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Priming Risky Choice: Do Risk Preferences Need Inferences?

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ABSTRACT

The notion that subtle influences, often falling outside awareness, can bias behaviour has a strong grip on both theoretical perspectives and the public imagination. We report three experiments that examined this idea in the context of risky choice. Experiment 1 ($N = 100$) appeared to find evidence for an interaction whereby participants primed but not reminded of the prime showed an assimilation effect (e.g. participants primed to be risk seeking became *more* risk seeking) whereas those who were primed and reminded showed a contrast effect (e.g. became *less* risk seeking). However, two further experiments ($N = 180$, $N = 128$) failed to find any evidence for this interaction, and none of the experiments found evidence for the asymmetry in awareness predicted by an 'unconscious' assimilation but 'conscious' contrast account. The data were analysed using both Null Hypothesis Significance Testing and Bayesian methods, and the implications of the conclusions arising from each are discussed. Whatever one's statistical predilection, the results imply a reduction of confidence in the belief that risk preferences need no inferences. Copyright © 2016 John Wiley & Sons, Ltd.

KEY WORDS risky choice; priming; unconscious; replication

Everyday notions such as 'gut instinct' and 'intuition' capture the idea that subtle influences often falling outside awareness can bias behaviour. This basic idea has a strong grip on both theoretical perspectives and the public imagination (e.g. Gigerenzer 2007; Lehrer 2009; Wilson, 2002; Zajonc, 1980). It is perhaps most forcefully championed in dual-system accounts of judgment and decision making, which have seen increasing popularity in recent years (e.g. Kahneman, 2011).

Erb, Bioy, and Hilton (2002) (hereafter EBH) built on pioneering work by Zajonc (1980), as well as related literature from the field of judgment (e.g. Loewenstein, Weber, Hsee & Welch, 2001) and social cognition (e.g. Higgins, Rholes, & Jones, 1977), to develop a prediction regarding the malleability of risk preferences. Specifically, they hypothesised that increasing the accessibility of risk-related information would influence people's preferences for risk, in the absence of any conscious appraisal of that influence.

To test their hypothesis, EBH gave participants vignettes describing situations in which people could indicate a preference for either a risky (e.g. bet on the long shot at a horse race) or less risky alternative (e.g. bet on the favourite). Prior to making these choices, participants engaged in an ostensibly unrelated priming task. Participants were given lists of 15 words and were asked to rank order the frequency with which they occurred in ordinary speech. Those in the 'risk-seeking' condition were given lists that included adjectives with positive connotations for risk seeking (e.g. adventurous), and negative connotations for risk avoidance (e.g. anxious). Those in the 'risk-averse' condition saw the opposite arrangement: negative connotations for risk seeking (e.g. rash) and positive for risk avoidance (e.g. careful).

Two central findings emerged. In a first experiment, participants primed to be risk seeking indicated stronger preferences for the risky option in the vignettes than those primed with risk aversion. In a second experiment, EBH included an additional factor—a 'reminder' in which half of the participants were asked some questions about the priming task (e.g. how many words do you think you could remember?) before completing the vignettes. An interaction was found whereby participants who had been reminded responded in a manner consistent with *correcting* or compensating for the influence of the prime, whereas those who were not reminded behaved like the participants in the first experiment by *assimilating* the prime. This pattern of assimilation (contrast) in the absence (presence) of reminders is consistent with other findings in the social priming literature (Herr, Sherman & Fazio, 1983; Loersch & Payne, 2011; 2014; Molden, 2014).

EBH argued that the findings of their second experiment, in particular, suggested that the priming context can influence how people make risk judgments in at least two ways. The first, they suggested, is 'preconscious' and results in the assimilation of the prime, and the second involves the 'conscious consideration of the priming event' (p. 257) and leads to the contrast effects (e.g. Molden, 2014). Together, they argued that their experiments 'attest to the power of preconscious processing in influencing risk preferences' (EBH, 2002, p. 257).

Explanations of social priming

The EBH results fit within a long tradition of what has become known as 'social priming': the activation of participants' mental representations of social targets or situations that are then claimed to have downstream effects on subsequent evaluations, judgments and actions (Molden, 2014; Newell & Shanks, 2014a). Crucially, the influence of these primes is assumed to occur either outside participants'

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awareness or in the absence of an intention to use the activated material (Loersch & Payne, 2014; Molden, 2014).

Note that this lack of awareness does not pertain to the priming episode itself but to the specific (potential) influence of the prime on subsequent behaviour. In the vast majority of social priming experiments—including that of EBH—participants are fully aware of the priming materials, and cognizant of the task, they are required to perform with them. At question is whether they are aware of the potential influence on their subsequent choices. Were the participants in the EBH experiments aware of the potential influence of having risk-positive or risk-negative mental representations activated?

We contend that one of the interpretations offered by EBH leads to a straightforward prediction about participants' awareness of the *potential influence* of the priming episode: Participants who were reminded should, if probed in a post-task test of awareness, be more likely to indicate an influence of the priming episode on their subsequent risk preferences than those who were not reminded. This prediction falls naturally from the idea that reminders lead to conscious correction, whereas no reminders lead to unconscious assimilation (EBH, 2002). This interpretation is by no means the only possible one, but it appears consistent with influential contemporary theories of social priming. For example, Loersch and Payne (2014) suggest that subtle primes—ones to which attention is not drawn—lead accessible content to be (unintentionally) misattributed to one's own response to a question afforded by the focal target. In contrast, well-remembered priming manipulations—such as those that participants are reminded about—tend to lead people to engage in 'effortful, motivated correction' (p. 146). If an action is effortful and motivated, it seems fair to assume that it is also deliberate and conscious.

EBH did not examine this prediction about the difference in awareness between reminded and non-reminded participants directly in their second experiment. They noted that in an 'open-ended' questionnaire used in the first experiment, only one (out of 47) participants reported a perceived influence of the priming episode on later risk preferences, but no awareness data were reported for their second experiment.

