Is Broad Bracketing Always Better? How Outcome Aggregation Leads to More Consistent Risk Preferences

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Abstract

In this paper, we extend the work on myopic loss aversion by examining how broader bracketing (via outcome aggregation) influences not only positive expected value gambles, but also negative expected value and pure-loss gambles. Better understanding how choice bracketing can affect risky choice has important implications for products that are inherently time-sensitive and entail varying levels of risk, including retirement accounts, portfolio allocations, insurance purchases, and preferences for lotteries. We show that broader choice brackets lead to more consistent risk preferences across all risk types, suggesting that outcome aggregation can help individuals make better choices over risks more generally. We also determine the mechanism behind the bracketing effects. Specifically, we propose three possible mechanisms for the bracketing effects we observe: (1) changing the decision weights placed on losses (loss aversion), (2) cognitive constraints related to the construction of probability distributions, and (3) changes in perceived risk. Better understanding the psychological process behind bracketing effects can help in designing interventions to improve decisions over risk.

Keywords: choice bracketing, myopic loss aversion, time horizon, risk-taking, risk perception, repeated gambles, investment decisions

Introduction

In approaching investment decisions, an investor often considers a financial allocation for which outcomes and feedback are accrued over time or over several repeated transactions. Many such investment risks can thus be thought of as happening in isolation (i.e., as one-shot gambles) or in an aggregate fashion over the time the investment is held by the individual. In the context of portfolio allocation, an investor can evaluate the returns of that portfolio on a short-term basis (e.g., once a day, once a week, or even once every couple of months) or on a long-term basis (e.g., once a year or less). Assuming that the underlying risk associated with the portfolio is not changing over time, the information available to the investor is identical under either evaluation strategy. However, short-term evaluations will inherently lead to more experienced losses, as even positive expected value (EV) assets necessarily entail some chance of loss. On the contrary, long-term evaluations will lead to less experienced losses and a better sense of the underlying probability distribution for the investment. Assuming that investors are loss averse, information that helps an investor visualize or understand how outcomes are aggregated over time can lead to better investment decisions, with better being defined by higher outcomes.

What happens if such financial risks do not have a positive EV, but rather a negative EV or entail just losses? For example, consider the purchase of insurance—this is a financial risk over pure losses since a consumer chooses between a sure loss (the premium) and a gamble over potential losses with different probabilities (including the probability of a loss larger than the premium and deductible involved in the policy). How would the presentation of information about the underlying risk against which the individual is insuring affect the decision about whether or not to purchase insurance? Arguably, a consumer would make different choices depending on whether he/she represented the risk as one occurring over one or a few trials or as one in which outcomes were aggregated over the length of time the policy would be held.

We will demonstrate that how a financial risk is represented has a significant effect on preferences for that risk. Specifically, individuals will prefer a smaller gain for sure when evaluating a positive EV gamble in a narrower frame (i.e., in relative isolation), but will prefer the same gamble when presented in a broader frame (as a probability distribution over all possible trials). When considering negative EV gambles or pure-loss gambles, individuals will prefer a larger potential loss (via the gamble) when presented in a narrower frame, but will prefer a smaller certain loss over that same gamble when presented with the outcome aggregation. Thus, our results suggest that outcome aggregation prevents preference reversals across identical financial risks and leads to more consistent preferences across risks (i.e., maximizing the expected value of returns across all risks).

The question of how individuals approach repeated plays of an identical gamble, and its implications for investment behavior has been well explored in the literature (Wedell and Böckenholt

1994, Keren 1991, Thaler and Johnson 1990, Klos et al. 2005, Redelmeier and Tversky 1992). Within the judgment and decision making literature specifically, this stream of research has been strongly influenced and informed by prospect theory (Tversky and Kahneman 1992, Kahneman and Tversky 1979). Prospect theory is a robust description of risky choice, with its pattern of risk-aversion for gains and risk-seeking for losses demonstrated empirically in many different settings (Gneezy et al. 2006, Langer and Martin Weber 2001, Barberis et al. 2001, Martin Weber and Camerer 1998, Camerer 2000, Odean 1998).

Perhaps the most well-known demonstration of how prospect theory aligns with repeated gambles is the work on myopic loss aversion (Benartzi and Thaler 1995, Gneezy and Potters 1997, Langer and Martin Weber 2001, Thaler et al. 1997). In Benartzi & Thaler's (1999) work on the equity premium puzzle, the authors were able to change risk preferences through choice bracketing such that individuals' choices over repeated positive EV gambles were less risk-averse. Specifically, in Study 2 the authors showed participants repeated mixed gambles described either in words (i.e., "N plays of gamble x") (narrow bracketing) or in terms of the distribution of aggregated possible outcomes (broad bracketing). By describing the distribution of outcomes rather than the more static description of the single gamble played multiple times, their participants liked the gambles more and appeared less loss averse. The authors describe these findings as supportive of the concept of myopic loss aversion. Accordingly, individuals are loss averse for mixed gambles, as predicted by prospect theory, but also myopic, since they consider the gamble in isolation rather than thinking about each one as a piece of a larger set of gambles with an overall outcome distribution that favors gains. The authors conclude that broader framing attenuates the effect of loss aversion, and changed preferences towards what would be predicted by expected value calculations.

In testing their approach, Benartzi and Thaler (1999) were contrasting the myopic loss aversion explanation against a normative account proposed by Samuelson (1963). Samuelson (1963) argued that the acceptance of a larger number of gambles, but the rejection of a single gamble, was a mistake because the rejection of a single gamble should automatically lead to the rejection of a sequential set of such gambles (Samuelson 1963). In other words, the mistake was in the acceptance of the broad bracket (a "fallacy of the law of large numbers"). Benartzi and Thaler (1999) argue instead that the mistake is in the rejection of the single gamble, which comes about purely because of loss aversion and because the larger life environment in which it is played is neglected. They argue that the choices made under broad brackets are the "correct" choices, taking into account the probability distribution of the many mixed gambles we may experience in settings like retirement investing or lifetime wealth accumulation.

This work and related empirical tests of myopic loss aversion (Benartzi and Thaler 1995, Haigh and List 2005, Thaler et al. 1997, Gneezy and Potters 1997) have clearly demonstrated that broad bracketing leads to more normative and financially optimal choices in a world of positive EV risks. However, less work has been done to understand how bracketing and loss aversion combine when the outcomes are predominantly negative. The original context for myopic loss aversion was the U.S. stock market, which has a positive EV over time (Benartzi and Thaler 1995). However, there are also environments where individuals face choices with negative outcomes or expected values over time, such as insurance policies or state lotteries. In this paper, we demonstrate that broader choice bracketing can lead to better choices for all gamble types. In this sense, broad bracketing forces individuals to use more rational strategies in their decision-making (Sokol-Hessner et al. 2009). Our findings imply that choice bracketing can be used to help individuals make more consistent choices over a wide variety of risky prospects. Further, such an effect requires no behavioral change, emotion regulation, or cognitive effort as it is simply a framing effect.

While the extant literature has shown that myopic loss aversion can be attenuated through the use of broader bracketing for positive EV gambles, the question of the mechanism behind such bracketing effects also remains unresolved. The work on myopic loss aversion suggests that broad bracketing reduces risk aversion by minimizing the salience of losses through outcome aggregation. To better understand the role loss aversion plays in bracketing effects, we measure individual-level loss aversion via the DEEP method. We also measure the weight put on losses for each risk an individual encounters to make a distinction between trait-level loss aversion and the decisional weight put on losses that can result from situational factors. Therefore, the lambda coefficient provided by the DEEP methodology can be thought of as capturing individual heterogeneity in loss aversion, while the "situational loss aversion" measure can be thought of as representing a judgmental error resulting from the decisional context (bracket). By measuring both, we can determine whether individual heterogeneity in loss aversion mediates bracketing effects or if bracketing works primarily by reducing the weight put on losses in the context of a decision (situational loss aversion).

Another potential mechanism for bracketing effects is perceived risk. When contemplating choices involving risk, individuals have two measurable inputs: preference and perception. Risk perception is a judgment about the risk and represents the beliefs or feelings that individuals have about the risk itself (Holtgrave and Elke U. Weber 1993, Elke U. Weber and Hsee 1998, Klos et al. 2005). In psychological models of risk-return, risk perception has been shown to better account for risk preferences than measures of variance, the standard measure of risk (Elke U. Weber and Hsee 1998, Elke U Weber and Milliman 1997). In previous work on perceived risk, it has been shown that framing effects can result from differences in risk perception across the frames (Mellers et al. 1997, Schwartz and Hasnain 2002). Thus, once perceived risk is accounted for, the framing effects disappear and individuals are consistent in their risk attitudes. Given the work on risk perception and framing, it is thus possible that bracketing effects are mediated entirely by risk perception. According to this explanation, broader brackets would reduce perceived risk relative to narrower brackets, and this would account for the difference in preferences across the brackets (the bracketing effect).

While perception and preference are often highly correlated, there are variables that can affect one and not the other (Barberis 2013b). The distinction between risk perception and preference, therefore, becomes important when the goal is changing behavior or recommending interventions. By measuring risk perception, we can better understand whether choice bracketing works through changes in perceived risk or through changes in decision weights. If choice bracketing only affects preferences, it is not clear that an intervention is necessary—for example, overweighting of outcomes is not necessarily a mistake like misestimating risk is (Barberis 2013a, Barberis 2013b). If, instead, bracketing affects beliefs about the level of risk, then targeted interventions can be used to change behavior.

Finally, work on bounded rationality suggests that a limiting factor for using rational risk strategies is cognitive capacity (March 1978, Kahneman 2003, Sokol-Hessner et al. 2009). Thus, bracketing effects may occur because individuals are unwilling or unable to appropriately calculate probability distributions on their own. For sequential risks, this is especially problematic because a simple calculation of expected value will not appropriately account for the cumulative nature of outcomes—specifically the balancing of negative and positive outcomes. While many individuals can calculate the expected value of a gamble that entails several trials, few, if any, can picture the entire probability distribution for different outcomes. The downside to this cognitive constraint is especially striking in the context of positive EV gambles, which can result in almost no exposure to losses as a result.

We test whether the limiting factor in using a more rational strategy for choice is the construction of aggregated outcomes (probability distribution) or the ability to consider the cumulative effects of repeated trials (myopia). It's possible that individuals only calculate the expected value of one trial of the gamble and then (insufficiently) adjust from there without realizing that the expected value across all trials is much higher than their calculated return (or the offered certainty equivalent). Therefore, if making the number of trials more salient improves choices (by maximizing expected value), then this suggests that individuals' choice strategies become more consistent when the time component of the sequential gamble is emphasized. This would also suggest an emphasis on the myopic nature of sequential risk calculation. However, it is also possible that myopia is not the driving factor behind bracketing effects, and that the probability distribution has to be provided for individuals to make better choices. This would suggest further that probability distributions are beyond the cognitive capabilities of most individuals and that the bracketing effect is attributable primarily to assisting with this constraint and providing information that individuals are unable to calculate on their own.

To preview the contributions of this paper, we extend the work on myopic loss aversion by examining how the aggregation of outcomes via broad bracketing influences not only positive EV mixed gambles, but also negative EV and pure-loss gambles. In three studies we show that broader bracketing leads to preference reversals across all gamble types, but that the direction of this reversal is different for positive EV gambles versus non-positive EV gambles (negative EV and pure-loss). Specifically, for positive EV gambles, participants prefer the certain (smaller) gain when evaluating choices in a narrow frame, but prefer the gamble when evaluating it through a broader frame. For negative EV and pure-loss gambles, participants prefer the gamble when evaluating it through a narrow frame, but prefer the certain (smaller) loss when evaluating choices in a broader frame. Across gamble types, our empirical findings imply that broader choice bracketing leads to more consistent preferences and more optimal choice strategies (by maximizing expected value).

In Study 1 we evaluate two potential mechanisms for bracketing effects: changes in perceived risk, and individual heterogeneity in loss aversion. We find that changes in perceived risk partially mediate the significant bracketing effects, while loss aversion has only a significant negative main effect. This suggests that broad bracketing changes decision weights in addition to changing beliefs about risk, providing evidence of a cognitive capacity explanation for the bracketing effect. In Studies 2 and 3, we further explore the potential mediating role of loss aversion by measuring situational loss aversion (the differing weights placed on losses relative to gains in the context of each bracket). We compare changes in this variable with the effect of perceived risk. This analysis shows that both situational loss aversion and risk perception partially mediate the bracketing effect for all gamble types. Finally, we also explore the role of myopia in choice strategies by measuring the weight placed on the number of trials in different brackets by adding a manipulation that makes only the number of trials, but not the outcome aggregation, salient. Our results ultimately demonstrate that the bracketing effect is being driven by cognitive constraints related to probability distribution construction, and not myopia (or underweighting the repeated nature of the gamble itself).

