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On the descriptive value of loss aversion in decisions under risk: Six clarifications

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Abstract

Previous studies of loss aversion in decisions under risk have led to mixed results. Losses appear to loom larger than gains in some settings, but not in others. The current paper clarifies these results by highlighting six experimental manipulations that tend to increase the likelihood of the behavior predicted by loss aversion. These manipulations include: (1) framing of the safe alternative as the status quo; (2) ensuring that the choice pattern predicted by loss aversion maximizes the probability of positive (rather than zero or negative) outcomes; (3) the use of high nominal (numerical) payoffs; (4) the use of high stakes; (5) the inclusion of highly attractive risky prospects that creates a contrast effect; and (6) the use of long experiments in which no feedback is provided and in which the computation of the expected values is difficult. In addition, the results suggest the possibility of learning in the absence of feedback: The tendency to select simple strategies, like "maximize the worst outcome" which implies "loss aversion", increases when this behavior is not costly. Theoretical and practical implications are discussed.

Keywords: prospect theory, status-quo bias, equity premium puzzle, contrast effect, choice lists.

1 Introduction

Loss aversion, one of the assumptions underlying prospect theory (Kahneman & Tversky, 1979), implies that losses loom larger than gains. That is, the absolute subjective value of a specific loss is larger than the absolute subjective value of an equivalent gain. This assertion was originally proposed in the context of decisions under risk: choice among known payoff distributions. It was later generalized to other settings, and was shown to provide an elegant explanation to a wide set of important behavioral phenomena. Famous examples include the endowment effect (Knetsch & Sinden, 1984), the status-quo bias (Samuelson & Zeckhauser, 1988), and under-investment in the stock market (Benartzi & Thaler, 1995). The significance of loss aversion is highlighted in Camerer's (2000) review of the practical implications of prospect theory: five of the ten examples are directly derived from loss aversion.

Another indication of the importance of loss aversion comes from Rabin's (2003) observation that the common abstraction of risk attitude with a concave utility function leads to unreasonable predictions. For example, it predicts that a person who rejects a low-stake prospect like "equal chance to win $11 or lose $10" would also turn down extremely attractive prospects like "equal chance to win $1,000,000,000 or lose $100". Rabin (2003) notes that his observation suggests that deviations from maximization in low-stake decisions are better described as indications of loss aversion than as reflections of the subjects' global utility function over wealth.

Previous research also suggests, however, that there are situations in which people are not loss averse. Most studies of the boundaries of loss aversion have focused on riskless choice (e.g., Gal, 2006; Morewedge et al., 2009; Novemsky & Kahneman, 2005; Ritov & Baron, 1992). For example, it was found that loss aversion is likely to emerge when the decision includes a status-quo option (Gal 2006; Ritov & Baron, 1992), but not when the decision involves exchanging goods, like money, that are given up as intended (Novemsky & Kahneman, 2005). Similarly, the ownership of multiple units attenuates the endowment effect and the implied loss aversion (Rottenstreich, Burson, & Faro, 2013).

The main goal of the current paper is to improve our understanding of the boundaries of loss aversion in decisions under risk. The examination of previous studies of loss aversion in risky and uncertain settings reveal mixed results. Whereas some studies document the loss aversion pattern, other studies show equal sensitivity to gains and losses. Indeed, recent studies of two of the best known indications of loss aversion show that small changes in the framing of the experimental tasks can eliminate the implied loss aversion bias. One example of the effect of framing is summarized in Table 1. The left-hand side presents Redelmeier and Tversky's (1992)

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Table 1: Mixed evidence for absolute loss aversion under different variants of the Samuelson's colleague problem. P(risk) refers to the proportion of subjects who chose to play the gamble.

Evidence for loss aversion	P(Risk)	No evidence for loss aversion	P(Risk)
Samuelson's colleague problem (Samuelson, 1963; Redelmeier and Tversky's, 1992 variant):		Abstract Samuelson's colleague problem (Ert & Erev, 2008):	
Task: Imagine that you have the opportunity to play a gamble that offers a 50% chance to win \$2000 and a 50% chance to lose \$500. Would you play the gamble?	45%	Task: Please choose between: 1. \$0 with certainty 2. \$2000 with probability of 0.5 −\$500 otherwise (with probability of 0.5)	78%

study of Samuelson's colleague problem. The results reveal a clear loss aversion pattern: most subjects behave as if they weigh a loss of \$500 more than a gain of \$2000. McGraw et al. (2010) demonstrate a similar pattern in a study of a symmetric bet; their results show that most participants reject the bet "equal chance to win or lose \$50" and judge the loss to be of higher absolute value than the gain. These observations are consistent with Kahneman and Tversky's (1979) assertion that "most people find symmetrical bets of the form (x, .50; −x, .50) distinctly unattractive" (p. 279). In their cumulative prospect theory paper Tversky and Kahneman (1992) capture this assertion with the assumption that the subjective value of objective losses is multiplied by a loss aversion parameter $\lambda > 1$. This abstraction implies that if $0<y<x$ then the bet (x, .50; −x, .50) is less attractive than the bet (y, .50; −y, 50); and more generally, risk aversion among mixed gambles. We refer to this assertion as the "absolute loss aversion" hypothesis.

The right-hand side of Table 1 presents a study of an abstract version of Samuelson's colleague problem. The results show that the tendency to weigh a loss of 500 over a gain of 2000 diminishes with the change of the frame. Specifically, when faced with a binary choice between a sure 0 payoff and the prospect (2000, .50; −500, .50) most subjects (78%) prefer the riskier mixed prospect. Notice that the difference between the two versions can be described as a status-quo effect: rejecting the gamble (the evidence for absolute loss aversion) occurs when the gamble is positioned as an alternative to the status quo of not playing (original Samuelson problem), but not when it is not (abstract Samuelson problem).

Table 2 presents a second example of a slippery loss aversion effect. The left-hand side shows a replication of Thaler et al.'s (1997) study of investment decisions. In the "Mixed" problem of this study most subjects prefer a safe asset that prevents losses and provides an average payoff of 25 units, over a risky asset that yields an average return of 100 units but involves frequent losses. An evaluation of the "Gain" problem, in which a constant of 1200 is added to all payoffs, shows that investment in the risky asset is increased once no losses are involved. Thaler et al.'s (1997) note that this pattern is implied by cumulative prospect theory (Tversky & Kahneman, 1992). They write: "an individual with the preferences described by cumulative prospect theory is only mildly risk averse for gambles involving only gains, but strongly risk averse for gambles that entail potential losses" (p. 651).[1] We refer to this assertion as the "relative loss aversion" hypothesis: It implies risk aversion in the gain domain, and stronger risk aversion in the mixed domain. The study in the right-hand side of Table 2, shows that merely changing the numerical description of the payoffs (hereafter referred to as "nominal payoffs") while keeping the actual payoffs constant by using a different monetary unit can dramatically change the choice pattern.[2] Specifically, when the nominal payoffs are low the likelihood of losing does not trigger a stronger risk aversion.

The current paper starts with a focus on the inconsistent results suggested by Tables 1 and 2. Study 1 examines the robustness of these inconsistencies in a simple experimental setting with real incentives. The results highlight two conditions that seem to trigger absolute loss aversion: the presentation of the risky option as an alternative to the status quo, and the use of high nominal payoff magnitudes. The results also show that relative loss aversion occurs only under the latter (high nominal magnitude) condition.

[1] In footnote 2 of their paper Thaler et al. clarified this assertion and noted that it only holds under prospect theory with certain parameters.

[2] Studies from other research domains confirm that people seem to be mainly influenced by nominal rather than actual values. This tendency affects spending behavior when using foreign currencies (Raghubir & Srivastava, 2002), and lead to higher perceived difference between attributes when they are expressed in larger scales, e.g., 900/1000 vs. 800/1000 as opposed to 9/10 vs. 8/10, (Pandelaere, Briers, & Lembregts, 2011).

Table 2: Mixed evidence for relative loss aversion under different variants of binary investment decisions. The notation N(x, y) refers to a draw from a normal distribution with a mean of x, and standard deviation of y. In TN(x, y) the payoff is truncated at 0 (0 is the worst possible payoff).

Evidence for loss aversion	P(Risk)	No evidence for loss aversion	P(Risk)
Binary investment decisions (Data from Barron & Erev, 2003; see also Thaler et al., 1997): Task: Repeated binary choice between two distributions.		Abstract investment decisions with low nominal payoffs (Erev, Ert & Yechiam, 2008): Task: Repeated binary choice between two distributions.	
Mixed problem: Safe: TN(25, 17.7) Risk: N(100, 354)	30%	Mixed problem: Safe: TN(0.25, 0.177) Risk: N(1, 3.54)	51%
Gain problem: Safe: N(1225, 17.7) Risk: N(1300, 354)	51%	Gain problem: Safe: N(12.25, 0.177) Risk: N(13, 3.54)	47%

Study 2 explores the difference between low and high actual stakes. It shows that absolute loss aversion emerges only with high stakes. This result is consistent with the observation that high stakes facilitate risk aversion (Holt & Laury, 2002; Weber & Chapman, 2005).

Study 3 explores the apparent inconsistency between the results of Study 1 and the results of studies that used choice lists (e.g., Tversky & Kahneman, 1992). Choice lists have been used to evaluate the acceptability of a prospect (e.g., a 50% chance to lose 10 and 50% chance to win *x*) over a fixed value/prospect (e.g., a 50% chance to win or lose 1), when one parameter of the riskier prospect (payoff *x* in this example) is systematically varied (e.g., between 8 and 15). Previous studies showed that the riskier prospect is chosen only when its gain (*x*) is larger than the value that equalizes the risky prospect's EV with the fixed prospect's EV (the equalizer value is 10 in the example). Study 3 shows that absolute loss aversion is likely to emerge only when the riskier prospect that equalizes the fixed prospect is listed among the least valuable risky prospects in the choice list, but not when it is placed in the middle of the list. This study also documents a reversal of the relative loss aversion pattern consistent with study 1's results.

Study 4 extends the examination of loss aversion to studies of 90 prospects that include "asymmetric" probabilities. The first part of this study (4a) finds evidence for absolute loss aversion when the prospects are associated with similar expected values, but finds no evidence for loss aversion in the early trials. The second part of this study (4b) finds that absolute loss aversion disappears when some of the problems involve choice between prospects with significantly different expected values. Consistent with the findings from Studies 1 and 3, the results show the reversed pattern from the pattern predicted by relative loss aversion. This reversed pattern is particularly strong when the safer prospect maximizes the probability of a positive outcome in the gain domain (i.e., when the risky prospect in the gain domain includes a zero outcome), but not in the mixed domain.

