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Framing effects and risk-sensitive decision making

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Prospect theory suggests that people are risk-averse when facing gains, but risk-prone when facing losses, a pattern known as the framing effect. Although framing effects have been widely demonstrated, few studies have investigated framing effects under conditions of need. Risk-sensitivity theory predicts that decision makers should prefer high-risk options in situations of high need, when lower risk options are unlikely to meet those needs. In two experiments, we examined (1) whether framing effects occurred in behavioural tasks involving risky decision making from description and decision making from experience, (2) whether participants' risky decision making conformed to the predictions of risk-sensitivity theory, and (3) whether decision framing interacted with conditions of need to influence decision making under risk. The results suggest that under all circumstances, risky decision making conformed to the predictions of risk-sensitivity theory. Framing effects were at least partially demonstrable under all experimental conditions. Finally, negative frames interacted with situations of high need to produce particularly elevated levels of risky choice. Together, the results suggest that risk-sensitivity theory can augment prospect theory to explain choice under conditions of need.

In economics, traditional normative models of decision making posit that people make utility-maximizing, or 'rational' decisions under virtually all circumstances. A large body of evidence, however, suggests that people often make 'irrational' decisions under various predictable conditions (e.g., Allais, 1953; Ellsburg, 1961; Kahneman & Tversky, 1979; reviewed in Aktipis & Kurzban, 2004). One such violation of normative utility models that has received substantial empirical attention is the framing effect. Prospect theory (Kahneman & Tversky, 1979) posits that people should exhibit a reversal of risk preferences in mathematically identical decisions contingent on whether the decision is framed negatively (in terms of a loss) or positively (in terms of a gain). Specifically, people tend to be risk-prone when facing losses (i.e., exhibiting loss aversion) and risk-averse when facing gains. Decision preferences conforming to the predictions of prospect theory have received considerable empirical support (reviewed in Levin, Schneider, & Gaeth, 1998; for a meta-analysis, see Kühberger, 1998).

Why do people exhibit vastly different levels of risk-acceptance in decision scenarios involving mathematically identical outcomes? Prospect theory suggests that people

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exhibit framing effects because the rate of increase in utility derived from gains is steeply diminishing: for example, gaining $100 is more valuable if one starts with $0 than if one starts with $10,000 (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981). In the domain of losses, however, the rate of decrease in utility diminishes more rapidly, and so risky behaviour may be engaged in to prevent any further experience of loss. As a consequence, loss facilitates greater risk-acceptance. Gains and losses are determined around a reference point (usually a net or relative zero outcome), where outcomes below the reference point represent losses and outcomes above the reference point represent gains. Importantly, reference points are derived from an individual's present state but can change based on expectations or biases of decision makers (Tversky & Kahneman, 1981).

Risk-sensitivity theory provides an account of how reference points conceptualized as minimal acceptable requirements, or need, may affect risky choice (Stephens, 1981; Stephens & Krebs, 1986). According to risk-sensitivity theory, decision makers should prefer high-risk options in situations of high need, when low-risk options are unlikely to meet those needs. Here, need refers to disparity between an individual's present state and a goal or desired state (Mishra & Lalumière, 2010). For example, someone with a $500 debt may prefer a 10% chance of winning $500 over receiving $50 with certainty. In this example, only the risky option offers a chance of meeting one's needs. More generally, risk-sensitivity theory posits that decision makers do not seek to maximize certain outcomes (e.g., maximizing dollars of income), but rather, seek to minimize the probability of experiencing outcomes that fail to meet their needs (e.g., avoiding debt; Rode, Cosmides, Hell, & Tooby, 1999). A growing body of evidence suggests that both non-human animals (reviewed in Kacelnik & Bateson, 1996, 1997) and humans (Deditius-Island, Szalda-Petree, & Kucera, 2007; Ermer, Cosmides, & Tooby, 2008; Koop & Johnson, 2010; Mishra & Fiddick, 2011; Mishra & Lalumière, 2010; Mishra & Lalumière, 2011b; Pietras & Hackenberg, 2001; Pietras, Locey, & Hackenberg, 2003; Rode *et al.*, 1999) conform to the predictions of risk-sensitivity theory when making risky decisions under conditions of need.

Almost every real-world decision is made under some condition of need. If someone is at distance from an acceptable threshold (e.g., possessing low income, or poor social status), they may do well to engage in risky behaviour to improve their situation (Wilson & Daly, 1985, 1997). Consequently, any risk-sensitive decisions involving both need and framing (i.e., the differential perception of potential loss or gain) may be affected by an important interaction between need and frame. If someone is in a situation of high need, and a high-risk option is the only option that allows for even a chance of meeting one's need, it should be chosen regardless of positive or negative framing. Someone in a situation of high need facing loss, however, may further elevate risk-accepting behaviour because of the particularly high salience of the perception of loss in this scenario. Previous research has shown that people perceive themselves to be in a situation of high need in negatively framed scenarios, lending support to the hypothesis that high need coupled with negative decision framing should motivate high levels of risky choice (Mishra & Fiddick, 2011; Wang, 2002).

