The bracketing breakdown: An exploration of risk tolerance in broad and narrow choice frames

by

Ester Moher

A thesis

presented to the University of Waterloo

in fulfillment of the

thesis requirement for the degree of

Master of Arts

in

Psychology

Waterloo, Ontario, Canada, 2009

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Ester Moher

Abstract

The field of decision making has largely focused on the influence of contextual factors on risk tolerance. Much work has focused on how the problem itself is presented, in hopes of understanding the circumstances under which individuals may be helped in areas of long-term investment and planning through encouragement of greater risk tolerance. Specifically, when making financial decisions, it has been suggested that by presenting individual decisions in groups (Gneezy & Potters, 1997), or by presenting feedback less frequently (Thaler et al, 1997), participants are able to process individual problems in a holistic manner, which encourages risk tolerance when deciding. This literature has typically made claims that these effects are dependent on how the problem is presented. However, evidence for the benefits of "broadly bracketed" problems often relies as much on the presentation of aggregated outcomes as it relies on the grouping of problems. The purpose of this thesis was to further examine whether bracketing effects might be attributable to manipulations of problem framing or outcome framing.

In addition, it has been suggested that perhaps individuals who differ in processing styles might respond differentially to framing effects in general (Frederick, 2005). That is, perhaps individuals who are more intuitive decision makers might be more susceptible to context-based changes, and so might show larger framing effects. Deliberative decision makers, on the other hand, might overcome these framing effects by reflecting on, or actively "reframing", the problem. A secondary purpose of this thesis was thus to investigate individual differences in the magnitude of the bracketing effect on risk tolerance.

In Experiment 1, problem and outcome bracketing were examined in the domain of discrete choices, while in Experiment 2, bracketing was examined with continuous investments. Results suggest that when investment opportunities are identical, problem framing encourages long-term risk tolerance. However, when choices are somewhat different from one another, as is often the case in real-world investment situations, outcome information is critical to encouraging long-term risk tolerance. Together, results suggest a critical reevaluation of the bracketing hypothesis and its application to long-term investment.

Acknowledgements

I would like to thank my supervisor Derek J. Koehler for his guidance over the past two years, and for his enthusiasm and support, especially in the early stages of this research. I would like to extend my appreciation to the readers of this thesis, Jonathan Fugelsang and Richard P. Eibach, for their constructive input regarding this thesis, and to my research in general. Finally, I would like to extend my appreciation to the Koehler-Fugelsang lab group for their thought-provoking and insightful comments regarding this thesis.

Table of Contents

List of Tables

List of Figures

Introduction

What makes for a "good" decision maker? Some might argue that good decision makers are able to make functional or rational choices in stressful situations—while deciding under time pressure, while performing a concurrent unrelated task, or while under emotional stress, they are able to accurately decide which options confer the most benefit given a preference set. Thus, being able to rely on intuitive or gut responses, or what "feels right", might be qualities of individuals with decision making expertise. Others, however, might challenge this idea, instead arguing that good decisions come about through thoughtful deliberation on the problem. Good decision makers, for example, might be individuals who behave rationally and in accordance with their preferences at all times. The best decisions instead might be made through ignoring gut instincts, and relying instead on less obvious elements of the problem (such as a calculation of expected value and personal preference), which requires more cognitive energy.

Perhaps the best decisions employ both the initial "gut" reaction, along with a more computational or controlled filter. Sloman (1996) elegantly summarized evidence for such a model in literature as far back as James (1890/1950), giving empirical support for such a dual-systems account for reasoning: one that is heuristic-based, and one that is rule-based. Sloman describes the former associative system as one that processes information based on heuristics (see also Kahneman, Slovic & Tversky, 1982). That is, associative processing is characterized by a reliance on perceptual features, operating in a generalized and automatic fashion. Sloman also identifies a rule-based, deliberative processing system that relies on computational principles, and which is systematic in function (see also Fodor & Pylyshyn, 1988). This second processing system is characterized by concrete operations, producing a response that makes logical or causal sense given the alternatives and the problem itself. Critically, these two systems work together to resolve conflict and aid decision making at different levels, based on the difficulty of the task, and on the circumstances under which decision making is conducted. For example, individuals often act on impulse when costs are low (e.g. buying a brand of cereal based on its advertising campaign or position on the store shelf, rather than because it dominates other competitor cereals in taste or nutritional value), suggesting that an associative system may guide the majority of low-stakes decision making. However, a rule-based system may more often be employed to justify more costly choices when risks of relying on intuitive decision making become greater (e.g. when buying a car).

Stanovich and West (2000) offer simple terminology and explanations for Sloman's (1996) two systems: "System 1" for the associative and intuitive system, and "System 2" for the rule-based and deliberative system. They delineate several additional important characteristics of both systems: System 1 is associative and holistic, relying very little on cognitive capacity for functioning, and relying greatly on problem context. Thus, System 1 seems to be a good candidate for making gut decisions, but is susceptible to biases arising from framing manipulations that influence context but not content. System 2, on the other hand, is rule-based and analytic, requiring time and cognitive resources to process information and guide decisions in a more structured, systematic manner. Because it operates at a slower pace, System 2 might be a candidate for effective monitoring of the output of System 1. On this note, Kahneman and Frederick (2005) suggest that System 2 processing takes into account less salient information, such as probability and base rate, which are important in making optimal choices, but which are not often intuitively attended to. Additionally, because System 2 requires a relatively large amount of cognitive energy to function appropriately, it is likely to be an ineffective supervisor when maintaining large quantities of information at once, or in situations where cognitive resources are already in use elsewhere (for example, when we are overwhelmed with emotion, or when we are tired).

This dual-systems framework has been substantiated in a variety of contexts. Hogarth (2002), for example, has noted the presence of a “tacit” or intuitive processing system (System 1), guided by implicit response, and a deliberative system (System 2), which censors thoughts and behaviors produced via the tacit system. Hogarth suggests that while the tacit system requires little effort to process information, it requires monitoring under many circumstances. However, he has also noted that the deliberative system requires a certain amount of resources to perform adequately—this “consciousness” is both limited in availability and costly to use. Thus, it is not actively employed in all decisions, though it serves as a monitor in all decision-making contexts at some level, and is rarely completely non-functioning. Finally, conscious deliberation can be overwhelmed with excessive amounts of information, suggesting that perhaps the presentation of well-structured, simplified information allows for optimal utilization of both tacit and deliberative processing.

Bargh, Chen and Burrows (1996) and Chen and Bargh (1999) have applied a dual-systems framework to stereotyping and impression-formation. They suggest that stereotyping occurs when we rely on more accessible attitudes and impressions, which are guided by automatic (and often non-conscious) evaluations. For example, when participants were instructed to either pull or push a lever in response to a positive or negative word, participants responded significantly faster on congruent trials (pushing motor response paired with negative words, or pulling motor response paired with positive words) than on incongruent stimuli (pushing paired with positive words, or pulling paired with negative words). Chen and Bargh

(1999) propose that faster reaction times on congruent trials are indicative of a more intuitive or automatic processing strategy to bring the positive closer and push the negative away: if both the word and motor task require behavior consistent with this heuristic, performance is faster, as it is guided almost exclusively by automatic or intuitive processing. Conversely, on incongruent trials, reaction times were slower: when the word and motor task require behavior consistent with different and conflicting heuristics, performance takes more time, suggesting that deliberation is employed to override intuition.

Further, dual-process models have been substantiated more recently using neuropsychological measures. Smith and DeCoster (2000), for example, propose a similar dichotomous model that employs memory systems analogous to the associative and rule-based systems previously mentioned. In their model, associative systems appear to rely on well-learned information that is readily accessible from memory, while rule-based systems are likely to rely instead on information that is acquired through inference and reasoning (and is hence only accessible when the individual is motivated and possesses cognitive capacity for the task). While Smith & DeCoster speak to what information dual-systems models rely on, McClure et al (2004) examined underlying structures associated with automatic (in their case, impulsive) and deliberative (in their case, patient) behaviors. Brain activity was measured during a series of intertemporal choices, between “smaller, sooner” monetary options and “larger, later” monetary options. The authors found that two areas were activated differentially: Beta areas, which represented limbic and paralimbic function, were activated disproportionately in the presence of immediately-available rewards. These areas are innervated largely by the dopamine system, which is thought to be responsible for conditioning of reward and motivation (see Di Chiara & Bassareo, 2007); McClure et al suggest that these areas are implicated in making impulsive decisions. Delta areas, on the other hand, which represented the lateral prefrontal cortex and associated areas, were activated when long-run options were considered. That is, delta areas were engaged when participants performed quantitative analyses of the problem set, considering the possible benefits to future opportunities over immediate ones. These areas are important in behavioral control and strategic planning (see Tanji & Hoshi, 2008), and so may be important in overriding intuitive, impatient responses of the limbic system. Indeed, McClure et al suggest that these two areas of activation represent competition between low-level, automatic processing (Beta areas) and the capacity for general reasoning and planning (Delta areas), analogous to the competition between intuition (System 1) and deliberation (System 2) described above.

While these are only a few examples from the literature, when taken together, they suggest that a dual-systems account may be helpful in understanding how people make decisions; indeed, this account accommodates the possibility of choices made at two levels: intuitive and deliberative.

Dual-systems Theories and Cognitive Reflection

One reliable finding among the various demonstrations of dual-systems theories is that employing System 2 processing requires much more effort than does relying on intuition. Consequently, to engage in System 2 processing requires some indication to move from very low levels of monitoring (System 1) to higher levels of active deliberation. Bargh, Chen and Burrows (1996) and Ebert (2001) suggest that in order to employ System 2 processing, we need to be motivated, we need to be aware of intuitive biases, and we need to have sufficient resources available to complete this more effortful task. For example, to employ more deliberative decision making strategies in a task, a participant needs to be motivated to perform, must have the time to allow for deliberation, and must have cognitive resources necessary to override intuition. This would suggest that perhaps the best domain for deliberation to be employed is one in which task demands are low, and where motivation to attend to the task is high. Additionally, there may be individual differences at play: those with more free cognitive resources in general might be better able to deliberate, even as motivations to perform decrease, task difficulty increases, and biases become less salient.

