threat, then the easiest way is to underestimate overall threat, probability, or consequences. The results are, however, consistent with a perception of control account, which predicts that the effect should only arise in situations where lower self-control puts an individual under greater risk.

5. Experiment 2

Experiment 2 had two goals. Firstly, whereas the previous studies tested self-control as a measured individual difference, here we manipulated felt self-control to directly test its causal role in the differential weighting of risk components. Doing so helps rule out the possibility that our effect is driven by some other variable correlated with individual differences in self-control (e.g., intelligence, thrill-seeking tendencies, socioeconomic status, or familiarity with the tested risk domains etc.). Manipulating self-control also helps to directly test whether the effect arises due to differences in past experiences. If the effect is driven by such differences between high and low self-control individuals, then manipulating feeling of self-control should not be enough to induce the differential weighting of risk components. Secondly, we included a control condition against which low and high self-control conditions could be compared. This allowed us to test whether both groups differentially weighted risk components compared to the control group or whether the effect only arises from low self-control individuals who are likely to be more threatened by the risk and hence show such weighting distortion. Addressing this issue both enriches our theoretical understanding of how self-control differences influence risk construction, and has important practical implications for predicting the occurrence of behavioral biases.

5.1 Method

In exchange for a chance to win a $75 gift-card, participants (N = 106; 75f) from the same national on-line pool as Experiment 1 participated in the experiment. We manipulated felt self-control using an ease-of-recall paradigm (Schwarz et al. 1991). In two conditions, participants were asked as part of an ostensibly unrelated first study to recall and write about two or ten occasions when they were able to "exercise self-control, discipline and willpower in the face of temptation". In a third control condition participants did not complete any recall task. Ease in recalling two instances of exercising self-control was predicted to lead participants to make positive inferences regarding their self-control abilities, and therefore result in greater perceived self-control (high self-control condition). Conversely, the relative difficulty of recalling ten instances of exerting self-control was predicted to reduce perceptions of self-control (low self-control condition).

In an independent manipulation check (N = 116), we tested to what extent this manipulation affected people's perceptions of their own ability to exercise self-control compared to others on a 7-point scale (1 = "much worse", 7 = "much better"). This confirmed a three-level difference in perceived self-control between the high, control, and low self-control conditions, $F(2, 114) = 10.73$, $p < .05$. Recalling two instances of past success in exercising self-control increased perceptions of one's own self-control abilities, compared to others, whereas having to recall ten such instances reduced perceptions of one's own self-control abilities ($M_{recall\text{-}2} = 5.68$, SD = 1.07; $M_{control} = 5.08$, SD = 1.26; $M_{recall\text{-}10} = 4.44$, SD = 1.21). After the recall manipulation, participants rated the consequences, probability, and overall threat for several risks from Experiment 1 using the same procedure as before. Here we only used high personal agency risks for which we expected risk distortions to occur.

The use of experimentally induced felt self-control in lieu of a self-control scale alters our regression model (3). The self-control terms are now represented by dummy variables for contrasts between the treatment and control conditions. For sake of consistency, where applicable the conditions are coded as 'low self-control' = 0, 'control' = 1, and 'high self-control' = 2. Note that in order to test whether both groups are differentially weighting risk, we must run two separate regressions (low vs. control and high vs. control). Thus, the coding applies to two separate regressions (low vs. control and high vs. control) and not one regression with a 3-level dummy variable. The control condition is coded as 1 in both regressions; and a higher value for the dummy variable reflects higher self-control. Regression (3) thus becomes

$$\ln(R) = \ln k + a \ln v(x) + b \ln p(x) + c\delta + d \ln v(x) * \delta + e \ln p(x) * \delta \qquad (6)$$

where δ is a dummy variable representing the treatment condition for self-control. This model has the following equivalent multiplicative form:

$$R = kv(x)^{\alpha} p(x)^{\beta} (e^{\delta})^{c} \qquad (7)$$

Where $\alpha = a + d * \delta$ and $\beta = b + e * \delta$ are the revised weights under self-control for risk-consequences and risk-probabilities, respectively.

5.2. Results and Discussion

We began our analyses by submitting our risk measures to the modified regression model (6) in two separate regressions (low vs. control and high vs. control). Using the same model selection procedures as in Experiment 1, we found that *c,* the main effect term for self-control, was once again non-significant. Dropping this term yielded a simplified regression model:

$$\ln(R) = \ln k + a \ln v(x) + b \ln p(x) + d \ln v(x) * \delta + e \ln p(x) * \delta \qquad (8)$$

Model (8) yielded lower BIC scores than Model (6) and improved p-values for parameters in the low self-control versus control regression. As Table 2 shows, when participants were induced to feel lower self-control relative to the control condition, we observed a significant positive interaction between the condition dummies and consequences (d) and significant negative interaction between the condition dummies and probability (e). This means that compared to the control group, participants induced to feel low self-control weighted consequences lower and probabilities higher when forming overall threat perceptions. In contrast, when participants felt higher self-control relative to the control group, the interaction terms between condition and consequences or probability were not significant for any risks. Thus, those with high felt self-control weighted risk components similarly as those in the control condition. It should be noted that a comparison of BIC scores for models (6) and (8) in the high self-control versus control regression is not meaningful since neither model has significant interaction terms. The lack of difference in the control and high self-control conditions suggests that the default level of felt self-control may be high. This would in turn make probabilities appear irrelevant and lead individuals in the control condition to weight consequences more. The idea is consistent with previous findings that people tend to be optimistic about their own abilities to carry out certain actions in general (i.e., self-efficacy; Bandura 1997), and to exert self-control in particular (Khan and Dhar 2007).

(Insert Table 2 about here)

As in Experiment 1, we tested and confirmed that both *a* and *b* were significant positive predictors in a simplified risk model removing *d* and *e* from the analysis, confirming the validity of applying the basic probability/consequences deconstruction of perceived risk to the risks we explored here. Once again, planned contrasts showed no significant differences in absolute risk perceptions (adjusted for demographics), between the treatment conditions (*p's* > .1, reported in Appendix 5-7). Consistent with Experiment 1, we also tested an additive model and found that it generated consistent results but produced a worse fit than a multiplicative model (Appendix 12).

This study makes several important contributions. First, by manipulating self-control rather than using a correlational individual difference measure, we establish its specific causal role in biased risk-component weighting. This helps rule out the possibility that the effect is driven by some other variable correlated with individual differences in self-control. The results also suggest that the effect is not due to learning from past experience, which should not differ across randomly assigned conditions. Furthermore, the results show biased risk construction is not simply limited to those chronically low in self-control, but may be exhibited by all individuals depending on situational and transient feelings of low self-control. That differential risk-construction processes can be activated contextually suggests that the effect is not driven by a general weighting bias or any mechanism stemming from dispositional differences in self-control ability. Additionally, by including a control group, we demonstrate that people low in perceived self-control construct risk perceptions significantly differently relative to those with a baseline level of self-control. That high perceived self-control does not lead to differential weighting relative to the control group suggests that the effect is not a continuous graded variation induced by shifting self-control levels, but only occurs when felt self-control is sufficiently low.

6. Experiment 3

Experiment 3 seeks to offer deeper insight on possible mechanisms of the effect by examining risks with smaller consequences. This helps us discern between several potential accounts for the effect observed in earlier studies. While the account based on perceived control predicts that the weighting distortions observed among low self-control individuals should not arise when risk consequences are small, if the effect arises due to a general tendency among low self-control individuals to overweight probability relative to consequences then the effect should arise regardless of the size of the outcome. Moreover, an account based on prior experience with risky behavior may also suggest that the effect should be as strong, if not more pronounced, for low consequence risks, since low consequence self-control failures and hence the subsequent risks are generally as common if not more common than high consequence risks.