Thus, part of the motivation for the current investigation was to examine the priming effects obtained by EBH and to see whether more extensive probing of participants' awareness could reveal evidence for 'unconscious' assimilation and 'conscious' contrast effects. The decision to delve more deeply into this effect was sparked by long-standing debates about the adequacy of awareness assessment in decision making (e.g. Newell & Shanks, 2014b) and other areas of cognition and learning (e.g. Lovibond & Shanks, 2002; Shanks & St.John, 1994). These extensive reviews of the literature have revealed multiple instances in which seemingly unconscious effects are 'explained away' when improved measures of awareness are employed. Although many of these investigations pertain to the direct awareness of primes or other material (e.g. subliminal priming) rather than the potential *influence* of consciously apprehended priming episodes, the lessons learned are equally applicable to the current context. The open-ended question method used by EBH is notoriously insensitive to the potential presence of conscious knowledge irrespective of whether that knowledge pertains to a priming stimulus or its influence on subsequent behaviour (Lovibond & Shanks, 2002; Newell & Shanks, 2014b; Shanks & St.John, 1994).

It is important to note that the inclusion of more extensive awareness questioning can have no direct impact on the reminder/non-reminder manipulation. This is because awareness questioning always occurs *after* the point at which participants might spontaneously engage in conscious correction. The hypothesis we seek to test is that participants who are reminded of the priming episode are then prompted to correct a response via conscious insight into the potential biasing influence of the prime (e.g. Loersch & Payne, 2014). If such correction is observed, and it is consciously mediated, then participants should be able to report their insight when afforded the opportunity *after* they have made their choices.

Replicability of priming effects

The interest in re-examining EBH was also influenced by current debates about the reliability and replicability of several findings in the social priming literature (Doyen, Klein, Pichon, & Cleeremans, 2012; Klein et al., 2014; Koole & Lakens, 2012; Newell & Shanks, 2014a, 2014b; Pashler & Wagenmakers, 2012; Shanks et al., 2013; Shanks et al., 2015). We are aware of no published replications of the EBH results, and thus, one goal of the current paper was to examine whether the finding is robust and generalisable. For example, is this finding one that a new PhD student might attempt to pursue and develop in a thesis?

To facilitate in this evaluation of the reliability of the effect, we report both standard Null Hypothesis Significance Testing (NHST) and Bayesian data analyses. The latter have become increasingly popular not least because they provide researchers with an opportunity to examine evidence in favour of the null hypothesis (e.g. Newell & Rakow, 2011; Shanks et al., 2013; Shanks et al, 2015), as well as arguably constituting a more coherent approach to assessing evidence than is offered by standard p values (Edwards, Lindman, & Savage, 1963; Rouder et al., 2012; Rouder et al., 2009; Verhagen & Wagenmakers, 2014; Wagenmakers, 2007). We report both types of analyses side by side, thereby allowing readers to draw their own conclusions about the implications of the results.

To foreshadow the remainder of the paper, we report three experiments that examine the potential influences of risk priming on risk preferences. Experiment 1 is a replication and extension of the EBH second experiment: more data per participant were collected, and a more specific awareness test was included. Experiment 2 incorporated a control group (neutral prime), increased data per participant further and extended the awareness questionnaire. Experiment 3 adopted a different priming task but used the same dependent measures.

In all three experiments, we expected to find the interaction between prime type and reminder condition driven by the assimilation of primes in the non-reminded conditions and the contrast with primes in the reminded conditions. We also predicted greater levels of awareness of the

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influence of the priming episode on risk preferences in the reminded than in non-reminded conditions. Following the experiments, we present a brief discussion of the effect sizes for the prime type by reminder interaction and the simple effect of priming in non-reminded participants in our data and those of EBH.

EXPERIMENT 1

This experiment was modelled on the second experiment reported in EBH. We discussed details of the experimental design with Dr Erb (first author of EBH) before commencing any experimental work.

Method

Participants

One hundred first-year undergraduate students (67 women) from the University of New South Wales took part in return for course credit. Our initial sampling goal, based on having more participants than EBH, was an *n* of 30 per between-subject condition. However, time constraints and the end of the teaching semester meant that we only reached 25 per condition. (Thereby still exceeding the *n* of 23 per condition in EBH Experiment 2).

Design and materials

Experiment 1 was a 2 (Prime Type: Risk Seek, Risk Averse) × 2 (Reminder: Present, Absent) between-subjects factorial design.

Priming task. The priming task involved ranking words (taken from EBH) in terms of their frequency in the language. In the Risk-Seek prime condition, the words comprised four words with positive connotations for risk seeking (*risk loving*, *adventurous*, *enterprising* and *daring*) and four words with negative connotations for risk avoidance (*worried*, *anxious*, *overprotective* and *timid*), along with seven neutral words (*disagreeable*, *conceited*, *polite*, *colourful*, *orderly*, *deceitful* and *thankful*). Those in the Risk-Averse prime condition received a word list with the same neutral words along with four words with negative connotations for risk seeking (*overprotective*, *rash*, *risky* and *inconsiderate*) and four words with positive connotations for risk avoidance (*well-considered*, *conscientious*, *responsible* and *careful*).

Reminder task. Participants in the reminder conditions were given a short questionnaire on completion of the priming task. It was only handed to participants after the cards and list of words were given back to the experimenter. The four questions (taken from EBH) were as follows:

> Did you find the task of ranking the words according to their frequency easy/difficult (check one box adjacent to the easy/difficult)?Do you remember how many words were in the list? [enter a number]Take a minute and try to recall the words in the list. How many words do you think would you be able to recall now? [enter a number] Memory fades over time. How many words from the list would you be able to recall after two weeks from now? [enter a number]

Note that participants were not required to write down any of the words, rather just to think about how many they could remember/recall.

Decision-scenario task. EBH used four short vignettes in their second experiment—an example is displayed in Figure 1 the remainder are in the Appendix. In contrast to EBH who only gave one scenario per participant in their second experiment, we presented all four in a different random order for each participant. Preferences were indicated on a 9-point scale.

Awareness measure. Participants were asked the following two questions:

Question 1: *'Thinking back to the task in which you ranked the frequency of words. Did you notice any particular pattern or theme to the words that were included?* If participants responded yes to this question, they were asked *If so, what was the theme or pattern?'*

Question 2: *'Do you think that anything on the ranking of word frequency task affected how you answered the decision scenario, gambling and the questions about activities tasks.'* If participants responded yes to this question, they were asked *'If so, how exactly did it affect you?'*

The aim with these questions was to provide an opportunity for a somewhat more specific test of awareness without unduly prompting participants. (Note that the second question refers to additional tasks given after the decision scenarios—see the Procedure for more details.)

Procedure

Participants arrived at the lab and were randomly allocated to a condition. The experiment began with the priming task.

This Sunday, Mr X decides to go betting on horses at the town racecourse. Having seen the odds proposed for the horses about to race, he has two possible choices to make. He can decide to bet on the favourite, whose chances of winning are the best. On the other hand, the odds offered on this horse are only 2 to 1 (for 10 placed, Mr X would receive 20). If he decides to bet on the outsider, the chances of winning are lower. On the other hand, the odds offered on this horse are 7 to 1 (for 10 placed, Mr X would receive 70). Imagine that you are in Mr X's position. Which choice would you tend to make?

(the favourite) 1 2 3 4 5 6 7 8 9 (the outsider)

Figure 1. Example scenario used in Experiment 1. See the Appendix for other scenarios

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Participants were handed 15 cards, each displaying a single word, and were asked to rank order them in terms of their frequency in ordinary speech. Participants recorded the order on a provided sheet of paper. Following completion of the priming task, participants in the no-reminder conditions progressed to the scenario task. These tasks were completed on the computer (rather than on pen and paper), and care was taken to reinforce the idea that the 'ranking' task and the 'scenario task' were unrelated. Participants in the reminder conditions completed the reminder task questionnaire before starting the scenario task. For each scenario, participants were asked to indicate on a 9-point scale which option they would prefer if they were the person described in the scenario. Participants were instructed to 'Please express your preference on a scale from 1-9 with 1 being definitely the first choice of action and 9 being definitely the second choice of action'. Following these decision scenarios, participants were given 10 simple monetary gambles and asked to indicate their preferences, and they were then given the Domain-specific Risk-taking (DOSPERT) scale of risk taking (Blais & Weber, 2006) and finally the awareness questions. We do not report data relating to the gamble tasks and the DOSPERT here.[1] Note that these additional measures were all administered *after* the decision scenarios and thus do not affect the interpretation of effects found in that task.

Results

We used both standard NHST and Bayesian statistical methods to analyse the data. To do so, we took advantage of new freely available software—JASP (Love et al., 2015)—which allows researchers to conduct both kinds of analysis side by side. We focus on Bayes factors (*BF*s), which give a measure of the likelihood of observed data given a particular 'model'. Model in this sense of the word does not refer to a psychological or computational model but simply to a statistical 'model' comprising main effects, interactions and so on. We use the default priors implemented by JASP in all analyses (see Verhagen & Wagenmakers, 2014, for a discussion of other approaches to selecting priors).

Figure 2 is a box plot showing data for the four cells of Experiment 1. The data are averaged across the four scenarios. Although risk preferences did differ somewhat across the scenarios (e.g. participants were somewhat more willing to take a risk in the horse betting scenario than the car buying one), scenarios did not interact with either prime or reminder and are thus not of direct theoretical interest. For this reason, we focus here on the data averaged across scenarios (as EBH also did).[2] (See the Appendix for additional analyses including scenario.)

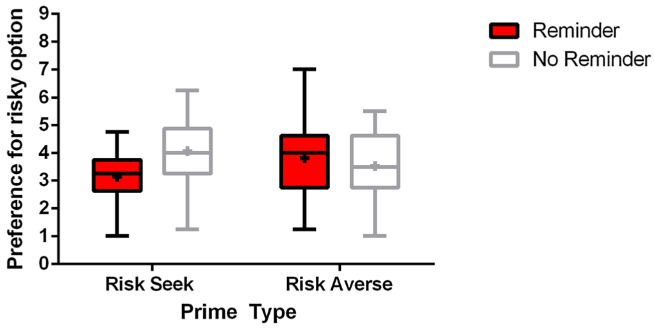

Figure 2. Box plot of the data averaged across decision scenarios in Experiment 1. The whiskers show the maximum and minimum values, the boxes contain the 25th to 75th percentiles, the solid line is the median and the + is the mean. Preferences were elicited on a 1–9 scale with higher numbers indicating preference for the riskier option

A visual inspection of the data in Figure 2 appears to provide some support for the predicted interaction between prime and reminder: Those primed to be risky *and reminded of the prime task* show slightly weaker preferences for the risky option than those not reminded. In contrast, those primed to be risk averse and subsequently reminded show slightly stronger preference for the risky option than those given no reminder. Thus, in line with EHB's findings, those participants reminded of the priming episode appear to correct for its influence and those not reminded appear to assimilate it.

Tables 1a and 1b display the full results from the standard (1a) and Bayesian analyses of variance (ANOVAs; 1b) conducted on the data contained in Figure 2. The comparison of the two sets of analyses is informative. According to the standard ANOVA, there is statistical support for the interaction between prime type and the presence of the reminder but no evidence of main effects for either. This pattern replicates what EBH found in their second experiment. (As noted earlier, we present effect-size analyses after reporting Experiment 3.) However, the Bayesian statistical model comparison suggests a rather different conclusion. The Bayesian analysis examines five different models: one with no main effects or interactions (the null), one with a main effect of prime (alone), a main effect of reminder (alone), one with both main effects and one with the interaction and both main effects. The column headed BF_{10} gives the Bayes factor stated in favour of the alternative hypothesis. A *BF* of 5, for instance, suggests that the data are five times more likely to have occurred under the model assuming the relevant effect than a model omitting this effect, whereas a *BF* of .20 indicates that the data are five times more likely to have occurred under the model omitting the relevant effect than a model including this effect.[3] What is immediately apparent is that the BF_{10} for models that include *any* effects are all smaller (less than 1) than the model that assumes no effects (null model). In other words, the model that is best supported by the data is the one with no effects.

An argument could be made, however, that the predicted effect of interest is the interaction between prime and

[1] Our original intention was to examine the effect of the prime on these additional measures, but no reliable or systematic effects were found, so we chose to focus on the original decision-scenario measures.

[2] A reviewer suggested that the priming effect might be more pronounced in the first scenario encountered by each participant. We examined this possibility by conducting the same 2 × 2 (Expt 1) and 2 × 3 (Expt 2, 3) ANOVAs on the data from the first scenario, separately for each experiment. These analyses revealed no significant effects of the prime, the reminder or the prime × reminder interaction in any of the experiments (all Fs < 2; all ps > .16).

[3] A commonly used 'yardstick' for interpretation of Bayes factors is Jeffreys's (1961) suggestion that Bayes factor of 1 to 3 is *barely worth a mention*, 3–10 is *substantial* and 10 and above is *strong evidence*.

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Table 1a. Analysis of variance on mean risk preferences in Experiment 1

Cases	Sum of squares	*df*	Mean square	*F*	*p*
Prime	.122	1	.122	.092	.762
Reminder	2.723	1	2.723	2.055	.155
Prime * Reminder	9.303	1	9.303	7.023	.009
Residual	127.155	96	1.325		

Note: Type III sum of squares.

Table 1b. Bayesian model comparison for mean risk preferences in Experiment 1

Models	P(M)	P (M|data)	BF_M	BF_{10}	% error
Null model	.200	.419	2.880	1.000	
Prime	.200	.092	.404	.219	.030
Reminder	.200	.210	1.061	.501	4.746e−5
Prime + Reminder	.200	.044	.185	.105	1.725
Prime + Reminder + Prime * Reminder	.200	.236	1.235	.564	5.125

Note: P(M), prior probability of the model referred to in the leftmost column; P(M|data), posterior probability of the model given the data; BF_M, change from prior to posterior model odds; BF_{10}, Bayes factor for each model against the null model; % error, error associated with the estimate of BF_{10}.

reminder. To assess evidence for the presence of the interaction 'alone', one can calculate a new *BF* by comparing the *BF* for the more complex model that contains main effects and the interaction with that of the model that lacks the interaction. This yields a BF_{10} of 5.37 (.564/.105), suggesting that the observed data are a little over five times more likely under a model that includes the interaction than one that does not.

Awareness questionnaire

Two central patterns emerged from the awareness questions: (i) almost a quarter of participants (23%) answered the second question in the affirmative, indicating that they did think the word-ranking task had influenced their subsequent responses. This is a much higher rate than the 1 participant (out of 47) identified by EBH using an open-ended question. Second, the hypothesis that more participants in the reminder conditions would be aware of the potential influence of the priming episode on subsequent preferences was not supported. The distribution of 'aware' participants is shown in Table 2. There is no evidence of there being more in the reminder than no-reminder conditions (although the small *n*s make conclusions difficult). The majority of participants (70%) thought, in response to Question 1, that there was a theme to the word-ranking task, and many (43%) suggested the theme was related to positive/negative words or emotions. Seventeen percent mentioned 'risk' in their response. Again, distributions of responses did not differ across conditions (Table 2).

Discussion

From the standard NHST perspective, these results suggest a replication (and partial extension) of the EBH finding. From a Bayesian perspective, this conclusion holds only if one considers, or conditionalises on, a subset of the possible models rather than the full 'space' of five models. The data from the awareness questionnaire are suggestive of underestimation of the extent of awareness in the EBH study but do not provide direct support for the 'unconscious' assimilation and 'conscious' contrast hypothesis.

One interpretation of the significant interaction in the absence of differences in awareness is that contrast effects *also* occur outside of awareness. It is possible that becoming aware of the potential bias—via the reminder—is sufficient to trigger an additional subconscious process of bias correction. Although this strikes us as rather non-parsimonious, and at odds with recent influential accounts of social priming (e.g. Loersch & Payne, 2011, 2014), it remains a possibility. For example, in the reminded conditions, the primed concepts could lead the primed material to be accessible in memory and then be used as a standard against which the subsequent scenarios are judged (e.g. Schwarz & Bless, 1992). A participant might, for instance, perceive betting on the long shot in a race as of low risk *compared with* the 'high risk' content brought to mind via the reminder of the priming episode. But this comparison process may be neither intentional nor mediated consciously (see EBH for an elaboration of this argument).

Rather than speculating on the basis of this single experiment, we decided to run another experiment in an attempt to shed further light on the reliability of risk priming, and the possible role of awareness. There were three main changes: first, the addition of a neutral prime control group—while the data from Experiment 1 suggest that risk-seeking and risk-aversion primes can alter *relative* preferences, it is not clear what the baseline level of risk preference is for these scenarios. In other words, we do not know whether risk seeking increases risk preference relative to a baseline or risk-aversion primes decrease it. Second, we extended the

Table 2. Number of participants who responded 'yes' to awareness measures in Experiment 1

Awareness questions	Experimental condition			
	RS no reminder	RS with reminder	RA no reminder	RA with reminder
Q1 *Theme?*	18	13	19	20
Q2 *Influence?*	7	3	8	5

Note: All groups had 25 participants. See Method section of Experiment 1 for the full awareness questions.
RS, risk seek-primed participants; RA, risk averse-primed participants.

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awareness questionnaire to include additional questions aimed at tapping into when, and how participants perceived a potential influence of the prime. Third, we included five additional brief decision scenarios modelled on EBH, in order to increase the number of data points per participant and to examine whether the priming effects would generalise beyond the stimuli used by EBH.

EXPERIMENT 2

Method

Participants

One hundred and eighty first-year undergraduate students 180 (114 women) with a mean age of 19.15 ($SD = 2.41$) from the University of New South Wales took part in return for course credit. Our sampling goal, which we achieved, was an *n* of 30 per between-subject condition.

Design and materials

Experiment 2 was a 3 (Prime Type: Risk Seek, Risk Averse, Neutral) × 2 (Reminder: Present, Absent) between-subjects factorial design.

Priming task. The priming task for the risk-seeking and risk-aversion prime groups was the same as in Experiment 1. In the neutral prime conditions, participants received the same neutral words as used in the other two conditions along with an additional eight neutral (with respect to risk-taking) words: *helpless*, *observant*, *rich*, *elegant*, *lovely*, *proud*, *adorable* and *clever*.

Decision scenarios. Participants responded to the same four scenarios along with an additional five new scenarios (randomly ordered). The additional scenarios are shown in the Appendix. They were based, loosely, on the five domains of risk taking identified in the DOSPERT scale (i.e. recreational, health, financial, social and ethical). It was our original intention to examine potential differences in priming across these domains (following some speculation about the impact of scenario types on priming in the General Discussion of EBH).

Reminder task. This was identical to the one used in Experiment 1.

Awareness measure. The full text of the awareness measure is presented in the Appendix. It comprised five questions that asked, in increasingly specific detail, whether participants felt their responses had been influenced by the priming manipulation. In addition to written responses, participants provided confidence ratings about the potential for an influence of the priming task and the direction of the influence (i.e. increased/decreased the propensity to choose the risky option).

Procedure

The procedure closely followed that of Experiment 1. Following the nine decision scenarios, participants completed the DOSPERT scale and an additional single question measuring risk preference; the gamble problems used in Experiment 1 were omitted. Finally, the awareness questionnaire was presented. We do not consider the data from the DOSPERT scale or the risk question.

Results

Figure 3 is a box plot showing all of the conditions of Experiment 2. The data are averaged across all nine decision scenarios.[2] Consistent with Experiment 1, there was an effect of scenario type, but because it did not interact with prime or reminder, it was not of direct theoretical interest, so we focus on the averaged data. (See the Appendix for additional analyses involving scenario.)

Visual inspection of the figure suggests two prominent features. First, there appears to be little evidence for a simple effect of priming in non-reminded participants; indeed, there is no apparent difference between the risk-seek, risk-averse and neutral primes (compare the unshaded boxes). Second, the reminder status does not seem to affect preferences in the risk-averse and neutral prime conditions, but there is a suggestion of the *opposite* of the predicted effect for risk seeking: participants primed to be risk seeking and *reminded* are slightly more risk seeking than their non-reminded counterparts. In short, these data appear not to replicate the patterns found in Experiment 1.

Tables 3a and 3b display the full results from the standard (2a) and Bayesian ANOVAs (2b) conducted on the data contained in Figure 3. The comparisons of the two sets of analyses are again informative.

The standard analysis finds no evidence of the predicted interaction and no evidence for either main effect. The Bayesian analysis suggests that the observed data are more likely under the null model than any other model (all $BF_{10} < 1$), and there is no support for the inclusion of the interaction ($BF_{10} = .011/.021 = .52$).

In two additional analyses (reported in full in the Appendix), we examined the pattern for the Experiment 2 data when focussing only on the four original scenarios used by EBH, and when combining the data from the

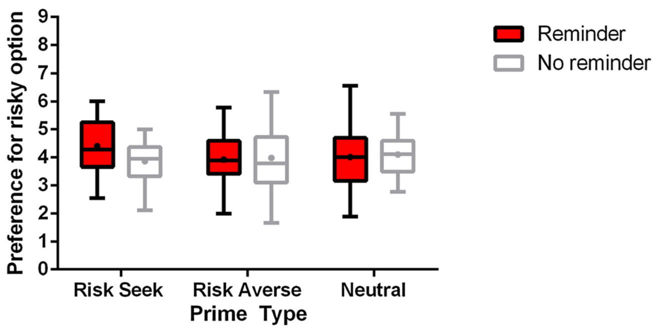

Figure 3. Box plot of the data averaged across decision scenarios in Experiment 2. The whiskers show the maximum and minimum values, the boxes contain the 25th to 75th percentiles, the solid line is the median and the + is the mean. Preferences were elicited on a 1–9 scale with higher numbers indicating preference for the riskier option

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Table 3a. Analysis of variance on mean risk preferences averaged across all scenarios in Experiment 2

Cases	Sum of squares	*df*	Mean square	*F*	*p*
Prime type	.898	2	.449	.498	.609
Reminder	.830	1	.830	.920	.339
Prime type * Reminder	3.700	2	1.850	2.052	.132
Residual	156.894	174	.902		

Note: Type III sum of squares.

Table 3b. Bayesian model comparison for mean risk preferences averaged over all scenarios in Experiment 2

Models	P(M)	P (M|data)	BF_M	BF_{10}	% error
Null model	.200	.732	10.922	1.000	
reminder	.200	.181	.884	.247	1.018e−5
Prime type	.200	.063	.270	.086	.008
Reminder + Prime type	.200	.016	.064	.021	2.613
Reminder + Prime type + Reminder * Prime type	.200	.008	.033	.011	3.067

Note: See Table 1b for explanation of column headers.

conditions and scenarios that were common to both experiments (i.e. the four original scenarios and the 2 × 2 reminder/no reminder by risk-seeking/risk-averse design).[4] The overall conclusions remain unchanged: The NHST analyses found no evidence for the interaction ($p = .15$ and .78, respectively, for the four original and combined analyses), and the Bayesian analysis suggested the data are most likely under a model with no effects. Interestingly, in the analysis that combined the data across the two experiments ($N = 220$), the Bayesian analysis revealed that the observed data are 200 times (i.e. 1/.005) more likely under the null model without any effects than the complex model with two main effects and the interaction. Furthermore, if one examines evidence for the interaction alone, by again comparing the model that includes main effects and the interaction ($BF_{10} = .005$) with the model that only has the main effects ($BF_{10} = .024$), then the calculated Bayes factor ($BF_{10} = .005/.024 = .21$) suggests the observed data are approximately five times more likely under a model *that omits* the interaction than under one that includes it (see the Appendix for the table of means for this analysis).

Awareness questionnaire

In the absence of a reliable priming effect, the force of any conclusions that can be drawn from the awareness questionnaire is somewhat reduced. Nevertheless, analyses of the responses revealed that 40% of participants (72/180) believed that their responses might have been influenced by the priming task and that they became aware of this influence at some point during the experimental procedure (e.g. during the scenario task, or when answering the awareness questionnaire). This higher percentage of 'influence-aware' participants—40% in Experiment 2 compared with 23% in Experiment 1—is most likely to have been driven by the increased opportunity to express awareness in the extended questionnaire used in Experiment 2. In particular, a portion of participants in every condition indicated becoming aware during the post-task questioning—a category that was not explicitly provided in Experiment 1.

There was no evidence, however, of systematic differences in the distribution of these 'aware' responders across the reminder and no-reminder conditions (35 and 37 participants, respectively). Nor was there any suggestion that this 40% responded differently on the decision scenarios to the 60% of participants who believed that their responses had not been influenced at all. The confidence measures revealed that on average participants had relatively low confidence that their answers had been influenced by the priming episode ($M = 3.74$, $SD = 2.04$; on 1–9 scale with higher numbers indicating higher confidence in being influenced) and were neutral in terms of the direction in which their responses might have been influenced ($M = 4.75$, $SD = 1.51$; on 1–10 scale with 1–4 indicating *more likely to choose safe*, 5 *neither* and 6–10 *more likely to choose risky*). Analyses of these data revealed no main effects nor interactions (all Fs < 1.2; all $BF_{10} < 1$).

Discussion

One straightforward inference from these results is that the effects found in Experiment 1 and by EBH do not generalise to novel decision scenarios. However, the analysis of the original four scenarios also failed to show evidence for the predicted interaction, or the simple effect of priming in the non-reminded participants in either analysis. The awareness data again suggested that the original EBH study underestimated the extent to which participants are aware of the potential influence of the priming episode but did not support the hypothesis of an asymmetry in awareness between the reminded and non-reminded participants. (Given the absence of reliable priming, this is perhaps not surprising.) In the General Discussion, we consider potential explanations for this overall pattern of findings, but first, we present a final experiment in which we investigated a different priming task.

EXPERIMENT 3

The priming task used in Experiments 1 and 2 aimed to activate mental representations related to risk via a relatively abstract word-ranking task. Several other studies have employed somewhat more direct 'narrative' primes in an attempt to influence risk-taking behaviour. For example, many studies discussed by Kenrick and Griskevicius

[4]Collapsing across the data from the two experiments violates the random assignment to experimental conditions. However, the experiments drew participants from the same subject pool, and both experiments were run by the same experimenter; thus, we think collapsing—in pursuit of a larger overall N—is defensible in these circumstances.

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(2013) require participants to read about romantic or 'neutral' episodes before indicating their willingness to engage in risky activities (e.g. unprotected sex). Similar narrative priming techniques have been used in conjunction with gambling, financial decisions and risky driving practices (Gilad & Kliger, 2008; Greitemeyer et al., 2013, although see Shanks et al., 2015, for a recent comprehensive re-evaluation of the reliability of many of these findings).

In Experiment 3, we examined the potential for a narrative prime to influence risky choices in the decision scenarios used in Experiments 1 and 2. Our goal in changing to a narrative prime was twofold. First, it provides a clear test of the generalisability of risk priming using a common dependent variable. Second, it has the potential to shed light on the mechanism(s) underlying priming effects.

To this end, we adopted the narrative primes previously used by Gilad and Kliger in a study of financial risk taking. The narratives aimed at advocating risk-seeking, risk-averse or risk-neutral behaviours, respectively. The 'risk-seeking prime story' was a short vignette describing a 'daring' person who had visited a casino, chosen to gamble and consequently won lots of money. The 'risk-averse-prime story' was about a responsible person who had chosen not to go to a casino, thereby avoiding a large monetary loss. In a neutral prime version, an attempt was made to give no biasing information about the risk seeking versus risk aversiveness of the person described in the vignette (the full vignettes are in the Appendix).

Rather than being abstract, these narratives are very similar to the decision scenarios subsequently provided to participants. As such, the narratives could function as 'role-model primes' that increase the accessibility of information related to successful risky people or 'sensible' safe people. (This is indeed the spirit in which these narratives were used by Gilad and Kliger.) At least two potential consequences of this more direct priming present themselves. One is that the predicted assimilation and contrast effects are strengthened, because the activated mental contents are more directly relevant to the dependent measures than the contents made accessible by the abstract prime. An alternative outcome is that the narrative primes are too blatant or salient (because of the overlap with the decision scenarios), thus preventing assimilation effects (because misattribution no longer occurs) and perhaps exacerbating contrast effects (because participants explicitly over-correct)—irrespective of the presence of the reminder (Loersch & Payne, 2014).

Method

Participants

One hundred and twenty-eight first-year undergraduate students (90 women) with a mean age of 19.6 ($SD = 3.48$) from the University of New South Wales took part in return for course credit. Our sampling goal was an n of 30 per between-subject condition, but we fell short owing to the Research Assistant running the experiment (the second author of the paper) taking up a new position (cell ns are 21 or 22). (For consistency across experiments, we wanted to have the same RA throughout the project.)

Design and materials

Experiment 3 was a 3 (Prime Type: Risk Seek, Risk Averse, Risk Neutral) × 2 (Reminder: Present, Absent) between-subjects factorial design.

Priming task. The vignettes about 'Danny', a person on holiday engaged in different activities, were used to prime risk attitudes (Appendix).

Decision scenarios. The same nine scenarios used in Experiment 2 were given in a random order for each participant.

Reminder task. This was adapted from the one used in Experiments 1 and 2 to reflect the different content of the priming task. Specifically, it asked about how many *adjectives* from the story participants thought they could remember.

Awareness measure. This was modelled on the one used in Experiment 2 and asked participants if and when they thought the priming task might have influenced their preferences in the decision scenarios and in what manner.

Procedure

This closely followed Experiments 1 and 2—participants were given the stories to read on a piece of paper and handed it back to the experimenter before beginning the computer-based scenario tasks.

Results and discussion

Figure 4 is a box plot showing all of the conditions of Experiment 3. Again, the data are averaged across all nine decision scenarios (footnote 2). Consistent with Experiments 1 and 2, there was an effect of scenario type, but because it did not interact with prime or reminder (in either the NHST or Bayesian analysis), it was not of direct theoretical interest, so we focus on the averaged data.

Visual inspection of these data suggests a similar story to that found in Experiment 2. There is no evidence for a simple effect of risk priming in the non-reminded

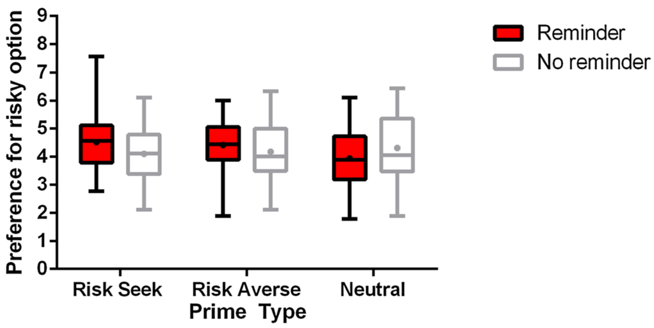

Figure 4. Box plot of the data averaged across decision scenarios in Experiment 3. The whiskers show the maximum and minimum values, the boxes contain the 25th to 75th percentiles, the solid line is the median and the + is the mean. Preferences were elicited on a 1–9 scale with higher numbers indicating preference for the riskier option

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Table 4a. Analysis of variance on mean risk preferences averaged across all scenarios in Experiment 3

Cases	Sum of squares	*df*	Mean square	*F*	*p*
Prime	1.006	2	.503	.454	.636
Reminder	.274	1	.274	.248	.620
Prime * Reminder	3.715	2	1.858	1.678	.191
Residual	135.082	122	1.107		

Note: Type III sum of squares.

Table 4b. Bayesian model comparison on mean risk preferences averaged across all scenarios in Experiment 3

Models	P(M)	P(M|data)	BF_M	BF_{10}	% error
Null model	.200	.741	11.422	1.000	
Prime	.200	.081	.354	.110	.028
Reminder	.200	.154	.727	.208	.053
Prime + Reminder	.200	.017	.068	.023	1.734
Prime + Reminder + Prime * Reminder	.200	.008	.030	.010	1.703

Note: See Table 1b for explanation of column headers.

participants, and no suggestion of the predicted interaction between priming and reminder. This impression is confirmed by the analysis (Tables 4a and 4b). The NHST (Table 4a) found no evidence of an interaction; the Bayesian analyses (Table 4b) indicated that the observed data were most likely under the null model and there was no evidence supporting the inclusion of the 'interaction alone' model (BF_{10} = .010/.023 = .43). Analyses that focus only on the four original EBH scenarios reveal a very similar pattern of (non-significant) effects (Appendix Tables A6 and A7).

The awareness questionnaire revealed that approximately half of the participants (55%, 70/128) thought that their preferences had been influenced by the priming task. The majority (38/70) indicated that they realised the possible influence as they read the decision-task scenarios. These relatively high percentages of 'influence-aware' participants are in line with the results of Experiment 2. The slight increase here (55%) over Experiment 2 (40%) may be due to the more obvious link between the narrative primes and the subsequent decision scenarios.

Despite this higher percentage, the confidence ratings indicated overall low confidence in the potential influence (M = 3.40, SD = 2.06; on 1–9 scale with higher numbers indicating higher confidence in being influenced) and were neutral in terms of the direction in which their responses might have been influenced (M = 4.78, SD = 1.25; on 1–10 scale with 1–4 indicating *more likely to choose safe*, 5 *neither* and 6–10 *more likely to choose risky*). Analyses including 'awareness' of the prime and of the confidence data did not reveal any evidence of systematic differences in responding across reminder conditions.

The use of an arguably more direct narrative prior in Experiment 3 had no reliable effect on risk priming. There was no evidence to suggest that this more 'blatant' prime enhanced contrast effects (Loersch & Payne, 2014), nor that the presence of a 'role model' in the prime stories had downstream consequences when considering the actions of similar actors in the decision scenarios. The awareness data suggested somewhat higher levels of overall awareness about the goals of the experiment (perhaps due to the more closely related nature of the prime) but no evidence of an asymmetry between reminded and non-reminded participants.

Effect-size analysis

We conducted an exploratory effect-size analysis focussing on the portions of the designs and data that were consistent across our three experiments and those of EHB, namely, the 2 (Prime Type: Risk Seek, Risk Averse) × 2 (Reminder: Present, Absent) design averaged across the four original scenarios. Where possible, we calculated Cohen's d for the prime × reminder interaction and the priming effect in non-reminded participants. For the simple effect of priming in non-reminded participants, our estimate of the effect size in EHB Experiment 1 was d = 1.35. This is over three times larger than any of the effects we estimated for our own data (all of which had larger sample sizes than EHB): Experiment 1 = .36; Experiment 2 = −.20; Experiment 3 = .12. Turning to the interaction, our estimate for EHB Experiment 2 was d = .56. This was comparable with that of our Experiment 1 (.53) but larger—and in the opposite direction—than that of Experiment 2 (−.32) and Experiment 3 (.03). We refrain from any attempts to calculate a meta-analytic effect size: EHB did not report sufficient information for calculating the variance around each effect size (nor for calculating the simple effect in their Experiment 2); thus, any attempt to combine effect-size estimates would be incomplete and statistically questionable. We thus simply report these estimated values and allow readers to draw their own conclusions.

GENERAL DISCUSSION

We tested the hypothesis that risky preferences could be primed either consciously *or* 'preconsciously' depending on whether participants were reminded of a priming episode. This is an intriguing claim because it contrasts with 'traditional' perspectives, which assume that preferences are constructed on the basis of consciously accessible rules (e.g. Payne, Bettman, & Johnson, 1993), or accord to the prescriptions of rational choice theory (e.g. Edwards, 1955; Newell, Lagnado, & Shanks, 2015); it goes beyond relatively uncontroversial theoretical perspectives, which propose emotional and affective influences on choice (e.g. Figner & Weber, 2011; Finucane, Peters, & Slovic, 2003; Loewenstein, et al., 2001).

Experiment 1 appeared to show support for the predicted interaction between priming and reminder type—particularly in the standard NHST analyses—but no

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suggestion of an asymmetry in awareness between reminded and non-reminded participants. Experiments 2 and 3 showed no evidence of the predicted interaction in either analysis, and no suggestion of differences in levels of awareness as a function of condition. All three experiments showed limited or no support for the simple effect of priming in the non-reminded participants, an effect which EHB had found very strong evidence for in their original study.

As others have noted, there is no such thing as an 'exact' replication (Stroebe & Strack, 2014), and our experiments do differ from those reported by EHB. However, the differences do not—from our interpretation—correspond to theoretically relevant ones. We used similar or identical tasks in an attempt to activate mental contents related to risk, and we used similar or identical measures of risk taking. Our sample (Australian university students) differed, but we note that EHB tested both French (Experiment 1) and American (Experiment 2) students, the latter of whom at least do not differ substantially in terms of culture and language from our own. We included additional decision scenarios to measure risk taking in Experiments 2 and 3, and although one might argue that these additions could 'dilute' the effect of the prime, we found no evidence for this in an analysis that focussed solely on the first scenario encountered by participants (see footnote 2). A search for further moderators is of course possible and should be driven by predictions derived from a theoretical model describing how priming effects might arise—as we attempted to do here using a popular contemporary framework (e.g. Loersch & Payne, 2014). However, there is no guarantee even when 'optimal' conditions have been identified that effects will be found reliably (see, e.g. the Nieuwenstein et al., 2015, attempt to find an 'unconscious thought' effect in a design with all the 'correct' moderators).

Results from other studies in which risk attitudes have been reliably primed might shed light on the inconsistencies between the current studies and EHB. For example, Gilad and Kliger (2008), from whom we adapted the priming task used in Experiment 3, report priming of risk attitudes in both economics undergraduates and professional investors. Likewise, recent evidence from Ludwig, Madan, and Spetch (2015) suggests that people can be induced to be more risk seeking when they are given reminders of previous winning experiences. However, in both of these cases, there is no evidence (Gilad and Kliger) or suggestion (Ludwig et al.) that these effects occur outside of participants' awareness of the potential influence of the prime. Perhaps attempts to extend or replicate these studies with the inclusion of more detailed measures of awareness could elucidate if and when risk primes are consciously or unconsciously (mis)attributed to subsequent responses.

In this regard, we agree with Loersch and Payne's (2014) suggestion that 'moving forward, priming studies should measure and report subjects' perceptions and suspicions, preferably in ways that could be compared across samples' (p. 151). Critics might argue that any such attempts—including our own in the current experiments—simply invite participants to 'tell more than they can know' (e.g. Nisbett & Wilson, 1977). While there might be some risk of this, we think that it is outweighed by the potential for offering accurate, relevant, insights into the bases of behaviour (Newell & Shanks, 2014b).

Our strong preference, however, before engaging in detailed theoretical discussions about the whens, whys and hows of particular effects is to establish their reliability and generalisability. If an effect is not 'real', then no explanation is required. The simple take-home message from the current studies is that if unconscious priming of risk attitudes using a procedure similar to EHB does occur, then the effects appear to be highly context dependent and fragile. They do not appear to generalise to novel scenarios or narrative primes, and they are not found consistently when using the same primes and the same dependent measures.

One's willingness to accept this general conclusion depends, in part, on whether one favours the Bayes factor or the p value. The clear conclusion from the Bayesian analysis is that the data from all three experiments are most likely to have been produced by a model with *no* effects. In Experiment 1, but not Experiment 2 or 3, the p value suggests the presence of the predicted interaction. With the growing call for the adoption of Bayesian analyses (e.g. Rouder et al, 2012; Verhagen & Wagenmakers, 2014; Wagenmakers, 2007; Wagenmakers et al., 2011; Wetzels, Grasman & Wagenmakers, 2012) and the increasing availability of tools to conduct them (e.g. JASP and R), we think that researchers will increasingly face these rather 'schizophrenic' conclusions. We choose here not to advocate 'sides' but let the readers draw their own conclusions. Interested readers can refer to debates highlighting the general conflict between Bayes factors and p values in terms of their evidential impact (Edwards et al. 1963; Rouder et al., 2012; Sellke, Bayarri, & Berger, 2001).[5]

Demonstrating the fragility of one particular effect or one particular procedure should not lead to a complete disregard of the notion that 'risk preferences need no inferences'. However, such results should offer pause for thought. Moreover, when viewed in the context of several other recent studies questioning the theoretical and empirical basis for social priming effects (e.g. Baumeister, Masicampo & Vohs, 2011; Doyen et al., 2012; Gomes & McCullogh, 2015 Klein et al., 2014; Newell, 2015; Newell & Shanks, 2014a,2014b; Pashler et al., 2012; