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Carryover of domain-dependent risk preferences in a novel decision-making task

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Abstract

We investigated whether people's risk taking tendency established in one domain (gains or losses) carries over to the other domain. Participants played a game in which they made repeated decisions between a fixed payoff and a risky option, where the outcome of the risky option depended on whether they had responded correctly on a difficult perceptual-memory task. In some trials, participants played to gain points; on others, they played to avoid losing points. In two studies, we observed the following pattern of results. 1) Participants risked less on gain trials than on loss trials. 2) This difference in risk taking persisted (carried over) when the domain changed from gains to losses and vice versa (with the effect of experiencing losses first being stronger than the effect of experiencing gains first). 3) There was no analogous carryover effect on responses to a delay discounting measure, but there was a carryover effect on responses on a risk attitude measure. We compare these results with those from other recent studies and discuss various ways of explaining them.

Keywords: risk preferences, delay discounting, carry-over

1 Introduction

Research on risky decision making has shown that people tend to be risk averse when considering potential gains but risk seeking when considering potential losses (e.g., Kahneman & Tversky, 1979). Imagine, for example, choosing between a sure $50, on the one hand, and a 50% chance to win $100, on the other hand. It is likely that most people would prefer the sure thing to the risky option even though the expected values of the two options are the same (i.e., +$50). Now imagine choosing between a sure loss of $50, on the one hand, and a 50% chance to lose $100. Here, people tend to prefer the risky option to the sure thing even though, again, the expected values of the two options are the same (i.e., −$50).

Although this *reflection effect* is not a universal law of risky decision making (e.g., Hershey & Schoemaker, 1980), it has been observed under many conditions by a range of authors (e.g., Kahneman & Tverssky, 1979; Pujara, Wolf, Baaaskaya & Koenigs, 2015; Schneider, Kauffman & Ranieri, 2016; Yechiam, Zahavi & Arditi, 2015). The usual interpretation of the reflection effect is provided by Kahneman and Tversky's (1979) prospect theory. According to prospect theory, people evaluate potential gains and losses according to an S-shaped value function. The part of the value function relating objective to subjective gains is concave, but the part relating objective to subjective losses is convex. This implies that, under most conditions, a sure gain has greater expected utility than a risky option with the same expected value, which is why people prefer the sure gain (the 'play it safe' option). At the same time (again under most conditions), a sure loss has greater disutility than a risky option with the same expected value, which is why people prefer the risky option. According to prospect theory, this reflection effect occurs if the probability of the gain or loss in the risky option is not extremely small (i.e., not smaller than about 0.12). This is because small probabilities are assumed to be over-weighted, which can compensate for the concavity or convexity of the value function (Hershey & Schoemaker, 1980).

As successful as prospect theory has been as an account of the reflection effect, it says relatively little about the effect of the context in which risky decisions are made (Schneider et al., 2016). In the present research, we are interested in this general issue and specifically in how risky decisions are affected by the context of other recent risky decisions. In particular, we ask whether making repeated risky decisions in one domain (gains or losses) affects people's level of risk aversion or risk seeking when they switch to the other domain. In other words, does risk aversion that people generally exhibit in the domain of gains *carry over* into the domain of losses, and does the risk seeking that people generally exhibit in the domain of losses exhibit a similar carryover effect

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into the domain of gains? We also ask whether the risk aversion or risk seeking established in one domain carries over to other personal risk-related measures, specifically, measures of delay discounting (Kirby & Marakovic, 1996) and risk attitude (Blais & Weber, 2006).

First, we review recent research that addresses our basic question, albeit with conflicting results. We then describe our novel decision-making task, which differs from those used in previous research in that the outcome of the risky option depends on whether participants responded correctly in a perceptual-memory task. The uncertainty associated with the risky option is thus skill-based and endogenous, unlike tasks traditionally used in risk research, which use stochastic/exogenous outcomes. We then report our two experiments, both of which demonstrate aspects of the reflection effect as well as carryover of both risk aversion and risk seeking into different domains. Both experiments suggest that the *loss-to-gain* carryover effect is stronger than the *gain-to-loss* carryover effect. Experiment 2 also suggests that the carryover effect can extend to other risk-related tasks and measures. Finally, we discuss various ways to explain this pattern of results and their implications more generally for decision-making under risk and uncertainty.

1.1 Previous Research

Two recent lines of research have a bearing on our central question of carryover effects. The first is the work of Schneider et al. (2016), who had subjects make choices between pairs of monetary gambles where each gamble had two equally likely outcomes. Although the two gambles in a pair always had the same expected value — which could be positive, negative, or zero — one of the gambles was always riskier in that it had greater variability. These gambles were organized in three blocks, the first and third of which consisted entirely of the same 18 control pairs that included potential gains and losses. For the second of the three blocks, however, these 18 control pairs were mixed with 18 other context pairs. In a between-subjects design, these 18 context pairs included only gains, only losses, or a mix of gains and losses. This design allowed the researchers to see how people responded to the control pairs on their own (Block 1), and how they responded to the same control pairs within a broader gain, loss, or mixed context (Block 2), as well as the extent to which any effects of the broader context carried over once it was removed (Block 3).

Their results showed a clear reflection effect. Across all three blocks, participants tended to choose the less risky of the two gambles for the gain pairs and the more risky of the two gambles for the loss pairs. Moreover, participants' choices for the control pairs in Block 2 were strongly influenced by the context. Specifically, when the control pairs were mixed with gain pairs, participants were relatively risk averse for both the context pairs *and* the control pairs. When the control pairs were mixed with loss pairs, participants were relatively risk seeking for both the context pairs and the control pairs. Finally, the risk aversion induced by the gain context and the risk seeking induced by the loss context in Block 2 carried over to Block 3. Thus, in this paradigm, there is fairly clear evidence for carryover of both risk aversion and risk seeking.

A second relevant line of research is the work of Yechiam et al. (2015). They had participants perform a task in which they had to decide to click one of two buttons on each of several trials. In the two gain conditions, one button represented a sure gain in points (either 1 point or 50 points), and the other represented a risky option with a 50% chance of gaining twice as many points (either 2 points or 100 points), and a 50% chance of gaining nothing. In the loss conditions, one button represented a sure loss in points (either 1 or 50), and the other button represented a risky option with a 50% chance of losing twice as many points (either 2 or 100) and a 50% chance of losing nothing. In these studies, the buttons were not labeled in any way so that participants had to learn from experience what the outcomes of pressing the two buttons were. Half the participants completed 100 trials in each of the two gain conditions, followed by 100 trials in each of the two loss conditions. The rest completed 100 trials in each of the two loss conditions followed by 100 trials in each of the two gain conditions.

As expected, participants exhibited a reflection effect; they were more likely to choose the sure gain in the win conditions and more likely to choose the risky option in the loss conditions. They were also less likely to switch from one button to the other from trial to trial in the gain conditions, and more likely to switch from one button to the other from trial to trial in the loss conditions. The researchers refer to these tendencies, respectively, as *gain calmness* and *loss restlessness*. Unlike in the study by Schneider et al. (2016), there was no carryover of risk aversion from the gain to the loss conditions or risk seeking from the loss to the gain conditions. There was, however, carryover of gain calmness and loss restlessness.

Although their empirical results are somewhat different, Schneider et al. (2016) and Yechiam et al. (2015) propose similar ideas to account for them. Specifically, they propose that gaining encourages people to maintain the status quo, which they do by avoiding risk and sticking with any strategy that is working 'well enough'. Losing, on the other hand, encourages people to abandon the status quo, which they do by taking risks and changing strategies. The two accounts differ somewhat in that Schneider et al. emphasize the role of positive versus negative affect, which causes people to adopt different goals while gaining and losing; Yechiam et al. (2015) emphasize the role of attention to the task, which is greater while losing than while gaining. We will examine these issues of affect and attention further in explaining our results below.