6.1. Method

The experiment (N = 137, 101f) followed the same basic procedure and analysis as Experiment 1, but for high personal agency risks that presented much less threatening consequences: catching a cold due to infrequent hand-washing, being fined for parking in a convenient but illegal space, developing bad breath from eating foods that leave lasting odors, attracting ants to one's kitchen due to inadequate cleaning, pulling a muscle due to skipping pre-run warm up and stretching, and being bitten by mosquitoes because of failing to apply insect repellent. However, instead of using a 6-item sub-scale, we used a longer 13-item scale recommended by Tangney, Baumeister, and Boone (2004). After completing the self-control measure, participants rated overall threat perception, consequences, and probability for reach risk scenario on the same scales as before.

A manipulation check confirmed that these risks were indeed perceived as less threatening, $M_{Exp\ 1} = 7.26$ $M_{Exp\ 2} = 5.68$, $t(116) = 7.70$, $p < .05$, and less consequential, $M_{Exp\ 1} = 7.84$ $M_{Exp\ 2} = 6.00$, $t(117) = 9.60$, $p < .05$, than those in Experiment 1.

6.2. Results and Discussion

To measure the effect of self-control on weighting differences, we submitted the measures for threat, consequence, and probability for each risk to regression model (5) (Table 3). For these lower consequences risks, low self-control individuals did not show distortions in risk component weighting (p's > .1 for all regression interactions d and e, except for pulling a muscle). However, the predictor terms a and b of the basic risk model (2) were still significant predictors (p's < .05 for all risks except parking fine) after the interaction terms were dropped, confirming that absence of the weighting bias was not simply due to the data being random noise. Consistent with Experiment 1, we also found no systemic differences in absolute perceptions of overall risk, probability, and consequences (p's > .1, means adjusted for income, gender, age, and race).

(Insert Table 3 about here)

This additional result provides further support against accounts based on difference in past experience and some general tendency to weight probability and consequences differently, which both predict the effect to persist in low consequence risks. However, the results seem to be consistent with a perception of control account. Specifically, it seems that the weighting bias only arises when the risks are threatening enough to worry low self-control individuals about their self-control shortcomings. Consequently, no weighting bias was observed for risks that are minor and insufficiently threatening.

In Experiments 1, 2, and 3, we documented the differential weighting of risk components not only because it is theoretically interesting but because understanding weighting differences can yield novel predictions for preferences and behavior even when no systematic differences in absolute risk perceptions are observed. In the next experiment, we demonstrate that self-control influences people's preferences for risk reducing products, services, and behaviors in a pattern uniquely predicted by the differential-weighting phenomenon.

7. Experiment 4A

Experiment 4A had three goals. Firstly, in the previous experiment we used subjective rating scales to elicit risk perceptions. To show that the general pattern of weighting bias observed earlier is robust, in the current experiment we examined actual choices. Secondly, we explored the real-world implications of biased risk construction for decision makers' preferences for risk mitigation measures– the measures an individual can undertake to prevent or mitigate harm that may arise from their daily activities (Slovic 1987). Risk mitigation measures can differ markedly in the relative degree to which they mitigate the probability versus consequences of threatening outcomes. Some measures primarily reduce a risk's potential negative consequences (e.g., a pill that regenerates damaged livers), whereas others mainly affect its probability of occurrence (e.g., a pill that prevents liver damage). Given our observation of low self-control leading to underweighting consequences and overweighting probabilities in forming overall threat perceptions, we predicted that compared to high self-control individuals, low self-control individuals would display relatively lower interest and preference for consequence mitigating measures than probability mitigating measures. This prediction directly arises from our risk-deconstruction approach and is not readily explained by previous models of risk mitigation that do not account for self-control. Thirdly, since Experiment 1 employed a correlational approach to capture self-control differences, one might wonder whether 'being at risk' rather than self-control was driving our previous results. To control for this, we also collected measures of previous engagement in relevant risky behaviors.

7.1. Method

Participants (N = 240; 129m) from the Amazon Mechanical Turk subject pool took part in the experiment in exchange for $1.50. First, participants completed the same 13-item self-control measure as in Experiment 3. Next, participants read scenarios that asked them to imagine facing risks with a high degree of self agency (imagine developing heart disease from unhealthy diet, becoming overweight from unhealthy eating, liver damage from drinking, lung cancer from smoking, and back damage from poor posture) and risks involving a low degree of self-agency (being infected in an influenza pandemic, home damaged from natural hazards, getting injured from playing a contact sport, product breakdown, bad weather on the road) (Table 4).

For each risk scenario (presented in randomized order), two risk-mitigation measures were presented: one was described as primarily reducing the probability of a risk (e.g., pills that prevent liver damage) and the other as primarily reducing the negative consequences of the risk (e.g., pills that aid in liver recovery and regeneration from damage; Table 4). Both sets of risk mitigation strategies were described to have the same costs. We further provided descriptions of the specific utility of each risk-mitigation measure. For example, for the liver damage prevention pills it was explained that, "these pills contain enzymes that have been shown to help the liver's processing of alcohol and prevent liver damage".

To emphasize our intended framing, we included explicit statements of whether the risk-mitigation measure was consequence- or probability- oriented (e.g., for the liver-damage prevention pills, "This product *reduces the chances* of you suffering health consequences from drinking, e.g., liver damage."). Participants were then asked to choose between the two risk mitigation strategies. Consistent with Experiment 1, we expected a differential preference for consequence versus probability oriented risk mitigation measures only for high agency risks.

In previous experiments, we did not measure any behavioral covariates or control for the degree to which individuals were in fact at risk (or felt at risk). Thus, it is plausible that 'being at risk' rather than self-control drove the results. To control for this participants also reported the extent to which they actually engaged in behaviors related to the risk (1 "never" - 9 "always"). For high agency risks we inquired about frequency or likelihood of eating unhealthy foods, driving fast enough to be ticketed, alcoholic drinks per week, smoking no/yes and if yes how many, and sitting with bad posture. For low agency risks we asked about the degree to which they were susceptible to flu relative to other people, how at risk their home was to the listed risks like burglary and natural hazards, susceptibility and history of injury from physical activities, reliability of phone in terms of needing repairs, how experienced they were with driving long distances.

(Insert Table 4 about here)

7.2. Results and Discussion

Overall, we found a significant interaction between self-control level and self-agency relevance on individuals' choice of probability versus consequence oriented mitigation strategies. A repeated measure general linear model with pooled choice for high versus low self-agency risks and z-scores of behavioral measures and demographics as covariates showed a significant interaction between self-control level and self-agency relevance level, $F(1, 184) = 4.02$, $p < .05$.

High self-agency risks. We found that an individual's level of self-control differentially predicted the choice of probability-reducing versus consequence-reducing measures for risks involving a high degree of self-agency. Compared to high self-control participants, low self-control participants (for illustrative purposes defined by median split of the self-control scale) preferred probability-mitigating strategies over consequence-mitigating strategies. Specifically, we submitted choice of strategy for the high self-agency risks as a 5-level within-subject factor to a general linear model with self-control level as a between-subjects variable and pooled demographic and behavioral measures z-scores as covariates. This analysis yielded a significant between-subjects preference for probability- versus consequence- mitigating strategies for low- versus high- self-control individuals, $F(1, 227) = 5.67$, $p < .05$.