A few previous studies have investigated the effect of need on risky choice in framed decision-making tasks (e.g., Mishra & Fiddick, 2011; Wang, 1996a, 1996b, 1996c, 2002). These studies have shown that people will sometimes violate the expectations of prospect theory in certain goal-directed conditions. Specifically, people tend to choose behavioural options that are most likely to meet their needs independent of decision framing. None of these studies, however, have explicitly examined the effect of an interaction between need and framing on risky choice. Furthermore, none of these

studies have investigated framing effects using behavioural tasks that measure risky choice involving decision making from experience. Instead, most have relied on the presentation of explicitly described decision scenarios, such as the classic Asian disease problem. Finally, none of these studies have used relevant real-world decision scenarios to examine whether framing interacts with conditions of need.

In two experiments, we examined whether framing effects occur in behavioural tasks, and whether framing interacts with conditions of need to affect risky choice. Experiment 1A examined whether framing effects occurred in behavioural tasks involving decision making from description and decision making from experience. Experiment 1B examined the interaction between framing effects and conditions of need in behavioural decision-making tasks. Experiment 2 examined whether framing interacted with conditions of need in decisions involving hypothetical investment scenarios. We predicted that (1) framing effects would be observed for behavioural tasks involving both decisions from description and from experience; (2) participants' decisions would conform to the predictions of risk-sensitivity theory, with participants in high need situations exhibiting higher risk-acceptance than participants in low need situations; and (3) conditions of high need would interact with negative framing to induce particularly high levels of risk-accepting behaviour.

EXPERIMENT 1A

Choice under positive and negative frames has been largely studied using explicit instructions to describe decision scenarios (known as *decision from description*; Hertwig, Barron, Weber, & Erev, 2004). Explicit information about expected values of decision options, however, is rarely available in natural environments. Outside of the laboratory, people often make risk-sensitive decisions based on experience with different behavioural options, thus acquiring a sense of the likelihood and magnitude of various outcomes associated with different behavioural options (known as *decision from experience*; Hertwig *et al.*, 2004). To our knowledge, only one study has demonstrated framing effects using a behavioural measure of risky choice involving decision making from experience[1] (Benjamin & Robbins, 2007). In this study, participants exhibited framing effects, exhibiting higher risk-acceptance in negative frames compared to positive frames. In Experiment 1A, we attempted to replicate previous findings demonstrating framing effects using behavioural risky decision-making tasks involving decisions from both description and experience. We predicted that participants would exhibit framing effects as predicted by prospect theory, exhibiting higher risk-acceptance in loss frames compared to gain frames.

Method

Fifty participants (25 female) were recruited from undergraduate psychology classes (age: $M = 20.6$, $SD = 2.20$, *Range*: 18–28). The same participants were used in both Experiments 1A and 1B. The experiment followed a within-subjects design, with each participant completing each of the tasks described below for Experiments 1A and 1B in both a positive and a negative frame. All of the positively framed tasks were completed together, as were the negatively framed tasks. The order of frame presentation was

[1] *We do note, however, that others have shown framing effects in tasks involving decision making from experience in non-risk domains (e.g., Levin & Gaeth, 1988).*

randomized across participants. All tasks within each frame were randomly presented on a computer. After completing each task, participants called the experimenter to make any relevant draws.

All earnings were denoted with poker chips and were traded in at the end of the experiment for a cheque. In the positive frame, participants collected their earnings after each task. In the negative frame, participants were given the maximum possible amount of earnings prior to engaging in each task, and returned chips back to the experimenter as determined by their decision outcomes at the end of each task. Expected average earnings from the positive and negative frames of each task were identical. Participants received the amount of their earnings from the tasks described in Experiments 1A and 1B as compensation. Average earnings across both Experiments 1A and 1B were $10.36 (*SD*: $4.75, *Range*: $3.50–$26.00).

Measures

Decision making from description: Choice task (CT)

The CT was presented in both a negative frame and a positive frame. In the positive frame, participants made six decisions, each between two monetary options (Mishra & Lalumière, 2010; Mishra & Lalumière, 2011a; adapted from Fessler, Pillsworth, & Flamson, 2004). Both options had equal mean expected values but differed in payoff variance. For example, 'Would you rather choose (A) $3 guaranteed, or (B) a 10% chance of earning $30?' At the end of the task, participants rolled a die and received the value of one of the six choices they made corresponding with the number on the die. If the number on the die corresponded to a risky option, participants drew a bead from a cup containing the appropriate ratio of black and white beads. For example, for the choice of a 10% chance of earning $30, participants drew from a cup containing 10% black beads and 90% white beads; if they drew a black bead, they earned $30. A total score of number of risky choices was computed.

The negative frame of the CT was identical as above, except participants made decisions between loss options with equivalent expected values. For example, the equivalent decision to the example in the positive frame above (i.e., involving the same expected value of $3) is as follows: 'You have $10. Would you rather choose (A) 100% chance of losing $7, or (B) 70% chance of losing $10?'

Decision making from experience: Balloon analogue risk task (BART)

The BART was presented in both a positive and a negative frame. In the positive frame, participants saw a computer screen with a deflated balloon and a 'PUMP' button (Lejuez *et al.*, 2002). For each pump of the balloon, participants earned half a cent and increased the balloon in size. The balloon was set to pop randomly, with an average of 65 pumps required before popping. If the balloon popped, participants lost all money gained for that trial. Participants could end the trial at any time by clicking on a 'COLLECT' button. Thirty trials were presented; the first five were excluded from analysis as training. The average number of pumps for all trials where the balloon did not pop was computed. Participants received all money earned from the last 25 trials. Instructions involving earnings were as follows: 'You will earn 0.5 cents for each pump'.

The negative frame of the BART was identical as above, except participants started with the maximum possible amount of earnings in the gain frame ($19.20), and participants avoided losing half a cent for each pump of the balloon. Instructions involving earnings were as follows: 'You will begin this task with $19.20 . . . You will

avoid losing 0.5 cents for each pump'. Participants who did not pump the balloon at all would have lost all of their possible earnings from the trial.

Results and discussion

Framing and decision making from description

A repeated-measures *t*-test was conducted on the number of risky decisions made in the positive and negative frames of the CT. Participants made significantly more risky choices in the negative frame compared to the positive frame, $t(49) = 5.17$, $p < .001$, $r = .59$, $M_{\text{negative}} = 3.1$, $M_{\text{positive}} = 1.7$.

Framing and decision making from experience

A repeated-measures *t*-test was conducted on risk-taking in the positive and negative frames of the BART. Participants engaged in significantly higher risk-acceptance in the negative frame compared to the positive frame, although this result was marginally significant, $t(49) = 1.97$, $p = .06$, $r = .27$, $M_{\text{negative}} = 45.4$, $M_{\text{positive}} = 39.9$.[2]

Although the order of positive and negative frames was counterbalanced between participants, it is possible that order effects influenced the results. To examine whether order effects were a problem in this study, we compared participants' scores on each of the measures within frame type (positive, negative) across the two different presentation orders. Patterns of risky choice between positively and negatively framed scenarios in the CT and the BART did not differ based on order of presentation (all *p*s > .05). Together, the results provide support for the hypothesis that framing effects occur in behavioural decision-making tasks involving both decisions from description and from decisions from experience.

EXPERIMENT 1B

Experiment 1A demonstrated that framing effects were at least partially demonstrable in behavioural tasks involving both decision making from description and decision making from experience. Experiment 1B was designed to examine whether such framing effects in behavioural tasks held when decisions were made under some consideration of need. Previous research has demonstrated that loss frames confer the perception of high need (Mishra & Fiddick, 2010; Wang, 2002). Thus, the interaction between conditions of high need and the salience of the perception of loss in negative frames should result in significantly elevated risky choice. We predicted that (1) participants would engage in greater risky choice in situations of high need (compared to situations of low need), conforming to the predictions of risk-sensitivity theory and (2) negative frames would interact with conditions of high need to produce particularly high levels of risk-acceptance.

Method

The same participants as in Experiment 1A were used. The same within-subjects experimental design as in Experiment 1A was also used, with participants completing

[2] *Similar analyses of variance were conducted for both the CT and the BART with sex as a between-subjects factor. The pattern of results obtained for analyses with and without sex included were identical, and so results collapsed across sex are presented.*

each of the tasks below in both a positive and a negative frame, grouped together in their respective frames. The structure of the tasks and the disbursement of earnings were identical to Experiment 1A.

Measures

Decision making from description: Variance preference under need (VPN)

The VPN was presented in both a positive and a negative frame. In the positive frame, participants made 20 decisions between a certain option, consisting of one of four fixed ratios of black to white beads totalling 100 (30:70, 50:50, 60:40, 70:30), and a risky option, consisting of a randomly determined combination of black and white beads totalling 100 (Rode *et al.*, 1999). For each decision, participants drew 10 beads with replacement. In order to earn any money, participants had to draw a certain number of black beads (i.e., meet a need requirement). Five need requirements were constructed. This need requirement was either one or two beads above, one or two beads below, or equal to the expected value of the certain option (abbreviated $+1$EV, $+2$EV, -1EV, -2EV, and 0EV, respectively).

Each level of need was presented for each of the different certain option ratios, leading to 20 decisions (4 certain option ratios $\times$ 5 need requirements). For example, 'You are required to draw *five* black beads out of ten. Would you rather draw from a cup containing (A) 70 black beads and 30 white beads, or (B) a randomly determined combination of black and white beads totalling 100'. In this example, (A) is the certain option, (B) is the risky option, and the level of need is seven (which is equal to two above the expected value of the certain option, or the $+2$EV condition). Instructions involving earnings were as follows: 'If you draw at least the minimum number of required black beads, you will earn \$5'.

At the end of the task, participants drew one of 20 numbered ping-pong balls and played out their decision in the scenario corresponding to the number drawn. Participants earned \$5 if they met their need. The dependent measure was the proportion of risky choices made under each of the five need conditions.

The negative frame of the VPN was identical as above, except participants started with \$5. If participants met their need, they were able to keep the \$5 they started with. The instructions involving earnings were as follows: 'You will begin this task with \$5 . . . If you draw at least the minimum number of required black beads, you will have a chance to keep the \$5 you began with'.

Decision making from experience: The ecological decision task (ECO)

The ECO approximates risk-sensitive decision making in a foraging context (Mishra & Lalumière, 2010). The ECO was presented in both a positive frame and a negative frame, and consisted of two parts. Part A was the training session. Participants saw 50 cartoon trees of four different colours, randomly presented one at a time on a computer screen. Clicking on each tree revealed some non-zero number of apples shown in the foliage of the tree. Each tree colour produced a specific mean and variance of return, approximating real-world foraging, which involves learning the yield characteristics of patches by experience. The four tree colours and four yield characteristics were paired randomly between participants. Two trees had different mean outcomes, but the same variance in outcome (Tree 1: $M_{\text{yield/day}} = 7.3$; $SD_{\text{yield/day}} = 2.5$; Tree 2: $M_{\text{yield/day}} = 4.7$, $SD_{\text{yield/day}} = 2.5$). The other two trees had the same mean outcome, but different variance in outcome (Tree 3: $M_{\text{yield/day}} = 8.0$, $SD_{\text{yield/day}} =$

6.0; Tree 4: $M_{\text{yield/day}} = 8.0$, $SD_{\text{yield/day}} = 0.9$). Previous research has demonstrated that participants are not explicitly aware of the yield characteristics of the four trees in the ECO, but still make risk-sensitive decisions as predicted by risk-sensitivity theory. This finding suggests that participants implicitly learn the yield characteristics of the different patches through experience (Mishra & Lalumière, 2010).

Part B was the decision-making phase. There were seven trials per block (described to participants as 7 days). Ten blocks were presented to each participant. The participants' goal was to 'survive' the week by obtaining 50 apples (earning $0.50). For each trial, participants were told to 'Click to see what trees [were] available within a day's walking distance'. The first five trials in each block presented a single tree, such that participants were fixed to be in one of two conditions by the sixth trial: low need (Tree 1 presented for trials 1–5, resulting in an apple total close to the survival threshold, $M = 36.5$), or high need (Tree 2 presented for trials 1–5, resulting in an apple total far from the survival threshold, $M = 23.5$). The only parameter that varied between the two conditions was the mean yield of the tree presented; Trees 1 and 2 both had the same yield variance. On trials 6 and 7, participants decided between two trees with the same mean yield, but different variance, one risky (high variance; Tree 3) and the other non-risky (low variance; Tree 4). The cumulative number of apples collected throughout each trial was shown visually using a graphic of a basket with the appropriate number of apples depicted within.

Trial 6 introduced participants to the decision-making task but was not used as a dependent measure. Trial 7 represented a risk-sensitive decision based on an immediate situation of low or high need. The dependent measure was the proportion of risky choices in trial 7. Instructions involving earnings for the positive frame of the ECO were as follows: 'If you live through the week, you will earn $0.50'.

The negative frame of the ECO was identical as above, except participants began with the maximum amount of money that could possibly be earned in the positive frame ($5). For each week survived, participants avoided losing $0.50. Instructions for the negative frame of the ECO involving earnings were as follows: 'You will begin this task with $5 . . . If you do not survive the week, you will lose $0.50'.

Data preparation

The probability of meeting one's need was calculated for each of the 20 decisions in the VPN using the formula, *probability of meeting need by choosing the low-risk option minus probability of meeting need by choosing the high-risk option* (Rode *et al.*, 1999). The probability of meeting one's need in the ECO was calculated using the equivalent formula for each of the 34 possible need scenarios for the seventh day decision trial (ranging from requiring 1–35 apples to meet one's need). Participants' actual decision tendencies for both tasks were calculated using the formula, *proportion of low-risk choices minus 0.5* (where 0.5 indicated indifference between the low- and high-risk options) for each need scenario.

Results and discussion

All data were normally distributed, and so parametric tests were used. One female participant did not complete the loss frame of the ECO and was excluded from all analyses involving the ECO. No outliers were detected.