1.2 The Present Task

In the present research, we used a novel task for investigating the carryover of risk aversion and risk seeking — one in which the outcome of the risky option depends on participants' success or failure at a perceptual-memory task (a 'delayed matching-to-sample' or DMTS task). On each trial, participants were presented very briefly with an image of an object or scene and then presented with an array of four images that included the original image (the 'target') along with three very similar ones. They then chose which of these four images they thought was the target, and also rated their confidence that they were correct. Finally, they chose between either a) a fixed payoff (the play it safe option) or b) a risky option, the payoff of which depended on whether they chose the correct image in the DMTS task. On gain trials, playing it safe resulted in a gain of 5 points. The risky option was a gain of 10 points if they were correct or 0 points if they were incorrect. On loss trials, the play it safe option was a loss of 5 points, and the risky option was a loss of 10 points if participants were incorrect and 0 points if they were correct.

Thus, in the present task, the risky decision is a metacognitive task based not only on perceptual-memory skill but also on participants' confidence in that skill and their ability to apply that confidence to a risky choice correctly. Therefore it involves considerable endogenous epistemic uncertainty (uncertainty associated with one's own lack of knowledge) as opposed to purely aleatory uncertainty (uncertainty associated with a random/stochastic process; Fox & Ulkumen, 2011). Our task, therefore, seems to be more representative of many everyday risky decisions, which have an element of skill and controllability (e.g., trading stocks, lying, or driving fast), rather than being due solely to stochastic uncertainty (e.g., playing roulette). Our task also allows us to see how gaining versus losing affects several other dependent variables, which might provide additional insight into the psychological processes involved. For example, if losing causes increased attention to the task, then we might expect participants who are losing to take longer and perform better on the DMTS task than participants who are gaining.

2 Study 1

Experiment 1 included five between-subject groups who experienced either: a) 100 gain trials; b) 100 loss trials; c) 50 gain trials followed by 50 loss trials; d) 50 loss trials followed by 50 gain trials, and e) 50 gain trials and 50 loss trials mixed. This design allowed us to establish whether there is a between-subjects reflection effect using our risky decision-making task. It also allowed us to look for carryover of risk aversion or risk seeking into the opposing domain, through the effect of the order of the trial blocks (placing the participant into sequential domains of gains followed by losses or vice versa). In addition, all participants completed the 27-item Monetary Choice Questionnaire (MCQ) – a measure of delay discounting (Kirby & Marakovic, 1996; Kirby, Petry & Bickel, 1999). This was to examine whether there was a correlation between risk taking on our task and delay discounting, but also to see if experiencing the domain of gains or losses could carry over not only between domains but also to responses on an ostensibly unrelated measure such as the MCQ. There is considerable research showing that delay discounting is positively correlated with risky behaviors like smoking and drug use (e.g., Bickel et al., 2007; Bickel, Odum & Madden, 1999); however, a study by Mishra and Lalumiere (2017) found only a weak and non-significant positive relationship between delay discounting measured using the MCQ and risk taking (measured using repeated choices between a sure thing and a risky option).

In the present experiment, we hypothesize that participants will take a greater risk on trials where they have to avoid losses (as opposed to trials where they are accumulating gains). However, this domain (loss or gain) will not affect accuracy or confidence in solving the perceptual-memory task. We also hypothesize that a participant's riskiness will carry over when the domain of reinforcement is switched; i.e., we will see relatively greater risk taking on gain trials following a 'context' block of loss trials, and less risk taking on loss trials after a block of gain trials. Finally, we hypothesize that participants will show greater impulsivity, as measured by the Monetary Choice Questionnaire, after a series of loss trials compared with gain trials.

3 Method

3.1 Participants

There were 498 participants: 359 women and 139 men. They were recruited from several courses in the Department of Psychology at California State University, Fresno, and were given credit in their courses in return for their participation.

3.2 Risky Decision-Making Task

Each participant completed 100 trials of the risky decision-making task, with each trial consisting of four parts: a delayed-matching-to-sample (DMTS) task, a confidence rating, an opportunity to risk points, and finally, feedback on accuracy and points earned (Figure 1). There were no repeated image sets used in the 100 DMTS tasks. At the beginning of each trial, participants pressed a key to present an image (the sample) centered on the computer screen for 200 milliseconds. This was followed by a blank screen for 1000 ms followed by an array consisting of the original image (in a random location) plus three similar images. The task was to select the image ('target') that matched the sample. After completing the DMTS task, participants rated

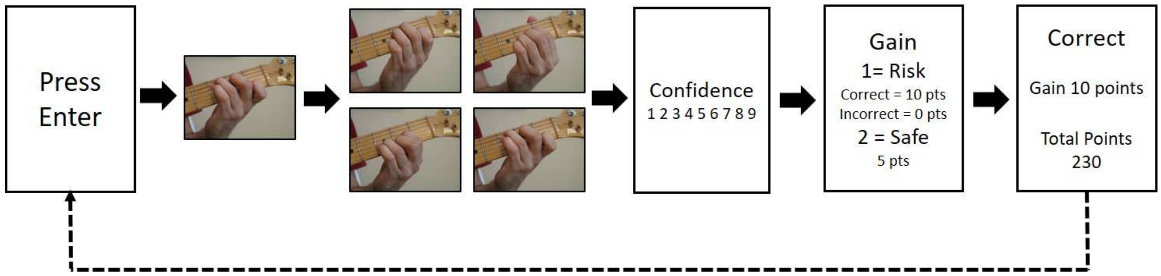

Figure 1: The sequence of events in a single 'gain' trial in the present experiments. Participants press a key to display a sample image for 200 ms, followed by a 1000 ms delay, and then four images appear. Participants choose the image they believe matches the sample, rate their confidence, decide whether or not to take a risk (the payoff of which depends on whether they previously selected the correct picture), receive feedback on correctness and points, and then begin the next trial with different images

their confidence that they had selected the correct image on a scale from 1 (certain they were incorrect) to 9 (certain they were correct). Then participants had to choose whether to play it safe and earn a fixed payoff or alternately take the risky option. Finally, they received feedback informing them whether they were correct on the DMTS task, how many points they gained or lost, and their current total points.

There were two types of trials. On gain trials, the play it safe option resulted in a gain of 5 points. If participants instead decided to risk, they gained 10 points if they had selected the target image, but they gained nothing if they had selected an incorrect image. On loss trials, playing it safe resulted in a loss of 5 points. If participants decided to risk, they lost nothing if they had selected the correct image, but they lost 10 points if they had selected an incorrect image.

3.3 Design and Procedure

Participants (n = 498) were tested in groups in a 24-station computer lab. Before beginning, they were informed of the importance of the experiment and asked to agree verbally that they would try their best to maximize their point totals. While there was no monetary incentive, others have found that earning points produces responding that is equivalent to earning small amounts of money in similar tasks (e.g., Goodie & Fantino, 1995).

Participants were assigned to one of five conditions. 1) *All Gain* (n = 101). Participants started with zero points and played 100 gain trials. 2) *All Loss* (n = 107). Participants started with 1000 points and played 100 loss trials. 3) *Gain-Loss* (n = 95). Participants started with 500 points and played 50 gain trials followed immediately by 50 loss trials. 4) *Loss-Gain* (n = 96). Participants started with 500 points and then played 50 loss trials followed immediately by 50 gain trials. 5) *Mixed* (n = 99). Participants started with 500 points and played a mixture of 50 gain trials and 50 loss trials, with all participants completing the same randomized sequence of gain and loss trials. In all conditions, the sequence of the images used in the DMTS tasks was the same for each participant. In the computer lab, the program for each condition was set up before participants entered the room, with each computer chosen at random to house particular conditions during different sessions. All computers showed a white screen with the words, 'Welcome to the experiment.' Participants chose their computer station without knowing which condition they were in.

Following the DMTS task, participants completed the 25-item Monetary Choice Questionnaire as a measure of delay discounting (Kirby & Marakovic, 1996; Kirby et al., 1999). For each item, participants made a hypothetical choice between a smaller amount of money right now (e.g., $40) and a larger amount after a delay (e.g., $65 after 70 days). Based on a participant's responses, it is possible to compute an approximation of that participant's discounting parameter (k) in the hyperbolic discounting function,

$$V = \frac{A}{1 + kD},$$

where V is the subjective value of the delayed reward, A is the amount of the delayed reward, D is the length of the delay, and k is the discounting parameter. (See Kirby & Marakovic, 1996, for details on the computations.) A higher value of k means that the delay has a greater impact on the individual's subjective valuation of the options and is widely considered to be an indication of impulsivity and risk taking.

4 Results

4.1 Overall Performance

Participants' mean proportion of trials correct on the DMTS task was 0.55 (SD = 0.07), their mean confidence rating was 5.90 (SD = 1.20), and the mean proportion of trials in which the risky option was selected was 0.65 (SD = 0.16). Pearson correlations between the means of risk, accuracy, and confidence showed a medium correlation between risk

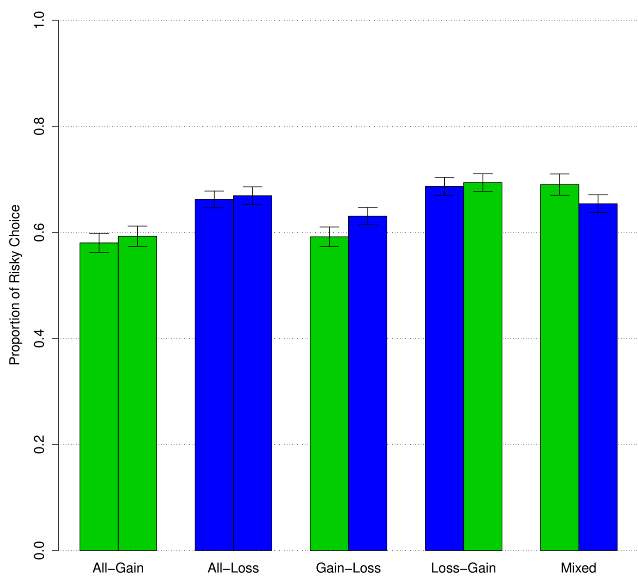

FIGURE 2: The mean and standard error for risk taking for the five groups. Green (lighter) bars represent gain trials, and blue (darker) bars represent loss trials. For all-gain, all-loss, gain-loss, and loss-gain groups, the left bar in each pair represents the first block of 50 trials and the right bar the second block of 50 trials. For the mixed group, the order of the bars is arbitrary because the gain and loss trials were mixed together.

and accuracy ($r(496) = 0.264$, $p < 0.001$). There were also medium correlations between risk and confidence, $r(496) = 0.381$, $p < 0.001$, and between accuracy and confidence ($r(496) = 0.366$, $p < 0.001$). We refer to Cohen (1992) when discussing effect sizes.

4.2 Risk

We were most interested in two analyses of the data concerning risk. First, is there a domain effect of gaining versus losing upon risk taking? Second, does any effect of gaining versus losing carry over from a block of gain trials to a block of loss trials, or vice versa? Figure 2 shows the mean proportion of trials in which the risky option was selected, in blocks of 50 gain and loss trials. To evaluate overall differences between the domains of gain and loss on risk, we combined the first 50 trials of the all-gain group and gain-loss group (participants had the same experience in these trials), and likewise combined the first 50 trials of the all-loss group and loss-gain group.

Participants chose the risky option more when losing than gaining ($t(397) = 4.91$, p < 0.001, $d = 0.49$). To examine block effects (first 50 trial block versus second 50 trial block), we focused on the all-gain and all-loss groups and found that there is a between-subjects difference in risk taking. A repeated-measures ANOVA comparing these two groups confirmed the main effect of domain (losses or gains) was statistically significant ($F(1, 206) = 11.37$, p = 0.001, $\eta_p{}^2 = 0.052$). However, there was no block effect ($F(1, 206) = 1.98$, $p = 0.159$, $\eta_p^2 = 0.010$). Nor was there a block x group interaction ($F < 1$). Finally, though risky choices differed across groups, all groups showed significantly greater than 50% risky choice, with the Cohen's d values of 0.72 (all-gain), 1.49 (all-loss), 1.02 (gain-loss), 1.80 (loss-gain), and 1.50 (mixed).

Focusing on the gain-loss and loss-gain groups, we see evidence of a within-subjects difference in risk taking for the gain-loss group only. When participants switched from the domain of gains to losses, their risk taking increased ($t(95) = -2.46$, $p = 0.015$, $d = -0.23$). There was no difference in risk taking between the blocks when switching in the converse direction, i.e., from losses to gains ($t < 1$).

To look for a gain-to-loss carryover effect for risk, we compared the second block of trials for the gain-loss group with the second block of trials for the all-loss group. This comparison is between two groups who completed the same 50 loss trials in the second block; however, the context differs for the gain-loss group (who had previously completed 50 gain trials) and the all-loss group (who had previously completed 50 loss trials). There would thus be evidence of a gain-to-loss carryover effect if the gain-loss group engaged in less risk taking in the second block than the all-loss group in the second block; we, however, found no significant difference ($t(200) = 1.65$, $p = 0.100$, $d = 0.24$).

To look for the converse carryover effect, that is, loss-to-gain, we compared the second block for the loss-gain group with the second block for the all-gain group. Evidence of a loss-to-gain carryover effect would be seen if the loss-gain group engaged in more risk taking in the second block than the all-gain group in the second block. The loss-gain group did indeed engage in significantly greater risk taking in this block ($t(195) = -3.99$, $p < 0.001$, $d = -0.57$). Indeed, the carryover effect was strong enough here that the proportion of risks taken in the second block of trials for the loss-gain group was greater than the second block of trials in the gain-loss group. That is, our results show paradoxically greater risk taking in gain trials compared to loss trials when a context block of losses precedes those gain trials, and when a context block of gains precedes the comparison block of losses ($t(189) = -2.73$, $p = 0.007$, $d = -0.40$).

Figure 2 shows that in the mixed group, there was no difference between risk taking on gain trials versus loss trials. It is, however, worth noting that overall risk taking in the mixed condition resembled the all-loss condition more than the all-gain condition; it was significantly greater than in the all-gain condition ($t(198) = 3.58$, $p < 0.001$, $d = 0.47$), but not significantly lower than in the all-loss condition (($t < 1$).

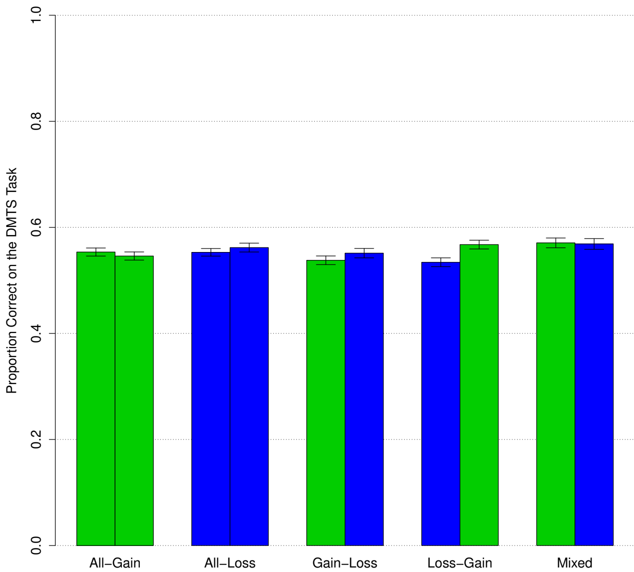

FIGURE 3: The mean and standard error for accuracy on the DMTS task for the five groups. Green bars represent gain trials, and blue bars represent loss trials. For all-gain, all-loss, gain-loss, and loss-gain groups, the left bar in each pair represents the first block of 50 trials and the right bar the second block of 50 trials. For the mixed group, the order of the bars is arbitrary because the gain and loss trials were mixed together.

4.3 Accuracy

We were next interested to see if gains versus losses affected accuracy on the DMTS task. It was possible that the domain of losses made participants riskier because it somehow made them more accurate (e.g., by increasing effort or focusing attention). Greater risk taking could thus be a product of being correct more often. Figure 3 shows the same plot as Figure 2, but with the mean proportion of trials in which the target was correctly selected for each of the five groups. The figure shows the groups differed little in their accuracy. As with risk, we combined the first 50 trials of the all-gain and gain-loss groups and compared those data with the combined first fifty trials of the all-loss and loss-gain group. We found no difference in accuracy ($t < 1$). An ANOVA comparing the all-gain and all-loss groups found no group effect ($F < 1$). Nor was there a block effect ($F < 1$) or a group x block interaction ($F(1, 206) = 1.88$, $p = 0.169$, $\eta_p^2 = 0.009$). We compared the second block of the all-loss group to the second block of the gain-loss group and found no difference in accuracy ($t < 1$). When comparing the second block of the loss-gain group to the second block of the all-gain group, and the difference in accuracy was not quite significant ($t(195) = 1.91$, $p = .057$, $d = 0.27$). Accuracy and practice do not, therefore, appear to be affected by the domain of losses or gains. Changes in risk taking would thus not seem to be a product of accuracy.

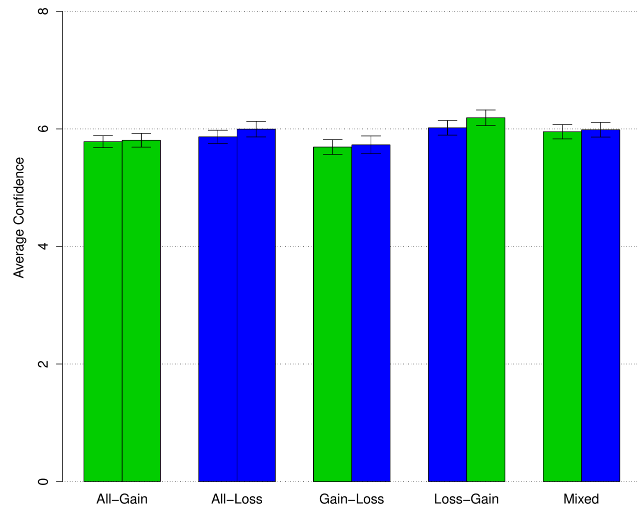

FIGURE 4: The mean and standard error for confidence scores for the five groups. Green bars represent gain trials, and blue bars represent loss trials. For all-gain, all-loss, gain-loss, and loss-gain groups, the left bar in each pair represents the first block of 50 trials and the right bar the second block of 50 trials. For the mixed group, the order of the bars is arbitrary because the gain and loss trials were mixed together.

4.4 Confidence

It is possible our results could be explained by some effect upon confidence in the domain of losses. Loss after loss may produce negative emotions that could ultimately result in reduced confidence. Alternatively, consistently losing points may somehow make participants more irrationally confident (because, for example, they felt they were paying greater attention); with greater confidence, they may have a justification for taking greater risks. Figure 4 shows the mean confidence scores plotted in the same way as Figures 2 and 3. As with accuracy, we do not see the large difference between groups or blocks that we see in the risk data (Figure 2). As with our previous analyses, we combined the first 50 trials of the all-gain and gain-loss groups and compared those data with the combined first fifty trials of the all-loss and loss-gain group, and we found no difference in confidence ($t(397) = 1.43$, $p = 0.16$, $d = 0.15$). Comparing the all-loss and all-gain groups, we found no overall group effect on confidence ($F < 1$). Nor did we find a block effect, ($F < 1$) or group x block interaction, ($F < 1$)). When comparing the second blocks of trials of the all-loss group and gain-loss group, we again found no difference in confidence ($t(200) = 1.06$, $p = 0.289$, $d = 0.09$). There was also no difference between the second blocks of trials in the all-gain group and the loss-gain group ($t(195) = -1.98$, $p = 0.057$, $d = -0.28$). These results

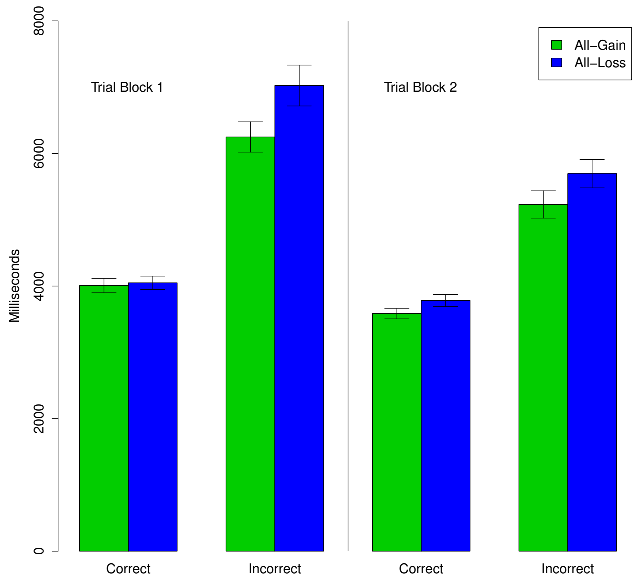

FIGURE 5: Means and standard error of individual median response times taken to respond to the target selection in the DMTS, during the first and second blocks of 50 trials. The figure shows that the all-gain group (green) took less time to respond than the all-loss group (blue). Responding incorrectly took longer, especially in the all-loss group.

provide evidence that the domain of gains or losses does not significantly affect confidence in the DMTS task.

4.5 Response Times

4.5.1 DMTS Response Times

On each trial, the DMTS response time is the time between when the four similar images are presented on the screen until when the participant clicked on one of the images to select it as the target image. For each participant, we computed the median response time of the first block of 50 and the second block of 50 DMTS trials. For the mixed group, the median response time was taken for the 50 gain trials and 50 loss trials. Using the within-subject median response times helped reduce the effects of outliers. We then calculated the means of these median response times for different groups. Table 1 in the Appendix presents the means and standard deviations of these individual medians for all five groups (for the first and second blocks of 50 trials, and for correct and incorrect responses). Although the Appendix tables show the response times for all five groups, we will here only focus on the all-gain and all-loss group for statistical analysis and figures. This is because we were particularly interested in how losses and gains affect reaction times. Also, as we will discuss, analyzing any carryover effects of response times is problematic.

Figure 5 shows that there was a strong practice effect, with participants responding faster in the second block than in the first ($F(1, 206) = 95.91$, $p < 0.001$, $\eta_p^2 = 0.318$). There was no significant difference between response times in the all-loss group compared with the all-gain group ($F(1, 206) = 3.10$, $p = 0.080$, $\eta_p^2 = 0.15$). However, as is typical in choice reaction time research (e.g., Pike, 1973), participants took longer to respond when they made incorrect responses than when they made correct responses ($F(1, 206) = 346.37$, $p < .001$, $\eta_p^2 = 0.628$). We found a significant group x correctness interaction, ($F(1, 206) = 4.60$, $p = .035$, $\eta_p^2 = 0.021$), with participants in the all-loss group taking especially long to make incorrect responses. Overall, response times on incorrect responses were slightly faster in the second block, whereas response times for correct responses remained about the same. This produced a block x correctness interaction, ($F(1, 206) = 37.32$, $p < 0.001$, $\eta_p^2 = 0.15$). These latency results may give support to the idea that participants find the prospect of a loss to be particularly aversive, and therefore they may spend more time thinking about the correct DMTS response when in the domain of losses as opposed to gains (this seems to be particularly the case when they are ultimately incorrect).