With respect to the actual behavioral engagement measures, we found that lower (higher) self-control was correlated with a higher (lower) propensity to actually engage in the risky behaviors ($r = .34$, $p < .05$). Thus, despite being correlated with greater engagement in risky behaviors, low self-control ironically reduced interest in making purchases or lifestyle changes that would mitigate the negative consequences of these risks—an effect uniquely predicted by our risk-weighting distortion results.

(Insert Figure 1 about here)

Low self-agency risks. For risks involving a low degree of self-agency, we did not find differences in the relative preference of risk management strategies between low versus high self-control individuals. The same analysis for the five low self-agency risks showed no significant between-subjects preference for probability- versus consequence- mitigating strategies for low- versus high- self-control individuals, $F(1, 263) = 1.18$, $p > .1$. It should be noted that the results trend in the opposite direction for non-agency risks as compared to agency risks.

Experiment 4A illustrates that the differential weighting effect has important practical implications and can generate testable predictions regarding preference and choice of risk mitigating products and lifestyle changes. The pattern of results is consistent with a perception of control account, which suggests that individuals low (versus high) in self-control find probabilities more relevant and hence put more weight on them and consequently choose strategies that help mitigate probability of a risky outcome. However, if motivated threat reduction is guiding the effect we would expect the effect for both high and low-agency risks. Also, we may reason that weighting distortion itself should serve to reduce the feeling of threat and thus eliminate or reverse the effect on choice. That is, if people were overweighting probability to allow for an overly optimistic view about the future (e.g., I will be part of the 1% of the population unaffected by risk despite unsafe behavior), then they should subsequently feel less threatened by the probability of risk and, if anything, should choose consequence-mitigating strategies instead. The study also provides further evidence against the notion that differences in past experiences account for differential weighting since the effect occurs even when prior history or experience was statistically controlled for.

8. Experiment 4B

In Experiment 4B we test the generalizability of the effect by examining whether it extends to positive risks. We used the same basic choice paradigm as Experiment 4A for situations where self-control was required to obtain an uncertain positive outcome.

8.1. Method

Participants from Amazon's Mechanical Turk subject pool (N = 235, 122f) took part in the study in exchange for $2. After responding to the same self-control scale used Experiment 3, participants read scenarios asking them to imagine facing risks in the positive domain that were either high or low in personal agency (see Table 5). High self-agency positive risks were situations where the successful exertion of self-control could improve the expected value of an uncertain outcome (e.g., earning an end-of-year bonus at work by working hard). Low self-agency positive risks were situations where self-control had no impact on the expected value of an uncertain outcome (e.g., picking an investment stock). Presentation order was randomized to control for order effects. For each risk, participants then chose between options that improved the consequences or probability of the outcomes (e.g., choosing to work in a team that has a small but more likely bonus, or a team that has a big but less likely bonus). To emphasize our intended framing, we included explicit statements of whether the choice was consequence- or probability- oriented (e.g., "One is more likely to give a bonus, the other has a bigger bonus"). All pairs of choices were described so that expected value and costs were similar.

(Insert Table 5 about here)

8.2. Results and Discussion

Overall results were consistent with the results for negative risks in Experiment 4A. We found that an individual's level of self-control differentially predicted the choice share of probability-reducing versus consequence-reducing measures for risks in the positive domain that were high in self-agency, but not for risks that were low in self-agency. A repeated measure general linear model with risk scenarios and self-agency relevance as within-subject variables yielded a significant overall interaction, $p < .05$.

High self-agency risks. Compared to high self-control participants, low self-control participants (for illustrative purposes defined by median split of the self-control scale) preferred probability-oriented strategies over consequence-oriented strategies. Specifically, we submitted choice of strategy for high self-agency risks as a within-subjects factor to a general linear model with self-control level as a between-subjects variable and demographics as covariates. This analysis yielded a significant between-subjects preference for probability-oriented versus consequence-oriented strategies for low versus high self-control individuals, $F(1, 222) = 7.92$, $p < .05$.

Low self-agency risks. For risks involving a low degree of self-agency, we did not find differences in the relative preference of risk management strategies for low versus high self-control individuals. The same analysis for the four low self-agency risks showed no significant between-subjects preference for probability- versus consequence- oriented strategies for low- versus high- self-control individuals, $F(1, 225) = .81$, $p > .1$.

(Insert Figure 2 about here)

The results are consistent with a perception of control account which suggests that individuals low (versus high) in self-control found probabilities more relevant since they are less able to exert the prerequisite amount of self-control to obtain a positive outcome (e.g., they may doubt that they will work hard enough to warrant a bonus). Hence they put more weight on probability-oriented strategies to help improve the probability of the positive outcome occurring and compensate for their relatively poor self-control. Note that these results also run counter to a motivational account, which may predict the effect to flip for positive risks. That is, lower self-control individuals would focus on what is most appealing to their motivations and thus weight the size of the possible rewards more. Overall, Experiments 4A and 4B extend the effect and its direct implications to a wider range of contexts in both negative and positive domains, and show self-agency to be a consistent boundary condition. These studies also build convergent validity by inferring risk weightings through decision makers' response to their risk rather than directly measuring risk perceptions as in Experiments 1, 2, and 3.

9. Experiment 5

In Experiment 5, we tested the temporal discounting account for the results: namely that low self-control individuals discount outcomes that are far in the future. In particular, it could be that people with lower levels of self-control are more present-oriented and do not put much weight on the future consequences of risky actions, and in doing so put relatively more weight on the probability of risks. This is plausible given that the consequence of failing to exercise self-control was distant in the future for many of the risks where the effect occurred (e.g., liver damage from alcohol consumption may only arise decades into the future). However, that the weighting bias persisted for risks with more immediate consequences (e.g., the consequence of getting into a car crash due to speeding is immediate) also suggests that inter-temporal discounting cannot fully explain the effect.

Nonetheless, to directly test an inter-temporal discounting account, we manipulated the temporal distance of self-control risks so that the risky behaviors were either temporally proximate or distant. The idea is that risky behavior that occurs sooner rather than later is also more likely to yield negative outcomes relatively sooner rather than later. For example, if one starts smoking earlier one may expect to develop the negative consequences of smoking sooner. Hence, whether the effect persists, disappears, or exacerbates under different temporal framings allows us to test the role that temporal distance plays in causing the effect. If the effect persists only when risks are temporally distant but not when risks are temporally proximate, then the effect may be driven partly by differences in temporal focus. If the effect persists in both conditions, then the effect likely occurs independently of temporal framing.

9.1 Method

Participants (N = 86, 55f) from the same national online pool as Experiment 1 took part in the experiment to win a $75 gift certificate. We used the same choice-based design as Experiment 4A where participants read about a particular self-control related risk and were then asked to choose between a consequence- or probability- reducing mitigation strategy.