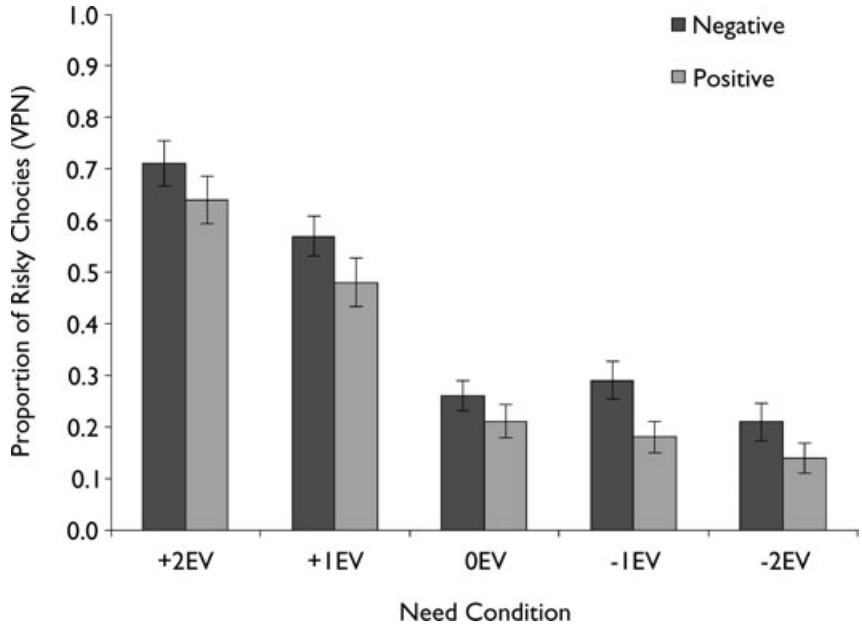

Figure 1. Proportion of risky choices (*M*, *SE*) made in the VPN under positive and negative frames.

Framing and risk-sensitive decision making from description

A repeated-measures analysis of variance (ANOVA) with frame (positive, negative) and need ($+1$EV, $+2$EV, 0EV, -1EV, -2EV) as within-subjects factors was conducted on the proportion of risky decisions made in the VPN. Participants made significantly more risky decisions in the negative frame compared to the positive frame, $F(1, 49) = 9.37$, $p = .004$, $\eta^2 = .16$, $M_{\text{negative}} = .41$, $M_{\text{positive}} = .33$. Participants in the higher need conditions made significantly more risky decisions than participants in the lower need conditions, $F(4, 196) = 56.12$, $p < .001$, $\eta^2 = .53$, $M_{-2\text{EV}} = .21$, $M_{-1\text{EV}} = .29$, $M_{0\text{EV}} = .26$, $M_{+1\text{EV}} = .57$, $M_{+2\text{EV}} = .71$. A linear contrast test indicated that the need effect followed a linear trend, $F(1, 49) = 76.77$, $p < .001$, $\eta^2 = .61$. A significant need by frame interaction was not observed, $F(1, 49) = .44$, $p = .78$, $\eta^2 < .01$. These results are shown in Figure 1.

Across all 20 decisions, the proportion of risky choices made in the VPN was highly correlated with the probability of meeting one's need with higher risk options, in both the positive frame, $r = .94$, $p < .001$, and the negative frame, $r = .93$, $p < .001$.

Framing and risk-sensitive decision making from experience

A repeated-measures ANOVA with frame (positive, negative) and need (high, low) as within-subjects factors was conducted on the proportion of risky decisions made in the ECO. Participants made a higher proportion of risky decisions in the negative frame compared to the positive frame, $F(1, 48) = 5.25$, $p = .03$, $\eta^2 = .10$, $M_{\text{negative}} = .59$, $M_{\text{positive}} = .51$. Participants also made a higher proportion of risky decisions in the high need condition compared to the low need condition, $F(1, 48) = 35.52$, $p < .001$, $\eta^2 = .42$, $M_{\text{high}} = .66$, $M_{\text{low}} = .43$. These results are shown in Figure 2. As predicted, a significant frame by need interaction was obtained, $F(1, 47) = 6.89$, $p = .01$, $\eta^2 = .13$. A follow-up repeated-measures *t*-test indicated that participants in the high need condition made a significantly higher proportion of risky decisions in the negative frame compared to the positive frame, $t(48) = 4.31$, $p < .001$, $r = .53$, $M_{\text{negative}} = .75$, $M_{\text{positive}} = .59$.

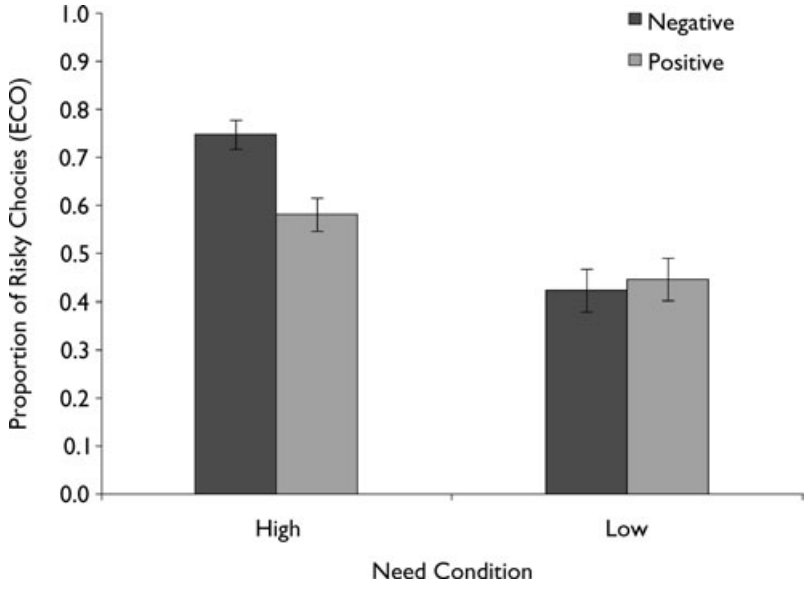

Figure 2. Proportion of risky choices (*M*, *SE*) made in the ECO under positive and negative frames.

There was no significant framing effect in the low need condition, $t(48) = .411$, $p = .68$, $r = .06$.[3]

Across need conditions, the proportion of risky choices made in the ECO was significantly correlated with the probability of meeting one's need with higher risk options in both the positive frame, $r = .29$, $p = .05$, and the negative frame, $r = .55$, $p < .001$.

As in Experiment 1A, order of measure presentation may have affected risky choice. We conducted similar analyses as in Experiment 1A to examine whether risky choice differed based on the order of frames received. Decision patterns in the ECO and in most conditions of the VPN did not differ based on order of presentation ($p > .05$). However, participants who received the positively framed VPN first made significantly more risky decisions in the +1EV need condition, $t(48) = 2.15$, $p = .04$. Overall, order effects appeared to have a minimal effect on the decision-making tasks used in both Experiments 1A and 1B.

The results of Experiment 1B provide support for both the predictions of risk-sensitivity theory and prospect theory. Participants engaged in significantly more risky choice in high need conditions compared to low need conditions, and in negative frames compared to positive frames. These results were obtained both in tasks reflecting decision making from description (VPN), and decision making from experience (ECO). The results also provide some evidence supporting the prediction that conditions of high need would interact with negative frames to produce particularly high levels of risky behaviour, although evidence for this hypothesis was mixed. This interaction was significant in the ECO, but not in the VPN.

Most studies that have examined framing effects, or even risk-sensitive decision making more generally, have utilized tasks that provide descriptive information about

[3] *As in Experiment 1A, results were identical when including sex as a between-subjects factor, and so analyses collapsed across sex are presented.*

decision options such as probabilities. This type of information is rarely available in everyday decision-making scenarios. That the predicted interaction between need and framing was found in the ECO, but not the VPN, suggests that the ECO may better represent decision making as it occurs in the real world, perhaps because decisions in the ECO are based on implicit learning of decision options (Mishra & Lalumière, 2010). It is also possible, however, that this effect was not observed in the VPN because it involved arbitrary choices (i.e., involving beads and arbitrary need targets) in abstract scenarios that do not necessarily have any relevance to real-world decision making. As a consequence, Experiment 2 examined whether a more relevant real-world investment scenario involving decision-making from description produced the expected risk-elevation in negatively framed conditions of high need.

EXPERIMENT 2

Although we sought to examine framed decision making under need in a more ecologically relevant manner in Experiment 1B (i.e., reflecting decision making from experience), the tasks to some degree still suffered from a lack of external validity. It is possible that evidence for an interaction between negative frames and conditions of need was equivocal in Experiment 1B because of this lack of external validity. Thus, in Experiment 2, we examined the interaction between conditions of need and framing in a task involving a series of decisions between hypothetical investment options. As in Experiment 1B, we predicted that participants would engage in significantly higher risky choice in conditions of high need (compared to conditions of low need), and in negative frames (compared to positive frames). Furthermore, we also predicted that participants would exhibit the highest levels of risk-acceptance in scenarios involving potential loss under a condition of high need.

Method

Eighty-four participants (49 female) were recruited from undergraduate psychology classes (age: $M = 18.8$, $SD = 1.1$, *Range*: 18–23). Participants received course credit for their participation.

Participants made six choices between a low-risk and a high-risk option (with identical expected values) involving a hypothetical investment scenario. The six scenarios presented involved the following conditions: (1) control (no need condition), negative frame; (2) control (no need condition), positive frame; (3) high need, positive frame; (4) high need, negative frame; (5) low need, positive frame; and (6) low need, negative frame. The high need condition was constructed such that participants were statistically more likely to meet their need with the high-risk option compared to the low-risk option. Conversely, the low need condition was constructed such that participants were statistically more likely to meet their need with the low-risk option compared to the high-risk option. In both the high and low need conditions, there was some possibility of participants meeting their need with either the high-risk or the low-risk option. The task was constructed in this way so that one option was not overwhelmingly or obviously more favourable than the other (a problem in previous studies of decision making from description; e.g., Mishra & Fiddick, 2011). In all scenarios, the expected values of both the low- and high-risk options were identical (i.e., the options only differed in outcome variance), and both the loss and gain options offered equivalent mean expected values.

The control scenario was described as follows. The values in brackets were those presented in the negative frame:

> You have an opportunity to cash out one of two stock portfolios you own in 2 weeks. You invested \$10,000 (\$14,000) into each portfolio initially, but each portfolio now has a different potential payout at the time you cash out. Which of the two portfolios would you prefer to cash out?
>
> (1) Receive your initial \$10,000 (\$14,000), with an 80% chance of earning \$500 (losing \$3,500), or a 20% chance of earning \$1,000 (losing \$3,000).
> (2) Receive your initial \$10,000 (\$14,000), with a 60% chance of earning nothing (losing \$4,000), or a 40% chance of earning \$1,500 (losing \$2,500).

The high need condition was identical to the control condition, except that it was prefixed by the statement, 'Imagine that you have an \$11,000 debt that you need to pay off as soon as possible'. The low need condition was also identical to the control condition, except that it was prefixed by the statement, 'Imagine that you have a \$10,500 debt that you need to pay off as soon as possible'. The order of the six decision scenario conditions was randomized, as was the order of the low-risk option (option A) and the high-risk option (option B) for each scenario.

Results and discussion

Collapsed across framing, participants were significantly more likely to prefer the risky option in the high need condition compared to both the low need condition, $\chi^2 = 11.07$, $p = .001$, and the control condition, $\chi^2 = 10.52$, $p = .001$; proportion choosing risky option: high need = .68; low need = .41; control condition = .42. Collapsed across need condition, participants exhibited a framing effect, indicating a significantly higher preference for the risky option in the negative frame compared to the positive frame, $\chi^2 = 7.31$, $p = .007$; proportion choosing risky option: negative frame = .59; positive frame = .42. Within each need condition, a significant framing effect was observed only in the high need condition, with participants engaging in significantly higher risky choice in the negative frame compared to the positive frame, $\chi^2 = 4.25$, $p = .04$, proportion choosing risky option: negative frame = .60; positive frame = .40. Significant framing effects were not observed within the low need condition, $\chi^2 = .71$, $p = .40$ (proportion choosing risky option: negative frame = .55; positive frame = .45), or in the control condition, $\chi^2 = 2.80$, $p = .09$ (proportion choosing risky option: negative frame = .60; positive frame = .40), although both results were in the expected direction. Finally, as predicted, participants exhibited the highest preference for the risky option in the high need/negative frame condition compared to all other conditions (all χ^2s > 4.24, ps $< .04$). Results are summarized in Figure 3.

The findings of Experiment 2 provide further support for the predictions of risk-sensitivity theory, with participants engaging in significantly more risky choice in situations of high need compared to situations of low need. Experiment 2 also provided further evidence for loss aversion in framed decision scenarios, with participants exhibiting significantly higher risk-preference in loss frames compared to gain frames. Finally, the results provided support for the hypothesis that the perception of potential loss interacts with situations of high need to produce particularly elevated levels of risky choice. These results were obtained using a task involving decision making in a real-world domain, suggesting that the results may be broadly generalizable.

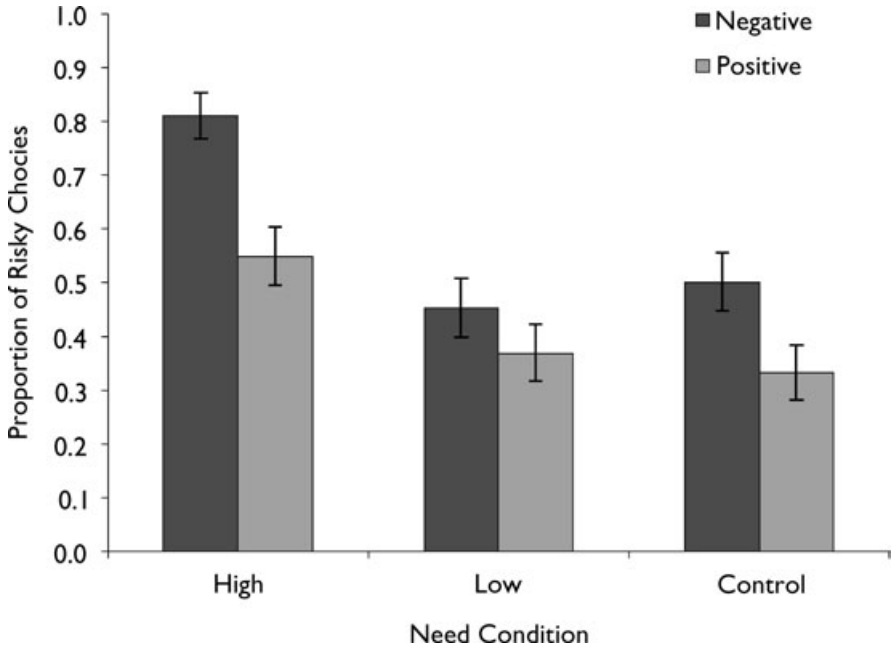

Figure 3. Proportion of risky choices (*M*, *SE*) made in the investment decision scenario under positive and negative frames.

GENERAL DISCUSSION

Framing effects were observed for behavioural decision-making tasks involving risky choice from description and decisions from experience. In both types of tasks, participants exhibited higher risk-acceptance in negatively framed decision scenarios compared to positively framed decision scenarios. These results replicate previous findings indicating that framing effects extend to behavioural measures of risk (Benjamin & Robbins, 2007). Framing effects were also observed in risky choice tasks involving decision making under situations of need, with participants making a higher proportion of risky choices in negatively framed decisions compared to positively framed decisions. Participants also exhibited higher levels of risk-acceptance in situations of high need compared to situations of low need, supporting the predictions of risk-sensitivity theory and replicating previous findings (e.g., Mishra & Lalumière, 2010).