One implication of this potential individual difference is that System 2 processing might be correlated with factors pertaining to cognitive capacity. Individuals with greater cognitive capacity might be predisposed to employing cognitive effort in decision making, whereas individuals with less cognitive capacity might make less effortful decisions. For example, perhaps individuals with larger working memory capacity (one potential measure of cognitive capacity) are able to hold more information at once, making deliberation itself easier. As a result, these individuals might be more likely to engage in more effortful decision making, which is especially helpful when task demands are high. Indeed, Barrett, Tugade and Engle (2004) summarize a host of benefits related to decision making that are associated with increased working memory capacity. Those with higher working memory capacity are better able to activate information from memory (such as exemplars or related information; see also Rosen & Engle, 1997), which is thought to aid in novel problem solving. In addition, those with higher working memory capacity are better able to ignore interfering information and suppress irrelevant or inappropriate information from influencing choices, which suggests that perhaps decision-making among these individuals is both more focused and less susceptible to bias. These findings are further supported by Leboeuf and Shafir (2003), who suggest that individuals with higher need for cognition (NC; another conception of measuring cognitive capacity), measured by a scale assessing how much an individual enjoys engaging in effortful thought, are more likely to recognize when they have made inconsistent choices across objectively identical but differently framed decisions (see also Smith & Levin, 1996). Thus, perhaps one of the central benefits to greater cognitive capacity is the ability to decipher what information is most relevant to choice, and what information is irrelevant or uninformative. At a capacity level, intelligence might confer some benefits in risk-related choice.

More intelligent individuals might also have better-developed skills employed by deliberation, such as math or statistical ability. Dohmen et al (2007) provide some evidence for this hypothesis, noting that individuals with poor math skills prefer to take fewer risks despite higher expected values associated with high-risk options. Similarly, more intelligent individuals might make more risk-tolerant decisions because they are generally more capable of maintaining deliberative ability in novel situations. For example, in situations where the objectively better option is not obvious, more cognitively able individuals might process choice-relevant information more effectively, and as a result are less susceptible to framing effects (Smith & Levin, 1996). Consequently, individuals with greater cognitive abilities are more efficient in identifying the best option.

Individuals with lower cognitive ability might thus have difficulty taking a broader perspective on a decision making task. As Smith & Levin suggest, individuals with greater need for cognition, who tend to use more effortful thought in decision making, are less biased by framing influences. These more deliberative participants tend to be less impulsive decision makers, suggesting that overcoming impatience is another benefit to enhanced cognitive ability. Indeed, Benjamin and Shapiro (2005) found that among Chilean high school students and Harvard undergraduates, those with greater cognitive ability, as measured by GPA and other standardized aptitude measures, tended to be more patient over time, as well as more risk-tolerant over small-stakes gambles. To quote Benjamin and Shapiro, "'cognitive ability' measures the ease or frequency with which the deliberative system overrides the automatic system" (2005), suggesting that cognitive ability has a critical role in dual-systems accounts for risk tolerance.

Frederick (2005) has provided an extensive summary of data examining the interaction of intelligence and cognitive capacity measures in relation to risk tolerance. Overall, his findings converge on a central theme: higher performance on measures of intelligence is associated with more long-term risk tolerance and reduced delay discounting. This again suggests that individuals with greater cognitive ability are better able to suppress an intuitive instinct to avoid risk (and to prefer immediate gains), and instead rely on a secondary, more deliberative response (the preference for larger, future options). Frederick proposes that the benefits conferred by possessing greater cognitive ability allow for reflection on the problem set (a System 2 process), and thus that intelligence plays a crucial role in processing style. According to this perspective, individuals who are more intuitive thinkers might be more susceptible to framing manipulations and biases in general, as they are more easily influenced by choice context (Stanovich & West, 2000). Conversely, those who are more deliberative might be less affected by biases, as they possess more resources to reflect on the problem and override potentially costly initial intuitive responses to risk.

The Bracketing Effect

Frederick's finding that cognitive reflection ability is directly related to ability to deliberate on a problem lends itself well to considering biases in risk tolerance. If we are aware that intuition appears to guide the decision making strategies of most people (see Soman, 2004), and that those with greater working memory capacity might view problems differently (i.e. with less interference from irrelevant contextual variables, and more focus on relevant information), perhaps there are alternative ways to frame choices that make the more beneficial option (in terms of expected value or utility) more likely to be chosen. Indeed, this idea has been lurking in the literature for decades: Kahneman and Tversky (1979) and Tversky and Kahneman (1981) noted that preferences change depending on how the problem itself is framed. For example, the Asian Disease Problem (Tversky & Kahneman, 1981) compares two identical problems (a sure thing or a risky option that offers the chance to save or lose more lives), but frames possible outcomes as either gains (lives saved) or losses (people who will die). When the problem is framed positively, participants are much more inclined to choose the sure thing, as it guarantees that they will avoid saving zero lives. That is, individuals prefer certainty when goals are positively framed. Conversely, when the problem is framed negatively, participants are more inclined to choose the risky option. That is, participants seem to be mentally reframed to take a risk because they are presented with a problem where the default is a net loss of life. Tversky and Kahneman conclude that when problems are framed negatively, people prefer uncertainty and risk over acceptance of a sure loss. These findings suggest that by changing the structure of the problem, perhaps the intuitive response itself might change from one of risk aversion (in the case of gains) to one of risk tolerance (in the case of losses). In a general sense, how a problem is framed has an obvious impact on how participants respond to it.

More recently, Kahneman (2003) has again noted that framing relies on “passive acceptance of the formulation given”, but that this bias can be corrected with metacognition, a more deliberative (System 2) process that involves awareness of personal thought. Reframing a problem might then encourage more risk-tolerant decision making by promoting engagement of System 2 processing. Much discussion has thus been focused on how choices or investments can be presented so as to maximize risk tolerance.

Manipulating how problems are presented to induce frame-based preference shifts has been examined in the context of bracketing (Thaler et al, 1997; Gneezy & Potters, 1997; Read, Loewenstein & Rabin, 1999; Leboeuf & Shafir, 2003). For example, Thaler et al (1997) presented investment options (choosing a risky stock versus a safe bond) to participants at intervals of one month, one year, or five years in simulated time, manipulating the frequency (in time) with which investments were made. The authors hypothesized that as the timeframe of investments increased (and as frequency of investing decreased), participants would become more risk tolerant, as losses themselves would be made less salient due to the averaging of outcomes over longer periods of time (see also Benartzi & Thaler, 1995). By seeing fewer pure losses, participants should then be more inclined to make riskier decisions, improving their overall outcomes. Indeed, participants who chose their investments and viewed outcomes monthly were significantly more myopic, choosing low-risk, low-payoff bonds more often than high-risk, high-payoff stocks. Conversely, participants who chose and viewed their investments every five years tended to make more risk-tolerant choices, investing more often in stocks, demonstrating less loss and risk aversion. Thaler et al (1997) conclude that frequent feedback of investments is likely to encourage our worst tendencies—making relatively riskless, but unprofitable, investment choices. Conversely, by encouraging adoption of a longer-term perspective in which outright losses are experienced less frequently, risk tolerance can be enhanced.

While Thaler et al's studies examine frequency of investment and feedback, at a more basic level they manipulate the scope with which problems and outcomes are presented. According to the bracketing hypothesis (Gneezy & Potters, 1997), when problems are grouped together, participants are more likely to make investments that offer high risk with high payoff, instead of choosing safer but less rewarding options. It has been suggested that by grouping problems together, or by offering a broader frame, participants are encouraged to take a broader decision-making perspective, and in turn consider long-term payoffs in addition to their immediate feelings of loss aversion. Read, Loewenstein and Rabin (1999) suggest that a broad frame helps individuals to consider "all the hedonic consequences of their actions"—a broad frame might help individuals realize the role that their emotions play in choice, and this realization helps them override risk-averse responses in favor of alternative actions that promote utility maximization. In the language of cognitive reflection, presenting problems in groups encourages individuals to become aware of the similarities of the problems, consider them over a longer horizon, and encourages more explicit calculation of associated risks. By encouraging active reconsideration of the problems themselves, individuals are more likely to make more risk-tolerant, deliberative responses that focus on overcoming intuitive reactions to avoid risk. Conversely, when investments are presented alone, or in a narrow bracket, participants appear to make decisions in isolation (even if decisions themselves are interrelated), and thereby fail to benefit from the cancellation of outright losses associated with one choice by gains associated with others. This framing encourages participants to “go with their gut”, behaving in a risk-averse manner, as attention is drawn to potential losses associated with risk (see Tversky & Kahneman, 1991), which leads to very little investment (or making low-risk, low-payoff choices), and later, smaller net earnings.

Gneezy and Potters (1997) investigated bracketing effects in the domain of grouped investments, examining whether risk tolerance would increase when several choices were presented at once, versus when those same choices were presented individually and sequentially. In this study, participants were given 200 cents per investment; additionally, investments were either presented sequentially (High frequency) or in groups of three (Low frequency). The authors suggested that in the High frequency investment scenario, participants would make smaller investments because, similar to participants in Thaler et al’s (1997) monthly condition, pure losses of invested money would be seen with much more frequency, inducing greater levels of loss aversion. Conversely, in the Low frequency investment scenario, because investments for each set of three are forced to be identical, participants should instead adopt a broader perspective, and so should be more likely to consider long-term payoffs instead of short-term outcomes, allowing for larger investments. Additionally, because outcomes of three investment trials are aggregated, outright losses are made less salient, allowing participants to focus instead on the benefits to investing, thereby producing larger investments. Gneezy and Potters confirmed their hypothesis: investments in the Low frequency condition were significantly greater than in the High frequency condition, leading the authors to conclude that broad problem framing reduced risk aversion by making outright losses seem less likely.

On this subject, Frederick (2005) notes that while amount of reflection might be manipulated by altering the frame of a problem, some individuals might be more reflective on their own, suggesting that framing effects might differentially impact risk-tolerance of some individuals more than others. Deliberative, reflective individuals should be less susceptible to framing effects in general, as they tend to second-guess their intuitions more frequently. Thus, deliberative individuals should show more consistent levels of risk tolerance, regardless of how problems are framed. Conversely, individuals who reflect less should base decisions more on a gut instinct, relying more on intuition and context of the problem.

Alternative Bracketing Hypotheses

While both Thaler et al (1997) and Gneezy and Potters (1997) provide evidence is support of the bracketing hypothesis, in both cases, the authors maintain that bracketing promotes risk-tolerant behavior by providing a more holistic or long-term view at the time the decision problem is presented; however, part of how problems have been broadly bracketed in these studies involves bracketing of outcome feedback as well. For example, in Thaler et al (1997), investment returns were presented such that "subjects saw a bar graph that displayed the aggregated returns of each fund and of their portfolio *for the period(s) to which the decision applied* (emphasis added)". Thus, participants in the monthly condition (Narrow bracket) saw more frequent, short-term feedback relative to participants in the 5-year condition (Broad bracket). Participants in the monthly condition thus were more likely to see small but frequent losses as a result of their investment decisions. Similarly, in Gneezy and Potters' (1997) studies, participants making high-frequency choices (Narrow bracket) were given feedback after each choice; additionally, due to the format of investments, a pure loss was experienced on approximately 2/3 of trials. Conversely, participants making low-frequency choices (Broad bracket) made investment decisions in groups of three, and saw feedback aggregated across three trials, containing trials that had won and lost. Gneezy and Potters note:

> "The probability of [experiencing] a loss decreases from 0.67 for a single lottery, to $(0.67)^3 = 0.30$ for three consecutive lotteries. If the financial consequences of the three lotteries are evaluated in combination rather than separately, then the lotteries should become more attractive".