Participants first completed the self-control measure used in Experiment 3. Next, participants were randomly assigned to one of three conditions (control, proximate, distant). In each condition, participants were presented with three agency-relevant self-control risks in randomized order (becoming overweight from overeating, lung disease from smoking, and back damage from poor posture). The control condition, like previous experiments, provides general information on a risk and no reference to time frame (e.g., "Becoming overweight from overeating can result in numerous health risks. Imagine that you are at risk and are considering ways to mitigate the health risks associated with being overweight"). In order to manipulate temporal distance, we supplemented the basic risk descriptions with specific scenarios that would occur either in a proximate or distant time frame (e.g., "Imagine you are visiting some close relatives for a two week trip… [who] are serious cooks…, so you are worried about gaining a lot of weight during your trip."). In the temporally proximate condition, the specific risk scenarios for each risk were ostensibly occurring in one week's time. In the temporally distant condition, the same risk scenarios were ostensibly occurring in 6 months (Appendix 13). The idea is that risky behaviors that occur sooner rather than later are also more likely to yield negative outcomes relatively sooner.

After reading the risk scenarios, participants in all conditions were asked to choose between probability versus consequence oriented risk mitigation strategies (same as Experiment 4A). Participants were also asked the degree to which they already engaged in risk-relevant behaviors: extent they overeat, eat too much unhealthy foods, and exercise (1 "never" - 9 "always"), smoking (no, yes, if yes how many daily), extent of back problems (1 "never" - 9 "always"), which we used as covariates in analysis.

9.2 Results and Discussion

Manipulation Check. To ascertain that perceptions of risks' temporal distance (i.e., when negative outcomes will occur) changed as intended by our temporal distance manipulation an independent sample of participants (N=83, 37f) evaluated the scenarios presented in the control, proximate, or distant conditions. For each scenario, participants indicated (on 7-point scales) how far in the future they thought the negative consequences of the risk occurred, as well as how soon someone who exercised poor self-control in the risk domain would experience negative consequences. The two measures were averaged to form a temporal distance score (α = .82) with higher value denoting that the negative outcome of a risk was perceived to be further in the future. Planned contrasts showed that the negative outcomes were indeed perceived to be temporally further away in the distant condition than in the proximate condition (overall, $M_{proximate} = 6.29$, $M_{distant} = 7.11$, $t(77) = 3.02$, $p < .05$; individually, $p < .1$ for overeating and $p < .05$ for smoking and back pain).

A repeated measure general linear model with choice of mitigating strategies for the three risks as a within-subjects factor, self-control level as a between-subjects variable, and age, gender, and behavioral measure as covariates yielded no significant interaction between temporal framing condition and self-control level, $F(2, 68) = 0.82$, $p > .1$. In other words, our manipulation of perceived temporal distance did not affect relative preferences for risk mitigation measures. However, consistent with previous experiments, the same analysis yielded an overall preference for probability-oriented over consequence-oriented risk mitigation measures among low self-control individuals, $F(1, 68) = 3.28$, $p < .05$.

(Insert Figure 3 about here)

Within Conditions. In the control condition, participants with a lower level of self-control were relatively more likely to choose probability-oriented measures over consequence-oriented measures in a manner consistent with previous experiments $F(1, 18) = 6.64$, $p < .05$. The same pattern of results was seen in the temporally proximate condition, but at a marginal level of statistical significance $F(1, 24) = 3.01$, $p < .1$. In the temporally distant condition, there were no significant differences in choice between self-control levels $F(1, 18) = .57$, $p > .1$.

We can infer from these results that lower self-control individuals were not simply underweighting consequences because they undervalue future outcomes. Such a temporal discounting mechanism would predict that low self-control individuals should underweight consequences even more under distant temporal framing, where the risks were further displaced in the future. This should have resulted in greater choice share for probability-oriented measures in the temporally distant condition. However, our results found that distant temporal framing did not exacerbate the effect, and in fact reversed it in two scenarios (see Figure 3). This result, together with the finding that the predicted weighting distortion also occurred in the immediate-risk car crash scenario and only arises in risk domains involving personal agency, suggests that differential weighting is not simply driven by different levels of inter-temporal discounting between high and low self-control individuals.

10. Experiment 6

In the last experiment, we further explored the generalizability of the effect in the context of monetary gambles. If our effect extends to this domain, we would expect lower self-control individuals to find higher probability, lower payoff gambles relatively more attractive. Examining gambles is insightful since gambles clearly involve risk but do not involve self-agency. In other words, people cannot influence the odds by exerting more or less self-control. Hence a perceived control account would predict that the differential weighting effect due to self-control differences should not arise in the context of gambling.

10.1 Method

This experiment was conducted with participants from Amazon's Mechanical Turk website once in the gain domain (n = 128), and then replicated in both the gain and loss domains (n = 192). We first measured participants' chronic self-control using the same individual difference measure as Experiment 3 before eliciting participants' risk preferences for monetary gambles using a Holt-Laury (2002) risk aversion task.

In this task, participants were instructed to choose between pairs of gambles, one after the other in fixed sequence. They were asked to pick a gamble as if they were given the chance to participate in one at a casino. The outcomes of the gambles were based on the roll of a 10-sided die. All ten pairs of gambles had a similar format: participants were asked to choose between two options, one with a smaller maximum payoff (p of winning $2.00, $1 – p$ of winning $1.60) and one with a bigger maximum payoff (p of winning $3.85, $1 – p$ of winning $0.10) in payoff. The probability p was 10% for gamble 1, 20% for gamble 2, etc., and 100% for gamble 10. For the first gamble, the high pay-off option was very unlikely. In subsequent gambles, the high pay-off option became more and more likely (see Appendix 14). For the loss domain scenario, probabilities and sums of money were the same, except that all outcomes were negative (e.g., 10% of losing $2.00 and 90% of losing $1.60 versus 10% of losing $3.85 and 90% of losing $0.10 for gamble 1). Here, participants were also told that they were in a situation where "all choices have bad outcomes and the only uncertainty is to resolve how bad the outcome will be".

The point at which the decision maker switched from the low to high pay-off option allowed us to calculate their risk aversion. This also allowed us to measure the degree to which people with lower (higher) self-control in general have more (less) focus on likelihood of winning a gamble, and less focus on the size of the monetary outcome. If our risk weighting effect extended to monetary gambles then we might expect a low self-control individual, who we have previously shown to be relatively more (less) focused on probability (consequence), to avoid the high-spread option that had a low chance of winning the bigger payoff and prefer the low-spread option that guaranteed a medium-sized payoff.

10.2 Results and Discussion

A repeated measures general linear model with choice of gamble as a within-subjects factor revealed no differences in monetary risk aversion between high versus low self-control individuals, $F(1, 127) = .32$, $p > .1$. Same pattern was observed in a separate experiment where we found no differences in monetary risk aversion for high and low self-control individuals for both gambles in the positive, $F(1, 190) = 1.64$, $p > .1$, and negative domains, $F(1, 191) = .27$, $p > .1$ (Figure 4), where all the payoffs were positive or negative, respectively. More germane to our interests, we did not find evidence of interaction effects with the same self-control scale used in our experiments, p's > .1, which suggests that self-control did not affect risk aversion in the gambles presented.

(Insert Figure 4 about here)

Although we were able to measure individuals' risk aversion, which were consistent in pattern with previous research (e.g., Holt and Laury 2002), Experiment 6 suggests that the effect does not generalize to gambles where people have no agency over the odds. Specifically, it does not seem that a lower score in behavioral self-control (as a chronic trait measured by a self-control scale) is correlated with differential risk weighting preferences for monetary gambles. This finding along with results of Experiments 1, 4A, and 4B supports the notion that differences in perceived control drive the differential weighting effect, which attenuates when control is not a relevant feature of the risk. It should be noted that prior research has shown that even for gambles where odds are not under individual's control, people may develop illusionary sense of control over the situation, which can lead them to perceive risk very differently. For instance, people behave as if they think they have greater control when they roll dice themselves than when someone else rolls for them (e.g., Fleming and Darley 1986) and prefer to pick their own lottery numbers than to have others pick for them (Dunn and Wilson 1990; Langer 1975). While our experimental setup made it unlikely for an illusionary sense of control to have played a role in this experiment, it is possible that our self-control driven weighting bias could be found in gambles where people develop an illusion of control over probabilistic outcomes.