Taken together our empirical findings show that broader bracketing leads to more consistent and optimal risk preferences. Further, we identify the mechanisms behind the bracketing effects. Across gamble types, the bracketing effect is jointly driven by changes in perceived risk, attenuated situational loss aversion, and cognitive capacity constraints. The process findings suggest targeted interventions that change perceived risk, remove cognitive constraints related to sequential risks, and change the weights placed on losses can improve decision-making for all risk types.

Study 1: Broad Brackets Produce More Consistent Preferences for all Gamble Types

In Study 1, we use a set-up similar to that of Benartzi & Thaler's (1999) Study 2, in which we ask participants to rate their willingness to take several gambles. Using their manipulation, subjects see the same gambles in both a narrow bracket (text description of the gamble and number of trials) and in a broad bracket (probability distribution of the gamble across all trials). We extend the authors' work by including gambles with a negative EV and pure-loss gambles (i.e., gambles over losses only). We replicate the authors' findings for positive EV gambles by showing that individuals switch from predominantly choosing the certainty equivalent under the narrow bracket to predominantly choosing the gamble under the broad bracket. For negative EV and pure-loss gambles, the opposite occurs: individuals switch from predominantly choosing the gamble under the narrow bracket to predominantly choosing the certainty equivalent under the broad bracket. The preferences expressed for the broadly bracketed problems suggest that outcome aggregation can be used to help individuals make more consistent and optimal decisions over risk. We also show that risk perception acts as a partial mediator for the bracketing effect, such that broader brackets lead to decreased (increased) perceived risk for positive EV (negative EV and pure-loss) gambles. Further, we measure loss aversion as a trait variable, and show that it has a significant negative effect on risk-taking even controlling for the effect of the choice bracketing manipulation and perceived risk.

Method

Study 1 was conducted online with 144 participants (39.6% female, M_{age} = 35.7 years) recruited through Amazon's Mechanical Turk ("mTurk"). This study is an extension of Benartzi & Thaler (1999)'s Study 2 with the inclusion of two additional gamble types: negative EV and pure-loss. In their Study 2, Benartzi & Thaler (1999) ask participants to consider *N* independent trials of a gamble with a probability *p* of winning an amount *x,* and a probability *(1 – p)* of losing an amount *y.* The bracketing manipulation involves either describing the gambles as "*N* plays of the gamble" (narrow bracket) or providing the full distribution of outcomes from the repeated plays (broad bracket). We replicate this approach across all gamble types. For the pure-loss gambles, participants consider *N* independent trials with a probability *p* of losing an amount *x*, and a probability *1 – p* of losing an amount *y.* The negative EV gambles appear the same as the positive EV gambles except that they have an expected value less than zero, while the positive EV gambles have an expected value greater than zero. All participants were asked to choose between the gamble and a certainty equivalent that was less than the expected value of the gamble (for the negative EV and pure-loss gambles, this means a certain amount that results in lower losses than the expected value of the gamble).

Study 1 has a 3 (Gamble Type: Positive EV, Negative EV, Pure-Loss) x 2 (Bracket: Broad, Narrow) within-subjects design. Thus, each participant was asked to evaluate seven positive EV gambles, six negative EV gambles, and six pure-loss gambles. Following the format of Benartzi & Thaler (1999), three of the gambles from each type were presented in a narrow bracket and one was presented in a broad bracket. For all gamble types, one of the gambles was a high-stakes version that had outcomes multiplied by ten. This version ensures that the same pattern of preferences holds over larger possible outcomes. For most of the broadly bracketed gambles, we truncated the distribution to exclude any outcome with less than a one percent chance of occurring (following Benartzi & Thaler's (1999) approach). For the positive EV gamble type, we included one gamble that had a non-truncated probability distribution (the seventh gamble). We included this non-truncated version to verify that the bracketing effect still occurs when small probability losses are included in the distribution. The gambles we used for each gamble type were constructed to have approximately the same payoff distribution, but different characteristics. In this sense, the bracketing manipulation is a framing effect since the information in both versions of the problem (narrow versus broad) is identical, only the presentation of that information changes. An example of the bracketing manipulation for each gamble type is shown in Figure 1.

In addition to asking participants to choosing between the gamble and certainty equivalent, we also asked participants to rate risk perception for each gamble. Risk perception was measured on a scale from one ("Not at all Risky") to seven ("Extremely Risky") (Blais and Elke U. Weber 2006). At the end of the survey, after the gambling questions, we asked all participants to respond to several questions about risk preferences using the Dynamic Experiments for Estimating Preferences or DEEP method (Toubia et al. 2013). The DEEP method provides estimates for lambda (loss aversion coefficient), sigma (curvature for the value function), and alpha (probability weighting parameter). Further, we asked participants to self-report gender and age. An example of the materials used in Study 1 can be found in the Appendix.

Results

Our analysis proceeds as follows: first we compare risk preferences by bracket (broad versus narrow) for each gamble type (positive EV, negative EV, pure-loss). Then we discuss the individual-level variables (risk perception, loss aversion, demographic variables). Finally, we combine all of the measures into a single model for both risk preference and risk perception.

Figure 1 *Example of Gamble Type and Bracketing Manipulations*

[Narrow Bracket Version] [Broad Bracket Version]

Positive Expected Value

[Narrow Bracket Version]

The gamble:

10%	*	Win $0.75
90%	*********	Lose $0.01

The gamble is played 90 times.

[Broad Bracket Version]

The gamble:

1%	#	Win $12
1%	#	Win $11
4%	####	Win $10
7%	#######	Win $9
12%	############	Win $8
16%	################	Win $7
18%	##################	Win $6
16%	################	Win $5
12%	############	Win $4
7%	#######	Win $3
4%	####	Win $2
1%	#	Win $1
1%	#	$0

Negative Expected Value

[Narrow Bracket Version]

The gamble:

10%	*	Win $0.25
90%	*********	Lose $0.10

The gamble is played 60 times.

[Broad Bracket Version]

The gamble:

2%	##	Lose $8
5%	#####	Lose $7
13%	#############	Lose $6
22%	######################	Lose $5
26%	##########################	Lose $4
20%	####################	Lose $3
9%	#########	Lose $2
2%	##	Lose $1

Pure-Loss

[Narrow Bracket Version]

The gamble:

90%	*********	Lose $0.10
10%	*	Lose $0.50

The gamble is played 50 times.

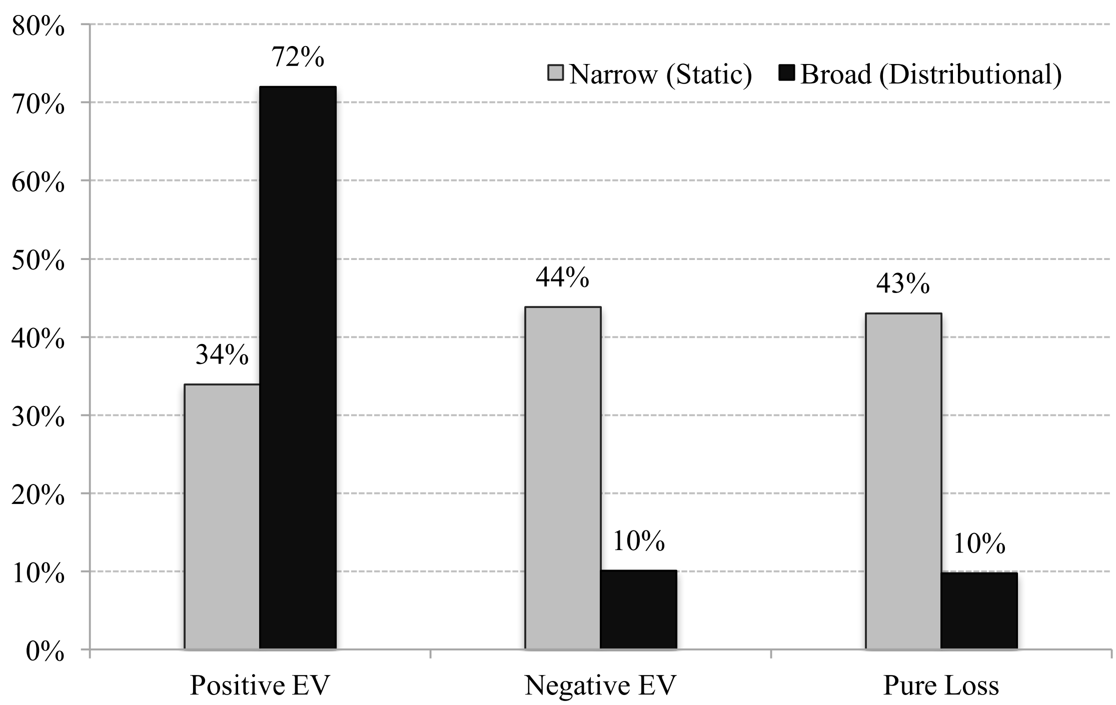
[Broad Bracket Version]

The gamble:

1%	#	Lose $11
7%	#######	Lose $10
7%	#######	Lose $9
10%	##########	Lose $8
28%	############################	Lose $7
15%	###############	Lose $6
12%	############	Lose $5
14%	##############	Lose $4
2%	##	Lose $3
1%	#	Lose $2

Risk Preferences. The results for risk preferences by gamble type and bracket are summarized in Figure 2. For the positive EV gambles, we see a replication of Benartzi and Thaler's (1999) findings: participants are risk averse when considering the gambles in the narrow brackets, but risk-seeking when considering them in the broad bracket. The difference in choice shares for the gamble between the narrow and broad bracket formats is highly significant (M_{Narrow} = 34% vs. M_{Broad} = 72%, $t(286) = -9.19$, $p <$ 0.001). While we present this information collapsed across all of the individual gambles, the pattern of results holds for each narrow bracket version of the gamble when compared to its broadly bracketed counterpart ($M_{Narrow1}$ = 36%, $M_{Narrow2}$ = 31%, $M_{Narrow3}$ = 33%, M_{Broad} = 77%, *ps* < 0.001 for all pairwise comparisons between the narrowly bracketed gambles and the broad bracket). These results demonstrate the bracketing effect for positive EV gambles: displaying the same financial risk in different bracketing formats leads to a preference reversal. Specifically, participants are relatively risk averse over the gamble when presented in a narrow bracket, but become relatively risk-seeking when that same gamble is presented in a broad bracket.

Figure 2: Percent of Participants Choosing the Gamble by Gamble Type & Bracket



Notes: (1) Broad and Narrow collapse across all gamble choices within that bracket type (e.g., the number displayed for the Broad Positive EV gambles is the average choice share across the broadly bracketed truncated gamble, non-truncated gamble, and high-stakes version of the gamble). (2) The differences between the Narrow and Broad conditions are significant at the p < 0.001 level for all gamble types.

The bracketing effect is significant for the high-stakes version of the gamble as well (when the outcomes were multiplied by ten) ($M_{NarrowHigh\text{-}Stakes}$ = 36% vs. $M_{BroadHigh\text{-}Stakes}$ = 75%, $p < 0.001$). Further, the gamble with the non-truncated probability distribution still garnered significantly higher choice shares for the gamble compared to the narrowly bracketed gambles ($M_{BroadNon\text{-}Truncated}$ = 65%, $ps < 0.001$ for all pairwise comparisons between the narrowly bracketed gambles and the non-truncated broad). Details for each gamble are presented in Table 1. This suggests that the bracketing effect is not specific to small outcome amounts or the fact that the probability distributions were truncated to only include outcomes with a one percent probability or higher.

Next, we turn to the gamble choice shares for the two gamble types not included in Benartzi & Thaler's (1999) original study: negative EV and pure-loss. As Figure 2 shows, we see the opposite pattern of results for these gamble types compared to the positive EV gambles. Participants are significantly more likely to accept the gamble when evaluating them in a narrow bracket compared to the broadly bracketed version (for negative EV gambles: M_{Narrow} = 44% vs. M_{Broad} = 10%, $t(286) = 8.73$, $p < 0.001$; for pure-loss gambles: M_{Narrow} = 43% vs. M_{Broad} = 10%, $t(286) = 8.95$, $p < 0.001$). As with the positive EV gambles, we combined gambles across bracket type, but the pattern of results holds when comparing the individual narrow gambles to the broad format of the gamble ($M_{NarrowNegEV1}$ = 44%, $M_{NarrowNegEV2}$ = 38%, $M_{NarrowNegEV3}$ = 44%, $M_{BroadNegEV}$ = 8%, $ps < 0.001$ for all pairwise comparisons between the negative EV Narrow and Broad questions; $M_{NarrowPure\text{-}Loss1}$ = 36%, $M_{NarrowPure\text{-}Loss2}$ = 42%, $M_{NarrowPure\text{-}Loss3}$ = 50%, $M_{BroadPure\text{-}Loss}$ = 11%, $ps < 0.01$ for all pairwise comparisons between the pure-loss Narrow and Broad questions). The results also hold for the high-stakes version of the gambles ($M_{NarrowHigh\text{-}StakesNegEV}$ = 50%, $M_{BroadHigh\text{-}StakesNegEV}$ = 12%, $p < 0.001$; $M_{NarrowHigh\text{-}StakesPure\text{-}Loss}$ = 42%, $M_{BroadHigh\text{-}StakesPure\text{-}Loss}$ = 8%, $p < 0.001$). The details for all gambles are shown in Table 1.

The results for the non-positive EV gambles also show a significant bracketing effect: risk preferences reverse across bracket types, such that participants are relatively more risk-seeking when evaluating narrowly bracketed gambles and relatively more risk averse when evaluating those same gambles in a broad bracket. These results also extend the previous research by showing that broad bracketing can lead to more consistent and optimal choices across all gamble types, not just gambles with positive expected values. This suggests that broad bracketing (via outcome aggregation) always helps individuals adopt more rational choice strategies over sequential risks.

Table 1 Choice Shares & Risk Perception by Gamble, Study 1

Gamble Description	Bracket Type	Pct Choosing to Gamble	Avg Risk Perception
Positive EV			
Gamble 1	Narrow	36%	3.86
Gamble 2	Narrow	31%	3.41
Gamble 3	Narrow	33%	3.40
Gamble 4	Broad (Truncated)	77%	2.66
Gamble 5	Broad (Non-Truncated)	65%	3.19
Gamble 6	Narrow (High-Stakes)	35%	3.97
Gamble 7	Broad (High-Stakes)	75%	2.73
Pure Loss			
Gamble 1	Narrow	36%	4.26
Gamble 2	Narrow	42%	4.06
Gamble 3	Narrow	50%	3.99
Gamble 4	Broad	11%	4.88
Gamble 5	Narrow (High-Stakes)	42%	4.45
Gamble 6	Broad (High-Stakes)	8%	5.27
Negative EV			
Gamble 1	Narrow	44%	4.32
Gamble 2	Narrow	38%	4.20
Gamble 3	Narrow	44%	4.49
Gamble 4	Broad	8%	4.87
Gamble 5	Narrow (High-Stakes)	50%	4.74
Gamble 6	Broad (High-Stakes)	12%	5.34

Notes: (1) Truncated means the probability distribution was limited to outcomes with a probability of 1% or more; (2) Non-Truncated means all outcome possibilities were displayed; (3) High-Stakes means the outcomes were multiplied by 10.

Individual Differences. As part of Study 1, we measured several individual-level variables: lambda (loss aversion), sigma (curvature of the value function), alpha (probability weighting parameter), age, and gender. For the risk preferences (lambda, alpha, sigma), we used the DEEP method of elicitation. This method uses adaptive questions to determine an individual's loss aversion coefficient, λ. The average λ across the sample was 1.83 (*SD* = 0.69). Most participants (62%) had a lambda coefficient equal to or greater than 1.75. This suggests that most participants are relatively loss averse. Interestingly, approximately 15% of the sample had a λ less than or equal to 1, suggesting that they weight losses less than gains.

Table 2 Correlation Table for Individual-Level Variables in Study 1

	Lambda	Sigma	Alpha	Age
Lambda	-	**-0.87**	**0.68**	0.10
Sigma	**-0.87**	-	**-0.67**	-0.10
Alpha	**0.68**	**-0.67**	-	0.05
Age	0.10	-0.10	0.05	-

Note: (1) Correlations in bold are significant at $p < 0.01$.

In Table 2, we present a correlation table for some of the individual-level measures. As Table 2 shows, the loss aversion coefficient (λ) is significantly negatively correlated with sigma, suggesting that the more loss averse a participant is, the less linear their value function. This corroborates previous research relating the dependence between λ and sigma (Toubia et al. 2013). We also see that λ and alpha are significantly positively correlated, suggesting that greater loss aversion is correlated with greater probability distortions (via the probability weighting function). The average sigma in the sample was 0.60 (*SD* = 0.19). Suggesting that, on average, participants have curvilinear (S-shaped) rather than linear value functions. These summary statistics for risk preferences suggest that broad bracketing can lead to more "correct" risk preferences for individuals who have prospect-theory consistent valuations (high degrees of loss aversion and non-linear value functions).

Overall Model of Risk Taking. In our previous analyses, we did not simultaneously control for the bracketing manipulation and other variables. This means that the bracketing effect could be attenuated by risk perception or loss aversion. To determine how choice bracketing affects risk preferences while controlling for these other important inputs, we ran a logistic regression with the choice to gamble as the dependent variable (1 = participant chose the gamble, 0 = participant chose the certainty equivalent/indifference). Specifically, our choice model is as follows:

$$Pr(Gamble_{ik}) = \beta_0 + \beta_1 X_i + \beta_2 X_{ik} + \beta_3 \mathbb{I}\{Broad_k\} + \beta_4 \mathbb{I}\{PosEV_k\} + \beta_5 \mathbb{I}\{Broad_k \cap PosEV_k\} + \beta_6 \mathbb{I}\{NegEV_k\} + \varepsilon_{ik} \quad (1)$$

where X_i contains all individual-level measures (i.e., loss aversion, sigma, alpha, age, and gender); X_{ik} contains gamble-specific measures provided by each individual (i.e., risk perception); and $\mathbb{I}(A)$ is an indicator function for gamble-level characteristics such that

$$\mathbb{I}(A) = \begin{cases} 1 \ if \ A \ is \ true \\ 0 \ if \ A \ is \ not \ true \end{cases}$$

Thus, for example, the indicator function $\mathbb{I}\{Broad_k\}$ is equal to 1 if the gamble was displayed in a broad bracket, and 0 if it was displayed in a narrow bracket. Finally, the standard errors, ε_{ik}, are clustered at the individual level to account for any correlation in the error terms from within-subject measurement (since all of our experimental factors were manipulated within-subjects).

Table 3 Regression Results for Study 1

	Chose to Gamble (1 = Yes, 0 = No)
Broad Bracket	-1.95***
	(0.21)
Positive EV Gamble	-0.72**
	(0.22)
Broad Bracket x Positive EV Gamble	3.43***
	(0.29)
Negative EV Gamble	0.20
	(0.10)
Risk Perception	-0.51***
	(0.06)
Loss Aversion Coefficient (Lambda)	-0.69***
	(0.19)
Sigma	-1.42
	(0.80)
Alpha	0.30
	(0.59)
Age	-0.01
	(0.01)
Female	0.15
	(0.16)
Constant	4.04***
	(0.96)

Notes: (1) Standard errors are clustered by participant and reported in parentheses; (2) reported coefficients are the untransformed coefficients from the logit model.

**** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$*

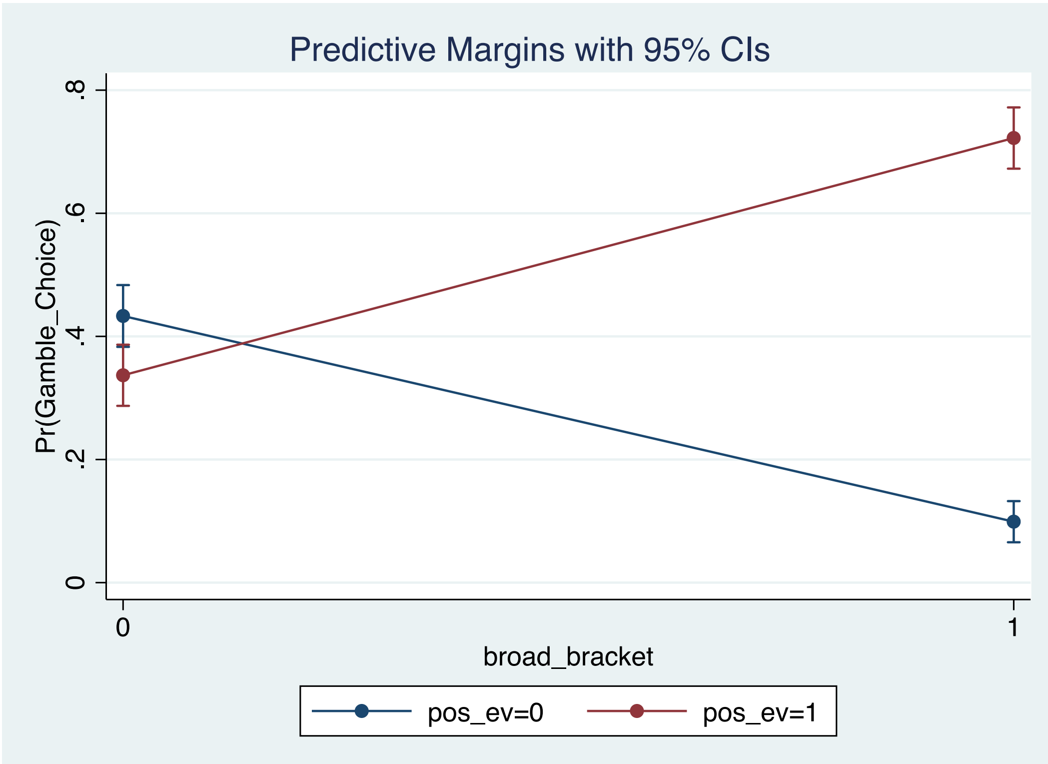
Given the model above, we are most interested in coefficient β_5, which shows the differential effect of broad bracketing by gamble type (positive EV, negative EV, or pure-loss), while controlling for perceived risk and loss aversion. Thus, any significant effect of bracketing in this model is independent of any simultaneous effects of these variables. The coefficients β_3 and β_4 represent the simple effects of broad bracketing and positive EV gamble types, respectively.

The results of our model are displayed in Table 3. First, the model shows that broad bracketing has a significant negative simple effect (β_3 = 1.95, z = -9.45, clustered SE = 0.21, $p < 0.001$), such that displaying a gamble in a broad bracket decreases risk-seeking for negative EV and pure-loss gambles. Importantly, there is a significant and positive interaction between broad bracketing and the positive EV gamble type (β_5 = 3.43, z = 12.01, clustered SE = 0.29, $p < 0.001$). This means that broad bracketing has a significant differential effect depending on the gamble type (positive EV, negative EV, or pure-loss). Specifically, broad bracketing increases risk-taking for positive EV gambles, and decreases risk-taking for negative EV and pure-loss gambles, as shown in Figure 3. This figure shows that moving from a narrow bracket to a broad bracket increases the likelihood of taking a positive EV gamble by 28.8% (Delta-method SE = 0.03, z = 9.27, $p < 0.001$), and decreases the likelihood of taking a non-positive EV gamble by 31.2% (Delta-method SE = 0.03, z = 11.52, $p < 0.001$). This is our main finding: broad bracketing leads to more optimal risk preferences across all gamble types, controlling for changes in perceived risk and individual-level loss aversion.

Gamble type also has an effect on the narrowly bracketed gambles such that individuals are less likely to take positive EV gambles (compared to negative EV gambles and pure-loss gambles) when they are being evaluated in a narrow bracket (β_4 = -0.72, z = -3.23, clustered SE = 0.22, $p < 0.01$). Thus, when being evaluated in a narrow bracket, all gamble types follow prospect theory predictions, such that individuals are relatively risk averse for positive EV gambles and risk-seeking for negative EV and pure-loss gambles.

Again, it is worth emphasizing that these results for risk preference hold even when controlling for perceived risk, which has a significant negative effect on the probability of choosing the gamble (β_2= -0.51, z = -8.95, clustered SE = 0.06, $p < 0.001$). This is in line with previous research showing that as perceived risk increases, risk-taking likelihood decreases (Elke U. Weber et al. 2002, Elke U. Weber and Hsee 1998). To confirm that risk perception partially mediates the effect of bracketing on gamble choice, we ran a bootstrapped (1,000 replications) moderated mediation analysis with broad bracketing (1 = broad bracket, 0 = narrow bracket) as the independent variable, risk perception as the mediator, gamble type (1 = positive EV, 0 = negative EV or pure-loss) as the moderator, and the remaining variables from the model as covariates (Model 8, Preacher & Hayes, 2013). This analysis resulted in a significant negative indirect effect for non-positive EV gambles ($a_1 \, x \, b$ = -0.39, bootstrap SE = 0.05, bias-corrected 95% CI: [-0.50, -0.29]) and a significant positive indirect effect for positive EV gambles ($a_2 \, x \, b$ = 0.40, bootstrap SE = 0.06, bias-corrected 95% CI: [0.28, 0.52]). This analysis confirms that changes in perceived risk partially mediate the bracketing effect. Thus, for positive EV (non-positive EV) gambles, broader brackets decrease (increase) perceived risk, which, in turn, increases (decreases) risk-taking.

Figure 3: Predicted Probabilities for Choosing the Gamble by Bracket & Gamble Type



Notes: (1) Figure 3 shows the marginal effect of bracket type (broad vs. narrow) on risk-taking by gamble type (positive EV vs. non-positive EV). The error bars shown are for the 95% confidence intervals at each point. All other variables are held at their mean value.

The direct effect (partial effect of choice bracketing) is positive and significant for positive EV gambles (c_1' = 1.48, SE = 0.15, p < 0.001) and negative and significant for non-positive EV gambles (c_2' = -1.94, SE = 0.17, p < 0.001). The significant direct effect of bracketing type in the mediation analysis further confirms that broad bracketing has a significant effect on risk preference that is separate from changes in beliefs. This suggests that the choice bracket itself affects risk preference that is not entirely explained by changes in the perceived level of risk associated with the gamble. While the bracketing manipulation can change the level of perceived risk for the same gamble, the bracket also has an effect on decision weights separate from this change. This provides initial evidence that the bracketing effect is also partially the result of cognitive constraints preventing the construction of a probability distribution.

Of the individual-level measures we took related to risk preference, only λ (the loss aversion coefficient) has a significant effect that is separate from any changes driven through the bracketing effect or risk perception. Individual-level loss aversion has a significant negative effect on risk preference, meaning that the more loss averse an individual is, the less likely they are to take the gamble ($\beta_{1lambda}$ = -0.69, z = -3.72, clustered SE = 0.19, p < 0.001). This coincides with other investigations related to loss aversion, suggesting that loss aversion plays an important role in risk preference. Including the loss aversion measure in the mediation model does not result in significant mediation (partial or otherwise). This suggests that differences in individual-level loss aversion do not mediate the bracketing effect. This further implies that there is a component of loss aversion that has a significant effect on preference separate from any changes in decision weights on losses that choice bracketing may induce. Therefore, in this model, lambda can be thought of as the hedonic or emotional component of loss aversion that varies across individuals (Sokol-Hessner et al. 2009).

Ultimately, Study 1 confirms our main predictions: broad bracketing can lead to more consistent and optimal risk preferences compared to narrow bracketing for all types of risks (positive EV, negative EV, and pure-loss). This effect is partially mediated by changes in risk perception. However, even controlling for perceived risk, we see a significant partial (direct) effect of the bracketing manipulation on risk preference, again suggesting that bracketing has an effect on decision weights separate from changes in beliefs. This finding implies that bracketing does not work solely because it reduces (increases) perceived risk for positive EV (negative EV and pure-loss gambles), as suggested in the original work on choice bracketing (Read et al. 1999). Finally, an individual's level of loss aversion has a separate effect on risk preferences such that controlling for the bracketing effect and risk perception, individuals with higher levels of loss aversion are less likely to take risks in general. Given that we measured individual-level loss aversion, we cannot tell whether bracketing changes the weight put on losses relative to gains for a given gamble, we can only tell how trait-level loss aversion affects aggregate risk preferences.

Study 2: Situational Loss Aversion and Two Different Types of Bracketing

The findings from Study 1 suggest that aggregating outcomes (broad bracketing) helps individuals make more consistent choices over risk. In Benartzi & Thaler's (1999) original study, the authors suggested that broad bracketing attenuates loss aversion. This conclusion is derived from a comparison of the narrowly bracketed gambles in which the gamble with the high probability of a small loss (90% chance of losing \$0.01—see Positive EV Gamble 1 in Table 1) has a significantly lower choice share. As Table 1 shows, we did not replicate this finding in Study 1, however, we did directly measure loss aversion at the individual level and showed it has a significant negative effect on risk preferences. Unfortunately, this does not help us better understand how loss aversion for a specific gamble may be impacted by the bracketing manipulation. In Studies 2 and 3, we introduce what we call situational loss aversion to directly test how the weight put on possible losses shifts with the bracketing manipulation.

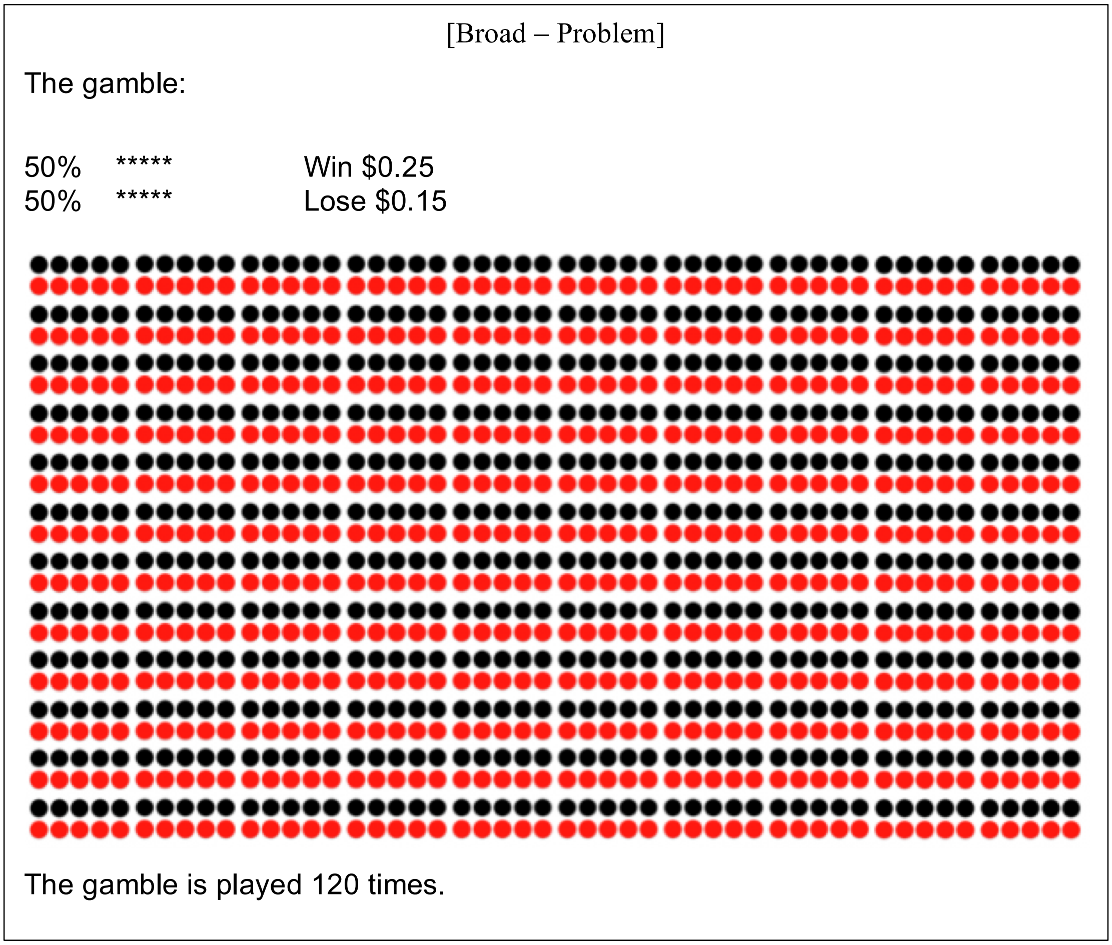
In addition to attenuating loss aversion, Benartzi & Thaler (1999) also propose that broad bracketing helps participants appropriately weight the number of trials inherent in the repeated gambling problem. However, their original studies were not able to explicitly test this postulation. Similarly, our

Study 1 is limited in this aspect—we do not know if the broad bracketing manipulation changes risk preferences because people are better able to weight the number of trials, or because it provides them with complex information that is hard to calculate (the probability distribution). More specifically, does broad bracketing help diminish myopia by helping people understand the repeated nature of the gamble or is it the aggregation of outcomes that is necessary for a bracketing effect to occur? We hypothesize that the bracketing manipulation works not because it helps people better weight the number of trials (reduces myopia), but because it provides information that is not easy for many people to calculate (the probability distribution for all possible outcomes). In order to better understand the process, we look at whether problem bracketing (explicitly illustrating the number of choices but not aggregating the outcomes) can also help people make better choices. If problem bracketing and outcome bracketing have similar effects, we know that bracketing works, in part, by reducing myopia. If the two types of bracketing are not equivalent, this would suggest that broad bracketing only works if it aggregates outcomes over time. Thus, further understanding the process behind the bracketing effect in Study 1 is a main question addressed in Studies 2 and 3.

Method

Study 2 was conducted online through mTurk with 291 participants (37.5% female, M_{age} = 33.2 years), and was structured similarly to Study 1. A main difference in Study 2 is that we change the design such that the bracketing manipulation is now a between-subjects factor. Thus, Study 2 is 3 (Bracket Type: Broad-Outcome, Broad-Problem, Narrow) x 3 (Gamble Type: Positive EV, Negative EV, Pure-Loss) mixed-factorial design, where Bracket Type is a between-subjects factor and Gamble Type is within-subjects. In each Bracket Type condition, participants evaluated six gambles total: two positive EV, two negative EV, and two pure-loss. One of each of these gambles was a high-stakes version of the other, as in Study 1. Participants saw all gambles in the bracket type they were assigned to, and the gambles were the same across conditions, only the format they were displayed in differed.

Figure 4 *Example of the Broad-Problem Bracket Type from Study 2*



Participants in the Broad-Outcome condition saw all gambles in the broad bracket format used in Study 1 (i.e., they saw the probability distribution for the gamble). Participants in the Narrow condition saw all six gambles in the narrow bracket format used in Study 1 (i.e., they saw the gambles described in text only). Finally, participants in the Broad-Problem condition saw the static information but also saw colored dots representing each choice. For example, one of the positive-EV gambles used was a 50% chance to win $0.25 and a 50% chance to lose $0.15, played 120 times. In the Broad-Problem condition, this gamble was described as in the Narrow condition (120 plays of a gamble with these outcomes) but below the text description there was an illustration of 120 blocks (representing each trial) with five red dots and five black dots. Each red dot represented a potential loss and each black dot represented a potential gain. An example of the Broad-Problem condition is shown in Figure 4. The Broad-Problem condition illustrates the number of choices without explicitly aggregating outcomes so we can distinguish whether the bracketing effect from Study 1 was driven by an increased focus on the larger number of trials or by providing probabilistic outcome information that is not calculated by participants (accurately or at all).

After making each of their choices, participants in all conditions provided a risk perception rating for the gamble. Risk perception was measured as in Study 1. In addition to risk perception, we also asked all participants to rate the importance of potential losses and the importance of the number of trials after each gamble. The importance of loss measure represents situational loss aversion—the decisional weight placed on losses in the expected value calculation used to determine preferences. The importance of the number of trials is a measure of myopia—how much the repeated nature of the gamble (separate from outcome aggregation) is weighted in risk preference. Measuring this variable allows us to determine whether bracketing effects work by reducing myopia (insufficient adjustment to the expected value in light of the repeated trials) or by directly addressing a cognitive constraint (calculation of the probability distribution/outcome aggregation), or both.

For the situational loss aversion measure we asked participants, "how important was the chance of losing money in your decision of whether or not to take the gamble?" For the importance of the number of trials measure, we asked participants, "how important was the number of trials in your decision of whether or not to take the gamble?" Participants responded to both measures on a seven-point scale ranging from one ("Not at all Important") to seven ("Extremely Important"). These measures were not included in Study 1. We added these measures to specifically test whether the importance of loss or the number of trials (or both) was explicitly affected by the bracketing manipulations. This is also why we changed the bracketing manipulation to a between-subjects factor. The importance of loss is especially interesting in that it allows us to measure whether there is situational loss aversion that can be affected by choice framing and is different from a trait-dependent loss aversion measure.