In short, in these studies, the bracketing manipulation has involved both how the decision problem was framed (in which a wide frame involved multiple investment decisions, or a single decision over a long horizon) and how the outcome of the decision is presented (in which the wide frame presents the results of multiple decisions in aggregate, or the results of a single decision that applied to a longer horizon.

The emphasis of these studies seems to be largely on the prospective, rather than retrospective, influence of bracketing on risk tolerance (i.e. the results are described as ones of problem rather than outcome framing). However, presentation of outcomes is often a critical factor in decision making. Indeed, Read, Loewenstein and Rabin (1999) note that part of the benefit of problem aggregation to risk-tolerance lies in comprehending consequences of actions: when sets are large, participants are better able to consider the joint outcomes of repeated or related decisions, which may encourage risk-tolerant decision making. This integration of outcomes is thus a critical component to bracketing effects.

The importance of integration of outcome information becomes obvious when considering an example often used in investment literature. When considering retirement savings, individuals have incentive to invest in somewhat risky, but ultimately more lucrative, options, rather than in safer but less profitable ones (Thaler et al, 1997); thus, there is incentive to encourage risk-tolerant investing behavior. Further, in the real world, these investments can be changed as time passes; if one particular sector is failing, individuals will often pull their investments out in favor of investing in an alternative. Thus, while initial allocation of resources might have depended on perceived risk of each investment, over time the importance of outcomes becomes obvious: as investors, we want to see how our money behaves. When investments grow, we tend not to change them; however, when investments shrink, we tend to reexamine our initial choices. Indeed, the investments themselves have not changed (that is, the problem frame has been consistent, and risk of the investment has not changed); however, presence of outcome information impacts how we choose to reallocate resources. Perhaps, then, bracketing effects are not exclusively due to how problems themselves are presented, but are also dependent on how feedback is presented. Indeed, this hypothesis seems more in line with the basic principles of loss aversion: losses loom larger than gains (Tversky & Kahneman, 1991), so seeing losses more frequently than gains, as in a Narrow bracket, is likely to produce more risk-averse behavior in general. Conversely, because the problems themselves display only probabilities of loss, they should induce less loss and risk aversion, and hence should have much less impact on changes to risk tolerance. Myopic loss aversion has been hypothesized as a construct of the problem frame, occurring prospectively; however, Tversky and Kahneman (1981) indicate that retrospective accounts of loss aversion and risk tolerance should also be considered.

This hypothesis has received some attention in the literature already. For example, Gneezy, Kapteyn and Potters (2003) modified the experimental design of Gneezy and Potters (1997) to compare risk tolerance when feedback was presented after one individual trial

(Narrow bracket) versus when feedback was aggregated every three trials (Broad bracket). In their 1997 study, investments were made with high or low frequency. High frequency decisions, or narrowly-bracketed investments, involved making an investment on a per-trial basis; feedback for each trial was offered after each investment. Low-frequency decisions, or broadly-bracketed investments, instead involved making investments that would be played repeatedly. Thus, participants were instructed to make investments that they would be content with if played out in the same scenario three times. It was hypothesized that low-frequency decision frames encouraged participants to take a long-term, holistic focus of the problem, which in turn would encourage more risk-tolerant investment behavior. However, the authors noted that differential feedback may have played a role in results, and so adapted their design to examine whether information feedback (outcome framing) or flexibility of portfolio adjustment (problem framing) was responsible for shifts in risk tolerance. In this study, for each investment period participants were given three identical lotteries to bid on, with probabilities of payoff identical to those in previous work (see Gneezy & Potters, 1997). At the end of each period, participants were informed of the outcomes to investments, and then progressed to the following period. However, for some participants (Low frequency), outcomes for each investment period counted for three investment periods. That is, for participants in the Low frequency condition, investments were made every third trial, and feedback was given at the end of each period. Thus, both choice and feedback were aggregated in a fashion similar to that of the original work of Gneezy and Potters (1997). In line with predictions of loss aversion, and predictions of their previous work, risk tolerance decreased when feedback was presented in high-frequency format (Narrow bracket) compared to when it was presented in a low-frequency aggregate every three trials (Broad bracket).

This study, however, appears closer to a replication of Gneezy and Potters (1997) when examined, as low-frequency feedback was accompanied again with low-frequency investing (Broad bracketing). Thus, the hypothesis that feedback format might affect risk tolerance more than problem presentation warrants further exploration.

Bracketing and Cognitive Ability

While one focus of this thesis is to disentangle the influence of problem and outcome framing effects, another is to examine whether individual differences play a role in susceptibility to these framing effects as well. For example, individuals who rely more on intuition might be more susceptible to framing effects in general, as was suggested previously, but might also be more susceptible to the more informative frame (that is, the frame that presents information in a more comprehensible manner). For example, if problem framing encourages risk tolerance through holistic processing, as is hypothesized by Gneezy and Potters (1997), intuitive individuals should be biased toward increased risk tolerance when problems are presented in groups. Conversely, if outcome framing instead encourages risk tolerance through aggregating and summarizing important information, intuitive individuals should instead only show increased risk tolerance when outcomes are aggregated, but be unbiased by problem framing. Deliberative individuals, on the other hand, who are inclined to reframe problems regardless of how they are presented, might instead only be sensitive to presentation of outcomes, which are uncertain. For example, if these individuals already convert problem information in some way, problem framing should have no effect; however, because outcomes cannot be known until presentation, perhaps only in this domain can risk tolerance be biased by framing manipulations.

One potential moderator of bracketing effects is thus the tendency to decide by relying on intuition versus deliberating on the choice, which can be quantified using the Cognitive Reflection Test (CRT; Frederick, 2005). Frederick hypothesizes that individuals who are intuitive processors (those who have low scores on the CRT) are likely to follow gut feelings, responding to test problems with the first (incorrect) response that comes it mind. Deliberative processors, who instead reflect on the problems (and score high on the CRT), are able to suppress this gut instinct, and so are able to come up with the correct response. Frederick found greater risk tolerance among those who scored high rather than low on the CRT, consistent with the possibility that those who are more prone to deliberation may process problem or outcome information in a broader manner than those who are less prone to deliberation.

Overview of Experiments

Two experiments were designed to disentangle the effects of problem and outcome bracketing on risk tolerance in investment decisions. Investments were presented individually or in sets of three (the problem frame); additionally, outcomes were presented individually or in aggregate form (the outcome frame). Experiment 1 investigated the effects of these bracketing manipulations in a discrete choice task, along the lines of that used by Thaler et al (1997) and Frederick (2005), involving similar but non-identical gambles. Experiment 2 investigated how the bracketing manipulations influence decisions on how much to invest in repeated, identical gambles of the kind investigated by Gneezy and Potters (1997).

Experiment 1

Participants

Eighty seven University of Waterloo undergraduates (15 males, 72 females) participated for course credit. Additionally, participants were informed that there was a chance of winning real money based on their performance on the task (to a maximum of $10).

Procedure

The current study used a 2 x 2 x 2 (Gain vs. Loss; Broad vs. Narrow problem; Broad vs. Narrow outcome) between-subjects factorial design.

Participants were brought into testing rooms either alone or in pairs, and were seated at individual computer terminals separated by dividers to allow for privacy. Once seated, an experimenter informed the participants that the experiment itself would have two components: a computer-based gambling task, and a paper-based questionnaire task. The computer task consisted of a series of 120 similar monetary choices. Participants would be endowed with $500 play money, which they would use to gamble with. On each choice, they would be presented with one certain option (for example, $50 for sure) and one gamble option (for example, a 1/3 chance of winning $155, or a 2/3 chance of winning nothing; a full list of stimuli can be found in Appendix A). Their task would be to choose the option that they preferred to participate in. It was emphasized that the participant should choose which option they preferred to have, and that there was no correct or incorrect choice on any given trial. Additionally, to reinforce choosing according to preferences, participants were informed that they would be paid a small amount (to a maximum of $10) in proportion to their earnings, in addition to receiving course credit.

Participants were informed that the task contained two blocks: one with gains, where they would win money, and one with losses, where they would lose money; order of these blocks was counterbalanced. Previous research (e.g. Kahneman & Tversky, 1979) indicates that people are typically risk-averse in the domain of gains (i.e. they prefer a sure gain over a gamble with equal or greater expected value), and risk-seeking in the domain of losses (i.e. they prefer a gamble offering a chance of avoiding loss over a sure loss, even if the latter has a lower expected value). The gambles were constructed such that, in the domain of gains, the sure gain had an equal or lower expected value than the gamble option, and in the domain of losses, the sure loss had a equal or greater (less negative) expected value than the gamble. Additionally, while payoffs varied slightly from trial to trial, probability of winning the larger amount (or losing the smaller amount) remained constant across all trials. For example, Gain trials were presented as:

Option A: Winning $50 for sure, OR

Option B: A 1/3 (33%) chance of winning $165, or a 2/3 (67%) chance of losing $7.50.

In all gain trials, Option B offered either an equal or greater expected value, and was thus arguably the objectively better choice. Similarly, Loss trials were presented as:

Option A: Losing $50 for sure, OR

Option B: A 1/3 (33%) chance of losing $165, or a 2/3 (67%) chance of winning $7.50.

Thus, in all loss trials, Option A presented either an equal or greater expected value, and was thus objectively a better choice (a full list of choice values is presented in the Appendix).

Wide bracketing has been shown to enhance risk tolerance in the domain of gains (Gneezy & Potters, 1997), but the effect of bracketing has not previously been investigated in the domain of losses. It is possible that wide bracketing enhances risk tolerance in the domain of losses as well. Indeed, when outcomes are framed negatively, individuals are more likely to take risks (Levin et al, 2002); thus, participants might show larger bracketing effects in loss domains. Alternatively, wide bracketing might make losses arising from playing the gamble seem more certain (e.g., "I might get lucky and avoid a loss by playing the gamble once, but by playing it three times I'm almost certain to lose something"), and as such enhance the attractiveness of accepting the sure loss. In short, by investigating bracketing effects in the domain of losses, it is possible to determine whether wide bracketing consistently enhances risk tolerance, or whether instead it enhances the impact of expected value considerations on choice.