11. Discussion

In this research we applied a decomposition approach to the construction of risk perceptions in order to explore its relationship with self-control. Doing so revealed that low self-control was associated with higher weighting of the probabilities of risks, and relatively reduced weighting of the consequences of risks, as constituent components influencing overall levels of perceived threat (Experiment 1). Beyond relying on individual differences in self-control, we show that directly inducing a state of lower felt self-control also led to differential weighting of risk components (Experiment 2), illustrating that changes to how risk is fundamentally constructed can arise due to situational and contextual factors. The effect not only distorted construction of risk perceptions but also affected choice of risk management strategies in both negative and positive domains (Experiments 4A and 4B). We reiterate a critical point that our results demonstrate how self-control differences affect the relative *weighting* of risk components in overall formulations of perceived risk, which is not to be confused with judgments of the actual levels of probability, consequence, or overall risk.

In this initial foray, besides documenting the basic effect and its immediate consequences, we also tested several important boundary conditions. We found that the effect occurs only when personal agency over risks is high (Experiments 1, 4A, and 4B). Furthermore, we found that the effect attenuated when risks were not sufficiently threatening, for example, when size of the negative outcome is small (Experiment 3). The results seem to support an account based on differences in perceived control in individuals who are low versus high in self-control. Besides providing some initial insight into the mechanism driving the phenomenon, the findings also render several alternative accounts unlikely. The effect does not seem to be caused by a general tendency among low self-control individual to overweight probability and underweight consequences or by a motive to reduce threat. The effect is also unlikely to arise due to differences in past experiences or because of greater inter-temporal discounting of consequences by low self-control individuals.

Beyond their theoretical contribution to understanding the relationship between self-control and risk perception, our findings have important practical implications. Specifically, the results generate important predictions regarding how self-control might influence the appeal of specific measures to mitigate risks. Consistent with our observed effect, we found that decision makers lower in self-control showed reduced interest in products and lifestyle changes oriented specifically toward reducing the consequences of risks, relative to those higher in self-control who demonstrated an opposite preference for risk mitigation strategies (Experiment 4A). Similarly, in the positive domain, those with lower self-control were more likely to choose options and strategies that increased their chances of success, relative to those with higher self-control who demonstrated a relatively greater interest in increasing the magnitude of an uncertain positive outcome (Experiment 4B).

This research also makes a methodological contribution to behavioral decision-making research by demonstrating the potential usefulness of regression models in revealing weighting differences between proposed underlying constituents of psychological constructs. Particularly, our interaction effect models allow for the measurement of how much an independent variable affects the relative contribution of two other variables to the variance of a dependent variable. Such a method, common in economics and other fields, can be more illuminating than traditional ANOVA tests by yielding precise elasticities of one variable's effect on another. The application of similar models in behavioral decision-making research might yield deeper insights into numerous behavioral processes that simple tests for overall mean differences would overlook. Other similar approaches might examine different variables, risk contexts, and component relationships, which in turn would entail different functional forms in the final regression analysis. Such analysis would be in the spirit of previous process-tracing models of psychological judgment, which use regression methods to extract decision process information (e.g., Einhorn, Kleinmuntz, and Kleinmuntz 1979).

Our findings also have numerous policy implications. For example, for those interested in promoting health and safety, the results afford a deeper and more nuanced understanding of populations under greater risk (Slovic 1987). For example, the finding that people with lower self-control were less interested in consequence reducing products and lifestyle change measures, even though they would benefit more from such measures (given their increased propensity to engage in the focal risky behaviors), is pertinent for designing measures to best improve the welfare of such individuals. Our results suggest that individuals low in self-control (either chronically or in a given situation) may be most persuaded to undertake risk mitigation and risk prevention measures that reduce the probability (versus consequences) of negative outcomes occurring, or when measures are framed as such. Concomitant implications may be drawn for the effective design of messages discouraging undesired behaviors, such as excessive drinking, unprotected sex, and lower saving, or for promoting strategies aiding self-control. If the primary target population of a message is indeed those with lower self-control over such behaviors, emphasizing high probability of negative outcomes may make for the most persuasive messages. As interest grows in transformative managerial research aimed toward protecting and improving individuals' welfare and well-being, our results may contribute valuably to developing ideas to help individuals overcome the lure of high-risk behaviors ranging from overindulgence at the dinner table or at a favorite store to serious addictions to drugs or gambling. For self-control related risks in the positive domain, our research suggests that individuals might be differentially motivated by different components of an uncertain reward, and that low self-control individuals are more interested in improving their chances of success, while high self-control individuals are more interested in enlarging the fruits of possible success.

Our results may also help explain other findings related to how susceptibility to negative outcomes may distort perceptual judgments. Impulsive criminals, for instance, have been shown to be less deterred by severity of punishment (consequence-oriented component) than certainty of punishment (probability-oriented component), a pattern opposite to the trends in the general population (Block and Gerety 1995). The current research may potentially explain such phenomena, with ramifications for theory and policy worthy of further exploration.

11.1 Directions for Future Research

Our findings serve as an initial demonstration of a distortion in risk construction driven by self-control differences and leaves several avenues open for further research. For example, while our focus was on biases in the risk weighting regardless of absolute perceptions of risk, future investigations could explore the relationship between the two. It is interesting that we do not find that lower self-control systematically relates to lower absolute estimations of risk, while much previous research does find that individuals most vulnerable to particular risks are more likely to underestimate risks on an absolute level (Bauman and Siegel 1987; Claster 1967; Strecher, Kreuter, and Kobrin 1995; Taylor and Brown 1988). One possible reason why we found differential weighting but no absolute differences in risk perception between high and low self-control groups could simply be that relative weighting biases are more prominent than absolute bias effects (Bontempo, Bottom, Weber 1997). Indeed, it is possible that absolute risk perception distortions are a more extreme effect that arises amongst the most biased individuals, who have the strongest motivation to distort risk information. This would be consistent with the fact that we did not recruit participants from at-risk populations like previous research that found distortions in absolute judgments of risk (Bauman and Siegel 1987; Claster 1967; Strecher, Kreuter, and Kobrin 1995), and subsequently did not find evidence of a motivationally driven process. Thus it could be that conducting the current studies with at risk-populations would yield both absolute perception and weighting biases. This also suggests that our effect is more ‘mild’, commonplace, and applicable to the general population. However, future research is needed to systematically examine these speculations and shed light on the relationship between judging overall threat and the relative weighting of its components.

Our experiments showed that consequences were underweighted by low self-control individuals but that probabilities were relatively weighted more: a pattern of results consistent with previous research finding that risk consequences were relatively less influential in decision making for the impulsive or impatient (e.g., Claster 1967; Weber and Hsee 1998). However, other research has suggested that cognitively impulsive individuals (who conceptually correspond to low self-control individuals) may be more likely to be insensitive to and ignore (i.e., underweight) probability information (e.g., Frederick 2005). Future research is needed to reconcile these findings with our results. Such differences in results may arise because in our experiments, both the extent and chances of the risky damages were completely left to the individual to decide. A different manner of distortion might arise under different risk elicitation procedures, for example if risk information were explicitly given or if precise probabilities were elicited.