We predicted that risk-acceptance should be highest in negatively framed scenarios involving high need. In Experiment 1B, we found support for this prediction in the ECO, a risk-sensitive decision-making task involving decision from experience, but not the VPN, a descriptive decision-making task. The expected interaction between need and frame may not have been observed in the VPN because it involved arbitrary decisions made about drawing black and white beads. Consequently, in Experiment 2, we presented participants with hypothetical investment decision scenarios with greater real-world relevance. As predicted, participants exhibited the highest level of risky choice in scenarios involving the perception of loss under a condition of high need.

Previous research examining the interaction between need and framing has not shown elevated risk-acceptance for decisions made in negative frames under conditions

of high need (e.g., Mishra & Fiddick, 2011; Wang, 2002). These other studies used the Asian disease problem, a widely used decision scenario involving hypothetical choices regarding actions leading to variable numbers of lives saved in the face of a pandemic (Tversky & Kahneman, 1981). The Asian disease problem involves a hypothetical scenario that is quite novel to participants: making medical decisions about responses to a pandemic is less relevant to people's day-to-day lives than hypothetical investment scenarios. As a consequence, patterns of decision making in the Asian disease problem may not be generalizable to other decision making contexts. The results of Experiments 1B and 2 in the present study suggest that perception of loss interacts with conditions of high need in decision scenarios involving non-arbitrary and relatable real-world outcomes to produce elevated risky choice. Further research is necessary to better understand the conditions under which conditions of high need interact with framing to produce elevated risk-taking.

Most risk-sensitive decisions made outside of the laboratory are made with some conception of potential loss or potential gain. Furthermore, most risk-sensitive decisions are also made under some consideration of need, in that they involve some conception of a goal or a desired outcome. Although prospect theory makes predictions about changes in risk-preferences involving framing, it does not explicitly address the role that need plays in decision making. Risk-sensitivity theory, however, provides a normative rationale of why conditions of need should affect risky choice. Importantly, previous research has shown that negatively framed decision scenarios confer the perception of high need (Mishra & Fiddick, 2011; Wang, 2002). As a consequence, it is possible that people do not necessarily engage in risk-taking in negative frames because of simple loss aversion. Rather, people may engage in elevated risk-taking in negative frames because they perceive themselves to be in a situation of high need (consistent with risk-sensitivity theory). The results of this study provide some support for this hypothesis, in that decisions made in a negative frame under a condition of high need facilitated particularly highly elevated levels of risk-acceptance, perhaps motivated by a particularly strong perception of high need. Risk-sensitivity theory may therefore in part account for framing effects (Mishra & Fiddick, 2011). Further research is necessary to investigate the degree to which loss aversion and the perception of need differentially facilitate risky choice.

Little is known about how need requirements are perceived or constructed in real-world situations, or how the perception of need motivates real-world decision making. In the present study, need requirements were constructed using explicitly defined goals. Some of these goals were arbitrary (e.g., a minimum requirement of number of beads drawn in order to earn money in the VPN), others reflected survival-based decision making that may not be particularly relevant to day-to-day life (e.g., a minimum requirement of number of apples required to 'survive' a week and earn money in the ECO), and still others reflected debt-motivated decision making that is more externally valid (e.g., a hypothetical pressing debt in the investment decision scenario, Experiment 2). However, many goals are not explicitly outlined or described in day-to-day decision making and may instead be in part constructed from social comparisons.

If someone is at distance from a desired state (e.g., making less money than comparable peers), and are unable to obtain desired outcomes with low-risk options, they may be motivated to engage in increased risky behaviour in an attempt to bridge the perceived gap between their own state and the state of relevant others. This perception of inequality in desired outcomes may play a role in constructing psychological need levels and motivating risky choice. We are currently examining the degree to which real-world manifestations of need, such as inequality, affect risky choice (Mishra & Lalumière,

2011b). It would be beneficial for future research to more broadly examine the degree to which risk-sensitivity theory can account for general patterns of decision making in various contexts, and the degree to which the social environment plays a role in constructing the perception of need in decision making.

To what degree do the behavioural tasks used in this study approximate real-world decision making? The decision-making tasks used in Experiments 1A and 1B (CT, BART, ECO, VPN) have varying degrees of external relevance. It is arguable that tasks involving decision making from experience have greater external validity, in that many decision options experienced outside of the laboratory are learned from experience and not explicitly described. However, it is difficult to generalize from largely artificial laboratory scenarios (such as that used in the ECO) to decisions made in the real world. Experiment 2 to some degree addressed this concern of external validity by presenting participants with a plausible investment scenario involving debt. Another concern with the generalizability of the results involves the domain-generality of decision making under risk. All of the tasks in this study involved monetary payoffs, but many decisions are made in non-monetary domains. Further research is necessary to examine whether prospect theory and risk-sensitivity theory can account for decision making in other domains involving different currencies (e.g., food decisions).

Together, the results of this study are consistent with the hypothesis that framing effects may not necessarily represent an 'irrational' violation of normative utility theories. Rather, framing effects may represent adaptive decision-making patterns that take advantage of cognitive biases designed to be sensitive to situations of need. The results of this study suggest that framing effects extend to decision-making tasks involving both decision making from description and decision making from experience, and that framing effects importantly interact with situations of need to produce risk-sensitive behaviour.

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