Once the computer-based investment task was completed, participants completed a paper-based questionnaire task, consisting of the Cognitive Reflection Test (Frederick, 2005) and the Numeracy Scale (Lipkus, Samsa & Rimer, 2001; see also Peters et al, 2006), measures of deliberative versus intuitive processing and math abilities, respectively.

Bracketing Conditions

Problems were either broadly or narrowly bracketed in a manner similar to that of Gneezy and Potters (1997). Additionally, we parsed the bracketing manipulation into two separate factors: a problem bracket and an outcome bracket, producing four conditions (tested in a between-subjects design).

Narrow problem, narrow outcome

In this condition, we aimed to replicate as closely as possible the Narrow Bracket condition of Gneezy and Potters (1997) using a discrete choice paradigm. In the narrow problem bracket, choices were presented individually. Participants were presented with 120 individual choices between a certain option and a gamble. Similarly, in the narrow outcome bracket, outcomes were presented individually. Thus, participants saw 120 individual outcomes paired with each choice. An example can be found in Figure 1.

Broad problem, broad outcome

This condition was intended to replicate the Broad bracket condition of Gneezy and Potters (1997) using a discrete choice paradigm (see also Frederick, 2005). In the broad problem bracket, choices were presented on-screen in groups of three. Participants saw all three choices at once, and all three remained on-screen until all had been responded to. Participants were able to make individual responses for each choice, but were instructed to think about the choices in any order they wished, as the order of presentation on-screen was not important. This was done to facilitate holistic processing of the choices, which is thought to mediate risk tolerance in broadly-bracketed problem framing.

In the broad outcome bracket, one slide was presented on-screen, informing participants of the individual outcomes of each choice they had previously made, as well as of an aggregate of those three choices (for example, “Overall, you won $225”). It was hypothesized that this aggregate might be of critical importance to risk tolerance in a Broad bracket in previous research as it summarizes feedback and thus displays less pure loss. An example can be found in Figure 2.

Broad problem, narrow outcome

In the first of two novel conditions, participants were presented with three choices on screen at once (the broad problem bracket), and were presented with three outcomes at once, but were not provided with an aggregate of these outcomes; thus, outcomes were framed narrowly. The main difference between this condition and the Broad/Broad condition was thus the absence of an aggregate outcome. An example can be found in Figure 3.

It was hypothesized that this condition would pit two possible accounts for bracketing against one another. According to traditional theories of bracketing, simply presenting choices together encourages risk-tolerant behavior; thus, regardless of how feedback is presented, the risky option should be chosen more often. Conversely, if bracketing effects result from outcome aggregation rather than problem framing, presenting choices in groups should have no effect on risk-tolerance when feedback is narrowly bracketed.

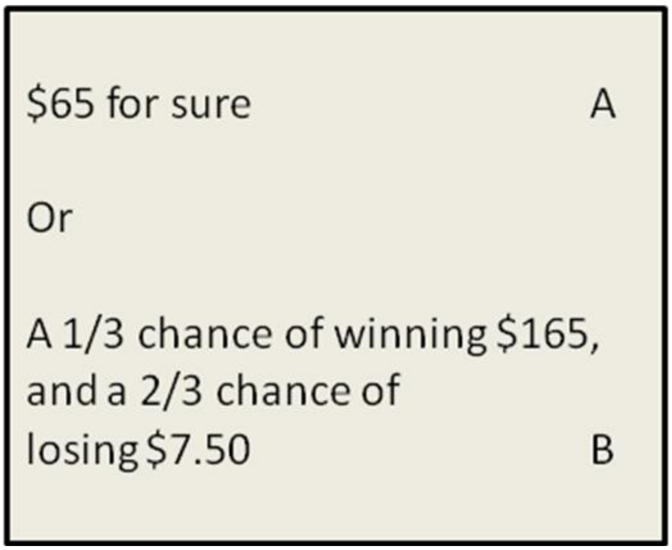
Narrow problem, broad outcome

This second novel condition further examined the influence of aggregated presentation of outcomes. In this condition, participants were presented with an individual choice (the narrow problem bracket), followed by an individual outcome for each associated choice. For every set of three consecutive choices, an aggregate of the last three outcomes was also presented (the broad outcome bracket). Thus, the only difference between this condition and the Narrow/Narrow condition was the presence of an aggregate outcome following every third trial. If bracketing effects are driven by effects of problem framing, then participants in this condition should not be more risk-tolerant. However, if aggregating outcomes drives the effect, these participants should choose the risky option more often. An example can be found in Figure 4.

Figure 1

Narrow problem/Narrow outcome condition

Problem frame:



Outcome frame:

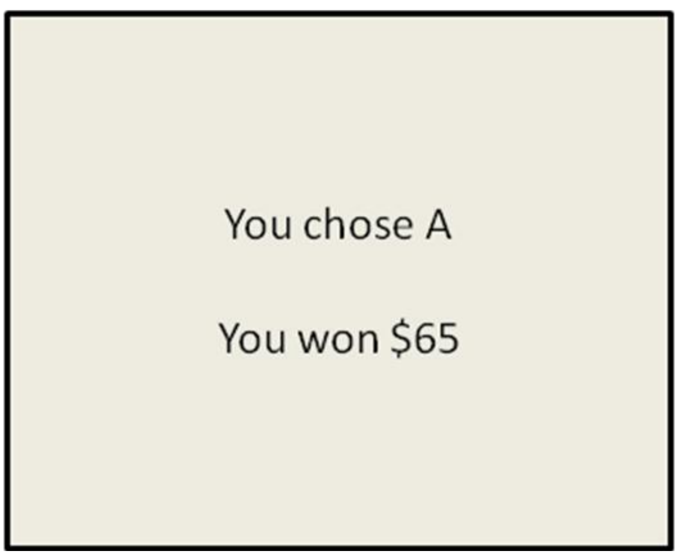


Figure 2

Broad problem/Broad outcome condition

Problem frame:

$50 for sure	A
Or	
A 1/3 chance of winning $165, and a 2/3 chance of losing $7.50	B
$55 for sure	C
Or	
A 1/3 chance of winning $175, and a 2/3 chance of losing $0	D
$55 for sure	E
Or	
A 1/3 chance of winning $180, and a 2/3 chance of losing $7.50	F

Outcome frame:

You chose B
You lost $7.50

You chose C
You won $55

You chose F
You won $180

Overall, you won $227.50

Figure 3

Broad problem/Narrow outcome condition

Problem frame:

$65 for sure Or A 1/3 chance of winning $225, and a 2/3 chance of losing $2.50	A B
$65 for sure Or A 1/3 chance of winning $200, and a 2/3 chance of losing $0	C D
$65 for sure Or A 1/3 chance of winning $205, and a 2/3 chance of losing $0	E F

Outcome frame:

You chose B
You lost $2.50

You chose C
You won $65

You chose F
You won $205

Figure 4

Narrow problem/Broad outcome condition

Problem frame:

$55 for sure A

Or

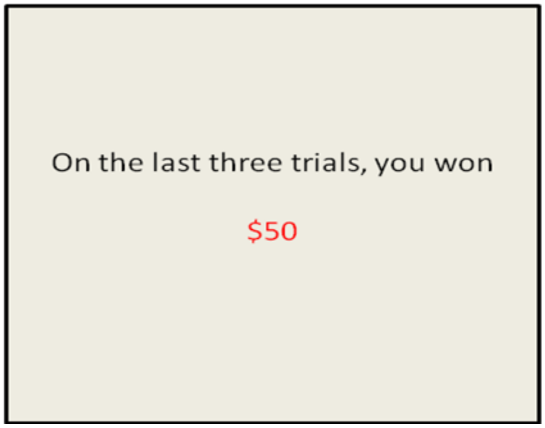
A 1/3 chance of winning $190, and a 2/3 chance of losing $0 B

Outcome frame:

You chose B

You won $0

Aggregate (presented every three trials)



Results

Average net winnings across Gain and Loss blocks was $1.67. Significant carryover was found between blocks: a oneway ANOVA confirmed that participants who completed the Loss block before the Gain block were significantly more risk tolerant, $F(1, 85) = 28.26$, $MSE = 1.75$, $p < 0.001$; thus, analyses presented represent only the first block of trials for each participant. In this reduced dataset, choice domain (Gains versus Losses) is now a between-subjects factor.

Table 1

Proportion of risky options taken across Problem and Outcome frames

Gain trials

Outcome frame	Problem frame		
	Narrow	Broad	Average
Narrow	0.40	0.13	0.27
Broad	0.45	0.34	0.40
Average	0.43	0.24	

Loss trials

Outcome frame	Problem frame		
	Narrow	Broad	Average
Narrow	0.67	0.19	0.43
Broad	0.68	0.58	0.63
Average	0.68	0.39	

A 2 (Gains vs. Losses) x 2 (Broad vs. Narrow Problem) x 2 (Broad vs. Narrow Outcome) factorial ANOVA was conducted to identify potential interactions. Risk tolerance was defined as the proportion of trials in which participants chose the risky option over the sure thing; higher scores indicated greater risk tolerance. Table 1 presents mean proportion of risky choices made based on problem and outcome bracket, separated by value (Gain or Loss) of the choice presented.

Significant differences were found between participants in Gain and Loss conditions, $t(85) = 3.92$, $p < 0.001$, suggesting that participants were more risk-seeking in blocks where losses were presented, in line with Prospect Theory (Kahneman & Tversky, 1979). This finding was found consistently across all Problem and Outcome conditions, measured with one-way tests, all $ps < 0.04$.

Significant differences were found across Problem and Outcome brackets, $F(1, 85) = 21.20$, $MSE = 1.21$, $p < 0.001$, and $F(1, 85) = 8.71$, $MSE = 0.56$, $p < 0.005$, respectively. These main effects suggest that while Problem framing encouraged risk tolerance more through the Narrow bracket, Outcome framing instead encouraged risk tolerance more through the Broad bracket. Additionally, a significant Problem x Outcome frame interaction was found, $F(1, 83) = 7.98$, $MSE = 0.37$, $p < 0.005$, suggesting that Problem and Outcome framing affected risk tolerance differentially when manipulated together. That is, Problem framing has greater impact on risk tolerance when outcomes are presented in aggregates than when outcomes are presented successively. This would suggest that a broad problem frame is not effective in encouraging risk-tolerant behavior, regardless of how outcomes are presented. Instead, a narrow problem frame is especially effective when outcomes are presented in a simplified, aggregated form. These findings suggest that previous accounts of bracketing (i.e.