It is difficult to analyze any carryover effects on response times. Specifically, in addition to any carryover effect due to having experienced gains versus losses, there is also likely to be a carryover effect based on having to adapt to a new payoff structure. This may cause participants who change domains in the second block to respond more slowly than participants who do not change. So if, for example, participants in the second block of the loss-gain condition take longer to respond than participants in the second block of the all-gain condition (which they do), it is unclear whether this is a context effect due to spending the first block experiencing losses, or because the payoff structure changed. For this reason, we do not consider carryover effects on response times further.

4.5.2 Risky-Decision Response Times

On each trial, the risky-decision response time was the time from when the option to take a risk or not was explicitly presented on the computer screen until when the participant pressed a key to indicate their decision. We computed each participant's median response time to make the risky decision for the first 50 and the second block of 50 trials. For the mixed group, we computed the median response time for the 50 gain trials and the 50 loss trials. We then (as for our analysis of DMTS response times) calculated the group means of these individual median response times. Table 2 in the Appendix presents these means and standard deviations for all five groups (for the first and second blocks of 50 trials, and for decisions to play it safe as well as decisions to choose the risky option).

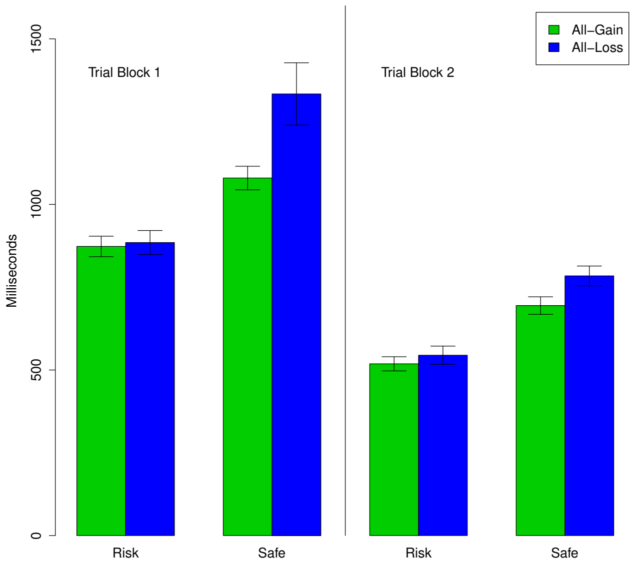

Figure 6: The means and standard error of time to make the choice of whether to risk or play it safe (on the first and second block of 50 trials). This figure shows that the all-gain group (green) took less time to respond than the all-loss group (blue), especially when they chose to play it safe.

Comparing the all-gain and all-loss groups (Figure 6) shows that participants in the all-loss group took longer to indicate their decision ($F(1, 197) = 5.23$, $p = 0.023$, $\eta_p^2 = 0.26$). Participants also took longer when eventually deciding to play it safe than when they selected the risky option ($F(1, 197) = 80.30$, $p < 0.001$, $\eta_p^2 = 0.29$). The all-loss group took especially long when eventually deciding to play it safe, with a significant group x decision interaction ($F(1, 197) = 6.79$, $p = 0.010$, $\eta_p^2 = 0.033$). Overall, the difference in response time between taking a risk and playing it safe decreased slightly in the second block, producing a block x decision interaction ($F(1, 197) = 6.48$, $p = 0.012$, $\eta_p^2 = 0.032$). There was also a block x group x decision interaction ($F(1, 197) = 4.57$, $p = 0.031$, $\eta_p^2 = 0.023$). This shows that when losing points, the decision to play it safe takes more time than when gaining points. This could be because taking the safe option guarantees a loss (of 5 points), so the participants struggle with the decision, which takes longer when they have to override their natural inclination to avoid a loss.

We present the response times in the loss-gain and gain-loss group in the Appendix (Table 2). However, analyzing the data for carryover effects suffers from the same problem we encountered with analyzing the target response times. Any difference between the first block and second block in the loss-gain or gain-loss groups (when compared to the all-loss or all-gain groups) could be due to the change in a domain or due to the change in the payoff structure.

In the mixed group, there was no significant difference in the amount of time to make a decision between loss trials and gain trials ($F(1, 89) = 2.62$, $p = 0.109$, $\eta_p^2 = 0.03$). Participants also spent more time deciding when to play it safe rather than risk ($F(1, 89) = 73.14$, $p < 0.001$, $\eta_p^2 = 0.45$).

4.6 Delay Discounting

A final question was whether experiencing gain or loss domains could affect delay discounting. To examine this, we computed a k value for each participant based on his or her responses on the MCQ (with higher k value indicating higher delay-discounting). We found that there was a small positive correlation between the k values and the proportion of trials on which a participant selected the risky option ($r(497) = 0.108$, $p = 0.015$). However, a one-way ANOVA showed that there were no differences in k values between the groups (all F's < 1). A focused comparison of the all-gain group ($M = 0.010$, $SD = 0.035$) and the all-loss group ($M = 0.011$, $SD = 0.030$) showed no difference between these two groups ($t < 1$).

5 Study 1 Discussion

Experiment 1 clearly shows that there was a difference in risk taking preference between gain and loss domains using our novel decision-making task featuring skill-based, epistemic uncertainty. This may not be considered a 'pure' reflection effect as it does not constitute a complete reversal in risk preferences between a gain and loss condition (for a review, see Schutz, 2013). However, we do see a greater preference for risk in the all-loss group compared to the all-gain group (a between-subjects effect), and a similar effect when switching from 50 gain trials to 50 loss trials in the gain-loss group (a within-subject effect). Interestingly, there was no such effect when gain and loss trials were intermixed.

Experiment 1 also showed a clear carryover effect of risk preferences. Experiencing a block of loss trials decreased risk taking in subsequent gain trials, but there was no significant difference when switching from gain trials to loss trials. This suggests that risk seeking is more likely to carry over into a new domain than risk aversion. It was also evident that the domain effect upon risk was not mediated to any significant degree by accuracy or confidence. Response time analyses showed that it took people longer to respond when they were incorrect in the DMTS task, and also when they decided to play it safe. These differences are magnified for loss trials. These results are consistent with the notion that experiencing different domains of gains and loss can create a psychological state or 'mindset' which persists across trials and when switching domains. This mindset carries over from the domain of losses to the domain of gains but does not appear to carry over when switching from gains to losses.

Furthermore, it does not appear to carry over to responses on a delay-discounting measure.

6 Study 2

Experiment 2 built on Experiment 1 in several ways. First, it was intended to examine whether the complex pattern of results observed in Experiment 1 could be replicated. Second, it was designed to explore the issue of how many (or how few) trials in one domain are necessary to create a carryover effect. In this experiment, therefore, the gain-loss and loss-gain groups experienced 20 trials in the first domain, followed by 80 in the other domain. Finally, Experiment 2 was intended to see whether risk aversion/seeking would carry over to yet another risk-related assessment — a self-report measure of risk attitudes. We hypothesize that the differences between the all-gain and all-loss groups in risk taking and response latency that we demonstrated in Experiment 1 will be replicated in the present study. The two groups that switch domains will allow us to see if only 20 trials are sufficient to record the carryover effect found in Experiment 1. Finally, we hypothesize that those experiencing loss trials, associated with greater risk taking, will endorse a greater level of risk taking behavior on the self-report measure.

6.1 Participants

There were 407 participants: 296 women and 111 men. They were recruited from several courses in the Department of Psychology at California State University, Fresno, and were given credit in their courses in return for their participation.

6.2 Design and Procedure

This experiment was identical to Experiment 1, with the following exceptions: 1) The gain-loss and loss-gain groups experienced 20 trials of one type followed by 80 trials of the other type. We henceforth refer to these groups as the gain20loss80 and loss20gain80 groups. The choice of a block of 20 context trials in the domain of gain or loss was not selected through any empirical process, but rather through pragmatic choice to see if a number of trials significantly less than the block of 50 trials (in Experiment 1) could influence risk taking in the second block (and/or influence the self-report measure). 2) The gain-loss group started with 800 points, and the loss-gain group started with 200 points. 3) There was no mixed group. 4) Instead of completing the MCQ, participants completed the DOSPERT, a self-report questionnaire designed to assess young adults' risk-taking attitudes (Blais & Weber, 2006). It examines 30 different risk behaviors that fall into five major areas: ethical, financial, health/safety, social, and recreational. For each behavior, participants rate the likelihood that they would engage in that behavior on a scale from 1 (*Extremely Unlikely*) to 7 (*Extremely Likely*). The intention was to evaluate the overall scores on the DOSPERT as a measure of risk-taking; we did not have any specific predictions about risk scores between the five areas.

7 Results

7.1 Overall Performance

Participants' overall performance was similar to that in Experiment 1. Participants' mean proportion correct was 0.55 (SD = 0.06); mean confidence rating was 5.82 (SD = 1.06); and the mean proportion of trials in which the risky option was selected was 0.65 (SD = 0.17). As in Experiment 1, proportion correct showed a small to medium positive correlation with participants' mean confidence rating, ($r(407) = 0.204$, $p < 0.001$). There was also a small correlation with the mean proportion of trials in which risk was taken ($r(407) = 0.160$, $p = 0.001$). Participants' mean confidence also showed a small-medium positive correlation with the proportion of trials in which a risk was taken ($r(407) = 0.278$, $p < 0.001$). There were no differences between the four groups in the proportion correct ($F < 1$) or in mean confidence rating ($F < 1$).

7.2 Risk Taking

We first investigated whether there were differences in risk taking between treatments in the first 20 trials. We combined the data for the first 20 trials in the all-loss and loss20gain80 groups and compared them with the first 20 trials of the all-gain and gain20loss80. We found that participants took a greater proportion of risks when experiencing the loss domain compared with those who experienced the gain domain ($t(405) = 4.87$, p < 0.001, $d = 0.48$). Second, we considered the block of 80 trials for each of the four groups. Figure 7 shows the means and standard errors of the proportion of risky choices made by each group over these 80 trials. An overall univariate ANOVA showed a difference in risk taking between the four groups ($F(3, 403) = 15.58$, $p < 0.001$, $\eta_p^2 = 0.104$).

As in Experiment 1, we see that the all-loss group engaged in more risk taking than the all-gain group ($t(202) = 6.50$, $p < 0.001$, $d = 0.92$). Further, we see that in their final 80 gain trials, the loss20gain80 group engaged in greater risk taking than the all-gain group ($t(205) = 4.88$, $p < 0.001$, $d = 0.68$). As for Experiment 1, this indicates a strong carryover effect upon risky choice when switching domains from losses to gains. Unlike Experiment 1, however, we also found a significant carryover effect in the other direction; the gain20loss80 group showed a lower propensity to take risks than the all-loss group ($t(198) = 2.00$, $p = 0.047$, $d = 0.282$). It is unclear why experiencing only 20 trials in

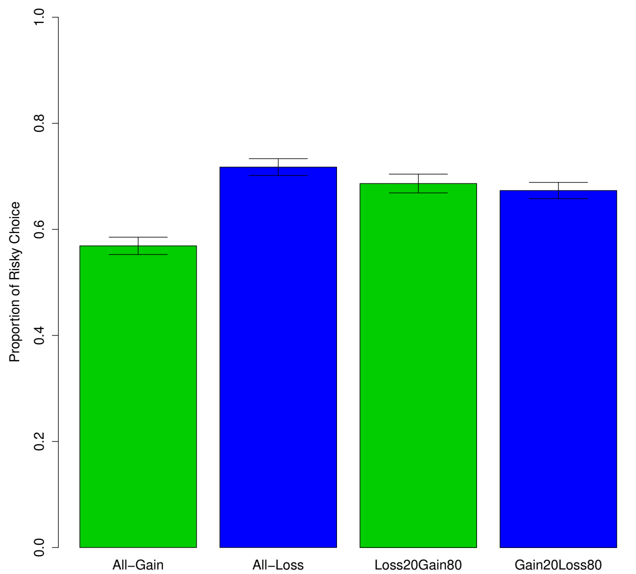

Figure 7: The means and standard errors of the proportion of risky choices over the last 80 trials for each group in Experiment 2. The green bars represent gain trials, and the blue bars represent loss trials.

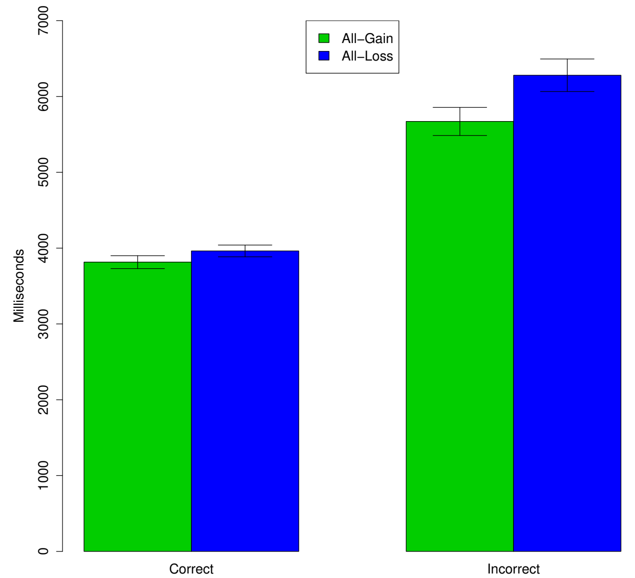

Figure 8: The means and standard error of the time to respond to the target selection in the DMTS during the last 80 trials. The figure shows that the all-gain group (green bars) took less time to respond than the all-loss group (blue bars). Responding incorrectly took longer, especially in the all-loss group.

the domain of gain in this experiment produced a carryover effect, whereas 50 trials in Experiment 1 did not produce it. It may be due to testing for differences between relatively small effect sizes; we cannot rule out the possibility of Type II error in Experiment 1 or Type I error in Experiment 2.

A univariate ANOVA found no difference in accuracy at solving the DMTS between the four groups ($F < 1$). A univariate ANOVA also found no difference in expressed confidence between the four groups ($F < 1$).

7.3 Response Times

As in Experiment 1, to reduce the effect of outlying results, we calculated the median response times for each subject on both the DMTS task as well as the decision to risk or play safe. We then calculated the means of these for each group.

7.3.1 DMTS Response Times

The DMTS response times for Experiment 2 are shown in Table 3 in the Appendix. As in Experiment 1, we examined any differences in the second block of the all-gain and all-loss groups (shown in Figure 8). The all-loss group took longer to respond than the all-gain group in these final 80 trials ($F(1, 202) = 3.99$, $p = 0.047$, $\eta_p^2 = 0.19$). Participants took longer to make incorrect responses than to make correct responses ($F(1, 202) = 399.40$, $p < 0.001$, $\eta_p^2 = 0.66$). Participants in the all-loss group took an especially long time when making incorrect responses as shown by a group x correctness interaction ($F(1, 202) = 4.88$, $p = 0.028$, $\eta_p^2 = 0.24$). These results are similar to the pattern seen in Experiment 1.

7.3.2 Risky Decision Response Times

The risky-decision response times for Experiment 2 are shown in Table 3 in Appendix 1. Figure 9 shows a similar pattern to the results of Experiment 1. The all-loss group took longer than the all-gain group to decide between risking or playing it safe ($F(1, 198) = 4.30$, $p = 0.039$, $\eta_p^2 = 0.021$). Overall, participants took longer when eventually deciding to play it safe ($F(1, 198) = 81.86$, $p < 0.001$, $\eta_p^2 = 0.292$). There was also a group x decision interaction ($F(1, 198) = 22.85$, $p < 0.001$, $\eta_p^2 = 0.103$). Finally, the all-loss group took a disproportionately long time when eventually deciding to play it safe.

7.4 Risk Attitudes (DOSPERT)

We computed participants' scores on the DOSPERT, with higher scores reflecting more positive attitudes toward risk. Overall there was a small correlation between the average score on the DOSPERT and the proportion of trials in which participants selected the risky option ($r(406) = 0.144$, $p = 0.004$). The mean DOSPERT score for the all-gain group was 3.26 ($SD = 0.67$), while the mean score for the all-loss group was 3.50 ($SD = 0.77$). The difference between the two groups was significant ($t(202) = 2.32$, $p = 0.021$, $d = 0.32$).

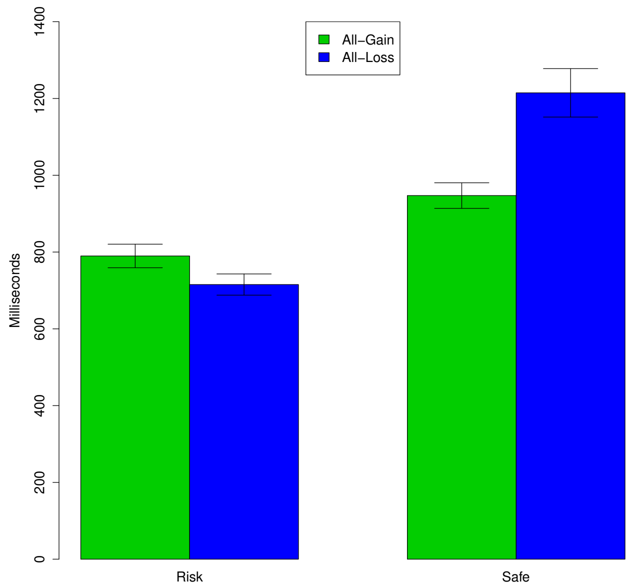

FIGURE 9: The means and standard error of the time to make a choice to risk or play it safe in the final 80 trials. This figure shows that the all-gain group (green) took less time to respond than the all-loss group (blue), particularly when the choice was to play it safew.

This suggests that the risk taking tendencies established in the gain and loss groups is able to carry over to responses on the DOSPERT. This interpretation would be strengthened in future studies by conducting a pre- and post-DOSPERT assessment. It is also of interest that just 20 trials in a context domain were able to influence DOSPERT scores, an effect which 'survived' the subsequent 80 trials in the other domain. Thus the gain-loss group, who experienced 20 gain trials prior to 80 loss trials, scored lower on the DOSPERT when compared with the all-loss group ($t(198) = 2.04$, $p = 0.043$, $d = 0.28$). However, there was no corresponding effect when comparing the loss-gain group with the all-gain group.

8 General Discussion

The two experiments reported here produce several novel and potentially important findings. First, there was a clear difference in risk taking between gain and loss conditions, with participants taking fewer risks (contingent on their DMTS performance) during a block of gain trials than during a block of loss trials. This was true for both between-subjects and within-subjects comparisons, and despite the fact that DMTS performance and confidence differed very little across conditions. However, this effect occurred only when the gain and loss trials were experienced as a block; when they were intermixed, no effect on risk taking was found between the two domains.

Second, there was clear evidence of a carryover effect on risk taking. Experiencing a context block of gain trials decreased risk taking for a subsequent block of loss trials (Experiment 2 only), and experiencing a context block of loss trials increased risk taking for a subsequent block of gain trials (in both Experiment 1 and Experiment 2). These carryover effects were asymmetric; the effect of prior losses on risk taking for gains was stronger than the effect of prior gains on risk taking for losses. The strong influence of loss is also evident in the higher risk taking observed in the mixed group on both gain and loss trials.

Third, response time analyses showed that participants took longer to respond for loss trials, especially when they were incorrect in the discrimination task and when they decided not to take a risk.

Many of the present results are consistent with those of Schneider et al. (2016) and can be explained by their mood-maintenance model. They proposed that experiencing gains leads to positive affect, which maintain the status quo, which they do by adopting the goal of avoiding risk. Conversely, experiencing losses leads to negative affect, which motivates people to escape the status quo (which they do by adopting the goal of taking risks). These different goals, then, are what potentially carry over when the domain changes from gains to losses or *vice versa*. The particular strength of this explanation is that it is consistent with a large body of research showing that people in a positive mood tend to behave in ways that are likely to maintain that mood, while people in a negative mood tend to behave in ways that are likely to change it (including by taking more risks), e.g., Isen and Geva, 1987; Isen and Patrick, 1983; Yuen and Lee, 2003.

This mood-maintenance model also provides insight into why experiencing gains and losses is able to carry over to responses on the DOSPERT. When people are gaining, and therefore in a positive mood, any kind of risk (ranging from bungee jumping through to having an extra-marital affair) may be less appealing due to its potential to upset the *status quo*. Similarly, when people are losing, and accordingly in a negative mood, any kind of risk may be more appealing because it offers the potential to escape the status quo. However, this raises the question of why there was no carryover effect of experiencing losses or gains to responses on the MCQ — a measure of delay discounting. The mood-maintenance model provides a possible explanation; from the perspective of this model, it is unclear how being in a positive versus a negative mood should relate to delay discounting. Opting for a smaller reward now over a larger reward later seems like a good way to maintain a positive mood, but it also seems a good option to change a negative mood. We included the MCQ on the basis of research showing positive correlations between delay discounting and risky behavior (e.g., Bickel et al., 2007; Bickel et al., 1999) and, indeed, we reproduce the weak positive relationship between MCQ score and risk taking in a laboratory task observed by Mishra and Lalumiere (2017). However, we might be unsurprised to find no consistent relationship between mood and delay discounting.

A further key result from the present experiments is that the effect of a context block of losses upon subsequent risk taking in the domain of gains was stronger than the effect of a context block of gains upon subsequent risk taking in the domain of losses. This is consistent with the broad principle that negative stimuli tend to exert stronger and longer-lasting effects across a wide variety of situations than do positive stimuli (Baumeister et al., 2001; Rozin & Royzman, 2001). We note, however, that neither Schneider et al. (2016) nor Yechiam et al. (2015) found this asymmetry in carryover effects on risk taking. A possible reason for this is the nature of our task compared to theirs. In their tasks, the outcome of a trial was the result of a random and uncontrollable process. In ours, the outcome depended on participants' skill in the perceptual-memory task, as well as the meta-cognitive problem of assessing one's skill and applying that self-assessment to a risky decision. Losses associated with one's 'own' failure may therefore have a stronger (or longer-lasting) effect than losses due to pure chance. At least one study, however, seems to contradict this idea. Vermeer and Sanfey (2015) found that people were more likely to accept a mixed gamble over a safe option immediately following a monetary loss than a monetary gain. This effect was stronger when the loss was the result of a dice roll than when it was the result of failure at a time estimation task. However, their experimental paradigm differed significantly from the present one; further research will be necessary to test possible contributors to these asymmetries.

Although the mood-maintenance model provides a reasonably good explanation for our results, an alternative explanation is provided by the attentional model presented by Yechiam et al. (2015), which is based on a large body of research into the cognitive, behavioral, and physiological effects of experiencing losses (Yechiam & Hochman, 2013). According to their model, losing leads to increased attention to a task, more exploratory behavior while attempting to master the task, and ultimately greater sensitivity to the contingencies of the task. In terms of our results, it could, therefore, be the case that experiencing a block of loss trials leads to increased attention, which in turn leads to increased risk taking as a means of more thoroughly exploring the task contingencies (as well as one's own perceptual and meta-cognitive abilities). This model is also consistent with the loss-to-gain carryover effect if heightened attention and arousal established in the loss condition persist into the gain condition. The attentional model is certainly consistent with longer response times we found when losing than while gaining, a result that has been observed consistently in previous research (e.g., Yechiam & Telpaz, 2013; Xue et al., 2011).

However, the attentional model has some weaknesses with respect to accounting for the present results. First, it is unclear why there would be a gain-to-loss carryover effect. One might expect that the sudden change in salience from gains to losses would produce an especially strong attentional response rather than an attenuated one (with which our results are more consistent). Similarly, it is unclear why there would be a carryover effect to a self-report risk attitude scale like the DOSPERT. We might also expect that heightened attention would lead to better performance at the DMTS task in loss conditions than in gain conditions, an effect we did not find.

Ultimately, we would suggest that neither the mood-maintenance or attentional models will provide an exclusive explanation of our results. The models have particular strengths as well as considerable overlap; both are likely to be helpful in explaining particular patterns in our results as well as providing useful frameworks for future research. An especially important similarity between the two models is their basic functional orientation, which they share with models from behavioral ecology applied to nonhuman animals. For example, the energy budget model of risk sensitivity (Stephens, 1981) argues that if an animal is in a positive energy state and surviving well with current behavior, then it should not make risky foraging choices. On the other hand, if the animal is not meeting its basic energy needs, it will take more risks to increase the chances of survival (even if these also risk death). Mood and attention would both be candidate (and non-exclusive) mechanisms involved in such behavioral strategies. We believe it would be worthwhile for future research to explore how the two models could account for results observed across species, not just humans.

8.1 Limitations

One limitation of our present study is that domains of gaining versus losing could be confounded with total points. So, for example, participants in the all-gain groups started with 0 points, while participants in the all-loss groups started with 1000 points. An alternative explanation for our reflection effect, then, is that those in the all-gain groups were risk averse because they needed to accumulate points, while those in the all-loss groups were risk seeking because they were 'playing with house money' (Thaler & Johnson, 1990). If this were true, however, we would expect to see a much smaller difference in risk taking between the first block of the gain-loss group and the first block of the loss-gain group (note both groups started with 500 points). Yet the difference between these groups in Experiment 1 was even *greater* than the difference between the all-gain and all-loss groups. Although it is possible that point totals might have had some effect on risk taking in the present experiments, they do not provide a good alternative explanation of our overall pattern of results.

A second limitation is difficulty in interpreting response times. Participants were given no instructions about how long they should take to do the task (e.g., to go as fast as possible while making the best decisions they could). Their response times were highly variable and probably reflected far more than simply the time to execute the basic motor/cognitive processes necessary to complete the task. They might have included time to strategize, time to notice what other participants were doing (which was possible because they were tested in groups in a computer classroom), and even time to rest briefly. Therefore it is not necessarily clear which components of the response process made participants take longer to make a risky decision on loss trials. In the time it took to decide whether or not to take a risk, participants might have been making meta-cognitive assessments about whether they had indeed selected the correct image and pondering the expected values of the risky option (versus playing it safe). Alternatively, they may have simply been 'putting off' a painful decision that was likely to result in a loss.

8.2 Future Research and Conclusions

While there is good evidence that both affective and attentional states can have short- and long-term influences on risky decisions, it is only recently that evidence has indicated that the simple experience of losses and gains can have effects beyond the point of the choice. There are many questions about the carryover effect which could be addressed with future research. For example, how long does the carryover effect last after experiencing losses or gains? Would a distracting task or extended inter-condition interval moderate the effect? Does experiencing losses or gains in ways other than a decision-making or gambling task affect future risky decisions? Are there differences between epistemic uncertainty and aleatory uncertainty in their influence on decision-making in the face of losses and gains? Finally, for how long do losses and gains affect emotions?

Answers to some of these questions might be found through neuroimaging studies. For example, in a meta-analysis of fMRI research, Knutson and Greer (2008) found that the nucleus accumbens was activated in anticipation of gains as well as self-reported positive arousal, whilst the anterior insula shows activity in anticipation of losses and self-reported negative arousal states. Xue et al. (2011) found that participants would take a risk more often if they had just lost a gamble as opposed to if they had just won one (thereby demonstrating a single-trial carryover effect). They found that after risking and losing, areas involved in executive functions such as the frontoparietal cortex were more active, and areas associated with the influence that emotions have on decision-making (such as the ventromedial prefrontal cortex and amygdala) were less active. Risking and winning, however, saw activation in dopaminergic 'reward systems' such as the nucleus accumbens, as well as the anterior cingulate cortex. The frontoparietal and the dorsolateral prefrontal cortex (DLPFC) system is often described as part of the 'deliberative network'; and the amygdala, insula, striatum, and nucleus accumbens as part of the 'affective network' (for review see Mohr, Biel, & Heekeren, 2010; Hytönen et al., 2014), with the former being slower to initiate choices than the latter. The activity of the 'deliberative network' during loss trials may account for the increased decision times observed in the present experiment. However, in a lottery game, Hytönen et al. (2014) found more risk taking after prior gains as well as prior losses, as compared with a neutral outcome. After both gains and losses, they found increased activity in affective brain areas and decreased activity of deliberative networks. The results of these fMRI studies provide support that different systems related to emotions and decision-making are affected by losses and gains, with corresponding effects upon behavior. Further research in this area might investigate the lasting psychophysiological effects of different domains of reinforcement on decision making.

Extended periods of losses and gains are common in almost every aspect of human life, ranging from the hunter-gathering activities of our ancestors, through to finding a partner, playing sports, taking exams, trading on financial markets, and warfare. The present findings of carryover from experiencing gains and losses in a skill-based task could have important real-world implications; understanding more about the underlying mechanisms should be a priority for future research in this field.

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Appendix: Response Time Data

Table 1: Means (and Standard Deviations) for Participants DMTS Choice Times, Separately by Group, Block, and Correctness.

	First Block Correct	First Block Incorrect	Second Block Correct	Second Block Incorrect
All Gain	4006.97 (1091.01)	6248.90 (2292.16)	3584.45 (802.88)	5230.77 (2066.32)
All Loss	4029.26 (1047.77)	6870.90 (3192.00)	3761.46 (928.10)	5603.91 (2216.14)
Gain-Loss	4322.97 (1056.04)	6605.20 (2012.31)	3953.15 (914.11)	5773.89 (1783.68)
Loss-Gain	4244.63 (1007.29)	6516.01 (1984.58)	3699.07 (745.52)	5367.03(1473.66)
	Gain Trials Correct	Gain Trials Incorrect	Loss Trials Correct	Loss Trials Incorrect
Mixed	4093.86 (1008.52)	6562.20 (2678.30)	4103.34 (1119.30)	6560.16 (2648.47)

Table 2: Means and Standard Deviations of Participants Median Times to Decide Whether to Take a Risk, Separately by Group, Block, and Decision (Safe vs. Risk)

	First Block Risk	First Block No Risk	Second Block Risk	Second Block No Risk
All Loss	876.26 (373.05)	1310.10 (951.44)	537.55 (284.67)	772.39 (300.54)
All Gain	876.32 (311.40)	1081.96 (357.02)	521.33 (213.14)	697.67 (264.02)
Loss-Gain	915.02 (362.79)	1461.82 (761.38)	559.33 (272.03)	850.87 (372.71)
Gain-Loss	988.49 (347.72)	1231.48 (501.79)	684.45 (276.46)	920.63 (363.05)
	Loss Trials Risk	Loss Trials No Risk	Gain Trials Risk	Gain Trials No Risk
Mixed	1320.85 (647.01)	1873.53 (888.21)	1214.97 (558.59)	1847.07 (992.19)

Table 3: Means and Standard Deviations of Participants' Median DMTS and Risky-Decision Response Times for the Final 80 Trials for Each Group in Experiment 2.

	DMTS Response Times		Risky-Decision Response Times	
	Correct	Incorrect	Risk	No Risk
All-Gain	3815.29 (858.94)	5676.02 (1872.31)	789.79 (309.85)	947.14 (333.07)
All-Loss	3963.08 (784.58)	6280.20 (2165.25)	715.33 (279.32)	1214.70 (631.03)
Gain-Loss	3936.88 (725.90)	6390.26 (2059.70)	766.13 (336.24)	1153.40 (559.95)
Loss-Gain	3917.58 (1033.88)	6168.77 (2031.11)	684.50 (348.03)	1019.33 (506.62)