At the end of the survey, after all of the gambling questions, we asked all participants to respond to questions measuring individual-level risk preferences, lambda, alpha, and sigma (all measured by the DEEP method), gender, and age, as we did in Study 1. An example of the materials used in Study 2 can be found in the Appendix.

Results

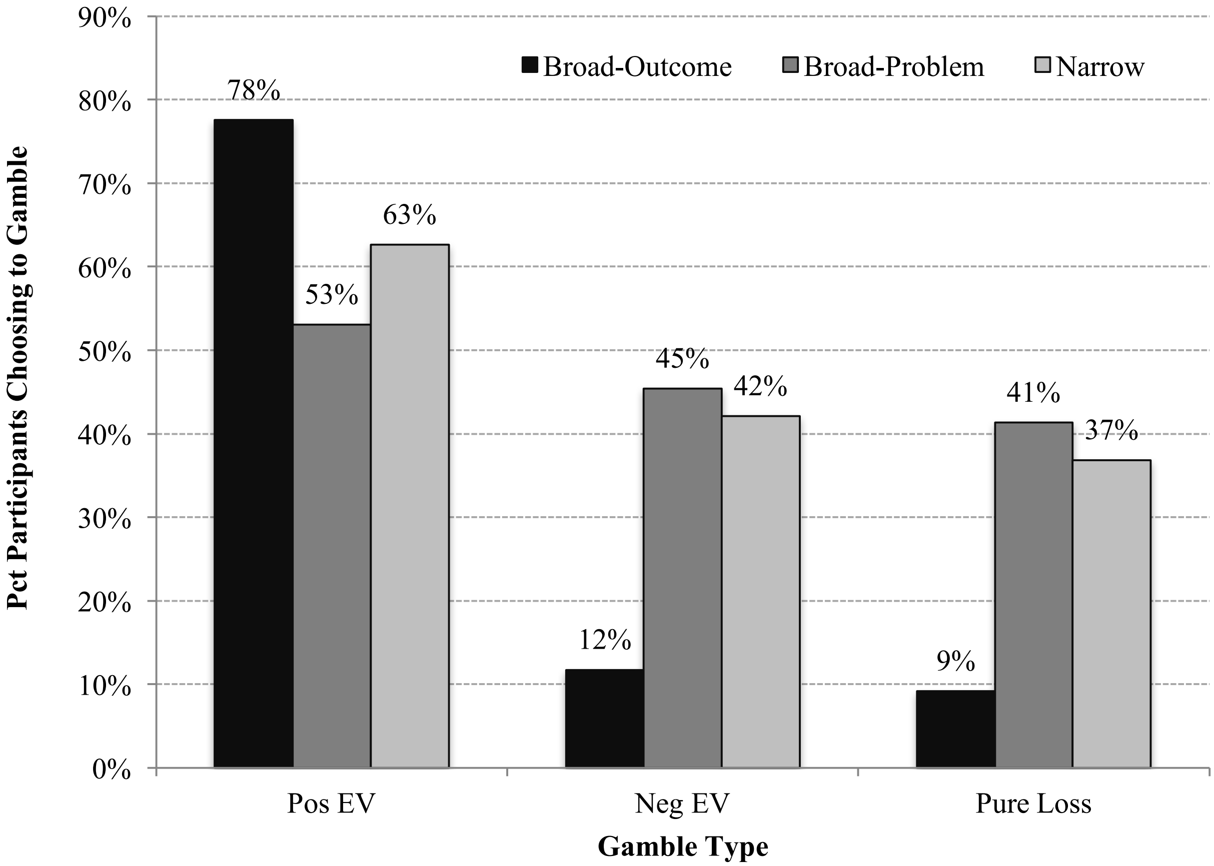
Our analysis proceeds as follows: first we address how the bracketing manipulations affect overall risk preferences (choice shares); next we turn to the new process variables—situational loss aversion (importance of loss) and myopia (importance of the number of trials); then we address the individual-level variables (lambda, alpha, sigma); and finally we conclude with a model of risk preference accounting for all manipulated factors, process variables (situational loss aversion, myopia, risk perception), and individual-level differences.

Risk Preferences. We first evaluated how risk preferences varied across bracketing conditions for each gamble type. These results are displayed in Figure 5 and summarized in Table 4. As the figure shows, participants in the Broad-Outcome condition are significantly more likely to take the positive EV gambles than participants in the Narrow condition ($M_{Broad\text{-}Outcome}$ = 78% vs. M_{Narrow} = 63%, $t(186.10) = -2.63$, $p < 0.01$); significantly less likely to take the negative EV gambles than participants in the Narrow condition ($M_{Broad\text{-}Outcome}$ = 12% vs. M_{Narrow} = 42%, $t(144.24) = 6.02$, $p < 0.001$); and significantly less likely to take the pure-loss gambles than participants in the Narrow condition ($M_{Broad\text{-}Outcome}$ = 9% vs. M_{Narrow} = 37%, $t(142.54) = 5.51$, $p < 0.001$). This replicates the significant bracketing effect from Study 1, wherein broad bracketing (through outcome aggregation) makes individuals relatively more risk-seeking for positive EV gambles and relatively more risk averse for non-positive EV (negative EV and pure-loss) gambles. We've now confirmed the bracketing effect across all gamble types and as a between-subjects manipulation.

Interestingly, the same pattern of results emerges when comparing the Broad-Outcome condition to the Broad-Problem condition: participants were more likely to take the positive EV gambles ($M_{Broad\text{-}Outcome}$ = 78% vs. $M_{Broad\text{-}Problem}$ = 53%, $t(188.56) = -4.26$, $p < 0.001$); less likely to take the negative EV gambles ($M_{Broad\text{-}Outcome}$ = 12% vs. $M_{Broad\text{-}Problem}$ = 45%, $t(154.23) = 7.01$, $p < 0.001$); and less likely to the take the pure-loss gambles in the Broad-Outcome condition compared to the Broad-Problem condition ($M_{Broad\text{-}Outcome}$ = 9% vs. $M_{Broad\text{-}Problem}$ = 41%, $t(149.71) = 6.58$, $p < 0.001$). This suggests that simply illustrating the number of trials does not have the same effect on risk preferences that explicitly aggregating outcomes into a probability distribution does.

Finally, if we compare the Broad-Problem and Narrow conditions, we see no significant differences between the two in terms of choosing the gamble (for positive EV gambles: $M_{Broad\text{-}Problem}$ = 53% vs. M_{Narrow} = 63%, $t(190.00) = 1.56$, $p = 0.12$; for negative EV gambles: $M_{Broad\text{-}Problem}$ = 45% vs. M_{Narrow} = 42%, $t(189.80) = -0.54$, $p < 0.59$; and for pure-loss gambles: $M_{Broad\text{-}Problem}$ = 41% vs. M_{Narrow} = 37%, $t(190.53) = -0.73$, $p < 0.47$). Thus, the Broad-Problem bracketing format is statistically equivalent to the Narrow bracket format. This result was unexpected, as we predicted that the Broad-Problem bracketing manipulation would produce a bracketing effect, however, this is not empirically confirmed. This provides initial evidence that a bracketing effect does not occur when just making the number of trials more salient, the aggregation of outcomes is necessary.

Figure 5 Choice Shares for the Gamble Across Condition and Gamble Type, Study 2



Importance of Losses and Trials. In previous work on myopic loss aversion, the bracketing effect between broad and narrow framing, has been attributed to both an attenuation of loss aversion and an increased weight on the number of trials. We measured both of these variables directly in Study 2 in order to distinguish between these two proposed mechanisms. First, we look at the importance of the number of trials (myopia). We would expect this variable to be of greater importance in the Broad-Problem and Broad-Outcome conditions compared to the Narrow condition since the number of trials is more explicitly illustrated in these conditions. We would further expect the importance of this variable to be highest in the Broad-Problem condition since this condition clearly illustrates the number of trials. These hypotheses, however, are not confirmed in the data, as summarized in Table 4.

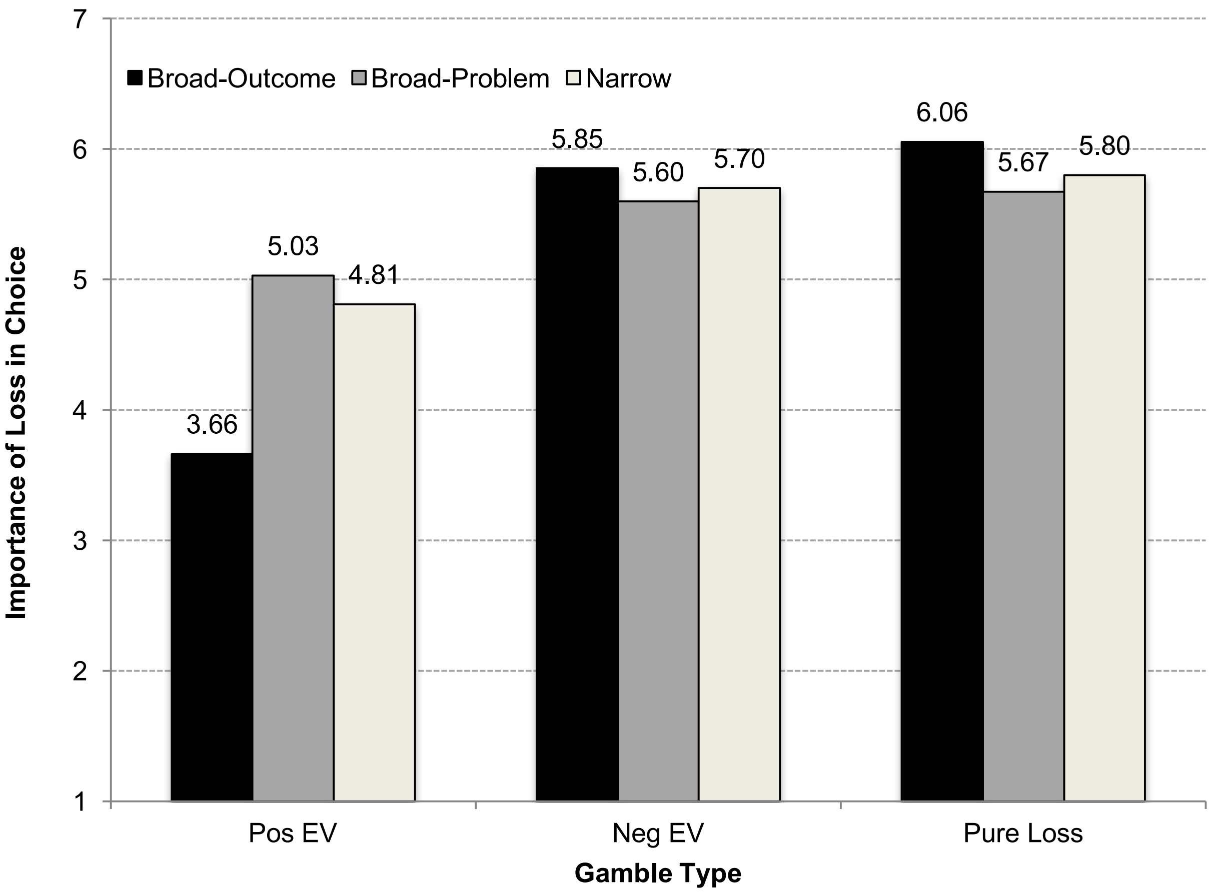
Table 4 Summary Statistics by Gamble & Bracket Type, Study 2

Gamble Description	Bracket Condition	Pct Choosing Gamble	Risk Perception	Importance of No. of Trials	Situational Loss Aversion
Positive EV					
Gamble 1	Narrow	67%	2.82	5.13	4.68
Gamble 1	Broad-Problem	54%	3.26	5.00	4.87
Gamble 1	Broad-Outcome	81%	2.62	4.18	3.58
Gamble 2	Narrow	58%	3.49	5.22	4.94
Gamble 2	Broad-Problem	52%	3.74	5.27	5.19
Gamble 2	Broad-Outcome	74%	2.84	4.45	3.74
Pure Loss					
Gamble 1	Narrow	34%	4.31	4.86	5.66
Gamble 1	Broad-Problem	42%	4.21	4.90	5.46
Gamble 1	Broad-Outcome	9%	4.77	4.46	5.73
Gamble 2	Narrow	40%	4.80	5.08	5.94
Gamble 2	Broad-Problem	41%	5.19	5.23	5.89
Gamble 2	Broad-Outcome	9%	6.06	4.20	6.38
Negative EV					
Gamble 1	Narrow	36%	4.13	5.07	5.54
Gamble 1	Broad-Problem	43%	4.18	4.95	5.40
Gamble 1	Broad-Outcome	9%	4.70	4.23	5.76
Gamble 2	Narrow	48%	4.81	5.23	5.86
Gamble 2	Broad-Problem	48%	5.16	5.23	5.80
Gamble 2	Broad-Outcome	14%	5.26	4.40	5.95

The importance of the number of trials in the decision to gamble is significantly lower in the Broad-Outcome condition than in the Broad-Problem or Narrow conditions across all gamble types (positive EV gambles: $M_{Broad\text{-}Outcome} = 4.32$, $M_{Broad\text{-}Problem} = 5.13$, $M_{Broad\text{-}Problem} = 5.17$, $ps < 0.001$ for comparisons between Broad-Outcome and each of the other conditions; negative EV gambles: $M_{Broad\text{-}Outcome} = 4.32$, $M_{Broad\text{-}Problem} = 5.09$, $M_{Narrow} = 5.15$, $ps < 0.001$ for comparisons between Broad-Outcome and each of the other conditions; and pure-loss gambles: $M_{Broad\text{-}Outcome} = 4.33$ vs. $M_{Broad\text{-}Problem} = 5.07$, $M_{Narrow} = 4.97$, $ps < 0.001$ for comparisons between Broad-Outcome and each of the other conditions). This suggests that the importance of the number of trials is only implicit in the Broad-Outcome bracket, and that the number of trials is relatively more salient in the other two conditions. In other words, the finding that the Broad-Outcome condition has the lowest ratings for the importance of the number of trials implies that the bracketing effect caused by outcome aggregation is not attributable to an increased weight on the number of trials in the repeated gamble (reduced myopia).

Our prediction that the importance of the number of trials would be rated the highest in the Broad-Problem condition was also not upheld empirically. When comparing this variable between the Broad-Problem and Narrow conditions, there is no statistical difference between the two (*ps* > 0.68 for all pairwise comparisons across gamble types). This suggests that illustrating the number of trials does not lead to any more weight being placed on that factor compared to just stating the number of trials in text format. This ultimately implies two things: (1) broad outcome bracketing does not help individuals better weight the number of trials relative to other bracketing types, and (2) graphically illustrating the number of trials does not help individuals better use this information (compared to just providing the information in text format).

Figure 6 *Situational Loss Aversion by Bracket Condition and Gamble Type, Study 2*



The effect of broad bracketing on risk preference is also predicted to work by attenuating loss aversion. From Study 1, we found only a significant main effect of individual-level loss aversion on risk preferences. Thus, we wanted to measure how the bracketing manipulation could specifically affect the weight placed on losses in the choice calculus. This variable can be thought of as situational loss aversion (the weight placed on losses driven by the choice context) rather than trait-level loss aversion (individual heterogeneity in the general hedonic response to losses). Thus, individuals may have a trait-level loss aversion coefficient (lambda via the DEEP method) that does not change in reaction to external stimuli, but there may also be a loss aversion response that shifts with changes in context and framing. This is what we are trying to measure with the importance of loss (situational loss aversion) variable. If loss aversion is attenuated by bracketing, as proposed by Benartzi & Thaler (1999), we would expect the situational loss aversion measure to be significantly lower in the Broad-Outcome condition compared to the Narrow condition for positive EV gambles. In contrast, losses should be more important and the measure should be significantly higher in the Broad-Outcome condition for negative EV and pure-loss gambles.

The results of this main effects analysis on situational loss aversion are summarized in Table 4 and illustrated in Figure 6. We focus on a comparison of situational loss aversion across gamble types between the Broad-Outcome and Narrow conditions, since there is not a bracketing effect for the Broad-Problem condition. For positive EV gambles, situational loss aversion is significantly lower in the Broad-Outcome condition than the Narrow condition ($M_{Broad\text{-}Outcome} = 3.66$ vs. $M_{Narrow} = 4.81$, $t(184.51) = 4.81$, $p < 0.001$). This suggests that the bracketing effect between the Broad-Outcome and Narrow conditions is attributable to changes in the weight placed on losses. For non-positive EV gambles, the relationship is less clear. For negative EV gambles, situational loss aversion is not statistically different between the two conditions ($M_{Broad\text{-}Outcome} = 5.85$ vs. $M_{Narrow} = 5.70$, $t(189.78) = -1.13$, $p = 0.26$). For the pure-loss gambles, situational loss aversion is marginally significantly higher in the Broad-Outcome condition relative to the Narrow condition ($M_{Broad\text{-}Outcome} = 6.06$ vs. $M_{Narrow} = 5.80$, $t(178.75) = -1.65$, $p = 0.10$). The results for non-positive EV gambles implies that the effect of bracketing on situational loss aversion is relatively stronger for positive EV. The main effects analysis for situational loss aversion suggests that the bracketing effect, it is at least partially driven by differing weights placed on losses between the bracket types.

Individual Differences. We find that lambda (individual-level loss aversion) is not significantly different depending on the bracketing manipulation (one-way ANOVA, indicator for Broad-Outcome condition: $F(291, 1) = 0.08$, $p = 0.78$; indicator for Broad-Problem condition: $F(291, 1) = 0.51$, $p = 0.47$). This is not to say that λ is not correlated with situational loss aversion; in fact, λ is significantly positively correlated with situational loss aversion ($r = 0.11$, $p < 0.001$). Thus, individuals with high levels of chronic loss aversion also see losses as more important in the context of a given risky choice, but the situational measure of loss aversion is further affected by the situation (the bracketing manipulations). Correlations between some of the individual-level variables we measured are shown in Table 5.

Table 5 Correlation Table for Individual-Level Variables, Study 2

	Lambda	Alpha	Sigma	Importance of Trials	Situational Loss Aversion	Age
Lambda	-	**0.80**	**-0.77**	-0.03	0.11	0.21
Alpha	**0.80**	-	**-0.79**	-0.03	0.08	**0.23**
Sigma	**-0.77**	**-0.79**	-	0.06	-0.03	**-0.19**
Importance of Trials	-0.03	-0.03	0.06	-	0.14	-0.02
Situational Loss Aversion	0.11	0.08	-0.03	0.14	-	0.05
Age	0.21	**0.23**	**-0.19**	-0.02	0.05	-

Note: (1) Correlations in bold are significant at $p < 0.05$.

Overall Model of Risk-Taking. In the analyses described above we were not controlling for multiple independent variables or the proposed process variables. In order to better understand the full set of relationships in the effects documented above, we ran a logistic regression of the choice to gamble against both gamble-specific and individual-specific measures. Like Study 1, the model can be represented as:

$$Pr(Gamble_{ik}) = \beta_0 + \beta_1 X_i + \beta_2 X_{ik} + \beta_3 \mathbb{I}\{Broad - Outcome_k\} + + \beta_4 \mathbb{I}\{PosEV_k\} + \beta_5 \mathbb{I}\{Broad - Outcome_k \cap PosEV_k\} + + \beta_6 \mathbb{I}\{NegEV_k\} + \varepsilon_{ik} \quad (4),$$

where X_i contains all of the individual-level measures (i.e., loss aversion, alpha, sigma, age, and gender); X_{ik} contains the gamble-specific measures provided by each individual (i.e., risk perception, importance of the number of trials, and situational loss aversion); and $\mathbb{I}(A)$ is an indicator function for gamble-level characteristics such that

$$\mathbb{I}(A) = \begin{cases} 1 \; if \; A \; is \; true \\ 0 \; if \; A \; is \; not \; true \end{cases}$$

Thus, for example, the indicator function $\mathbb{I}\{Broad - Outcome_k\}$ is equal to 1 if the gamble being considered by an individual was displayed in a broad-outcome bracket, and 0 if it was displayed in a broad-problem or narrow bracket. Given that we expect a differential effect for positive EV gambles and non-positive EV gambles by bracketing type, we also include an interaction term between the Broad-Outcome and positive EV indicator variables. Since the main effects analysis did not show a bracketing effect between the Broad-Problem and Narrow conditions, nor was there a statistically significant difference between the Broad-Problem and Narrow conditions with respect to the dependent measure of interest (risk preferences), we combined the Broad-Problem and Narrow conditions. Thus, we only include an indicator for Broad-Outcome condition in the regression model. Finally, the standard errors,

ε_{ik}, are clustered at the individual level to account for any correlation in the error terms from within-subjects measurement.

Table 6   Regression Results, Study 2

	Chose to Gamble (1 = Yes, 0 = No)
Broad-Outcome Condition	-1.67*** (0.23)
Positive EV Gamble	0.16 (0.21)
Broad-Outcome x Positive EV Gamble	2.42*** (0.37)
Negative EV	0.17 (0.13)
Risk Perception	-0.45*** (0.13)
Situational Loss Aversion	-0.14** (0.06)
Importance of No. of Trials	0.12** (0.05)
Lambda	-0.2623589 (0.24)
Sigma	0.69 (0.91)
Alpha	.4330197 (0.86)
Age	-0.02** (0.01)
Female	-0.01 (0.15)
Constant	2.19* (1.00)

Note: (1) Standard errors are clustered by participant and reported in parentheses; (2) reported coefficients are coefficients from the logit model; (3) female is a dummy variable for participant gender where 1 = female, 0 = male.

**** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$*

The results from this regression, summarized in Table 6, replicate the bracketing effect from Study 1: broad bracketing (Broad-Outcome condition) leads to more optimal risk preferences (relative risk-seeking for positive EV gambles and relative risk aversion for negative EV and pure-loss gambles) compared to narrow bracketing. This is confirmed by the significant negative coefficient on the interaction between the Broad-Outcome condition indicator and the positive EV gamble indicator (β_5 = 2.15, clustered SE = 0.44, z = 4.91, p < 0.001) as well as the significant negative coefficient for the simple effect of the Broad-Outcome condition (β_3 = -1.57, clustered SE = 0.26, z = -6.00, p < 0.001).

Further, from the regression results we are better able to understand how the Broad-Outcome condition affects choice. In Table 6 we see that situational loss aversion has a significant negative effect on risk preferences such that the more weight put on losses, the less likely a participant is to take a gamble ($\beta_{2situational\ loss\ aversion}$ = -0.15, clustered SE = 0.06, z = -2.58, p = 0.01). This holds even controlling for the significant negative effect of risk perception ($\beta_{2risk\ perception}$ = -0.46, clustered SE = 0.06, z = -8.27, p < 0.001). This suggests that the focus on losses has an effect on risk preference that is separate from risk perception, further implying that situational loss aversion is not completely captured by perceived risk. Finally, the lambda coefficient has only a directional effect on risk-taking preference when we control for situational loss aversion ($\beta_{1lambda}$ = -0.25, clustered SE = 0.16, z = -1.58, p = 0.11). This suggests that loss aversion that responds to changes in choice framing and bracketing has a more significant direct effect on risk preference than overall individual-level loss aversion.

From Table 6, we also see that the importance of the number of trials has a significant positive effect on the likelihood of accepting the gamble ($\beta_{2trials}$ = 0.11, clustered SE = 0.05, z = 2.46, p = 0.01). This suggests that individuals who are better at weighting or accounting for the number of trials in the gambling choice are more likely to take the gamble. For positive EV gambles, this leads to more optimal risk preferences, but for negative EV and pure-loss gambles, this leads to greater risk-seeking. This further implies that individuals do not appropriately integrate this variable when considering negative EV or pure loss-gambles. It is important to note that this effect holds even controlling for the different bracketing manipulations, since we know from the main effects analyses that the importance of the number of trials was rated as significantly lower in the Broad-Outcome condition than either of the Broad-Problem or Narrow bracketing conditions. Again, the asymmetric effect of this variable on positive EV and non-positive EV gambles suggests that individuals do not know how to properly account for the repeated number of trials even if they think that they can (i.e., even if they give a high rating for the importance of the number of trials in the context of the study).

Mediation Analysis. We specifically measured situational loss aversion to test whether it mediated the bracketing effect. Since risk perception partially mediated the bracketing effect in Study 1, we ran a bootstrapped moderated multiple mediation analysis (1,000 replications), wherein we tested whether perceived risk and situational loss aversion jointly and separately mediated the bracketing effect on risk preferences. The moderator was gamble type (positive EV versus non-positive EV) and this moderation occurred between the IV (Broad-Outcome indicator) and the mediating variables and between the IV and DV (choice) (Model 8, Preacher & Hayes, 2013).

This analysis confirmed that both situational loss aversion and perceived risk jointly mediate the bracketing effect. For positive EV gambles, the indirect effect of risk perception is positive and significant (a_1 x b_1 = 0.26, bootstrap SE = 0.06, bias-corrected 95% CI: [0.13, 0.38]) as is the indirect effect of situational loss aversion (a_2 x b_2 = 0.16, bootstrap SE = 0.06, bias-corrected 95% CI: [0.05, 0.29]). This means that both perceived risk and situational loss aversion jointly mediate the bracketing effect for positive EV risks. Further, the size of the effect for risk perception is larger than the effect for situational loss aversion. The significant mediation by situational loss aversion suggests that the bracketing effect works in part by changing the weight placed on losses in the decision calculus. Thus, broader bracketing can help overcome the judgmental error component of loss aversion.

For non-positive EV gambles (negative EV and pure-loss), the indirect effect of risk perception is significant and negative (a_1 x b_1 = -0.26, bootstrap SE = 0.05, bias-corrected 95% CI: [-0.36, -0.17]). Situational loss aversion also has a significant negative indirect effect when controlling for the mediation by perceived risk (a_2 x b_2 = -0.03, bootstrap SE = 0.01, bias-corrected 95% CI: [-0.07, -0.01]). The magnitude of the indirect effect is smaller for situational loss aversion compared to risk perception, as it was with positive EV gambles as well. Thus, this significant multiple mediation suggests that both situational loss aversion and perceived risk jointly mediate the bracketing effect for all gamble types. The direction of the effect varies by gamble type such that broader brackets increase risk-taking for positive EV gambles by reducing perceived risk and situational loss aversion; while for non-positive EV gambles, broader brackets decrease risk-taking by increasing perceived risk and situational loss aversion. Ultimately, this mediation analysis confirms that the bracketing effect works in part by changing the weight individuals place on losses.

While we have shown multiple moderated mediation by perceived risk and situational loss aversion for all gamble types, these results have to be considered in light of significant conditional direct effects (for positive EV gambles: c_1' = 0.69, SE = 0.22, $p < 0.01$; for non-positive EV gambles: c_2' = -1.72, SE = 0.19, $p < 0.001$). This implies that there is something specific to the bracketing manipulation that affects risk preference separate from changes in perceived risk and situational loss aversion. This again, suggests that broad bracketing changes the weights used in the decision calculus. This lends further support to a mechanism related to cognitive constraints: the broad bracket provides information that individuals are unable to calculate, even when provided with the information to do so.

Overall, Study 2 has replicated the bracketing effect from Study 1 for all gamble types, and has provided further process evidence for the bracketing effect. Across two studies we now know that broad bracketing (via outcome aggregation) leads to more consistent risk preferences for gambles of all types. The mediation analyses suggest that all three proposed mechanisms play a role in the bracketing effect across gamble types: changes in perceived risk, changes in the weight placed on losses, and assistance in overcoming cognitive constraints through the provision of the probability distribution.

The null effect for the Broad-Problem condition was somewhat surprising in that we thought illustrating the number of trials would help participants better understand the cumulative nature of the gambles and reduce myopia more than in the Narrow bracket condition. However, contrary to this prediction, the Broad-Problem condition was statistically equivalent to the Narrow bracket condition in terms of choice patterns and effects. One potential problem with the set-up of Study 2, however, is that we used all equal probability gambles (every gamble in the set involved 50-50 probabilities). It's possible that the Broad-Problem condition did not have an effect not because such an effect does not exist, but rather because making the number of trials salient for 50-50 gambles does not help participants appreciate the cumulative effect of gains (positive EV gambles) or losses (negative EV and pure-loss gambles) since they are evenly split in the manipulation. To ensure that our null effect was not due to the fact that we only used 50-50 gambles, we ran Study 3 in which we include gambles with probabilities that are not equal across outcome types (e.g., 90% probability of outcome 1, 10% probability of outcome 2 and vice versa).

Study 3: Problem Bracketing with Unequal Outcome Probabilities

We ran Study 3 to determine whether the lack of a bracketing effect for the Broad-Problem condition in Study 2 was due to the fact that all of the gambles we used had even probabilities across outcomes (e.g., 50% chance of outcome 1, 50% chance of outcome 2). The use of even outcome probabilities could be problematic since illustrating the number of trials does not as clearly show the overwhelming number of positive (negative) outcome possibilities for positive EV (negative EV or pure-loss) gambles since the number of outcomes is evenly split. With gambles that have uneven outcome probabilities (e.g., 90% chance of a positive outcome, 10% chance of a negative outcome) this can help make different outcome types more salient. For example, for a positive EV gamble with a 90% chance of a positive outcome and a 10% chance of a negative outcome, the Broad-Problem format will show an overwhelming number of black (positive outcome) dots relative to red (negative outcome) dots. Thus, it's possible that the Broad-Problem bracketing manipulation is more effective for non-even outcome probabilities. We explore this possibility in Study 3.

Method

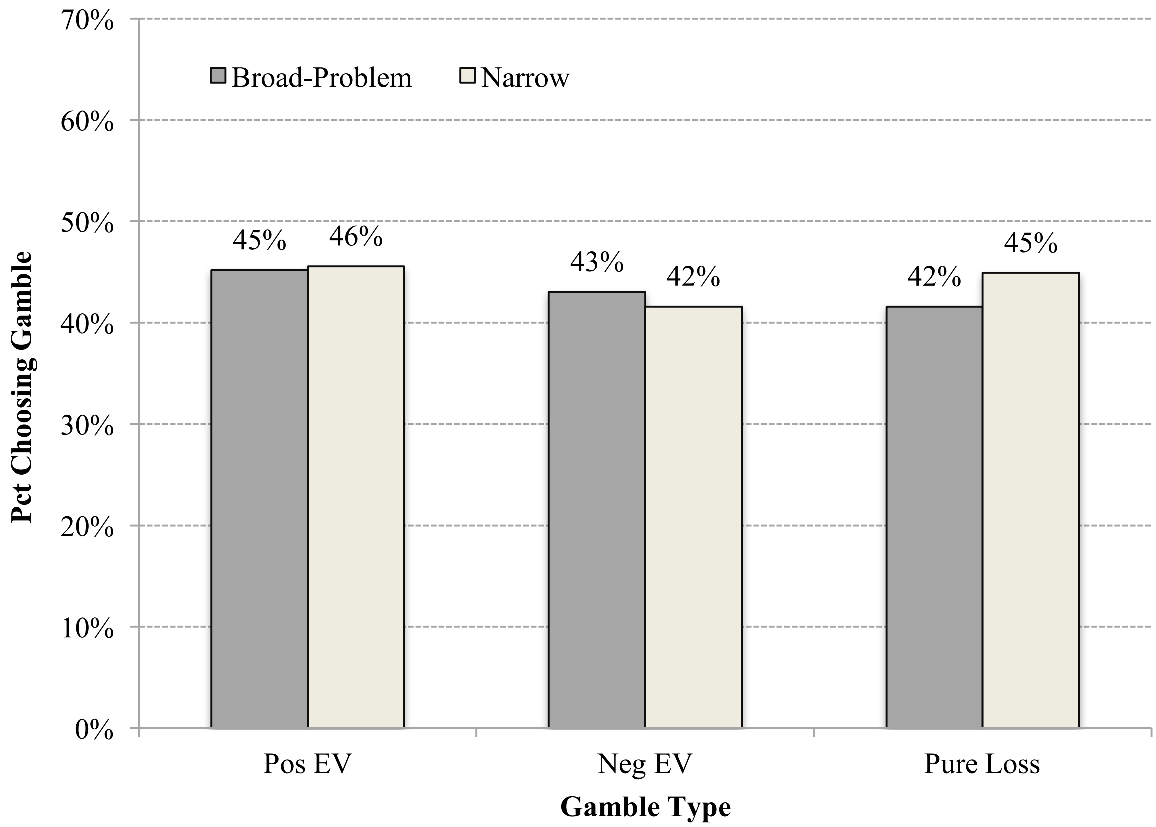
The method for Study 3 is identical to that of Study 2 except that we used three gambles for each type (positive EV, negative EV, and pure-loss) and we dropped the Broad-Outcome condition since we are only interested in potential differences between the Broad-Problem and Narrow conditions. Participants were 194 mTurk users (50.5% female, M_{age} = 33.3 years). Participants saw all of the gambles in the format they were randomly assigned to in their condition. The three gambles we used for each type had the same outcome probabilities. These were: (1) 50% chance of outcome 1, 50% chance of outcome 2; (2) 10% chance of outcome 1, 90% chance of outcome 2; and (3) 90% chance of outcome 1, 10% chance of outcome 2. We asked all participants the same questions about each gamble that we asked in Study 2: risk perception, situational loss aversion, and the importance of the number of trials. At the end of the survey, after all of the gambling questions, we asked all participants to respond to several questions measuring risk preferences (lambda, alpha, and sigma as measured by the DEEP method), gender, and age. An example of the materials used in Study 3 can be found in the Appendix.

If Broad-Problem is more effective for uneven outcome probabilities and this explains the null effect from Study 2, then we should expect to see no bracketing effect for the even outcome probability gambles, and a significant bracketing effect for the uneven outcome probability gambles. If the Broad-Problem framing helps participants better weight the number of trials and affects situational loss aversion, then participants should be more (less) likely to take positive EV (negative EV and pure-loss) gambles compared to participants in the Narrow condition. However, if the bracketing effect from Study 2 is only found with the explicit aggregation of outcomes in the probability distribution, then we will see no effect of bracketing type even for the uneven outcome gambles.

Results

Our analysis proceeds as follows: first we address how the bracketing manipulation affects overall risk preferences (choice shares) and then we turn to the process variables—situational loss aversion (importance of loss) and myopia (importance of the number of trials.

Figure 7: Choice Share for Gamble Across Condition and Gamble Type, Study 3



Risk Preferences. We first evaluate how risk preferences vary across the Broad-Problem and Narrow conditions for each gamble type. These results are displayed in Figure 7 and summarized in Table 7. As the figure shows, participants in the Broad-Problem condition do not look much different from participants in the Narrow condition in terms of choosing the gamble, and this holds across gamble type (positive EV gambles: $M_{Broad\text{-}Problem}$ = 45% vs. M_{Narrow} = 46%, $t(188.70) = 0.01$, $p = 0.94$; negative EV gambles: $M_{Broad\text{-}Problem}$ = 43% vs. M_{Narrow} = 42%, $t(191.86) = -0.27$, $p = 0.79$; pure-loss gambles: $M_{Broad\text{-}Problem}$ = 42% vs. M_{Narrow} = 45%, $t(190.97) = 0.64$, $p = 0.53$). This replicates the findings from Study 2, wherein broad bracketing (through problem aggregation) does not significantly affect risk preferences relative to risks presented in a narrow bracket. Thus, problem bracketing does not produce a bracketing effect since gamble choice shares are statistically equivalent between the Broad-Problem and Narrow conditions.

Table 7 Summary Statistics for Each Gamble, Study 3

Gamble Description	Bracket Condition	Pct Choosing Gamble	Risk Perception	Importance of No. Trials	Situational Loss Aversion
Positive EV					
Gamble 1	Narrow	48%	3.25	5.42	5.11
Gamble 1	Broad-Problem	44%	3.83	4.98	5.28
Gamble 2	Narrow	50%	3.48	5.45	5.04
Gamble 2	Broad-Problem	45%	3.47	4.94	4.95
Gamble 3	Narrow	40%	3.67	5.37	5.32
Gamble 3	Broad-Problem	46%	3.81	5.12	5.18
Pure-Loss					
Gamble 1	Narrow	39%	4.50	5.06	6.02
Gamble 1	Broad-Problem	41%	4.75	5.12	5.51
Gamble 2	Narrow	39%	4.74	5.15	5.99
Gamble 2	Broad-Problem	30%	4.95	5.08	5.58
Gamble 3	Narrow	57%	4.31	5.24	5.85
Gamble 3	Broad-Problem	54%	4.15	4.83	5.39
Negative EV					
Gamble 1	Narrow	44%	4.45	5.01	5.84
Gamble 1	Broad-Problem	41%	4.72	5.09	5.68
Gamble 2	Narrow	41%	4.63	5.15	5.93
Gamble 2	Broad-Problem	43%	4.78	4.91	5.63
Gamble 3	Narrow	41%	4.64	5.02	5.95
Gamble 3	Broad-Problem	45%	4.84	4.76	5.66

Note: Gamble 1 of each type has even outcome probabilities, Gambles 2 and 3 of each type have uneven outcome probabilities.