Thaler et al, 1997; Gneezy & Potters, 1997) might have been inaccurate in assuming that presentation of several choices together encourages holistic processing and long-term perspectives in decision making. Instead, perhaps outcomes are more critical to influencing risk tolerance.

No other higher order interactions were found, suggesting that trends were similar across Gain and Loss blocks with regard to changes in risk tolerance. For this reason, one-way analyses were conducted to examine main effects separately.

Problem Framing

In both Gain and Loss domains, risk tolerance, as measured by proportion of risky options chosen, was significantly greater in Narrow frames, suggesting that choices presented individually produced more risk-tolerant behavior than problems presented in groups. This effect was marginally greater among Loss trials, $F(1, 85) = 1.98$, $MSE = 1.22$, $p = 0.09$, suggesting that differences between broad and narrow problem brackets were somewhat magnified relative to gain trials. Again, this finding is supported by Prospect Theory (Kahneman & Tversky, 1979), as it suggests that risk tolerance is greater in general in loss domains, and is also more susceptible to framing effects.

Outcome Framing

In both Gain and Loss domains, risk tolerance, as measured by proportion of risky options chosen, was significantly greater in Broad frames, suggesting that outcomes presented individually produced less risk-tolerant behavior than those presented in aggregate. These effects were not significantly different across Gain or Loss trials, all $ps > 0.30$, suggesting that effects were consistent in size across blocks.

CRT and Numeracy

The CRT was administered to examine whether participants identified by this measure as more deliberative thinkers were more or less affected by the bracketing manipulation than those identified as more intuitive thinkers. Additionally, to examine any benefits conferred by mathematical ability, the Numeracy scale was administered as a measure of participants' mathematical computation abilities. The two scales were positively correlated, $r(86) = 0.39$, $p < 0.001$, suggesting that participants with high cognitive reflection abilities also excelled in mathematical computation.

Table 2

Proportion of risky choices made in Experiment 1 based on CRT

Gain trials

	Problems		Outcomes	
	Low CRT	High CRT	Low CRT	High CRT
Narrow	0.44	0.36	0.27	0.25
Broad	0.20	0.28	0.40	0.39
Difference	-0.24	-0.08	0.13	0.14

Loss trials

	Problems		Outcomes	
	Low CRT	High CRT	Low CRT	High CRT
Narrow	0.67	0.68	0.39	0.53
Broad	0.37	0.43	0.68	0.59
Difference	-0.30	-0.25	0.29	0.06

Table 3

Proportion of risky choices made in Experiment 1 based on Numeracy

Gain trials

	Problems		Outcomes	
	Low Numeracy	High Numeracy	Low Numeracy	High Numeracy
Narrow	0.39	0.47	0.27	0.26
Broad	0.26	0.19	0.36	0.51
Difference	-0.13	-0.28	0.09	0.25

Loss trials

	Problems		Outcomes	
	Low Numeracy	High Numeracy	Low Numeracy	High Numeracy
Narrow	0.71	0.66	0.65	0.61
Broad	0.39	0.40	0.36	0.52
Difference	-0.32	-0.26	-0.29	-0.09

CRT

Recall that the CRT is thought to measure intuitive versus deliberative processing styles. Participants who attain low scores on the test are thought to approach problems intuitively, relying on automatic responses and gut instinct, whereas participants who attain high scores on the test are thought to approach problems critically, applying some effort to reframe problems and suppress incorrect intuitive responses.

Frederick (2005) notes that high CRT scorers are able to wait longer periods of time in order to receive a larger (hypothetical) reward. Additionally, this trend is also evidenced in the domain of risk tolerance: high CRT scorers are more likely to take a risky option (with higher expected value) over a sure thing. This would suggest that perhaps participants with high CRT scores on a discrete choice task would be more risk tolerant.

To further examine impact of intuitive versus reflective processing, risk tolerance scores were divided by CRT score (see Table 2), and analyzed in a 2 (Gains vs. Losses) x 2 (Broad vs. Narrow Problem) x 2 (Broad vs. Narrow Outcome) x 2 (High vs. Low CRT) factorial ANOVA. To examine CRT scores, we compared participants who were rated as more intuitive (scoring 0 or 1, $N = 49$) to those who were rated as more deliberative (scoring 2 or 3, $N = 32$). (Additionally, as in Frederick (2005), we compared participants who were rated as most intuitive (those with a CRT score of 0, $N = 32$) and those who were rated as most deliberative (those with a CRT score of 3, $N = 14$); however, no differences were found.)

No significant differences were found across CRT groups, $F(1, 85) < 1$, $MSE = 0.05$, $p > 0.40$, suggesting that more deliberative participants were no more likely to engage in more risk-tolerant decision making than intuitive participants. Additionally, no higher order interactions involving CRT score were significant. Thus, to further examine any differences, main effects were examined in a series of one-way ANOVA tests.

In Gain blocks, no significant differences were found between low and high CRT groups amongst Problem frames, all ps > 0.20. However, when outcomes were broadly framed, more deliberative participants (with CRT scores of 3) behaved in a more risk tolerant manner, $F(1, 85) = 7.76$, $MSE = 0.13$, $p < 0.05$. Thus, in the Gain domain, intuitive participants were not affected more by the Problem bracketing manipulation relative to deliberative participants; however, inclusion of an aggregate in presentation of Outcome encouraged more deliberative participants to behave in a more risk tolerant manner relative to intuitive participants. Thus, in the Gain domain, deliberative participants were more affected than intuitive participants by the outcome bracketing manipulation, suggesting that presentation of an aggregate in outcome frame might be most influential when participants are better able to reflect on this unique piece of information.

In Loss blocks, no significant differences were found between low and high CRT groups, all ps > 0.20. Thus, in the Loss domain, deliberative and intuitive participants were not affected differentially by the bracketing manipulations.

Numeracy

A similar examination of risk tolerance was performed using the Numeracy Scale. Scores were subjected to a median split; thus, the High Numeracy group consisted of individuals scoring greater than 9 (N = 40), whereas the Low Numeracy group consisted of individuals scoring less than 9 (N = 41). No significant differences were found between

Numeracy conditions, all ps > 0.20, suggesting that mathematical ability played no role in overall risk tolerance.

To further examine effects of Numeracy on risk tolerance, a linear regression was performed. No relationship was found between Numeracy and proportion of risky choices taken, $F(1, 85) = 0.61$, $MSE = 0.04$, $p > 0.40$, again suggesting that mathematical ability was a poor predictor of overall risk tolerance and choice behavior.

Discussion

The purpose of Experiment 1 was to examine the bracketing effect in domains of gains and losses with respect to framing of problems and outcomes, as well as with regards to cognitive reflection and cognitive ability of individual participants.

Specifically, the purpose of Experiment 1 was to gain a better understanding of whether problem or outcome framing had a stronger influence on bracketing effects. Problem framing has historically been the focus of previous hypotheses; however, the present research suggests that outcome framing seems to play a critical role in enhancing risk tolerance instead.

Results of Experiment 1 suggest that indeed, the Problem frame of a choice matters—however, results of this study contradict previous theoretical accounts of bracketing, which suggest that by presenting problems in groups, participants should be better able to think of problems holistically (see Thaler et al, 1997 and Gneezy & Potters, 1997). Instead, it appears that when making discrete choices, individually-presented choices encourage participants to make more risk-tolerant decisions.

Perhaps individually-presented choices produce more risk-tolerant behavior because they present small amounts of information, and smaller chances of loss, which pertain to one decision, whereas broadly-bracketed choices present a large amount of information, and larger chances of loss, that cannot be handled as easily. In a Narrow Problem frame, participants may be more inclined to take a gamble over a sure bet in both gain and loss domains because they are only holding one risk in mind at once. Conversely, in a Broad Problem frame, three risks are being maintained at once, which might encourage more risk-averse behavior. In a Broad Problem frame, perhaps participants become overwhelmed with the amount of risk information presented, and as a result revert to a risk-averse heuristic.

These results suggest that previous findings showing that broader brackets enhance risk tolerance are likely due to the effect of outcome bracketing rather than problem framing. When outcomes are presented sequentially or individually, participants may have difficulty thinking of choices in a long-term approach, and tend to make risk-averse decisions on subsequent trials. However, when aggregate outcome information is provided, participants behave in a more risk-tolerant fashion. Thus, perhaps the presence of an aggregate outcome, not the presence of aggregated problems, encourages participants to consider individual choices as part of a set. This holistic processing might then result in more risk-tolerant decision making, possibly by leading participants to adopt a long-term decision policy in which expected value has relatively more impact, and that provides some buffering from losses on individual trials or choices.

Lastly, it was hypothesized that level of cognitive ability should mediate the impact of the bracketing manipulation. That is, more intuitive participants might be more inclined to make context dependent decisions, as they are less inclined to reassess information presented to them in general. Only one demonstration of differential responses across framing based on cognitive reflection abilities was found, suggesting that perhaps participants who are more deliberative in nature might be better equipped to selectively attend to important information such as aggregates, or summary information. Individuals with lower cognitive reflection abilities, on the other hand, might attend equally to all information presented, and so are less inclined to behave in a more risk-tolerant fashion when an aggregate is presented. That is, perhaps individuals with lower cognitive reflection abilities do not overweight outcome aggregates when considering the risk of decisions. However, these effects, when present, are small, suggesting that perhaps the framing manipulation used in the current studies is not strong enough to pit System 1 and 2 against each other in order to produce large differences across cognitive ability levels (Stanovich & West, 1998).

While these results suggest that the bracketing effect might be better explained through outcome framing, the task of Experiment 1 was distinct from those in previous research in several ways. Experiment 1 involved discrete choices, whereas previous research (Gneezy & Potters, 1997) has instead employed continuous investment decisions. That is, in Experiment 1 participants had to choose between a sure thing and a gamble, while in Gneezy and Potters' study, participants instead chose how much of an initial endowment to invest in a gamble, and how much to keep (as a sure gain). Continuous investment decisions might allow for more specific examinations of changes in risk tolerance, whereas discrete choice tasks allow for only two options: accepting a sure thing, or accepting a risky gamble. Perhaps using a continuous measure of risk tolerance might allow small and non-significant differences across cognitive ability levels to be amplified; similarly, perhaps a continuous measure of risk tolerance might amplify bracketing effects observed in Experiment 1.

In addition, the task of Experiment 1 differs from previous demonstrations of the bracketing effect in terms of the choices presented themselves. Experiment 1 offered very similar, but non-identical choices presented either individually or in groups. However, previous research has used identical, repeated investment decisions for all trials. For example, Gneezy and Potters (1997) used the same investment decision for all 12 trials in their experiments. Thus, on broadly bracketed trials, participants saw one investment, and made a bet that would be played three times. However, in our Broad Problem condition, participants saw three similar choices and were asked to make individual decisions for each. Perhaps, instead of considering whether they should take the sure thing three times, or take the gamble three times, participants instead chose to gamble on the choice that dominated other presented options in either expected value or maximum payoff. Indeed, on Gain trials, average proportion of gambles chosen was exactly 1/3, suggesting that this might be the case. Thus, for Experiment 2, investments for all trials were identical to avoid encouraging participants to seek the single "best" option in the bracketed set.

Perhaps most importantly, the failure of Experiment 1 to produce a problem bracketing effect in the same direction as in previous research, as noted above, might be due to the complexity arising from presentation of three distinct decisions for simultaneous consideration. It is possible that the typical problem framing effect reappears once the added complexity arising from presenting distinct decision problems is eliminated.

Experiment 2

Participants

Eighty University of Waterloo undergraduates participated for course credit. Additionally, participants were informed that there was a chance of winning real money in addition to credit.

Procedure

The current study used a 2 x 2 (Broad vs. Narrow problem; Broad vs. Narrow outcome) between-subjects factorial design.

Participants were brought into testing rooms either alone or in pairs, and were seated at individual computer terminals separated by dividers to allow for privacy. Once seated, an experimenter informed the participants that the experiment itself would have two components: a computer-based gambling task, and a paper-based questionnaire task. The computer task consisted of a series of 12 identical investments, replicated from Gneezy and Potters (1997). Participants would be endowed with 100 cents per trial, which they would use to invest with. On each trial, they would be presented with the same investment opportunity: they would be able to invest as much or as little of the allotted 100 cents in an investment which would return 2.5 times their original investment 1/3 of the time (plus the original investment), but which would pay out nothing 2/3 of the time. It was emphasized that the participant should invest as much as he/she felt comfortable with, and that there was no correct or incorrect amount to invest on any given trial. Additionally, to reinforce choosing according to preferences, participants were informed that they would be paid in proportion to their earnings, in addition to receiving course credit.

Bracketing conditions

As in Experiment 1, both problem and outcome bracketing were varied between subjects.

Narrow problem, narrow outcome

In this condition, we again aimed to replicate as closely as possible the Narrow Bracket condition of Gneezy and Potters (1997). In the narrow problem bracket, investments were presented individually. Thus, participants were presented with 12 individual investments. Similarly, in the narrow outcome bracket, outcomes were presented individually. Thus, participants saw 12 individual outcomes paired with each choice.

Broad problem, broad outcome

Again, this condition was used as a replicate of the broad bracket condition of Gneezy and Potters (1997). Identical investments were presented on-screen in groups of three. Participants saw all three at once, and all three remained on-screen until a response had been made. Participants were informed that in this problem frame, because the investment opportunities were identical, and because they would be given identical amounts of money to invest in each, they would thus be required to make identical investments in all three jointly-presented investments. To enforce this requirement, the computer program was designed to display the participant's response beside each of the investments. Thus, if the participant chose to invest 75 cents, he/she would see "75" displayed three times on the screen, beside each of the three investments.

In the broad outcome bracket, one slide was presented on-screen, informing participants of the individual outcomes of each choice they had previously made, as well as of an aggregate of those three choices (for example, "Overall, you won 293 cents").

Broad problem, narrow outcome

Participants in this condition were presented with three investments on-screen at once (the broad problem bracket), and were presented with three outcomes at once, but were not provided with an aggregate of these outcomes; thus, outcomes were framed narrowly. The main difference between this condition and the Broad/Broad condition was thus the absence of an aggregate outcome.

Narrow problem, broad outcome

In this condition, participants were presented with an individual investment (the narrow problem bracket), followed by an individual outcome. For every three trials, an aggregate of the last three trial outcomes was also presented (the broad outcome bracket). Thus, the only difference between this condition and the Narrow/Narrow condition is the presence of an aggregate outcome on an additional slide.

Once the computer task was completed, participants completed the paper-based "questionnaire task", consisting of the Cognitive Reflection Test (CRT; Frederick, 2005) and the Numeracy Scale (Lipkus, Samsa & Rimer, 2001; see also Peters et al, 2006), measures of deliberative versus intuitive processing and math abilities, respectively.

Results

The average net winnings across conditions was $6.57. A 2 (Broad vs. Narrow Problem) x 2 (Broad vs. Narrow Outcome) factorial ANOVA was conducted with risk tolerance as the dependent measure. Risk tolerance was defined as the average proportion of investment (maximum of 100 cents per trial) made across trials; higher scores indicated greater risk tolerance.

A significant difference was found between Narrow and Broad problem frames, $F(1, 78) = 8.97$, $MSE = 5514.12$, $p < 0.01$, whereby narrowly-presented problems induced more risk tolerant behavior. This finding suggests, contrary to findings in Experiment 1, but analogous to theory proposed in previous bracketing literature (Gneezy & Potters, 1997), that the bracketing effect in this context is largely due to problem framing. Indeed, in support of this hypothesis, no significant effect of outcome frame was found, $F(1, 78) = 0.07$, $MSE = 50.57$, $p > 0.50$, suggesting that in a continuous investment task, outcomes had no role in influencing risk tolerance. Finally, there was no interaction between the two experimental factors, suggesting that the problem frame was responsible for any changes in risk tolerance.

Table 4

Proportion of risky options taken across Problem and Outcome frames in Experiment 2

Outcome frame	Problem frame		
	Narrow	Broad	Average
Narrow	52.40	68.90	60.65
Broad	49.74	66.69	58.22
Average	51.07	67.80	

Table 5

Proportion of risky options taken across CRT in Experiment 2

	Problems		Outcomes	
	Low CRT	High CRT	Low CRT	High CRT
Narrow	47.30	54.38	54.35	64.39
Broad	64.89	70.68	57.85	59.09
Difference	17.59	16.30	3.50	-5.30

Table 6

Proportion of risky options taken across Numeracy in Experiment 2

	Problems	
	Low Numeracy	High Numeracy
Narrow	49.33	52.49
Broad	63.52	70.33
Difference	14.19	17.84

	Outcomes	
	Low Numeracy	High Numeracy
Narrow	57.22	61.96
Broad	54.42	61.26
Difference	-2.80	-0.70

CRT and Numeracy

Again, the CRT was used to examine whether deliberative or intuitive participants would be more or less affected by the bracketing manipulation. Additionally, to examine whether any benefits were conferred by other cognitive abilities, the Numeracy scale was used to examine participants' mathematical abilities. The two scales were positively correlated, $r(79) = 0.49$, $p < 0.001$, suggesting that participants with high cognitive reflection abilities also excelled in mathematical computation.

CRT

To further examine effects, Problem and Outcome frames were examined in conjunction with CRT score in a 2 (Narrow vs. Broad Problem) x 2 (Narrow vs. Broad Outcome) x 2 (High vs. Low CRT) factorial ANOVA. As in Experiment 1, we compared Low CRT scorers (those with scores of 0 or 1, N = 39) to those with High CRT scores (those with scores of 2 or 3, N = 41). (As in Experiment 1, and Frederick (2005), we compared participants who were rated as most intuitive (a CRT score of 0 N = 22) and those who were rated as most deliberative (a CRT score of 3, N = 21); however, no differences were found).

Across Problem and Outcome frames, no significant differences were found between low and high CRT groups, all $Fs < 1.9$, $ps > 0.19$. Thus, intuitive participants behaved no differently than those who were deliberative, suggesting that neither group was more vulnerable to bracketing manipulations. Additionally, there were no significant interactions between CRT scores and the experimental factors.

Numeracy

A similar examination of risk tolerance was performed using the Numeracy Scale. As in Experiment 1, a median split divided High Numeracy (scores of 10 or 11, N = 47) and Low Numeracy groups (scores of 9 or less, N = 33). A 2 (Narrow vs. Broad Problem) x 2 (Narrow vs. Broad Outcome) x 2 (High vs. Low Numeracy) revealed no significant differences between Numeracy groups, $p > 0.30$, suggesting that numeracy ability played no role in risk tolerance. Additionally, no higher-order interactions were observed, suggesting that numeracy ability had no role in susceptibility to bracketing manipulations.

A linear regression was run to examine whether Numeracy score predicted risk tolerance. Again, however, this analysis was not significant, $F(1, 78) = 1.05$, $MSE = 708.02$, $p > 0.30$, suggesting that mathematical ability played no role in determining how much individuals invested.

Discussion

The purpose of Experiment 2 was to replicate findings of Experiment 1 using methodology of previous research on the bracketing effect. It was hypothesized that, as in Experiment 1, when problems were presented sequentially, participants might be more focused on the investment, which may lead to better understanding of expected values of the problems themselves, which in turn might encourage more risk-tolerant behavior and more investment. Additionally, it was hypothesized that by including an aggregate in presentation of feedback, participants might be more inclined to view individual investments as part of a set, which in turn would encourage holistic processing, long-term forecasting, and more risk tolerance. Finally, it was hypothesized that by using a continuous investment task, perhaps bracketing effects might be amplified, as the continuous task might allow participants to demonstrate preferences more explicitly. Alternatively, by simplifying the structure of problems, perhaps problem framing effects might reemerge, as in previous research (Gneezy & Potters, 1997). That is, perhaps the outcome framing effect demonstrated in Experiment 1 was due in part to the importance of outcomes, but was also due to interaction between simplified outcomes and complicated, diverse problems.

Indeed, results of Experiment 2 suggest the latter set of hypotheses is true: when problems were presented in groups, they encouraged more risk tolerance, supporting previous explanations of the bracketing effect: explicitly grouping problems together encourages participants to view them as a group, which leads to making investment decisions that are more risk-tolerant (Thaler et al, 1997). Moreover, outcome bracketing played little or no role in determining risk tolerance, again suggesting that the problem frame is critical to the bracketing effect. The results of Experiment 2 suggest that the original account for bracketing holds some validity: risk tolerance is increased when problems are presented in an aggregate fashion.

In addition, it was hypothesized that perhaps cognitive ability may play a role in risk-tolerance and susceptibility to the bracketing manipulation. That is, perhaps participants who are more intuitive processors might be more inclined to accept the frame in which a problem is presented, whereas participants who are more deliberative in nature might be more inclined to actively “reframe” the problem. Results of Experiment 2 suggest that regardless of individual cognitive reflection or ability, there are no differential susceptibilities to bracketing effects. It was hypothesized that by using a continuous investment task, perhaps any small or non-significant effects found in Experiment 1 might be amplified in Experiment 2. Instead, however, any differences were minimized or eliminated in the present study, suggesting that cognitive ability plays no role in susceptibility to bracketing effects in particular, and perhaps to framing effects in general.