The results from the current studies suggest that loss aversion is highly sensitive to the context in which the decision is made. People exhibit loss aversion in certain situations, but not in others. The implied attitude toward losses appears to depend on six features of the experimental task.

2 Study 1—Status quo and nominal magnitude effects in one-shot decisions with real incentives

The main objective of Study 1 is to evaluate the robustness of the framing results presented above. The first part of this study (Study 1a) examines if the effect of the status-quo format (Table 1), and the nominal payoff (Table 2) can be observed in one-shot decisions with real incentives. Studies 1b and 1c are designed to clarify these results.

2.1 Study 1a: Replication

2.1.1 Experimental design

The current study focused on the problems presented in Tables 3 and 4. The subjects were 150 undergraduate students. Seventy five subjects were assigned to the low-nominal payoff condition in which the payoffs were pre-

Table 3: Examination of absolute loss aversion under different low-stake real payoff variants of the Samuelson's colleague problem.

Evidence for loss aversion	P(Risk)	No evidence for loss aversion	P(Risk)
Symmetric Samuelson Task: one-shot binary choice You have the opportunity to play a gamble that offers a 50% chance to win 1000 Agoras and a 50% chance to lose 1000 Agoras. Do you want to play it?	32%	Abstract symmetric Samuelson Task: one-shot binary choice Please choose between: 1. 0 with certainty 2. 1000 Agoras with probability of 0.5 −1000 Agoras otherwise (p=0.5)	49%

sented in Sheqels (1 Sheqel = $0.27), and the other 75 were assigned to the high-nominal payoff condition in which the same payoffs were presented in Agoras (1 Sheqel = 100 Agoras). For example, a 10 Sheqels payoff is presented as 10 Sheqels in the low nominal magnitude condition, and as the equivalent 1000 Agoras in the high nominal magnitude condition. So this presentation manipulation did not change the actual payoffs. It only changed the nominal (numerical) payoff magnitude between conditions.

The problems were presented one at a time in random order chosen for each subject. The subjects were told that at the end of the session one problem would be randomly selected and then played for real to determine their final compensation. It was explained that their final payoff will be the sum of a 20 Sheqels showup fee, and the outcome of their choice in the selected problem. The possible final payoff ranged between 10 and 70 Sheqels. Each subject was presented with 17 problems: The target problems, and several fillers. One of the filler problems involved a choice between a safe option (4 Sheqels for sure) and a dominant risky option (7 or 5 Sheqels with equal probability). This problem was included to evaluate people's attention to the different payoffs. The subjects who chose the dominated safe option in this problem were excluded from the analysis.[3]

2.1.2 Results and discussion

The results reveal that the well-known loss aversion patterns can be observed in the current low stakes real incentive setting, but that these patterns are highly sensitive to the exact framing of the prospects. The study of the symmetric Samuelson's problem (Table 3, left) demonstrates that only 32% of the subjects find the prospect "equal chance to win or lose 1000 Agoras" attractive when they are asked if they are willing to play it. This rate is significantly lower than 50%, $Z(63) = 2.89$, $p = .004$, and supports the "absolute loss aversion" hypothesis. The right hand side of Table 3 reveals that when this symmetric Samuelson choice problem is presented as an abstract choice between zero payoff and the same gamble, almost half the subjects (49%) find this prospect of "equal chance to win or lose 1000 Agoras" attractive. The difference between the two variants of Samuelson's problem is significant, $\chi^2(1) = 5.76$, McNemar's test for correlated proportions, $p = .016$. It suggests that the absolute loss aversion pattern is enhanced by the framing of the safe prospect as the status quo.

The symmetric and abstract variants of the Samuelson problems were also compared under low nominal magnitude condition. The problems were equivalent to these in Table 3 except that payoffs were presented as 10 Sheqels instead of 1000 Agoras. The results reveal no evidence for absolute loss aversion neither in the abstract Samuelson problem (P(risk) = 0.52), nor in the symmetric Samuelson problem (P(risk) = 0.53). This finding suggests that the effect of the status-quo framing is enhanced by high nominal magnitude.

The left hand column of Table 4 reflects a relative loss aversion pattern: In the high nominal payoff conditions the typical subject seemed to be *more* risk averse in the mixed problem (P(risk)=38%) than in the gain problem (P(risk)=54%), $\chi^2(1) = 3.125$, McNemar's test, $p = .077$, indicating a nearly significant difference. The right-hand column of Table 4 presents the opposite pattern: In the low nominal payoff condition the subjects were *less* risk averse in the mixed problem (P(risk) = 51%) than in the gain problem (P(risk) = 31%). This difference is significant, $\chi^2(1) = 11.11$, McNemar's test, $p < .001$, and suggests a reversal of the relative loss aversion pattern. The reversal of the relative loss aversion pattern between the high and low nominal magnitudes was confirmed by a repeated measures logistic regression, which revealed a significant interaction between the nominal magnitude (high/low) and the choice domain (mixed/gain), $Z(1)=3.29$, $p = .001$.

[3] After applying this criterion we were left with 63 and 59 subjects in the high and low magnitude conditions respectively. Including all 150 subjects in the analysis does not change the main results.

Table 4: Examination of relative loss aversion in decisions under risk with low nominal payoffs (Sheqels) and high nominal payoffs (Agoras; 1 Sheqel = 100 Agoras)

Evidence for loss aversion	P(Risk)	No evidence for loss aversion	P(Risk)
Abstract investment decisions with high nominal payoffs Task: one-shot binary choice		Abstract investment decisions with low nominal payoffs Task: one-shot binary choice	
Mixed problem with high nominal payoff: Please choose between: 1. 500 Agoras with certainty 2. 1500 Agoras with probability of 0.5 −500 Agoras otherwise (p=0.5)	38%	Mixed problem with low nominal payoff: Please choose between: 1. 5 Sheqels with certainty 2. 15 Sheqels with probability of 0.5 −5 Sheqels otherwise (p=0.5)	51%
Gain problem with high nominal payoff: Please choose between: 1. 4000 Agoras with certainty 2. 5000 Agoras with probability of 0.5 3000 Agoras otherwise (p=0.5)	54%	Gain problem with low nominal payoff: Please choose between: 1. 40 Sheqels with certainty 2. 50 Sheqels with probability of 0.5 30 Sheqels otherwise (p=0.5)	31%

A possible explanation to these opposing patterns involves the assertion that the high nominal magnitude has two related effects: It increases the tendency to simplify the task by focusing on the probability of gains and losses (Payne, 2005), and might also increase confusion. Thus, it moves choice behavior toward random choice in the gain domain (from 31% to 54%), and it leads to loss aversion-like behavior in the mixed domain when the safe option is framed as the status quo, or when it maximizes the probability of gains and minimizes the probability of losses. Implicit in this explanation is the assertion that people tend to exhibit risk aversion in the gain domain even when payoffs are low.[4] Notice that this explanation also captures the risk/loss neutrality observed in the Abstract Symmetric Samuelson problem discussed above (choosing between sure 0 and gaining or losing 1000), in this problem choosing the zero payoff minimizes the probability of loss but also the probability of gain, so the focus on the probabilities of gains and losses implies random choice.

In summary, Study 1a replicates the well-known demonstrations of absolute and relative loss aversion in one-shot decisions with real low stakes incentives, and clarifies the boundaries of these patterns. The study of Samuelson's colleague problem reveals that the absolute loss aversion pattern emerges only when the safe prospect is framed as the status quo and the nominal payoffs are high. The study of relative loss aversion shows that this pattern emerges when the nominal payoffs are high, but the opposite pattern emerges when the nominal payoffs are low. Studies1b and 1c were designed to evaluate the robustness of these boundaries of loss aversion.

[4]This prediction of prospect theory was supported by many previous studies. For example, only 35% of the subjects in Erev et al.'s (2010) decisions from description condition preferred the gamble "11.5 with probability 0.6; 3.7 otherwise" (expected value of 8.08) over a sure gain of 7.9.

2.2 Study 1b—The possibility of losses

Under one explanation of the risk neutrality documented in the abstract mixed conditions of Study 1a (the abstract symmetric Samuelson problem and the mixed problem with low nominal payoff) it reflects a house money effect (Thaler & Johnson, 1990): That is, the subjects were informed that possible losses would be covered by their participation fee, and for that reason did not treat them as real losses. Study 1b examines the robustness of the results in an environment that minimizes the house money effect. In order to facilitate the generation of real losses, subjects were recruited for two experiments: the one that is reported here, and a filler (unrelated) experiment. The earnings from the filler experiment ranged between 20 and 32 Sheqels. The order of the experiments was counterbalanced. Subjects were told that they will be paid for their effort in the filler study, and that they can win or lose money in the target study. That is, we followed Holt and Laury's (2002) suggestion to let subjects "work" for the money.

The experiment focused on the following pair of problems (the outcomes represent payoffs in Sheqels, decisions were made for real money):

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The mixed problem:
Safe: 10 with probability 0.5 [P(risk) = 0.58], −10 otherwise
Risk: 20 with probability 0.5, −20 otherwise

The gain problem:
Safe: 30 with probability 0.5 [P(risk) = 0.31], 10 otherwise
Risk: 40 with probability 0.5, 0 otherwise

2.2.1 Experimental design

Seventy-two Technion students served as paid subjects in this study. The subjects sat in front of personal computers and were presented with each of the two problems shown above. Problem Gain was created by adding a constant to all payoffs of Problem Mixed. In each problem, subjects were asked to mark the prospect they preferred to play. The order of the problems was balanced over subjects. At the end of the experiment one problem was randomly selected, and its payoff was realized according to the subjects' choice in that problem. Final payoffs of the target experiment ranged between a loss of 20 Sheqels and a win of 40 Sheqels (−$5 and +$10).

2.2.2 Results and discussion

The choice rates of the risky options are presented to the right of the two problems. The proportions of risky choices were much higher in the mixed problem (58%) than in the gain problem (31%).[5] This pattern replicates the results of Study 1a (see right hand side of Table 4) and implies a significant reversal of the relative loss aversion pattern, $\chi^2(1) = 11.11$, McNemar's test, $p < .001$. This reversal is consistent with people's risk aversion among gains, and the finding of risk/loss neutrality in the mixed domain. It is also possible that the reversal reflects a tendency maximize the probability of a positive outcome (and avoid the zero outcome). We evaluate this possibility in the studies below.

The current findings replicate the results of the low magnitude condition in study 1a, suggesting that the results of study 1a cannot be attributed to a house money effect.

[5] We also checked for possible order effects: neither the ordering of the two problems, nor the ordering of the two experiments had an effect on the current results. In all four orders the proportion of risky choice in the mixed problem was extensively higher than in the gain problem. It is also worth noting that the proportion of risk taking in the mixed problem is not significantly different from 50%, $Z(71) = 1.41$, $p = .194$.