To investigate whether the non-significant effect of problem aggregation on choice shares was an artifact of the chosen probabilities, we compared choice shares for gambles with even probabilities separately from choice shares for gambles with uneven probabilities across bracketing types. Of the three gambles we used for each type, one had even outcome probabilities and two had uneven outcome probabilities. We combine the two uneven outcome probability gambles in the analyses that follow. If the outcome probabilities were the reason for the null effect, then we should see significant differences in the choice measure for the uneven probability gambles (gambles 2 and 3) across bracketing conditions, but no such differences for the even probability gambles. When we do this comparison across all gamble types, we do not see a significant difference in choice shares for any gamble type or probability split between the Broad-Problem and Narrow conditions (*ps* > 0.10). These results are summarized in Table 8. These results suggest that the null effect in Study 2 was not due to the nature of the probabilities chosen for the specific gambles. Moreover, this implies that problem aggregation does not lead to a bracketing effect and explicitly illustrating the number of trials does not lead to less myopia. Ultimately, our results further confirm that individuals are not able to accurately account for a probability distribution without it being explicitly displayed for them.

Importance of Loss/Trial. Again, the impact of broad bracketing has been attributed to both an attenuation of loss aversion and an increased weighting for the importance of the number of trials. In Study 2 we found that situational loss aversion was attenuated for positive EV gambles in the Broad-Outcome condition relative to the Narrow condition, but that this pattern of results was not found for the Broad-Problem condition relative to the Narrow condition. We also found that the importance of the number of trials was rated lower in the Broad-Outcome condition relative to the other two conditions, but while the differences in this variable do significantly affect risk preferences, they do not lead to more normative risk preferences for all gamble types. We again compare these variables between the Broad-Problem and Narrow bracketing conditions.

First we look at the importance of the number of trials. Though we did not find this in Study 2, we still expect this variable to be of greater importance in the Broad-Problem condition compared to the Narrow condition since the number of trials is explicitly illustrated in this condition. Again, this hypothesis is not confirmed in the data, as summarized in Table 8. In fact, the data suggest the opposite: if anything, there is directional evidence to support the finding that participants in the Narrow condition weight the number of trials more heavily than participants in the Broad-Problem condition across gamble types (positive EV gambles: $M_{Broad\text{-}Problem} = 5.01$ vs. $M_{Narrow} = 5.41$, $t(188.86) = -1.95$, $p = 0.05$; negative EV gambles: $M_{Broad\text{-}Problem} = 4.92$ vs. $M_{Narrow} = 5.06$, $t(189.58) = 0.65$, $p = 0.52$; pure-loss gambles: $M_{Broad\text{-}Problem} = 5.01$ vs. $M_{Narrow} = 5.15$, $t(191.07) = 0.66$, $p = 0.51$). This replicates our findings from Study 2 wherein the Broad-Problem condition did not significantly differ from the Narrow condition on this variable. Again, this is surprising given that the number of trials is explicitly illustrated and should help participants in the Broad-Problem condition better weight the number of trials in their decision.

Table 8 Comparison between Even and Uneven Probability Gambles, Study 3

	Even			**Uneven**		
	Broad-Problem	*Narrow*	*p-value*	*Broad-Problem*	*Narrow*	*p-value*
Choice Share (Pos EV)	44%	48%	0.63	46%	45%	0.84
Choice Share (Neg EV)	41%	44%	0.71	44%	41%	0.55
Choice Share (Pure Loss)	41%	39%	0.75	42%	48%	0.28
Risk Perception (Pos EV)	**3.83**	**3.25**	**0.02**	3.64	3.57	0.76
Risk Perception (Neg EV)	4.72	4.45	0.21	4.81	4.64	0.41
Risk Perception (Pure Loss)	4.75	4.50	0.35	4.52	4.55	0.92
Importance of Trials (Pos EV)	4.98	5.42	0.07	5.03	5.41	0.07
Importance of Trials (Neg EV)	5.09	5.01	0.75	4.84	5.08	0.28
Importance of Trials (Pure Loss)	5.12	5.06	0.81	4.95	5.19	0.27
Importance of Losses (Pos EV)	5.28	5.11	0.45	5.06	5.18	0.59
Importance of Losses (Neg EV)	5.68	5.84	0.32	5.65	5.94	0.07
Importance of Losses (Pure Loss)	**5.51**	**6.02**	**0.01**	**5.48**	**5.92**	**0.02**

Notes: (1) Even and Uneven refer to the outcome probabilities for each gamble type. Even gambles have a 50% chance of outcome 1 and a 50% chance of outcome 2; uneven gambles are the average for two gambles—one with a 90% chance of outcome 1 and a 10% chance of outcome 2, and one with a 10% chance of outcome 1 and a 90% chance of outcome 2. (2) The p-values reported are for a t-test comparing the Broad-Problem and Narrow conditions for each probability type. For example, the p-value reported for the Choice Share (Pos EV) in the Even column, is comparing the value for the Broad-Problem condition (even split probabilities) to the Narrow condition (even split probabilities). (3) p-values less than 0.05 are in bold type font.

The importance of the number of trials is also not moderated by the probabilities used in the gambles. As shown in Table 8, comparing this measure across bracketing conditions separately for even and uneven probability gambles does not show any significant effect (though the importance of the number of trials is rated as marginally significantly higher for the Narrow condition for positive EV gambles). This further suggests that explicitly framing risky choices to illustrate the number of trials does not lead to less myopia than narrow framing.

In Study 2 we did not find any significant differences between the Broad-Problem and Narrow conditions for the situational loss aversion measure for any of the gamble types. Looking at Table 7, we see that this result is replicated for positive EV gambles ($M_{Broad\text{-}Problem}$ = 5.14 vs. M_{Narrow} = 5.16, t(191.92) = 0.10, p = 0.92). However, for the other two gamble types (negative EV and pure-loss), we see partial evidence that the Broad-Problem condition *decreases* the importance of losses relative to the Narrow condition (negative EV: $M_{Broad\text{-}Problem}$ = 5.66 vs. M_{Narrow} = 5.91, t(190.34) = 1.73, p = 0.08; pure-loss: $M_{Broad\text{-}Problem}$ = 5.49 vs. M_{Narrow} = 5.95, t(179.53) = 2.78, $p < 0.01$). This could, in part, explain why the Broad-Problem condition does not lead to more consistent risk preferences—instead of increasing feelings of loss aversion for the negative EV and pure-loss gambles, which would lead to relative risk aversion instead of relative risk-seeking, the Broad-Problem manipulation reduces these feelings and likely increases the preference to gamble over losses.

If we look at situational loss aversion by outcome probabilities (even vs. uneven) as shown in Table 8, the same general pattern of results holds, suggesting the specific outcome probabilities are not driving the differences in situational loss aversion across bracketing conditions. Specifically, the difference in the importance of losses is non-significant for positive EV gambles with both even and uneven probabilities. For negative EV gambles, the difference in the importance of losses is still marginal for the uneven probability gambles, but non-significant for the even probability gambles (even gambles: $M_{Broad\text{-}Problem}$ = 5.68 vs. M_{Narrow} = 5.84, t(191.99) = 1.00 p = 0.32; uneven gambles: $M_{Broad\text{-}Problem}$ = 5.65 vs. M_{Narrow} = 5.94, t(186.57) = 1.83, p = 0.07). Finally, for the pure-loss gambles, the pattern of results is the same for both probability types across bracketing conditions, such that the importance of loss is rated as significantly higher in the Narrow bracket compared to the Broad-Problem bracket (even gambles: $M_{Broad\text{-}Problem}$ = 5.51 vs. M_{Narrow} = 6.02, t(180.31) = 2.72, p = 0.01; uneven gambles: $M_{Broad\text{-}Problem}$ = 5.48 vs. M_{Narrow} = 5.92, t(181.49) = 2.43, p = 0.02). This could also explain why we did not see a significant effect of the Broad-Problem bracket on situational loss aversion in Study 2—the effect seems to be stronger for uneven probability than even probability gambles.

Our main effects analyses for choice shares, importance of the number of trials, and situational loss aversion suggest that the null effect for the Broad-Problem condition from Study 2 is not attributable to the specific characteristics of the gambles used in that study (i.e., having even probabilities for outcomes does not account for the finding that the Broad-Problem condition does not produce a bracketing effect). Given that we found a null bracketing effect over risk preferences for the Broad-Problem condition, we do not report our regression analyses as in the previous studies. These analyses confirm the null effect across probability types and are available from the authors upon request.

Overall, our results from Study 3 replicate a null effect. While it is hard to make claims based on the lack of a finding, the results at least provide strong evidence that bracketing that highlights the number of trials is not as effective at changing risk preferences as bracketing that aggregates outcomes. Thus, not all kinds of bracketing are created equal. Moreover, given the highly significant effect of outcome bracketing, it seems that the bracketing effect produced by this manipulation has more to do with an inability to accurately think about probability distributions (or even consider them at all). Bracketing or framing manipulations that do not provide explicit probability distributions seem to be less effective in that they produce less consistent and suboptimal risk preferences.

Summary & Discussion

Better understanding how choice bracketing can affect risky choice has important implications for products that are inherently time-sensitive and entail varying levels of risk, such as financial products, insurance policies, or lottery ticket purchases. For example, if an individual is allocating funds across a 401k, he/she may be influenced by how the information about the investment is presented. If each statement is thought of as a single "trial" in which the individual receives investment feedback, the investor may underweight the number of trials that will occur over his/her lifetime and may change his/her allocation based on this insensitivity to the cumulative feature of the risk (the amount of time that will elapse). The reaction to the number of trials can change depending on how information about the investment is presented. For these reasons, understanding how the combination of several choices and feedback about those choices over time affects the initial decision is especially important.

Across three studies, we replicate the findings of previous research showing that broad bracketing (via outcome aggregation) leads to relative risk-seeking for positive EV gambles. We were able to extend these findings by confirming that this result occurs because of a decrease in situational loss aversion (loss aversion related to the choice itself, not as an individual-level measure), a decrease in perceived risk, and an attenuation of cognitive constraints related to probability distribution construction. We further extend the findings related to myopic loss aversion by demonstrating that broad bracketing (again, through outcome aggregation) can also lead to more optimal risk preferences (reduced risk-seeking) for gambles over losses (i.e., negative EV and pure-loss gambles). This bracketing effect is also driven partially by increasing perceived risk, increasing situational loss aversion, and partially by alleviating cognitive constraints. Thus, the same mechanism lies behind the bracketing effects for all gamble types, but the direction of the indirect effect varies depending on the expected value domain. This suggests that financial advisors may find it more helpful to focus on measures related to loss aversion and risk perception rather than traditional economic measures of risk aversion in order to better help their clients.

We find that a bracketing effect is only produced via outcome aggregation—a similar effect is not found when using a visual aid to explicitly illustrate the number of trials. This suggests that in order to help individuals make better decisions over risk, they should be provided with a probability distribution over returns, rather than just a text description or a visual aid depicting the number of "trials" inherent to the decision. Doing so will lead to relative risk-seeking over positive EV investments, and relative risk aversion over negative EV or pure-loss investments (versus risk aversion and risk-seeking, respectively). Our findings also suggest that, more generally, bracketing or framing manipulations that decrease (increase) loss aversion and decrease (increase) perceived risk for positive EV (non-positive EV) risks will lead to more consistent risk preferences.

Ultimately, a large part of the bracketing effect for all gamble types is attributable to cognitive capacity constraints. Accordingly, individuals change the weight placed on the expected benefits when provided with the probability distribution, and they are not able to replicate or construct the distribution on their own (even when the number of trials and cumulative nature of the risk is made more salient). Our results suggest that effective bracketing manipulations are driven primarily by cognitive limitations. When presented with a description of the risk, individuals rely on heuristics or simplified calculations to determine their preferences (i.e., calculating the EV of one trial and insufficiently adjusting). The provision of the probability distribution does not engage more deliberate or careful thought, rather it provides information that can be used quickly and efficiently to determine preferences that are ultimately more optimal. This further implies that it is unlikely many participants even realized that the probability distributions from Study 1 were representative of the other gambles they had encountered. Thus, the simple provision of a probability distribution can improve decision-making over risk, and does so without the need for behavioral change, emotion regulation, or effortful thought processes.

In our studies we only focused on two types of broad bracketing: outcome aggregation and problem aggregation. We found that only outcome aggregation produced a bracketing effect relative to narrow bracketing. While we can suggest that problem aggregation will not be effective in changing risk preferences, we do not know if there exists another type of broad bracketing that could also produce a bracketing effect but that does not involve the provision of a probability distribution. Future research could investigate other possible manipulations that affect loss aversion but do not require the use of a full probability distribution, since this information may not always be available across all investment or risk types.

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