Finally, it was hypothesized that perhaps results of Experiment 1 might be a result of the unique task. In Experiment 2, methodology of Gneezy and Potters (1997) was used, and no evidence for the impact of outcome bracketing was found, suggesting that perhaps the mechanism behind the bracketing effect differs based on task. In Experiment 2, because investments were identical, perhaps presentation of outcomes matters less because the information it provides is redundant (i.e. it is more readily calculated from individual outcome information than was the case in Experiment 1). It is possible that participants in the Broad Problem frame behave in a more risk-tolerant manner because the presentation of three identical investments cues them to consider the element of repeated play of the task. Thus, the format of outcomes might matter less because the problem frame is more informative. To examine this, a one way ANOVA was conducted comparing Broad/Broad and Broad/Narrow conditions. The only difference between these conditions was presence of an aggregate in the former condition. No significant differences were found, $F (1, 37) < 1$, $MSE = 47.44$, $p > 0.50$, suggesting that the presence of an aggregate had no effect on risk tolerance when the problem frame was broadly-bracketed. Further, when comparing Narrow/Narrow and Narrow/Broad conditions, which again differ only in the presence of an aggregate in the latter condition, no significant differences are found either, $F (1, 39) < 1$, $MSE = 72.06$, $p > 0.50$, suggesting that any influence of outcomes is overshadowed by the framing of the problem.

General Discussion

The aim of this thesis was to examine the underlying mechanisms of the bracketing effect. Previously, assumptions had been made that by presenting investment decisions in aggregates, participants would take a broader focus on the task, and would make more risk-tolerant decisions.

Experiment 1 examined the bracketing effect in domains of gains and losses using discrete choices. It was hypothesized that while the problem frame might be important in determining risk tolerance because it encourages participants to view problems as part of a set physically, the outcome frame might be equally, if not more relevant in making long-term risk-tolerant choices, as feedback tends to be important in reinforcing risk tolerant decisions.

Results of Experiment 1 suggest that the problem frame is important; however, results of this study contradict previous theoretical accounts of bracketing (see Thaler et al, 1997 and Gneezy & Potters, 1997), instead suggesting that individually-presented problems encourage more risk-tolerant choices. Perhaps this presentation format is helpful because participants were given only small amounts of information at once, which encourages them to take worthwhile risks. Conversely, more risk-averse behavior when problems are presented in groups might be due to information overload. In this case, perhaps participants have difficulty examining problems together, and so fail to notice similarities between them.

Results of Experiment 1 suggest that the format of feedback is also important to the bracketing effect. When outcomes are presented individually, participants have difficulty representing choices with a long-term, broad focus, and instead tend to make risk-averse decisions. When aggregates are provided, participants are cued to broaden their focus, and so behave in a more risk-tolerant fashion.

Experiment 2 was designed to bridge the theoretical gap between Experiment 1 and previous demonstrations of the bracketing effect. Instead of a discrete choice paradigm, the investment task used by Gneezy and Potters (1997) was adapted. It was hypothesized that a continuous task might amplify smaller deviations in risk tolerance. Additionally, Experiment 2 employed identical investments, as in Gneezy and Potters, to control for any investment behavior related to participants investing only in the "best" (as defined by greater expected value or larger maximum payout) of three options presented in a broad bracket. Again, it was hypothesized that when problems were presented sequentially, participants might be more focused on the investment, which might encourage more risk-tolerant behavior. Additionally, by including an aggregate in presentation of feedback, participants might be more inclined to view individual investments as part of a set, which in turn would encourage holistic processing and more risk tolerant investments

However, neither of these hypotheses was supported by data in Experiment 2. Problems presented in groups encouraged more risk tolerance, and outcomes played little or no role in determining risk tolerance, supporting previous explanations of the bracketing effect. Thus, in Experiment 2, explicitly grouping problems encouraged holistic processing, and led to increased investment relative to when problems were presented individually.

Together, these results suggest that perhaps the mechanism behind the bracketing effect differs based on task. In Experiment 2, because investments were identical, perhaps presentation of outcomes mattered less because the outcome frame provided redundant information. However, when the task was more analogous to a real-world investment circumstance, and investment choices were similar but not identical, presentation of outcomes was critical to risk-tolerant decision-making. Aggregated information in feedback helped to reinforce both the similarities of choices and the benefits to taking the risky option. Future work in this discipline should thus focus on examination of continuous investments that are highly similar, but non-identical, making them more analogous to real-world investments.

Finally, in both experiments it was hypothesized that either cognitive ability or processing style might mediate susceptibility to the bracketing manipulation. Intuitive participants might be more inclined to make context-dependent decisions, as they are less inclined to reflect on information presented to them. Conversely, more deliberative or reflective individuals might overcome contextual biases, as they tend to actively reframe information, regardless of its presentation format.

No evidence for these hypotheses was found. In Experiment 1, only one demonstration of differential responses across framing based on cognitive reflection abilities was found, suggesting that perhaps participants who are more deliberative in nature might be better equipped to selectively attend to important information such as aggregates, or summary information. Individuals with lower cognitive reflection abilities, on the other hand, might attend equally to all information presented, and so are less inclined to behave in a more risk-tolerant fashion when an aggregate is presented. That is, perhaps individuals with lower cognitive reflection abilities do not overweight the importance of outcome aggregates when considering the risk of decisions. However, when the task itself as adjusted to be more sensitive to changes in risk preference, no differences were found between individuals based on processing style or cognitive ability.

Similarly, in Experiment 2, no differential susceptibilities to bracketing effects were seen. It was hypothesized that by using a continuous investment task, perhaps any marginal differences found in Experiment 1 might be amplified; instead, however, any differences were minimized or eliminated. Together, results suggest that cognitive reflection ability plays little or no role in moderating susceptibility to bracketing effects in specific, and perhaps to framing effects in general.

What can be said about the bracketing effect?

These findings suggest that there are circumstances under which the bracketing effect is brought about through problem framing (as in Experiment 2; Gneezy & Potters, 1997), and there are circumstances under which the bracketing effect is brought about through outcome framing (as in Experiment 1). But how can this information be applied to a broader understanding of investment behavior?

Previous research on the bracketing effect has suggested that problem framing encourages risk tolerance by encouraging participants to make more holistic decisions, thus behaving in a manner that encourages long-term forecasting (Thaler et al, 1997). Our results instead suggest that risk tolerance is encouraged when information is easy to process: in Experiment 1, risk tolerance was maximized when problems were presented individually, and when outcomes were presented in aggregate. Recall that the problems used in Experiment 1 were all slightly different from one another, and thus might have required more capacity to be processed in groups. Thus, participants presented with a broadly bracketed set of choices were required to make several similar, but ultimately different, computations of risk, which may have encouraged them to focus on the number of risks (which was greater in the broad frame on a per-trial basis), as opposed to the magnitude of risk (which remained constant over trials). This risk tolerance or aversion set by the problem frame then interacts with presentation of outcomes. When outcomes are presented individually, participants are exposed to one win and two losses for every three trials. Again, as in the problem frame, because amount of money won or lost on each trial is slightly different, participants are again biased to focus on the win-to-lose ratio, instead of the amount won or lost over several trials (the objectively more important information). However, when an aggregate is incorporated into feedback or outcomes, participants are instead biased to attend to the magnitude of gains or losses, instead of the win-to-lose ratio. For gains, an aggregate outcome frame encourages risk tolerance by presenting a large sum that represents benefits of taking the riskier option (or of making larger investments in the gamble). That is, participants might learn, over trials, that as they begin to take riskier actions, overall their net earnings increase. Alternatively, in loss domains, this summary becomes a larger negative number, representing greater losses, as risky action increases. However, participants tend to respond to losses by taking more risky choices: as Kahneman and Tversky (1979) note, “a person who has not made peace with his losses is likely to accept gambles that would be unacceptable to him otherwise”. That is, when a participant has just felt the sting of a loss, he or she is more likely to bet on a long shot, instead of taking the objectively safer option, even if that option possesses higher expected value, as was the case in the experiments presented previously. By presenting losses in aggregate, then, participants were biased to make riskier decisions on subsequent trials, just as they were in gain domains.

In contrast, this pattern was not observed in Experiment 2, where problems presented were identical in form. Here, participants appear to recognize that while the number of risks presented is greater in a broad problem frame, the magnitude of those risks has not changed; as a result, in a broad problem frame, risk tolerance is increased, as has been the case in previous demonstrations of the bracketing effect (see Gneezy & Potters, 1997). Further, outcome framing appears to have no effect on risk tolerance, suggesting that outcomes hold weight in manipulating risk tolerance only when they convey new information. That is, when participants have already attended to the identical probability distribution of investments, the problem frame has successfully encouraged risk-tolerant decision making. As a result, the outcome bracketing effects observed in Experiment 1 do not exist when the task is changed in Experiment 2: the information they provide (that is, the summation of outcomes and aggregation of problems) has already been conveyed to participants through the problem frame.

The importance of bracketing to investment

Bracketing of problems has often been used as an argument for aggregating investment choices, as it has generally led to more risk tolerance in the short run and increased net wealth in the long run (Thaler et al, 1997; Gneezy & Potters, 1997). Results of the two experiments presented suggest that a critical divide exists in this assumption. Indeed, Thaler et al (1997) and Gneezy and Potters (1997) are accurate in suggesting that when choices are identical, broadly bracketing their presentation is helpful in increasing risk-tolerant financial decision making. For example, when presenting investors with long-term investments that do not change over time, individuals are more likely to invest more when presented with only one decision. Indeed, it would seem redundant to present individuals with the opportunity to invest in a company by presenting individual risks for each share—it is implied that each share has identical risk and expected value. Instead, investors are presented with one risk statement, and choose to purchase as many shares as they choose (analogous to methodology of Experiment 2). Additionally, when feedback on investments is given, the format may have little effect on perceived risk, as this information has already been clearly represented in the minds of investors.

However, when the investment options themselves differ in risk, these assumptions fall short. For example, when investors are deciding which funds to invest in, they are often presented with several different options at once. Each option contains its own variety of risks, and these risks may aggregate in the minds of investors in a way similar to that of participants in Experiment 1: investors may attend to the number of risks presented, and not to the (more important) magnitude of risks. In turn, a broad bracket might have detrimental effects on risk tolerance, as investors have not attended to the most important information (magnitude of risk), and instead choose the funds containing fewer numbers of risks. Further, these individuals might be more sensitive to outcome presentation, as it may carry a larger weight in conveying to these individuals the actual risk of the investments they have chosen to participate in.