2.3 Study 1c—Risk taking in 90 low nominal-magnitude problems

Study 1c was designed to evaluate the generality of the current results in a multi-problem choice setting. In this setting, subjects face many consecutive, but independent, choice problems and make choices separately for each problem, without realizing the outcomes of their choices. At the end of the study one problem is randomly selected and played for real to determine the subject's payoff. This design is popular among studies of decisions under risk (e.g., Brooks & Zank, 2005; Erev et al., 2010; Rieskamp, 2008).

As in Studies 1a and 1b, Study 1c focuses on a comparison of choice among prospects that involve gains and losses (mixed condition) and choice among prospects with nonnegative outcomes (gain condition). The mixed condition examined the 90 decision problems presented in Appendix 1. The problems were counterbalanced in terms of the EV associated with the different alternatives. In 40 problems the riskier prospect was associated with the higher EV, in another 40 problems the riskier prospect was associated with the lower EV, and in 10 problems both prospects had the same EV. The gain condition examined 90 problems that were created by adding a constant to the payoffs of the mixed problems. This constant was the sum of the absolute value of the largest possible loss (in the original mixed problem) plus a random draw from the set {0, 1, 2, 3}. This rule implied that in ¼ of the problems in the gain condition the low payoff from the risky prospect was zero, and in ¾ of the problems it was higher.

2.3.1 Experimental Design

Forty six students participated in this study. Each subject was seated in front of a personal computer and was then presented with the 90 choice problems (the mixed problems or their positive linear transformation to gains). Twenty two subjects were assigned to the mixed condition and 24 to the gain condition. The order of the problems was randomized for each subject. The subjects received a show up fee of 30 Sheqels. At the end of the experiment one of the problems was randomly selected to determine the subject's final payoff, which ranged between 9 and 62 Sheqels ($2.25 and $15.5, respectively).

2.3.2 Results and discussion

Across all problems without a dominant option, the proportion of risky choices was 48% in the mixed condition and 43% in the gain condition. Consistent with the previous studies subjects did not exhibit absolute or relative loss aversion. Rather, the results suggested, if anything, a reversal of relative loss aversion. To test the significance of this trend we calculated a risk taking score for each subject (the proportion of risk taking over all problems) and then compared these scores between the two conditions. The results showed that in the current setting the reversed relative loss aversion trend is not significant, $t(44) = 1.04$, $p = .30$.

A similar pattern was documented in an analysis of the ten problems with the same EV. The rate of risky choice over these problems was 51% in the mixed condition and only 41% in the gain condition. Once again, although the direction of this pattern suggests reversed relative loss aversion, the difference between conditions did not reach significance, $t(44) = 1.00$, $p = .320$.

Recall that in about ¼ of the problems in the gain domain the low payoff from the riskier option was zero (no gains). Thus, it is possible that the observed risk aversion between gains was driven by people's reluctance to the risk of not gaining. To evaluate this possibility we analyzed the problems that included a zero payoff, and compared them with the other problems. The results reveal that the proportion of risk taking in the gain domain was 37% when the low payoff was zero, and 45% when the low payoff was higher. A paired sample t-test shows a nearly significant difference, $t(23) = -1.85$, $p = .077$, suggesting that the zero payoffs facilitated risk aversion. Analysis of the problems that do not include zero shows that the rate of risk taking (45%) is not significantly lower than 50% ($t(23) = -1.50$, $p = .147$) and is not significantly lower than the rate of risk taking in the mixed condition, $t(44) = 0.51$, $p = .611$.

The findings of Study 1c suggest that the results of Studies 1a and 1b are not unique to specific problems: across 90 problems subjects did not exhibit neither absolute nor relative loss aversion while choosing between simple prospects.

3 Study 2—The effect of high stakes

Study 1a demonstrated the effect of the nominal magnitude on relative loss aversion, yet the actual payoff magnitude was fixed, and was relatively low. The current study is aimed to complement study 1a by exploring the potential effect of real payoff magnitudes on loss aversion. Although the abstraction of loss aversion in prospect theory does not address any magnitude effect, there are reasons to believe that behavior might be highly affected by payoff magnitude. First, while not addressing this empirically, Kahneman and Tversky (1979, p 279) have noted that *"the aversiveness of symmetric fair bets generally increases with the size of the stake"*. Second, a magnitude effect on risk aversion is often found: risk aversion increases with the payoff magnitude. This phenomenon has been labeled as "relative risk aversion" (Holt & Laury, 2002), and "the peanuts effect" (Weber & Chapman, 2005). Third, a recent study found a payoff magnitude effect on loss aversion in pleasantness ratings of losing (or finding) a monetary sum, and when the subjects are asked to indicate the amount of money they would be willing to risk losing in a hypothetical coin flip game (Harinck et al., 2007). The current study explores the robustness of this potential effect in the domain of risky choice and real incentives.

3.1 Experimental design

Forty six undergraduate students participated in the current study. All subjects were presented with the four problems presented in Table 5 in a 2X2 design (stakes: Low/High, domain: Mixed/Gain) and several filler problems. At the end of the study one problem was randomly selected and played for real and the subjects realized the payoff in that problem. All payoffs were described in Sheqels. The subjects' show-up fee was contingent upon the randomly selected problem.[6] It was composed from the low value from R (the riskier option) in that problem and additional 5 Sheqels. Subjects were not told about this show-up payoff rule. They were just told that they play the gambles for real payoffs, that they will get some show-up fee at the end of the session, and that any losses or gains will be subtracted/added to their show-up fee.

3.2 Results and discussion

The left hand-side of Table 5 that presents the high stakes problems reveals that only a minority of the subjects (22%) find the prospect: "equal chance to win or lose 100" attractive. This rate is significantly smaller than 50%, $Z(45)= 3.83$, $p < .001$, and supports the "absolute loss aversion" hypothesis. The results further show that a similar rate (26%) found the prospect "equal chance to win 200 or 0" attractive. Thus, there was no evidence for a relative loss aversion in this study ($\chi^2(1) = .22$, McNemar test for the difference in risk taking between the two problems). The right hand-side of Table 5, which presents the results of the low-stakes condition, shows no evidence for absolute loss aversion: the rate of risky choice is 48%, which is not significantly different from 50%, $Z(45) < 1$, NS. Furthermore, the risk aversion in the gain domain disappears as well: the rate of risky choice is 43% and does not significantly differ from 50%.

The differences between the proportions of risk taking between the high and low stakes conditions are significant both in the mixed domain ($\chi^2(1) = 10.28$, $p = .001$,

[6] The reason for this payment scheme is that using a flat show-up fee would require endowing all subjects with at least 100 Sheqels (so they can lose 100) which seems wasteful for such a short study.

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Table 5: The low and high stakes problems examined in Study 2 (outcomes represent payoffs in Sheqels, decisions are for real money).

	High stakes	P(Risk)	Low stakes	P(Risk)
Mixed	S: 0 for sure R: 100 with probability of 0.5 −100 otherwise (p=0.5)	22%	S: 0 for sure R: 10 with probability of 0.5 −10 otherwise (p=0.5)	48%
Gain	S: 100 for sure R: 200 with probability of 0.5 0 otherwise (p=0.5)	26%	S: 10 for sure R: 20 with probability of 0.5 0 otherwise (p=0.5)	43%

McNemar test) and in the gain domain ($\chi^2(1) = 4.00$, $p = .045$, McNemar test).

Taken together, the results suggest a robust payoff magnitude effect on loss aversion: absolute loss aversion is observed under high stakes but not under relatively low stakes.

4 Study 3—Choice lists and the contrast effect

The results presented above appear to be inconsistent with several previous studies that have documented absolute and relative loss aversion in decisions among relatively low stake prospects. The clearest demonstrations of loss aversion in experiments that involve real incentives come from studies that have used the choice list paradigm. In the typical choice list study subjects are asked to compare a sequence of similar binary risky prospects to a single safe prospect. The common results reveal absolute loss aversion: When the gambles have similar expected values, the subjects prefer the safe prospect over a riskier mixed gamble. For example, Tversky and Kahneman (1992) found that most subjects prefer "0 for sure" over a gamble that promises an equal chance to win or lose 25. Similarly, they found that most subjects prefer a gamble that promises an equal chance to win 50 or lose 25 over a gamble that promises an equal chance to win 100 or lose 50. The typical subjects in these studies behave as if losses loom about twice as large as gains. For example, most subjects exhibit indifference between "0 for sure" and "equal chance to win 60 or lose 25". Similar results were documented by Fehr and Goette (2007) and Gaechter, Johnson, and Herrmann (2010).

The main goal of Study 3 is to highlight the importance of one contributor to the difference between the current results and the typical results from choice list studies. It focuses on the role of the contrast effect (Sherif, Taub, & Hoveland, 1958; Stewart et al., 2003), which refers to the subject's tendency to draw on non-target stimuli as a reference for assessing the target stimuli (see related findings by Schwarz, 1999). For example, consider a person that likes only one "target" item in the desert menu. The contrast effect implies that this target item will feel more expensive when it is the most expensive item in the menu, than when it is the cheapest item in the menu.

The experiments reported in Study 1 control for the contrast effect by minimizing comparisons between different risky prospects (and by insuring similar expected values for the safe and the risky prospects). In contrast, the clearest demonstration of loss aversion comes from choice lists studies that allow for the possibility of a contrast effect. The current study examines the significance of the contrast effect by comparing the four sets of problems presented in Table 6. Notice that each set has one target pair (in bold) in which the safe and the risky prospects have the same expected value. The two sides of Table 6 differ with respect to the ranking of the relative attractiveness of the target risky prospect in the set. The risky target has low rank on the left side of the table (the "biased" sets), and it has the median rank on the right side of the table (the "balanced" sets). As in our previous studies we examine a "mixed" condition, which comprises gambles that include both gains and losses, and a "gain" condition in which a constant is added to all payoffs to exclude the possibility of losses.

4.1 Experimental design

One hundred and fifty students participated in the study. They were randomly assigned to one of four conditions and received a one-page questionnaire with seven choice problems that corresponded to one of the four sets presented in Table 6 (biased-mixed, biased-gain, balanced-mixed, or balanced-gain). As in Study 1b, the subjects were recruited for two experiments: the current "target" study, and a filler experiment, and the subjects in the mixed condition knew that in case of losing in the target study their losses would be subtracted from their earnings in the filler study. The earnings from the filler experiment averaged around 30 Sheqels, and the order of the experiments was counterbalanced. Final earnings of the target

Table 6: The four sets of gambles and the observed choice rates in Study 3. The notation (x, p; y) refers to a two-outcome prospect that yields a payoff of x with probability p and a payoff of y otherwise.

Evidence for absolute loss aversion			No evidence for absolute loss aversion		
Biased Mixed			Balanced Mixed		
Safe	Risk	P(Risk)	Safe	Risk	P(Risk)
(+2, 0.5; -2)	**(+10, 0.5; -10)**	**0.34**	(+2, 0.5; -2)	(+4, 0.5; -10)	0.03
(+2, 0.5, -2)	(+12, 0.5; -10)	0.50	(+2, 0.5, -2)	(+6, 0.5; -10)	0.15
(+2, 0.5, -2)	(+14, 0.5; -10)	0.53	(+2, 0.5, -2)	(+8, 0.5; -10)	0.36
(+2, 0.5, -2)	(+16, 0.5; -10)	0.74	**(+2, 0.5, -2)**	**(+10, 0.5; -10)**	**0.62**
(+2, 0.5, -2)	(+18, 0.5; -10)	0.79	(+2, 0.5, -2)	(+12, 0.5; -10)	0.79
(+2, 0.5, -2)	(+20, 0.5; -10)	0.87	(+2, 0.5, -2)	(+14, 0.5; -10)	0.85
(+2, 0.5, -2)	(+22, 0.5; -10)	0.89	(+2, 0.5, -2)	(+16, 0.5; -10)	0.92
	Mean	0.67		Mean	0.53
Biased Gain			Balanced Gain		
Safe	Risk	P(Risk)	Safe	Risk	P(Risk)
(12, 0.5; 8)	**(20, 0.5; 0)**	**0.23**	(12, 0.5; 8)	(14, 0.5; 0)	0.03
(12, 0.5; 8)	(22, 0.5; 0)	0.20	(12, 0.5; 8)	(16, 0.5; 0)	0.05
(12, 0.5; 8)	(24, 0.5; 0)	0.31	(12, 0.5; 8)	(18, 0.5; 0)	0.10
(12, 0.5; 8)	(26, 0.5; 0)	0.46	**(12, 0.5; 8)**	**(20, 0.5; 0)**	**0.21**
(12, 0.5; 8)	(28, 0.5; 0)	0.63	(12, 0.5; 8)	(22, 0.5; 0)	0.44
(12, 0.5; 8)	(30, 0.5; 0)	0.80	(12, 0.5; 8)	(24, 0.5; 0)	0.67
(12, 0.5; 8)	(32, 0.5; 0)	0.83	(12, 0.5; 8)	(26, 0.5; 0)	0.79
	Mean	0.49		Mean	0.33

study ranged between a loss of 10 Sheqels and a gain of 26 Sheqels.

4.2 Results and discussion

The top left hand side of Table 6 presents the results for the biased-mixed condition. The observed proportion of risk-taking in the target problem ("+2, −2" or "+10, −10") was 34%. This rate is consistent with the prediction of absolute loss aversion, and is nearly significantly lower than 50%; $Z(37) = 1.95$, $p = .052$. A different pattern is documented in the balanced mixed condition (Table 6, top right). The proportion of risk-taking in the target problem of this condition was 62% (not significantly different than 50%, $Z(38) = 1.44$, $p = .149$). The difference between the two conditions is significant, $\chi^2(1) = 5.76$, $p = .016$, as predicted by the contrast effect.

A comparison of the gain and the mixed conditions in Table 6 reveals a reversed relative loss aversion pattern: Stronger risk aversion in the gain domain. This effect is mild in the biased conditions, and is clearer in the balanced conditions. The proportions of risk-taking in the biased conditions (mixed vs. gain) are 34% vs. 23% in the target problems, $\chi^2(1) = 1.15$, $p = .284$, and 67% vs. 49% over all seven problems, $t(71) = 2.58$, $p = .022$. The proportions of risk taking in the balanced conditions (mixed vs. gain) are 62% vs. 21% in the target problems, $\chi^2(1) = 13.56$, $p < .001$, and 53% vs. 33% over all seven problems, $t(76) = 3.78$, $p < .001$. The reversal replicates the previous low stake studies in finding risk neutrality between mixed gambles, and replicates the common finding of risk aversion in the gain domain. Since the gain gambles involved zero outcomes, it is also possible that the risk aversion among gains was further facilitated by "zero avoidance".

In summary, the results show that the evidence for absolute loss aversion is sensitive to the contrast effect: In the current context, a manipulation of the contrast effect drives the implied absolute loss aversion pattern. This observation is not likely to surprise students of the contrast effect (see similar observations by Sherif & Hoveland, 1961; Sherif, Taub, & Hoveland, 1958, and see Stewart et al., 2003 analysis in the domain of risky choice), but it is often ignored in the study of loss aversion. In addition, the results show that decisions among low stake and low nominal magnitude might reflect a reversed relative loss aversion pattern; the subjects were *less* risk averse in choice between gains and losses (the mixed conditions) than in choice between nonnegative payoffs (the gain conditions).

5 Study 4: Beyond fifty-fifty prospects

The main objective of Study 4 is to improve our understanding of the difference between the results from Study 1c that finds no evidence for loss aversion in the multi-problem setting (90 independent choices between low-magnitude prospects), and the results from several previous studies that indicated evidence for loss aversion in such settings (Brooks & Zank, 2005; Erev et al., 2010). The main difference between these studies and Study 1c is that the latter was focused solely on fifty-fifty gambles (i.e., gambles with two-possible outcomes, each occurring with 50% probability). There are reasons to believe that this difference might have contributed to the contingent findings. As noted by Wakker (2013), it is possible that mixed fifty-fifty gambles (gambles with two equally likely outcomes) simply trigger more risk taking than other gambles.[7] Studies 4a and 4b evaluate this hypothesis by examining 90 "asymmetric" prospects: gambles that are associated with probabilities that are different from 50%.

5.1 Study 4a. Risk taking in 90 low nominal-magnitude problems with similar EV

Several previous attempts to extend the study of mixed gambles beyond the fifty-fifty setting (Brooks & Zank, 2005; Erev et al., 2010) reveal an absolute loss aversion tendency that appears to contradict the results documented in Study 1. To explore the relation to previous studies, Study 4a focuses on choice between 90 asymmetric gambles with similar expected values. The problems are presented in Appendix 2.

5.1.1 Experimental design

Sixty students participated in the current study. Thirty subjects were assigned to the mixed condition and 30 to the gain condition. The study used the same procedure as described in Study 1c with the exception of the set of problems. The problems examined here (Appendix 2) involve a choice between asymmetric risky and safe prospects with similar EV. As in Study 1c, each subject faced 90 consecutive problems without feedback. The problems in the gain condition were created by adding a constant to the payoffs of the mixed problems. This constant was the sum of the absolute value of the largest possible loss (in the original mixed problem) plus a random draw from the set {0, 1, 2, 3}. As in Study 1c subjects received a show-up fee of 30 Sheqels. At the end of the experiment one problem was randomly selected to determine the subject's final payoff, which ranged between 12 and 53 Sheqels (about $3 and $13.25, respectively).

5.1.2 Results and discussion

The overall proportion of risk taking in the mixed condition was 41%, which was significantly lower than 50%, $t(29) = -2.31$, $p = .03$; thus, the results reflect absolute loss aversion. The rate of risky choice in the gain condition was only 28% which was even lower than the level of risky choice in the mixed condition, $t(58) = -2.39$, $p = .02$. This difference documents, once again, a reversed relative loss aversion pattern.

To address the possibility that zero payoffs influenced risk taking in the gain domain we analyzed separately the problems in which the low payoff from the risky prospect was zero, and the ones in which it was higher. The proportion of risk taking was 20% when the low payoff was zero, and 30% when it was higher. A paired sample t-test shows that the difference is significant, t(29) = −3.17, p = .0036, suggesting that zero payoffs facilitated risk aversion. Yet, even when low payoffs were larger than zero, the level of risk taking (30%) was significantly below 50% (t(29)= −5.06, p < .0001) and was nearly significantly lower than the risk taking in the mixed condition, t(58) = 1.87, p = .066.

The difference between Study 1c, which did not document an absolute loss aversion (48% risk taking between mixed prospects), and Study 4a, which did (41% risk taking between mixed gambles; and the similar results by Brooks & Zank, 2005; Erev et al., 2010), is consistent with the assertion that fifty-fifty gambles might facilitate risk taking and reduce the tendency to exhibit absolute loss aversion. A potential explanation of the difference between the fifty-fifty prospects and prospects with other probabilities is that fifty-fifty prospects seem easier to evaluate. Since the outcomes are occurring with the same probability, one needs only to compare the relative gains and losses without computing probabilities. This explanation implies that risk seeking can be also facilitated by other means of simplifying choice even when the prospects are not associated with a probability of 50%. One such means could be making the differences between

[7] This observation is consistent with the results of several previous studies of fifty-fifty gambles that include symmetric gains and losses and show no evidence for risk aversion in choice between such gambles (Battalio, Kagel, & Jiranyakul, 1990; Thaler & Johnson, 1990; Yechiam & Ert, 2011). Coombs and Pruitt (1960) speculated that fifty-fifty gambles are relatively popular because they are simpler than other gambles.

prospects more apparent in some problems by increasing the difference between their expected values. Study 4b is designed to evaluate this implication.

5.2 Study 4b: Risk taking in 90 low nominal-magnitude problems with different EV

The current study uses the same method as Study 4a to study the 90 problems presented in Appendix 3. Like Study 4a, the current study includes many problems in which the EV of the two prospects is similar. The main distinction between the problems considered here and those considered in Study 4a is that the current study also includes problems with higher EV differences between prospects. To clarify this difference we computed the relative EV difference as REV = (EV[R]−EV[S])/std[R], where EV[R] and EV[S] are the expected values of the two prospects, and std[R] is the standard deviation of the riskier prospect. As Table 7 shows, all Problems in Study 4a had absolute REV below 0.10; in the current study (4b) 60 of the 90 problems have absolute REV above 0.10. The difference in expected values between the safer and riskier prospects is counterbalanced: the riskier gamble is associated with the higher EV than the safer gamble in 30 problems, lower EV in another 30 problems, and almost equal EV in the remaining 30 problems.

5.2.1 Experimental Design

Forty two students participated in this study. Each subject was presented with the 90 choice problems (Appendix 3). Twenty one subjects were assigned to the mixed condition and 21 to the gain condition, which was created by the same procedure as in Study 4a. The order of the problems was randomized for each subject. Subjects received a show-up fee of 30 Sheqels. At the end of the experiment one of the problems was randomly selected to determine the subject's final payoff, which ranged between 15 and 52 Sheqels ($3.75 and $13, respectively).

5.2.2 Results and discussion

The right-hand side of Table 7 shows the main results of Study 4b (the left-hand side shows the results of study 4a). The table reveals that the overall proportion of risk taking in the mixed condition of Study 4b was 50%. Thus the results show no evidence for absolute loss aversion. The proportion of risk taking in the gain condition was significantly lower (26%), $t(40) = 4.61$, $p < .0001$. This result shows a reversed relative loss aversion tendency, which is in line with the previous study.

The rate of risky choice across the 30 problems with similar EV was 51% in the mixed condition of Study 4b and only 21% in the gain condition, $t(40) = 5.08$, $p < .0001$. Once again, these observations show no evidence for absolute loss aversion and significant evidence for reversed relative loss aversion.

An evaluation of the effect of zero payoffs on risk raking in the gain domain reveals that the proportion of risk taking in the gain domain was 18% when the low payoff was zero, and 29% when the low payoff was higher. A paired sample t-test shows that the difference is significant, $t(20) = -3.8$, $p = .001$, suggesting that zero payoffs from the risky prospect facilitated risk aversion. Yet, even when the low payoff is larger than zero the level of risk taking was significantly below 50%, ($t(20) = -7.95$, $p < .0001$) and significantly lower than the risk taking in the mixed domain, $t(40) = 4.03$, $p < .001$.

The difference between the results of Study 4a (41% risk taking between mixed gambles) and Study 4b (50% risk taking between mixed gambles) suggests that the counter-evidence to absolute loss aversion is not unique to fifty-fifty prospects. It supports the idea that simplifying choice, either by focusing on fifty-fifty prospects, or by increasing the expected value differences even if only in some problems, may eliminate the tendency to exhibit absolute loss aversion.

5.3 The effect of repeated experience without feedback, and a speculation

Figure 1 presents the proportion of choices of the riskier mixed gamble over time in the three long studies presented above (1c, 4a, and 4b) and in the two published studies that have motivated Study 4a (Brooks & Zank, 2005; and Erev et al., 2010). The data suggest that the discrepancy between the different studies increases with time. The initial behavior in all five studies appear to reflect risk neutrality (the choice rates in the first block do not differ from 50%), but at least in some cases experience significantly increase risk aversion. A paired t-test comparison of risk taking levels per subject between the first and last block of trials suggests that the increase in risk aversion with time is significant in the studies that documented an absolute loss aversion tendency (Study 4a: $t(29) = 2.48$, $p = .019$; Erev et al.: $t(39) = 2.17$, $p = .036$, and nearly significant in Brooks and Zank's study: $t(48) = 1.86$, $p = .069$), but is insignificant in the other two studies that have not found evidence for loss aversion (Study 1c: $t(21) = 0.32$, $p = .750$; Study 4b: $t(20) = 1.44$, $p = .165$).

Recall that the subjects in the current studies did not receive any feedback concerning the outcomes of their choices. Thus, the effect of time is not a reflection of reaction to feedback. We speculate that the effect of time may be an indication of learning without feedback (Weber, 2003). Specifically, it is possible that at

Table 7: Summary of studies 4a and 4b. N is the number of problems in each category. The 90 gambles in each condition were classified based on REV: the normalized difference between the EV (expected value) of Prospect R and the EV of Prospect S. REV = (EV[R]−EV[S])/std[R], where std[R] is the standard deviation of Prospect R.

		Evidence for loss aversion (Study 4a)		No evidence for loss aversion (Study 4b)	
Condition	REV	N	P(Risk)	N	P(Risk)
Mixed	Smaller than -0.20		-	8	0.22
	From -0.20 to -0.11		-	22	0.26
	From -0.10 to -0.01	18	0.43	8	0.47
	0	48	**0.40**	14	**0.53**
	From 0.01 to 0.10	24	0.41	8	0.53
	From 0.11 to 0.20		-	22	0.70
	Larger than 0.20		-	8	0.80
		Mean	**0.41**		**0.50**
Gain	Smaller than -0.20		-	8	0.04
	From -0.20 to -0.11		-	22	0.06
	From -0.10 to -0.01	18	0.29	8	0.18
	0	48	**0.28**	14	**0.21**
	From 0.01 to 0.10	24	0.26	8	0.23
	From 0.11 to 0.20		-	22	0.51
	Larger than 0.20		-	8	0.55
		Mean	**0.28**		**0.26**

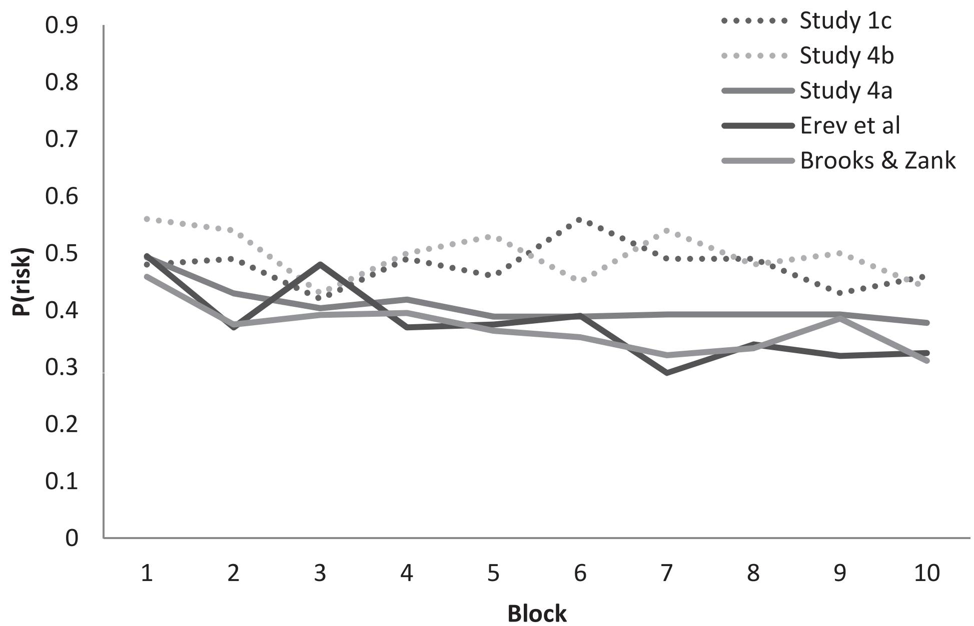
the initial trials of the experiment the subjects tend to consider several strategies: compensatory strategies like the expected value maximization rule or equal weighting (Dawes & Corrigan, 1974), as well as simpler and non-compensatory strategies like "minimize the probability of loss" (Payne, 2005; Wu & Markle, 2008) or "maximize the worst possible payoff". When all the strategies lead to similar expected outcomes, the subjects "learn" to favor the simpler strategies. If the simpler strategies are more likely to imply loss aversion (e.g., its plausible that taking shortcuts increases attention to worst case scenarios implied by these shortcuts), the absolute loss aversion pattern is expected to emerge with time when these strategies save effort and have little effect on the expected outcomes (Studies 4a, Erev et al. and Brook & Zank), but not when the EV maximization rule is easy to use (fifty-fifty studies like 1c) or when it is easy to see that the simple rules impair expected return (large REV as in Study 4b).

Partial support for the current speculation is provided by a post-hoc analysis that focuses on the correlation between the difference between the prospects' expected values [EV(safe)-EV(risk)] in the first block of trials in Study 4b, and the proportion of safe choices in the subsequent trials. The correlation over the 42 subjects is positive and significant (r = 0.41, p < .01). Subjects who experienced that EV(safe) > EV(risky) in the first block of 9 trials were more likely to prefer the safer option in subsequent trials (exhibiting an "absolute loss aversion"), than subjects who experienced EV(safe) < EV(risky) in the first trials. Thus, early examples of the value of simple rules that favor the safe option (e.g., "maximize the worst payoff") in the first few trials increased the tendency to make choices consistent with it.

6 Discussion and conclusions

The current paper presents six clarifications of the descriptive value of the loss aversion assertion in decisions under risk. The first two clarifications focus on the conditions that give rise to *relative loss aversion* (stronger risk aversion in choice between mixed payoffs that include both gains and losses than in choice between nonnegative outcomes). The results summarized in Table 4 (Study 1a) show that this tendency emerges when two conditions are satisfied: *(1) the safer prospect increases the probability of a positive outcome in the mixed domain but not in*

Figure 1: Proportion of choices of the riskier mixed gamble over time in Study 1c, 4a, 4b, and the studies reported by Erev et al. (2010) and Brooks and Zank (2005). The data is summarized in 10 blocks of 9 trials. The dashed lines represent studies that included choice between both similar and different EV prospects (studies 1c, 4b), and the continuous lines represent studies that focused only on choice between similar EV prospects (Erev et al., Brooks and Zank, Study 4a).



the gain domain, and (2) the prospects involve high nominal payoff magnitude. In addition, Table 4 presents a reversed relative loss aversion tendency under low nominal payoff magnitude. Our subsequent studies that focus on low nominal magnitudes (1b, 1c, 3, 4a, and 4b) showed a reversed relative loss aversion tendency: stronger risk aversion in choice between gains than between mixed prospects. This pattern was particularly strong when the safer prospect increases the probability of a positive outcome in the gain domain (i.e., when the risky prospect in the gain domain includes a zero outcome) but not in the mixed domain. Thus, it can be a reflection of a tendency to maximize the probability of gains (Payne, 2005).

The other clarifications shed light on the conditions that give rise to *absolute loss aversion* (risk aversion in choice between gambles that involve both gains and losses). The most important clarification in this class involves the effect of *framing of the safe prospect as the status quo*: Table 3 (Study 1a) shows that absolute loss aversion is facilitated by this framing: Absolute loss aversion appears when people are asked whether they would accept a gamble (so the gamble is framed as the alternative to the status quo), and diminishes when people are asked to simply choose between prospects. Studies 1b and 1c show the robustness of this pattern in choice among low magnitude fifty-fifty gambles.

A forth clarification involves the *magnitude of actual stakes*: Study 2 demonstrates that absolute loss aversion is observed under high, but not under low stakes.

The fifth clarification involves the use of the choice list paradigm that facilitates the *contrast effect*. Study 3 shows a clear tendency of absolute loss aversion when the risky prospect in the target problem is relatively unattractive: that is, most of the other problems include more valuable risky prospects. This tendency was eliminated when the relative attractiveness of the prospects in the target problem was balanced.

The final clarification involves the emergence of absolute loss aversion in long studies with asymmetric gambles. Study 4a shows evidence for absolute loss aversion in a long study that focuses on asymmetric gambles with similar expected values. Study 4b shows that when problems of choice among prospects with significantly different expected values are also included, the absolute loss aversion tendency is diminished even in choices between the prospects with similar EV. We speculate that these and similar results can be captured with the hypothesis of some learning without feedback. Specifically, it is possible that the tendency to follow simple strategies that imply loss aversion increases over time when these strategies are effective (i.e., when they reduce effort without impairing expected return).

6.1 Two interpretations

The implications of the current results to the loss aversion hypothesis can be described in two very different ways. One description implies that each of the six clarifications sheds light on one manipulation that generates loss aversion, and on the boundaries of this effect. The alternative description implies that the current results shed light on manipulations that mask a general loss aversion tendency.

The "masking" interpretation is consistent with McGraw et al.'s (2010) demonstration that the judgment of the absolute magnitude losses is larger than the absolute judgment of gains. However, there are also important shortcomings of this interpretation. First is the observation that the judgment results, like the choice results, are slippery. In a recent paper Yechiam et al. (2013) replicated McGraw et al.'s findings when the subjects wore eye tracking glasses, and then eliminated the effect by telling participants that the glasses detect lies (and that the detection of lies will reduce their payoff). Yechiam et al. note that this pattern can be a reflection of an overgeneralization of a complaint bias: People complain (overrate the losses, and underrate the gains) because there are many situations in which complaining is effective.

A more significant shortcoming of the "masking" interpretation is the fact that it is less careful. Unlike the masking interpretation, the "generators" interpretation describes the current results, and does not add untested assertions. That is, it does not assume specific attitude toward losses in the situations that were not studied here.

Another advantage of the generators summary is the observation that at least five of the current clarifications are reflections of well-known and robust behavioral tendencies, rather than situation-specific masks. The effect of nominal (numerical) payoffs on relative loss aversion can be captured with the assertion that the tendency to maximize probability of a gain (Payne, 2005) is enhanced by large nominal (numerical) payoffs. Under one explanation of this pattern it reflects stronger diminishing sensitivity with the increase of nominal representation of payoffs (Erev et al., 2008), which seems consistent with research of the psychophysics of numbers (e.g., Deane, 2007).

The observed sensitivity of absolute loss aversion to the framing of the safe alternative as the status quo simply reminds us that loss aversion is only one of many contributors that have been suggested to explain the status-quo bias (e.g., Anderson, 1993; Gal, 2006; Ritov & Baron, 1992; Samuelson & Zeckhouser, 1988). Thus, the framing of option as a status quo increases its attractiveness even when this framing does not change the predictions of loss aversion as captured by prospect theory (Kahneman & Tversky, 1979).

The effect of payoff magnitude is anything but surprising. As noted by Rabin (2003) the traditional implementation of expected utility theory overestimates this effect. Loss aversion is important to capture risk aversion in choice among low stake gambles, but our results suggest that this pattern is not general: there are many situations in which people exhibit risk neutrality in choice among low stakes mixed gambles.

The large impact of the contrast effect, documented in Study 3, is not likely to surprise students of the contrast effect. Previous research has shown the importance of this effect in decisions under risk (see Stewart et al., 2003). We chose to include a replication of this well-known effect here because it is often ignored in the study of loss aversion. We hope that the current clarification of the significance of this effect will help to reduce this tendency.

Another advantage of the generators summary is implied by the fact that our research focused on the well-known demonstrations of the loss aversion pattern (i.e., the Samuelson Colleague's problem presented in Table 1 and the Thaler et al. investment problem presented in Table 2). The current results show that each of these demonstrations has clear boundaries. The evidence for a general loss aversion bias would look much weaker had we used a different problems selection criterion. In particular, we could focus on factors that generate behavior that appears to reflect a reversed loss aversion bias. One example is betting behavior. The framing of the choice task as a betting game leads most subjects to participate in betting games with negative expected return (Sonsino et al., 2002). Another example is multi-alternative investment decisions with feedback. Ben Zion et al. (2010) show that in this setting people tend to prefer risky stocks over safer index funds with higher expected return. A third example comes from studies of market entry games (Erev, Ert & Roth, 2010). Analysis of the initial behavior in these games shows that 70% of the subjects favor a risky entry to the market that can lead to unspecified gain or loss, over a safer option. A forth example is provided by Slovic et al. (2002). They noticed that the addition of a small loss (of 5 cents) to the gamble "7/36 chance to win \$9, and \$0 otherwise" increases the tendency to select it over a safer prospect with higher expected value. Finally, Yechiam and Hochman (2013) show that the addition of losses can increase the tendency to choose a gamble over a safer prospect with lower expected return.

Table 8: Empirical estimates of the loss aversion parameter. The described payoffs are the payoffs described in the experimental task, the actual payoff is the actual realization of the described payoff ("None" means that payoffs were hypothetical).

Study	λ estimate	Described payoffs	Actual payoffs
Andersen et al. (2010)	0.78−1.01	Up to $8	−$8 to $8
Reiskamp (2008)	1.00	Up to €100	−€5 to €5
Harrison & Rutström (2009)	1.38	Up to $8	−$8 to $8
Schmidt & Traub (2002)	1.43	Up to DM400	None
Glöckner & Pachur (2011)	1.05−1.99	Up to €1200	€10 to €12
Booij et al. (2010)	1.58	Up to €1000	None
Booij & van de Kuilen (2009)	1.80	Up to €1000	None
Abdellaoui et al. (2007)	2.04	Up to FF40,000	None
Abdellaoui et al. (2008)	2.61	Up to €10,000	0 to €1000*

* One out of 48 subjects was randomly selected and paid only for her choices between gains at rate of 1/10 of the described payoffs.

6.2 Quantitative tests

The definitions of the relative and absolute loss aversion, considered here, are the common qualitative interpretation of loss aversion in the applications of prospect theory (Camerer, 2000; Thaler et al., 1997). These interpretations can be derived from prospect theory with some additional assumptions (concerning the value of the reference point, the shape of the weighting function, and the concavity of the value function). Recent studies propose quantitative definitions of loss aversion, and elegant procedures to estimate this construct (see theoretical abstractions by Köbberling & Wakker, 2005; Schmidt & Zank, 2005; Wakker, 2010; Zank, 2008). These procedures allow direct estimation of the "loss aversion coefficient" (λ), controlling for the additional assumptions of prospect theory. This coefficient captures the tendency to overweight losses; $\lambda = 1$ implies equal weighting of gain and losses, and larger values imply loss aversion.

To clarify the relationship of the current results to this line of research we present, in Table 8, the estimated loss aversion coefficient in the studies reviewed by Booij, van Praag, and van de Kuilen (2010) and two additional recent studies (Glöckner & Pachur, 2011; Reiskamp, 2008). The results reveal large differences between studies (λ between 0.71 and 2.61) and a strong positive relationship between the estimated loss aversion parameter (λ values) and the (described and actual) payoff magnitude. Thus, the results seem to be consistent with the current analysis; they demonstrate the contingent nature of loss aversion, and the significance of two of the contributors to this contingent nature that were clarified here.

6.3 The adaptive decision maker explanation

The current results are consistent with the adaptive decision maker idea (Payne, Bettman, & Johnson, 1993; and see related ideas in Gilboa & Schmeidler, 1995; Gigerenzer & Selten, 2001; and Skinner, 1953). According to this approach decision makers tend to select easy strategies that have led to the best outcomes in similar cases in the past. The past experiences that affect behavior in the current settings can be divided to two classes: Old experiences that occur before the beginning of the experiment, and new experiences that occur during the experiment. Study 4b and the data summarized in Figure 1 demonstrate the importance of new experiences: The emergence of absolute loss aversion in long low-stakes studies can be predicted based on the cost of using simple rules like the "minimize the probability of loss": Absolute loss aversion appear to emerge with time when such simple rules that implies loss aversion are effective. That is, minimize effort with a little effect on the expected return.

The other effects, discussed above, can be reflections of (overgeneralizations from) old experiences. The effect of the status-quo framing, demonstrated in Tables 1 and 3, can reflect overgeneralization from past experiences with market for lemons (Akerlof, 1970). It seems reasonable to assume that the status-quo framing increase the tendency to rely on past experience with tricky risky offers like typical SPAM emails (Ert & Erev, 2008).

The effects of the actual and nominal payoff magnitude might reflect the fact that when the stakes are high it is typically wise to be careful, and collect as much information as possible. Finally, the contrast effect might reflect the fact that it is typically wise to accept the best risky prospect, and avoid the worst risky prospects. Indeed, relative judgment is the optimal strategy in the many problems (Freeman, 1983).

6.4 Practical implications

In order to evaluate the practical implications of the contingent nature of loss aversion, suggested here, we reconsider three of the best-known natural phenomena that have been explained by loss aversion. Specifically, we focus on the status-quo bias (Samuelson & Zeckhauser 1988), the endowment effect (Knetsch & Sinden, 1984; Thaler, 1980), and underinvestment in stocks (Benartzi & Thaler 1995). The leading explanations of all three phenomena assume a general loss aversion bias; thus, they appear to be inconsistent with the contingent interpretation of loss aversion. Yet, two observations suggest that the existence of these interesting phenomena may actually emphasize the potential importance of the current results. The first observation is that loss aversion is only one of many feasible explanations for these phenomena: Alternative explanations of the status-quo bias include the omission bias (Baron & Ritov, 1994; Ritov & Baron, 1992), decision avoidance (Anderson, 2003), and implicit recommendations (McKenzie, Liersch, & Finkelstein, 2006). Non-loss-aversion accounts of the endowment effect can be based on asymmetric information (Dupont & Lee 2002), mere ownership (Brenner et al. 2007; Morewedge, Shu, Gilbert, & Wilson, 2009), misconceptions (Plott & Zeiler, 2005) and inertia (Gal, 2006). Finally, underinvestment in stocks can the explained without loss aversion by assuming monetary constraints (Constantinides, Donaldson, & Mehra, 2010), habit persistence (Constantinides, 1990), impact of rare disastrous events (Rietz, 1988) and/or incomplete markets (Aiyagari & Gertler, 1991).

A second, and more important, observation concerns the generality of the trend suggested by the phenomena explained by loss aversion. It is easy to find natural phenomena that appear to reflect reversals of the phenomena that were explained by "loss aversion". One example is "overtrading in the stock market" (Odean, 1999). The term "overtrading" captures the fact that people tend to trade more than predicted under the rational model; overtrading appears to reflect a reversal of the status-quo bias. Thus, under the assumption that the status-quo bias reflects loss aversion, overtrading might be described as a reflection of a reversed loss aversion bias. A second example is overbidding in auctions (see a recent review by Kagel & Levin, in press) that might reflect a reversal of the endowment effect. The endowment effect implies that potential buyers undervalue products that they do not own, while overbidding could imply the opposite. Finally, analyses of investments decisions reflect "insufficient diversification" (Barber & Odean, 2000; Ben Zion, Erev, Haruvy, & Shavit, 2010; Polkovnichenko, 2005) that could imply risk seeking. Thus, if risk aversion in the stock market reflects loss aversion (Benarzi & Thaler, 1995), insufficient diversification can be described as a reversed loss aversion bias.