Finally, future research may also explore what other individual, situational and/or contextual factors may shift people’s level of felt self-control and bring about similar weighting distortions in risk components. In Experiment 2 we used a commonly employed ease-of-recall paradigm, which affected participants' ratings of their ability to exert self-control relative to others. While it is not clear whether our manipulation also affected participants' absolute sense of self-control (i.e., the actual amount of self-control the participants were able to exert, as opposed to how much self-control they felt), it nonetheless yielded our effect. Future research may examine how tasks and contexts that directly deplete self-control resources (such as initial acts of self-regulation or making unrelated choices, e.g., Wang, Novemsky, Dhar, and Baumeister 2010) may subsequently affect people’s weighting of risk components during risk construction and subsequent choice.

11.2 Conclusion

In exploring the effect of self-control on risk construction processes we have identified a novel risk component weighting effect. But our examination is far from definitive. Rather, the value of our work comes from uncovering a new phenomenon, and by opening a new avenue and approach for future research. We hope this work stimulates further investigations on both general and specific interplays between self-control and risk perception, two extensive topics that have a wide and deep range of theoretical, practical, and social significance.

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Table 1: Results for Regression Model in Experiment 1.

Risk	Standardized Beta for Parameters of Regression Model (5)										
	Consequence		Probability		Cons*SC		Prob*SC				
	a	sig.	*b*	Sig.	*d*	sig.	*e*	sig.	adj. R^2	BIC of Model (5)	BIC of Model (3)
High Personal Agency											
Heart disease from overeating	-2.85	*.05*	2.83	*<.01*	3.36	*<.01*	-2.46	*<.01*	.53	-349	-345
Diabetes from overeating	-4.49	*<.01*	5.70	*<.01*	5.16	*<.01*	-5.34	*<.01*	.44	-302	-299
Speeding crash	-0.36	*.25*	1.27	*<.01*	0.84	*.03*	-0.83	*.06*	.61	-314	-311
Lung cancer from smoking	-1.34	*<.01*	1.95	*<.01*	2.21	*<.01*	-2.05	*<.01*	.64	-384	-382
Illness from GM foods	-1.00	*<.01*	1.85	*<.01*	1.27	*<.01*	-1.23	*<.01*	.77	-286	-281
Low Personal Agency											
Plane crash	0.66	*.03*	0.06	*.92*	-0.34	*.29*	0.52	*.39*	.40	-154	-149
Avian flu from traveling	-0.24	*.72*	0.80	*.18*	0.62	*.36*	-0.36	*.58*	.39	-215	-216
Car breakdown	0.55	*.26*	0.31	*.46*	-0.14	*.79*	-0.15	*.76*	.48	-208	-207
Hard drive crash	0.64	*.04*	0.32	*.23*	0.01	*.98*	0.03	*.92*	.59	-250	-251

The interpretation of the effect rests largely on the sign and significance of the parameters *d* and *e*, which reflect how much self-control affects the weighting of each risk component in overall perceived risk. We see divergent effects of self-control on the weighting of consequences and probability in overall risk construction (columns *d* and *e*) for high personal-agency risks. A positive (negative) parameter shows increased (decreased) weighting of that parameter for higher levels of self-control. The parameters are not significant for low personal-agency risks. Model (5) was chosen over Model (3) using a backward elimination procedure. For high personal agency risks, Model (5) also yielded lower BIC scores than Model (3).

Table 2: Results for Regression Model in Experiment 2.

Condition	Consequence		Probability		Cons* δ		Prob* δ				
	Standardized Beta for Parameters of Regression Model (8)										
	A	sig.	*b*	sig.	*d*	sig.	*e*	Sig.	adj. R^2	BIC of Model (8)	BIC of Model (6)
Low Self-Control Cond.											
Heart disease from overeating	-0.76	*.03*	2.33	*<.01*	3.48	*<.01*	-3.01	*<.01*	.33	-255	-253
Speeding crash	0.13	*.44*	1.13	*<.01*	1.11	*<.01*	-1.17	*<.01*	.75	-234	-230
Liver damage from drinking	-0.63	*.05*	1.82	*<.01*	2.07	*<.01*	-2.18	*<.01*	.47	-295	-291
Lung cancer from smoking	-0.50	*.02*	1.56	*<.01*	2.84	*<.01*	-3.01	*<.01*	.62	-287	-283
High Self-Control Cond.											
Heart disease from overeating	0.23	*.28*	0.46	*.05*	-0.12	*.90*	0.10	*.92*	.26	-338	-342
Speeding crash	0.18	*.37*	0.37	*.13*	-0.24	*.64*	0.31	*.56*	.24	-223	-222
Liver damage from drinking	0.33	*.21*	0.43	*.07*	-0.14	*.80*	0.09	*.87*	.33	-319	-314
Lung cancer from smoking	-0.03	*.87*	0.79	*<.01*	0.31	*.51*	-0.26	*.57*	.45	-335	-331

Note. A higher value for dummy variable δ denotes higher self-control level. We see divergent effects of perceived self-control on consequences and probability weighting (columns *d* and *e*) in risk construction. A positive (negative) parameter shows increased (decreased) weighting of that parameter for higher levels of self-control. Induced lower self-control results in lower (higher) weighting of consequence (probability) but the parameters are not significant for induced high self-control.

Model (8) was chosen over Model (6) using a backward elimination procedure. For the low self-control condition, Model (8) also yielded lower BIC scores than Model (6).

Table 3: Results for Regression Model for Experiment 3

Risk	Standardized Beta for Parameters of Regression Model (5)								
	Consequence		Probability		Cons*SC		Prob*SC		
	a	sig.	*b*	Sig.	*d*	sig.	*e*	sig.	adj. R^2
With interaction terms									
Catch cold	-0.92	*.59*	1.52	*.13*	1.42	*.40*	-1.31	*.19*	.37
Parking fine	1.54	*.38*	-0.58	*.50*	-1.05	*.55*	0.59	*.49*	.23
Bad breath	-0.94	*.42*	2.03	*.07*	1.49	*.20*	-1.74	*.12*	.42
Ants in kitchen	-2.12	*.17*	2.50	*.18*	2.53	*.11*	-2.28	*.22*	.18
Pulling muscle	3.66	*.03*	-1.50	*.23*	-3.19	*.06*	1.74	*.17*	.44
Mosquito bite	1.85	*.26*	-0.58	*.36*	-1.21	*.46*	0.77	*.23*	.48
Without interaction terms									
Catch cold	0.50	*<.05*	0.22	*<.05*					.37
Parking fine	0.50	*<.05*	0.01	*.94*					.24
Bad breath	0.54	*<.05*	0.28	*<.05*					.41
Ants in kitchen	0.38	*<.05*	0.17	*<.05*					.17
Pulling muscle	0.53	*<.05*	0.22	*<.05*					.43
Mosquito bite	0.65	*<.05*	0.18	*<.05*					.48

Self-control differences did not result in weighting distortions for risks with relatively minor consequences. However, probability and consequence were significant components for all risks except one.

Table 4: Risk Mitigation Strategies in Experiment 4A.