In sum, it appears as though the problem bracketing effect carries weight when investment decisions are identical; however, when investment decisions are even slightly different, an alternative view should be taken, where outcomes are aggregated so as to help individuals to refocus investments with a long-term perspective. Indeed, future research should focus on situations in which problem framing carries weight, situations in which outcome framing carries weight, and how this information can help individuals make more productive and prosperous investment decisions. In pursuit of gaining further understanding of problem and outcome bracketing effects, ongoing research has thus been focused on resolving task-based issues in the current work. Specifically, we are currently testing problem and outcome bracketing hypotheses using a task that combines methodologies of both experiments presented above. That is, individual investments will still be similar, as in Experiment 1, but participants will not make an all-or-none, discrete choice of whether to invest or not. Instead, participants will be able to invest up to 100 cents in each investment option, as in Experiment 2. Additionally, participants will be able to invest different amounts in each investment, unlike in Experiment 2. For example, in a broad problem frame, three similar investments will be presented at once, but participants will not have to invest identical amounts in each. Thus, in many ways this new design modifies Experiment 2 such that the task becomes more analogous to real-world investment scenarios that previous research has aimed to test.

Finally, at a more general level, ongoing research has been focused on understanding the mechanisms behind both problem and outcome framing. Are bracketing effects a result of unique presentation of risk information? If this is the case, individuals might benefit from any reframing of information that encourages them to focus on the most important information—that which denotes risk and associated payoffs. Ultimately, gaining insight into how information presentation can influence risk tolerance is an important element in promoting long-term investment strategies that allow individuals to overcome risk-averse heuristics and biases.

Appendix

Appendix A: Choice pairs used in Experiment 1

Gain trials

Certain Option	Risky Option 1 (1/3)	Risky Option 2 (2/3)
50	165	-7.5
50	160	-5
50	170	-5
50	160	-2.5
50	165	-2.5
50	170	-2.5
50	160	0
50	165	0
50	170	0
50	175	0
55	180	-7.5
55	185	-7.5
55	175	-5
55	180	-5
55	185	-5
55	170	-2.5
55	175	-2.5
55	180	-2.5
55	185	-2.5
55	190	-2.5
55	170	0
55	175	0
55	180	0
55	185	0
55	190	0
60	200	-10
60	205	-10
60	195	-7.5
60	200	-7.5
60	205	-7.5
60	190	-5
60	195	-5
60	205	-5

60	190	-2.5
60	195	-2.5
60	200	-2.5
60	210	-2.5
60	190	0
60	195	0
60	200	0
60	205	0
65	215	-10
65	220	-10
65	210	-7.5
65	215	-7.5
65	220	-7.5
65	225	-7.5
65	205	-5
65	210	-5
65	215	-5
65	220	-5
65	225	-5
65	200	-2.5
65	210	-2.5
65	215	-2.5
65	220	-2.5
65	225	-2.5
65	200	0
65	205	0
70	230	-10
70	235	-10
70	225	-7.5
70	230	-7.5
70	235	-7.5
70	220	-5
70	225	-5
70	230	-5
70	235	-5
70	220	-2.5
70	225	-2.5
70	230	-2.5
70	235	-2.5
70	240	-2.5
75	235	-5

75	235	-2.5

Loss trials

Certain Option	Risky Option 1 (1/3)	Risky Option 2 (2/3)
-75	-235	2.5
-75	-235	5
-70	-240	2.5
-70	-235	2.5
-70	-235	5
-70	-235	7.5
-70	-235	10
-70	-230	2.5
-70	-230	5
-70	-230	7.5
-70	-230	10
-70	-225	2.5
-70	-225	5
-70	-225	7.5
-70	-220	2.5
-70	-220	5
-65	-225	2.5
-65	-225	5
-65	-225	7.5
-65	-220	2.5
-65	-220	5
-65	-220	7.5
-65	-220	10
-65	-215	2.5
-65	-215	5
-65	-215	7.5
-65	-215	10
-65	-210	2.5
-65	-210	5
-65	-210	7.5
-65	-205	0
-65	-205	5
-65	-200	0
-65	-200	2.5

-60	-210	2.5
-60	-205	0
-60	-205	5
-60	-205	7.5
-60	-205	10
-60	-200	0
-60	-200	2.5
-60	-200	7.5
-60	-200	10
-60	-195	0
-60	-195	2.5
-60	-195	5
-60	-195	7.5
-60	-190	0
-60	-190	2.5
-60	-190	5
-55	-190	0
-55	-190	2.5
-55	-185	0
-55	-185	2.5
-55	-185	5
-55	-185	7.5
-55	-180	0
-55	-180	2.5
-55	-180	5
-55	-180	7.5
-55	-175	0
-55	-175	2.5
-55	-175	5
-55	-170	0
-55	-170	2.5
-50	-175	0
-50	-170	0
-50	-170	2.5
-50	-170	5
-50	-165	0
-50	-165	2.5
-50	-165	7.5
-50	-160	0
-50	-160	2.5
-50	-160	5

References

Bargh, J. A., Chen, M. & Borrows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype activation on action. Journal of Personality and Social Psychology, 71 (2), 230-244.

Barrett, L. F., Tugade, M. M. & Engle, R. W. (2004). Individual differences in working memory capacity and dual-process theories of the mind. Psychological Bulletin, 130 (4), 553-573.

Benartzi, S. & Thaler, R. H. (1995). Myopic loss aversion and the equity premium puzzle. The Quarterly Journal of Economics, 110 (1), 73-92.

Benjamin, D. J. & Shapiro, J. M. (2005). Does cognitive ability reduce psychological bias? Working paper, Harvard University.

Chen, M. & Bargh, J. A. (1999). Consequences of automatic evaluation: Immediate behavioral predispositions to approach or avoid the stimulus. Personality and Social Psychology Bulletin, 25 (2), 215-224.

Di Chiara, G. & Bassareo, V. (2007). Reward system and addition: What dopamine does and doesn't do. Current Opinion in Pharmacology, 7 (1), 69-76.

Dohmen, T., Falk, A., Huffman, D., & Sunde, U. (2007). Are risk aversion and impatience related to cognitive ability? CEPR Discussion Paper No. DP6398.

Ebert, J. E. J. (2001). The role of cognitive resources in the valuation of near and far future events. Acta Psychologica, 108 (2), 155-171.

Fodor, J. A. & Pylyshyn, Z. W. (1988). Connectionism and cognitive architecture: A critical analysis. Cognition, 28, 3-71.

Frederick, S. (2005). Cognitive reflection and decision making. Journal of Economic Perspectives, 19 (4), 25-42.

Gneezy, U., Kapteyn, A. & Potters, J. (2003). Evaluation periods and asset prices in a market experiment. The Journal of Finance, 58 (2), 821-837.

Gneezy, U. & Potters, J. (1997). An experiment on risk taking and evaluation periods. The Quarterly Journal of Economics, 112 (2), 631-645.

Hogarth, R. (2002). Deciding analytically or trusting your intuition? The advantages and disadvantages of analytic and intuitive thought. UPF Economics and Business Working Paper No. 654.

James, W. (1950). The principles of psychology. New York: Dover. (Originally published 1890).

Kahneman, D. (2003). A perspective on judgment and choice: Mapping bounded rationality. American Psychologist, 58 (9), 697-720.

Kahneman, D. & Frederick, S. (2005). A model of heuristic judgment. In The Cambridge handbook of thinking and reasoning, ed. Holyoak, K., & Morrison, R. G., Cambridge, England: Cambridge University Press, 267-294.

Kahneman, D., Slovic, P. & Tversky, A. (1982). Judgment under uncertainty: Heuristics and biases. Cambridge, England: Cambridge University Press.

Kahneman, D. & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. Econometrica, 47 (2), 263-291.

LeBoeuf, R. A. & Shafir, E. (2003). Deep thoughts and shallow frames: On the susceptibility to framing effects. Journal of Behavioral Decision Making, 16, 77-92.

Levin, I. P., Gaeth, G. J., Schreiber, J., & Lauriola, M. (2002). A new look at framing effects: Distribution of effect sizes, individual differences, and independence of types of effects. Organizational Behavior and Human Decision Processes, 88 (1), 411-429.

Lipkus, I. M., Samsa, G. & Rimer, B. K. (2001). General performance on a Numeracy scale among highly educated samples. Medical Decision Making, 21 (1), 37-44.

McClure, S. M., Laibson, D. I., Loewenstein, G. & Cohen, J. D. (2004). Separate neural systems value immediate and delayed monetary rewards. Science, 306 (5695), 503-507.

Peters, E., Vastfjall, D., Slovic, P., Mertz, C. K., Mazzocco, K. & Dickert, S. (2006). Numeracy and decision making. Psychological Science, 17 (5), 407-413.

Read, D., Loewenstein, G. & Rabin, M. (1999). Choice bracketing. Journal of Risk and Uncertainty, 19 (1-3), 171-197.

Rosen, V. M. & Engle, R. W. (1997). The role of working memory capacity in retrieval. Journal of Experimental Psychology: General, 126 (3), 211-227.

Sloman, S. A. (1996). The empirical case for two systems of reasoning. Psychological Bulletin, 119, (1), 3-22.

Smith, E. R. & DeCoster, J. (2000). Dual-process models in social and cognitive psychology: Conceptual integration and links to underlying memory systems. Personality and Social Psychology Review, 4 (2), 108-131.

Smith, S. M. & Levin, I. P. (1996). Need for cognition and choice framing effects. Journal of Behavioral Decision Making, 9 (4), 283-290.

Soman, D. (2004). Framing, loss aversion and mental accounting. In the Blackwell Handbook of Judgment and Decision Making Research, ed. Harvey, N. & Koehler, D. J. London, England: Blackwell, 379-398.

Stanovich, K. E. & West, R. F. (1998). Individual differences in rational thought. Journal of Experimental Psychology: General, 127 (2), 161-188.

Stanovich, K. E. & West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate? Behavioral and Brain Sciences, 22 (5), 645-726.

Tanji, J. & Hoshi, E. (2008). Role of the lateral prefrontal cortex in executive behavioral control. Psychological Reviews, 88, 37-57.

Thaler, R. H., Tversky, A., Kahneman, D. & Schwartz, A. (1997). The effect of myopia and loss aversion on risk taking: An experimental test. The Quarterly Journal of Economics, 112 (2), 647-661.

Tversky, A. & Kahneman, D. (1981). The framing of decisions and the psychology of choice. Science, 211 (4481), 453-458.

Tversky, A. & Kahneman, D. (1991). Loss aversion in riskless choice: A reference-dependent model. Quarterly Journal of Economics, 106 (4), 1039-1061.