In other words, the current results suggest that the contingent nature of loss aversion should be considered in the analysis of field data. Whereas most previous attempts to relate the loss aversion assertion to field research focused on phenomena that can be explained as reflections of loss aversion, it is easy to think of phenomena that can be explained with the opposite bias. Namely, it is possible that better understanding of the contingent nature of loss aversion can be of practical value.

6.5 Summary

Most applications of loss aversion interpreted it to mean that people exhibit stronger risk aversion in choices that involve possible gains and losses than in choices that involve only gains. The current results reject this assertion; they show weaker risk aversion in choice between mixed prospects than in choice between gains. Moreover, in a wide set of conditions, decisions among mixed prospects show a choice pattern that is more consistent with risk neutrality than with risk aversion. These results can be captured with the assertion that the exact effect of losses does not result from a stable perceptual construct: losses do not always loom larger than gains. Rather, the results highlight six specific conditions that trigger the pattern predicted by the loss aversion assertion.

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Appendix 1. The 90 mixed problems evaluated in study 1c.

Prob.	S1	Ps	S2	R1	Pr	R2	Pr-mix	Pr-gain	Prob.	S1	Ps	S2	R1	Pr	R2	Pr-mix	Pr-gain
1	7	0.5	−8	11	0.5	−11	0.77	0.50	46	7	0.5	−7	9	0.5	−9	0.45	0.58
2	6	0.5	−6	13	0.5	−16	0.00	0.38	47	5	0.5	−5	8	0.5	−8	0.50	0.38
3*	12	0.5	−12	11	0.5	−14	0.09	0.17	48	9	0.5	−9	12	0.5	−12	0.41	0.25
4	4	0.5	−6	13	0.5	−13	0.73	0.33	49	6	0.5	−6	10	0.5	−10	0.59	0.29
5	11	0.5	−11	12	0.5	−13	0.05	0.21	50	4	0.5	−4	11	0.5	−11	0.50	0.33
6	7	0.5	−7	9	0.5	−10	0.14	0.42	51	5	0.5	−5	12	0.5	−11	0.64	0.29
7	4	0.5	−4	9	0.5	−12	0.09	0.21	52	4	0.5	−4	7	0.5	−6	0.68	0.33
8	5	0.5	−5	7	0.5	−8	0.05	0.46	53	11	0.5	−9	12	0.5	−11	0.27	0.29
9	5	0.5	−5	12	0.5	−14	0.00	0.17	54	5	0.5	−2	6	0.5	−6	0.05	0.25
10	7	0.5	−7	8	0.5	−11	0.05	0.29	55	8	0.5	−5	13	0.5	−13	0.18	0.29
11	9	0.5	−9	11	0.5	−12	0.18	0.33	56	10	0.5	−10	13	0.5	−12	0.64	0.54
12*	10	0.5	−13	12	0.5	−12	0.91	0.75	57	8	0.5	−7	11	0.5	−11	0.32	0.50
13	5	0.5	−6	9	0.5	−9	0.77	0.42	58	12	0.5	−9	13	0.5	−13	0.18	0.21
14	8	0.5	−8	12	0.5	−15	0.18	0.21	59*	7	0.5	−5	6	0.5	−6	0.05	0.13
15	9	0.5	−10	11	0.5	−11	0.82	0.75	60	6	0.5	−6	12	0.5	−11	0.59	0.50
16	5	0.5	−8	13	0.5	−13	0.73	0.67	61	4	0.5	−4	6	0.5	−5	0.91	0.92
17	7	0.5	−7	10	0.5	−11	0.09	0.21	62	6	0.5	−6	10	0.5	−9	0.68	0.46
18	8	0.5	−9	10	0.5	−10	0.86	0.75	63	6	0.5	−3	8	0.5	−8	0.14	0.17
19	10	0.5	−10	12	0.5	−14	0.05	0.21	64	4	0.5	−1	5	0.5	−5	0.00	0.29
20	11	0.5	−11	14	0.5	−13	0.73	0.54	65	8	0.5	−8	12	0.5	−9	0.86	0.79
21	4	0.5	−4	6	0.5	−7	0.05	0.38	66	8	0.5	−6	12	0.5	−12	0.27	0.13
22	9	0.5	−9	11	0.5	−10	0.86	0.63	67	5	0.5	−5	12	0.5	−10	0.73	0.58
23	11	0.5	−11	13	0.5	−12	0.91	0.63	68	6	0.5	−6	13	0.5	−11	0.59	0.54
24	6	0.5	−9	12	0.5	−12	0.73	0.63	69	6	0.5	−6	11	0.5	−9	0.77	0.71
25	7	0.5	−7	8	0.5	−11	0.05	0.17	70	8	0.5	−8	11	0.5	−10	0.59	0.63
26	6	0.5	−8	11	0.5	−11	0.82	0.46	71	11	0.5	−8	12	0.5	−12	0.09	0.33
27	11	0.5	−11	12	0.5	−13	0.14	0.42	72	10	0.5	−10	13	0.5	−11	0.82	0.58
28	5	0.5	−6	11	0.5	−11	0.64	0.46	73	8	0.5	−8	10	0.5	−9	0.86	0.58
29	5	0.5	−7	8	0.5	−8	0.91	0.75	74	7	0.5	−6	8	0.5	−8	0.27	0.38
30	4	0.5	−4	5	0.5	−6	0.14	0.21	75	6	0.5	−4	10	0.5	−10	0.18	0.38
31	6	0.5	−7	12	0.5	−12	0.77	0.33	76	11	0.5	−10	13	0.5	−13	0.27	0.21
32	10	0.5	−10	11	0.5	−12	0.05	0.29	77	4	0.5	−3	5	0.5	−5	0.23	0.21
33	6	0.5	−6	7	0.5	−8	0.05	0.25	78	5	0.5	−5	10	0.5	−8	0.68	0.46
34	9	0.5	−9	13	0.5	−14	0.18	0.13	79	9	0.5	−9	11	0.5	−10	0.86	0.54
35	4	0.5	−6	9	0.5	−9	0.82	0.54	80	9	0.5	−9	12	0.5	−10	0.82	0.67
36	4	0.5	−5	9	0.5	−9	0.86	0.58	81	6	0.5	−6	9	0.5	−7	0.86	0.83
37	6	0.5	−6	8	0.5	−9	0.09	0.29	82	9	0.5	−9	11	0.5	−10	0.73	0.83
38	4	0.5	−7	13	0.5	−13	0.86	0.33	83	7	0.5	−6	13	0.5	−13	0.23	0.46
39	2	0.5	−3	9	0.5	−9	0.68	0.38	84	8	0.5	−8	12	0.5	−10	0.68	0.46
40	4	0.5	−4	6	0.5	−7	0.05	0.21	85	7	0.5	−7	10	0.5	−8	0.86	0.75
41	5	0.5	−5	11	0.5	−11	0.45	0.42	86	5	0.5	−5	11	0.5	−10	0.68	0.42
42	1	0.5	−1	10	0.5	−10	0.45	0.38	87	5	0.5	−5	10	0.5	−7	0.86	0.54
43	5	0.5	−5	6	0.5	−6	0.73	0.67	88	4	0.5	−3	8	0.5	−8	0.18	0.25
44	4	0.5	−4	5	0.5	−5	0.55	0.33	89	4	0.5	−4	7	0.5	−5	0.91	0.46
45	4	0.5	−4	7	0.5	−7	0.50	0.50	90	9	0.5	−8	10	0.5	−10	0.32	0.42

Proportion of risk taking across problems without dominant strategy: Mixed: 0.48, Gain: 0.43

Note: Each problem involved a choice between a safer prospect (S1, Ps; S2) and a riskier (higher variability, or in the case of equal variability: larger losses) prospect (R1, Pr; R2).The columns Pr-mix and Pr-gain present the proportion of choices in the riskier prospect (R) in each of those problems in the mixed and gain conditions respectively (*in three problems one of the prospects dominates the other: the safer prospect is the dominant choice in Problems 3 and 59, and the risky prospect is the dominant choice in Problem 12).

Appendix 2. The 90 mixed problems evaluated in study 4a.

Prob.	S1	Ps	S2	R1	Pr	R2	Pr-mix	Pr-gain	Prob.	S1	Ps	S2	R1	Pr	R2	Pr-mix	Pr-gain
1	7	0.38	−6	16	0.47	−16	0.57	0.20	46	8	0.46	−9	15	0.46	−15	0.40	0.27
2	9	0.57	−2	10	0.8	−18	0.37	0.27	47	3	0.51	−8	11	0.46	−14	0.37	0.20
3	10	0.49	−7	16	0.54	−16	0.43	0.23	48	6	0.52	−7	12	0.55	−15	0.50	0.33
4	10	0.5	−4	13	0.57	−10	0.50	0.20	49	10	0.46	−5	19	0.51	−16	0.50	0.27
5	8	0.5	−10	11	0.45	−11	0.53	0.57	50	7	0.49	−10	16	0.37	−12	0.23	0.30
6	8	0.51	−3	14	0.64	−18	0.50	0.17	51	10	0.39	−1	14	0.59	−12	0.40	0.23
7	1	0.57	−6	15	0.5	−19	0.30	0.17	52	6	0.55	−3	17	0.58	−19	0.43	0.20
8	4	0.47	−2	13	0.57	−15	0.43	0.23	53	9	0.52	−3	11	0.66	−12	0.57	0.40
9	8	0.53	−9	17	0.39	−11	0.30	0.43	54	9	0.47	−6	13	0.61	−18	0.63	0.23
10	3	0.38	−10	10	0.44	−17	0.77	0.20	55	4	0.54	−5	19	0.4	−13	0.20	0.07
11	11	0.36	−11	15	0.4	−15	0.60	0.20	56	2	0.54	−3	16	0.52	−18	0.30	0.13
12	11	0.41	−10	18	0.33	−11	0.37	0.40	57	10	0.53	−9	17	0.45	−12	0.40	0.23
13	4	0.37	−8	18	0.37	−16	0.40	0.37	58	1	0.56	−9	17	0.24	−10	0.43	0.33
14	8	0.57	−7	18	0.54	−18	0.23	0.27	59	4	0.59	−5	17	0.44	−13	0.23	0.07
15	10	0.37	−6	14	0.51	−15	0.57	0.43	60	11	0.36	−5	15	0.43	−10	0.57	0.23
16	7	0.36	−4	14	0.55	−17	0.40	0.27	61	7	0.36	−4	19	0.47	−17	0.53	0.30
17	3	0.62	−4	14	0.56	−17	0.33	0.17	62	11	0.49	−2	16	0.64	−16	0.37	0.37
18	8	0.56	−5	18	0.54	−16	0.17	0.13	63	1	0.5	−1	14	0.44	−11	0.40	0.47
19	8	0.4	−2	14	0.56	−13	0.53	0.50	64	4	0.38	−6	15	0.43	−15	0.50	0.23
20	6	0.55	−5	12	0.5	−10	0.20	0.23	65	6	0.42	−10	13	0.47	−18	0.50	0.13
21	3	0.65	−5	11	0.6	−16	0.23	0.30	66	7	0.39	−10	12	0.33	−11	0.53	0.47
22	6	0.59	−6	16	0.56	−18	0.20	0.27	67	11	0.57	−6	17	0.6	−16	0.33	0.30
23	6	0.4	−10	12	0.42	−15	0.73	0.63	68	6	0.38	−4	17	0.43	−13	0.57	0.23
24	10	0.63	−2	13	0.7	−12	0.20	0.20	69	6	0.57	−11	18	0.36	−12	0.27	0.27
25	7	0.4	−11	15	0.41	−17	0.43	0.37	70	2	0.4	−4	14	0.44	−14	0.43	0.37
26	3	0.45	−7	18	0.29	−11	0.20	0.23	71	6	0.41	−10	15	0.34	−13	0.43	0.40
27	4	0.47	−6	15	0.44	−14	0.27	0.20	72	11	0.57	−11	19	0.54	−19	0.10	0.30
28	9	0.5	−2	16	0.57	−13	0.40	0.37	73	8	0.46	−4	14	0.62	−19	0.57	0.37
29	7	0.67	−10	18	0.53	−17	0.23	0.10	74	7	0.56	−8	13	0.52	−13	0.43	0.23
30	2	0.41	−10	17	0.31	−15	0.47	0.30	75	7	0.65	−11	12	0.64	−19	0.27	0.30
31	9	0.66	−9	11	0.66	−13	0.47	0.30	76	2	0.65	−10	17	0.42	−16	0.37	0.30
32	2	0.6	−10	13	0.49	−18	0.43	0.20	77	4	0.36	−9	17	0.24	−11	0.47	0.47
33	2	0.45	−6	16	0.41	−15	0.47	0.20	78	3	0.58	−6	16	0.51	−18	0.43	0.10
34	9	0.41	−4	19	0.46	−14	0.43	0.20	79	6	0.41	−5	17	0.42	−13	0.40	0.27
35	10	0.42	−10	13	0.39	−11	0.43	0.33	80	6	0.34	−5	11	0.55	−16	0.53	0.27
36	8	0.43	−8	18	0.44	−16	0.47	0.20	81	4	0.47	−8	15	0.47	−18	0.40	0.23
37	8	0.65	−1	14	0.65	−12	0.13	0.03	82	8	0.5	−7	14	0.56	−17	0.47	0.33
38	9	0.61	−5	14	0.58	−11	0.30	0.20	83	7	0.64	−10	15	0.46	−11	0.27	0.30
39	4	0.65	−3	17	0.43	−10	0.27	0.30	84	11	0.61	−1	12	0.81	−18	0.57	0.43
40	1	0.63	−9	14	0.44	−16	0.40	0.20	85	4	0.51	−9	18	0.4	−16	0.23	0.10
41	1	0.49	−8	16	0.35	−14	0.30	0.33	86	3	0.47	−3	19	0.34	−10	0.20	0.30
42	5	0.54	−10	11	0.41	−11	0.47	0.47	87	2	0.5	−7	14	0.47	−17	0.53	0.20
43	6	0.37	−4	12	0.47	−11	0.50	0.23	88	9	0.6	−8	12	0.67	−18	0.57	0.40
44	5	0.56	−7	14	0.45	−12	0.33	0.43	89	9	0.6	−9	10	0.71	−18	0.63	0.60
45	11	0.55	−8	14	0.59	−14	0.63	0.10	90	3	0.55	−8	14	0.49	−17	0.33	0.23

Mean P(risk) across problems: Mixed: 0.41, Gain: 0.28

Note: The notations are the same as in Appendix 1.

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Appendix 3. The 90 mixed problems evaluated in study 4b.

Prob.	S1	Ps	S2	R1	Pr	R2	Pr-mix	Pr-gain	Prob.	S1	Ps	S2	R1	Pr	R2	Pr-mix	Pr-gain
1	4	0.52	−10	7	0.49	−16	0.05	0.10	46	10	0.48	−4	16	0.51	−7	0.81	0.38
2	5	0.54	−4	10	0.49	−12	0.33	0.05	47	4	0.46	−5	12	0.51	−10	0.71	0.62
3	3	0.52	−9	7	0.47	−15	0.29	0.05	48	9	0.48	−3	15	0.53	−7	0.86	0.43
4	4	0.57	−3	6	0.5	−8	0.14	0.00	49	3	0.43	−4	8	0.5	−6	0.86	0.52
5	5	0.63	−5	6	0.67	−14	0.33	0.00	50	5	0.37	−5	14	0.33	−6	0.86	0.52
6	7	0.56	−5	10	0.49	−10	0.14	0.00	51	5	0.44	−7	10	0.51	−10	0.71	0.48
7	3	0.58	−9	7	0.5	−15	0.29	0.05	52	9	0.42	−3	15	0.5	−7	0.67	0.19
8	7	0.42	−6	11	0.41	−12	0.29	0.05	53	6	0.58	−7	12	0.59	−11	0.67	0.43
9	4	0.42	−6	6	0.42	−11	0.29	0.05	54	6	0.58	−4	11	0.58	−6	0.90	0.76
10	3	0.39	−5	4	0.47	−11	0.19	0.00	55	5	0.61	−3	11	0.53	−4	0.71	0.71
11	1	0.38	−9	4	0.49	−18	0.52	0.19	56	9	0.62	−1	18	0.51	−4	0.38	0.38
12	11	0.64	−9	13	0.6	−15	0.14	0.05	57	9	0.36	−11	15	0.4	−13	0.67	0.62
13	9	0.42	−4	10	0.47	−10	0.29	0.00	58	4	0.58	−9	10	0.53	−10	0.81	0.62
14	7	0.55	−10	10	0.51	−16	0.24	0.05	59	10	0.45	−7	16	0.49	−10	0.71	0.57
15	8	0.46	−10	10	0.49	−17	0.29	0.10	60	10	0.54	−8	17	0.51	−10	0.62	0.62
16	5	0.65	−7	9	0.64	−14	0.52	0.10	61	7	0.35	−5	14	0.36	−9	0.71	0.14
17	3	0.47	−5	8	0.46	−9	0.62	0.24	62	5	0.53	−3	9	0.54	−8	0.38	0.05
18	10	0.53	−10	14	0.5	−13	0.38	0.05	63	10	0.47	−10	13	0.5	−14	0.52	0.14
19	3	0.58	−7	7	0.57	−12	0.43	0.10	64	7	0.42	−3	12	0.43	−7	0.52	0.29
20	10	0.54	−11	16	0.49	−15	0.33	0.24	65	11	0.46	−10	15	0.51	−16	0.67	0.24
21	6	0.4	−3	9	0.53	−9	0.76	0.33	66	3	0.6	−6	9	0.47	−9	0.33	0.52
22	2	0.66	−9	6	0.63	−15	0.57	0.10	67	9	0.34	−2	15	0.37	−6	0.57	0.38
23	3	0.58	−8	6	0.62	−14	0.57	0.29	68	8	0.42	−3	14	0.38	−6	0.62	0.29
24	3	0.59	−4	8	0.48	−7	0.33	0.14	69	4	0.41	−3	7	0.52	−8	0.71	0.10
25	2	0.65	−6	7	0.59	−12	0.67	0.10	70	6	0.35	−2	12	0.41	−7	0.52	0.29
26	10	0.46	−7	13	0.53	−13	0.57	0.14	71	7	0.54	−10	13	0.47	−13	0.38	0.29
27	8	0.56	−10	11	0.6	−16	0.48	0.00	72	10	0.44	−8	16	0.4	−11	0.43	0.29
28	1	0.37	−5	4	0.58	−12	0.57	0.43	73	5	0.63	−1	12	0.42	−4	0.24	0.29
29	10	0.43	−5	14	0.5	−11	0.38	0.19	74	5	0.57	−10	11	0.5	−14	0.57	0.33
30	6	0.67	−8	10	0.59	−11	0.52	0.10	75	8	0.33	−6	11	0.41	−10	0.52	0.10
31	9	0.65	−5	15	0.61	−8	0.76	0.76	76	5	0.35	−9	8	0.39	−15	0.14	0.14
32	2	0.64	−3	10	0.57	−8	0.71	0.38	77	3	0.36	−2	8	0.43	−10	0.43	0.10
33	2	0.49	−6	8	0.52	−9	0.81	0.62	78	6	0.51	−2	9	0.48	−8	0.14	0.00
34	9	0.36	−9	16	0.39	−11	0.86	0.62	79	9	0.64	−9	11	0.61	−16	0.19	0.00
35	7	0.45	−10	12	0.53	−14	0.81	0.38	80	10	0.55	−7	14	0.47	−12	0.19	0.05
36	7	0.62	−6	14	0.55	−8	0.52	0.33	81	6	0.38	−7	8	0.45	−14	0.24	0.05
37	11	0.66	−2	18	0.57	−4	0.48	0.67	82	2	0.34	−11	4	0.43	−18	0.52	0.14
38	1	0.36	−9	10	0.39	−12	0.76	0.48	83	9	0.64	−1	12	0.61	−10	0.05	0.05
39	6	0.46	−6	13	0.48	−9	0.62	0.57	84	6	0.54	−6	9	0.52	−13	0.29	0.00
40	2	0.46	−7	8	0.51	−10	0.90	0.71	85	7	0.54	−2	10	0.49	−8	0.14	0.05
41	7	0.37	−4	15	0.38	−6	0.71	0.62	86	4	0.63	−7	6	0.62	−15	0.29	0.10
42	8	0.66	−6	15	0.59	−9	0.67	0.48	87	6	0.34	−8	9	0.41	−15	0.29	0.05
43	1	0.43	−5	9	0.37	−6	0.76	0.43	88	5	0.57	−1	6	0.63	−9	0.24	0.05
44	3	0.63	−8	8	0.65	−12	0.81	0.48	89	8	0.37	−3	12	0.35	−8	0.33	0.14
45	4	0.37	−3	11	0.48	−7	0.76	0.29	90	3	0.63	−4	7	0.52	−11	0.19	0.10

Mean P(risk) across problems: Mixed: 0.50, Gain: 0.26

Note: The notations are the same as in Appendix 1.