Risk	Probability Reducing Measures	Consequence Reducing Measures
High Self-agency Risks		
Heart disease from unhealthy eating	Preventative medication	Purchasing health insurance offering higher quality cardiac-care services
Becoming overweight from unhealthy eating	Gym membership to prevent weight gain	Switching to a low-sodium, low-cholesterol diet said to reduce negative consequences of excessive weight
Liver damage from drinking	Pill that improves alcohol-processing and reduces the chances of liver damage	Pill that helps with liver regeneration and reduces consequences of liver damage.
Lung cancer from smoking	Switch to cigarettes with fewer combustibles said to reduce chances of developing lung cancer	Switch to a diet heavy in foliates and vitamin C said to help the body fight cancer should it develop
Back damage from poor posture	Wear orthopedic back support a few hours each day to reduce chance of injury	Sign up for yoga class to improve flexibility and strength so any injuries will be less serious.
Low Self-agency Risks		
Catching the next flu pandemic	Wear heavy-duty surgical mask in public places to reduce infection chances	Take generic anti-viral drugs daily that make the flu milder
Home suffering risks (e.g. natural hazards, burglary, etc)	Home insurance that covers all types of damage but only pays for half the costs of damage	Home insurance that covers half as many risks, but pays for all the costs of damage
Getting hurt when playing a contact sport	Padding which covers more of your body but offers less protection to areas it covers	Padding which covers less of your body but protects those areas better.
Product breakdown for smart phones	Phone that does not break down often but costs more to fix	Phone that breaks relatively more often but costs little to fix.
Driving on a long distance road trip in bad weather	Road that has low chance of bad weather, but very adverse conditions if weather is bad.	Road that has high chance of bad weather, but relatively less adverse conditions if weather is bad.

Table 5: Risk Management Strategies in Experiment 4B.

Positive Risk	Probability Increasing Measures	Consequence Increasing Measures
High Self-agency Scenario		
Life extending daily vitamins that also need diligent uptake and diet	Higher chance of working even if not diligent, potentially increases lifespan by 2 years	Lower chance of working if not diligent, potentially increases lifespan by 5 years
Choosing a work team at a firm that has different incentive schemes	A team that is more likely to get bonuses for hard work but the bonus is low (5% of salary)	A team that is less likely to get bonuses for hard work but bonus is high (20% of salary)
Choosing between two licenses for commercial fishing	A license to fish in area where catches are more likely throughout the day and there is less competition, but the catches are smaller.	A license to fish in area where fish is abundant early in the morning. Bigger catches but also greater competition against others at earlier hour.
Choosing between two sponsorship schemes for a charity half-marathon	Finish the race at pace that you are confident about if you train normally, to raise $2000.	Finish the race at a challenging pace that you will need to train harder for, to raise $5000.
Low Self-agency Scenario		
Government sponsored solar panel on roof to generate electricity	Install at spread-out angles that are more likely to catch sunlight	Install at a direct angle so that more electricity is generated when there is sunlight.
Investing $1000 tax-rebate in stock market	Invest in firm that is diversified and has a higher chance of turning a profit regardless of market	Invest in firm that is highly specialized but will have very big profits if its market sector does well.
Buying a last-minute birthday gift for your boss	Chocolates - your boss eats them but also receives this gift often (so less impressive)	Tickets to a play – your boss loves theater, but you are not sure on genre (but more impressive if you choose right).
Gambling at a casino	Play a card game that is easier to win a hand in, but winnings per hand are smaller	Play a card game that is harder to win a hand in, but winnings per hand are bigger.

Figure 1: Choice of Risk Mitigation Strategies in Experiment 4A.

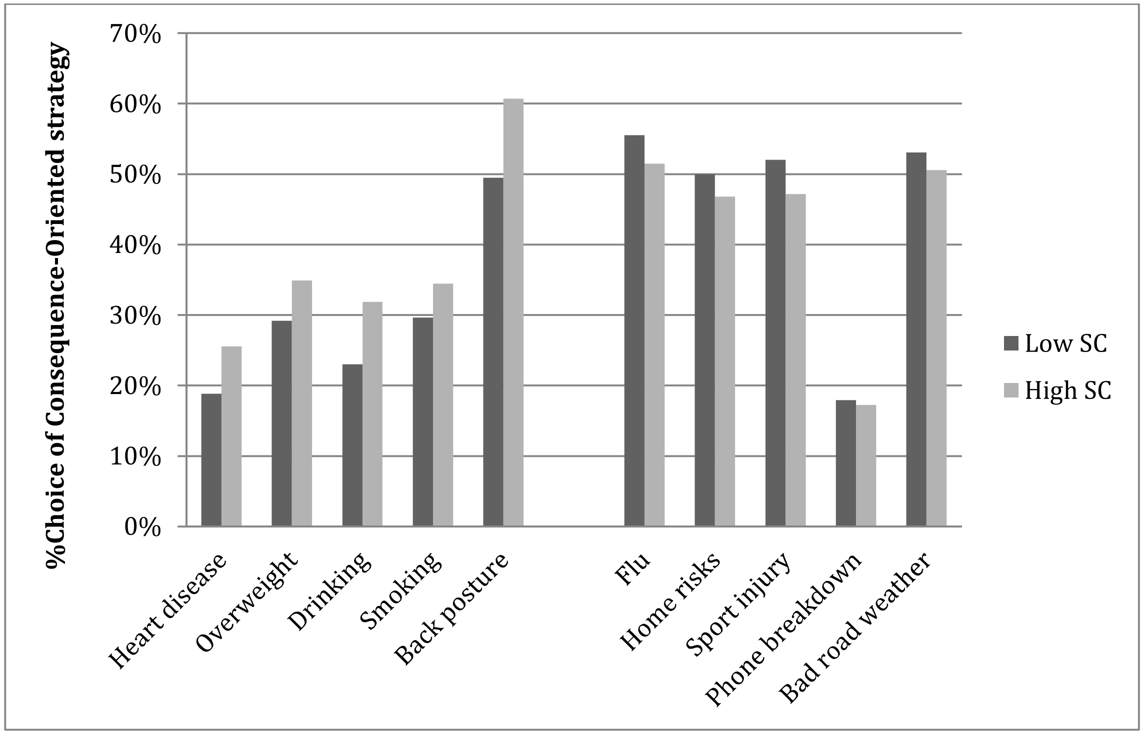


Figure 2. Choice of Risk Management Strategies in Experiment 4B.

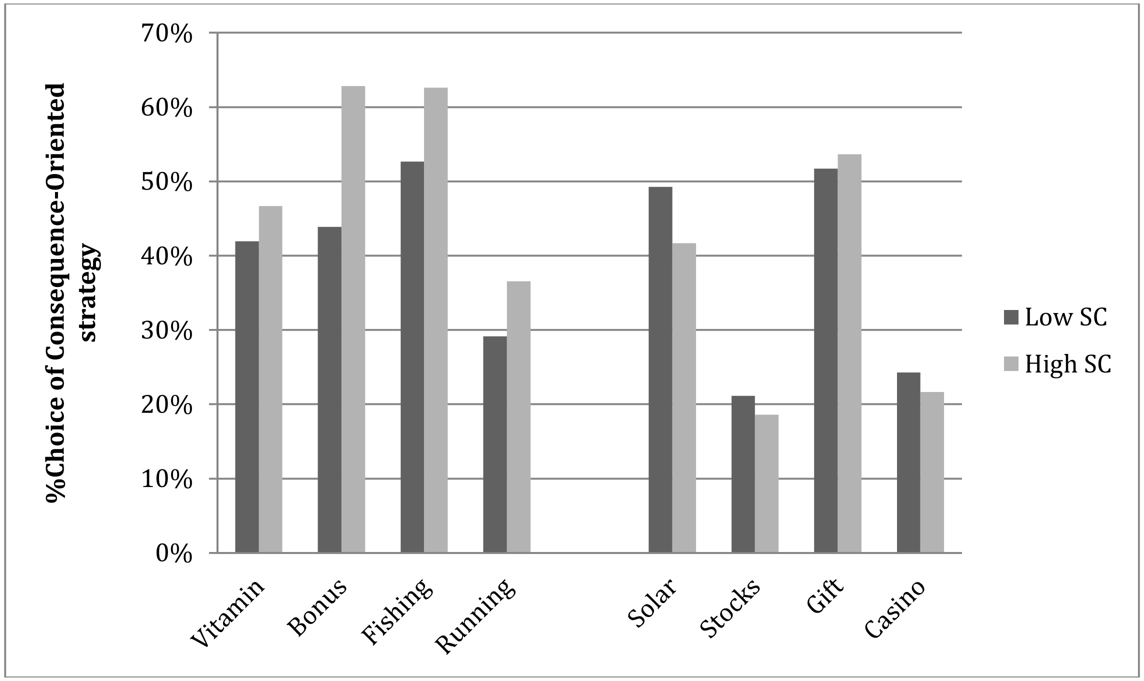


Figure 3: Choice of Risk Mitigation Strategies Under Different Temporal Framings in Experiment 5.

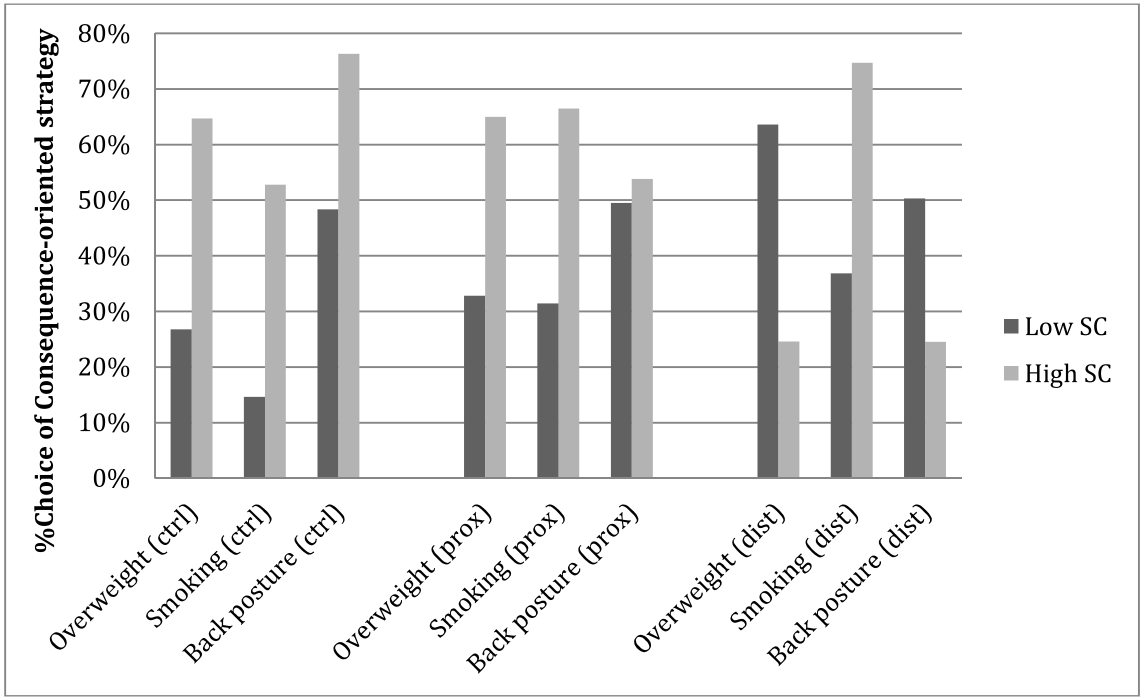
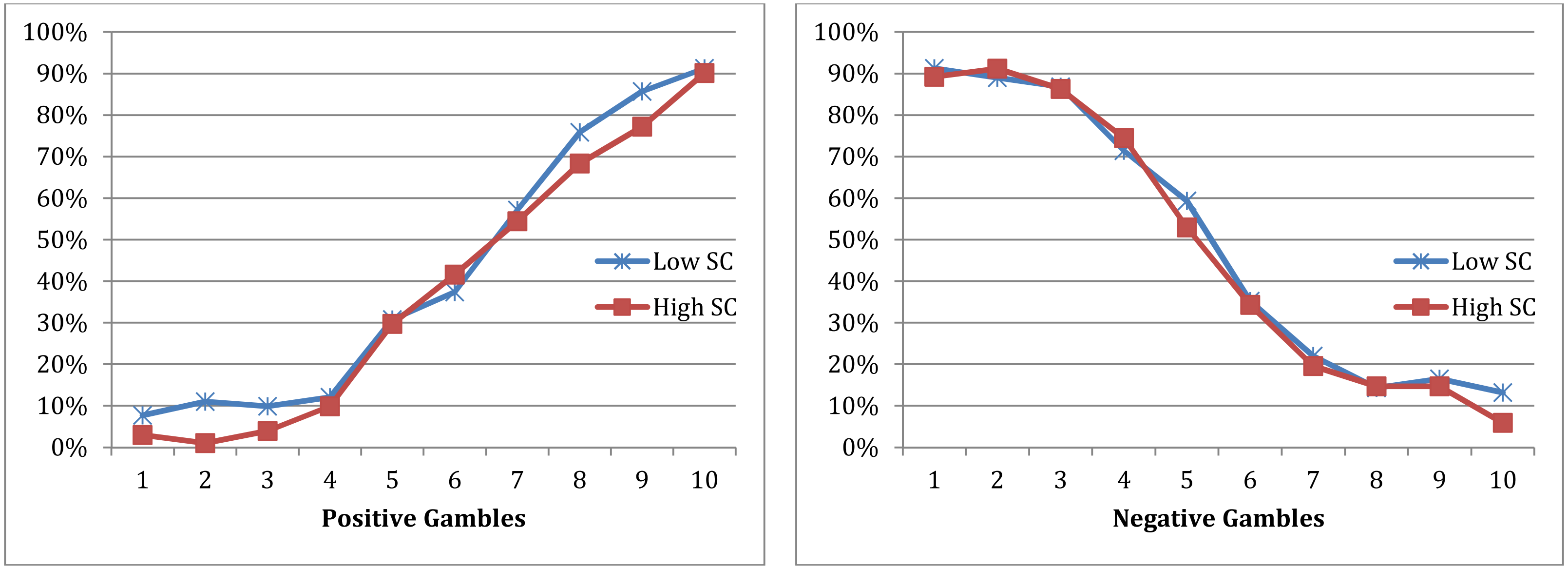


Figure 4: Choice of Riskier Option for Monetary Gambles in Experiment 6



A Holt-Laury task showed no differences between high and low self-control individuals for monetary risk aversion in the gain (left) and loss (right) domains. X-axis represents a continuum of binary gambles (positive or negative) that range from the high payoff/loss outcome being very unlikely (1) to the high payoff/loss outcome being extremely likely (10). Y-axis represents choice share of high-spread option (which contained the high payoff/loss outcome).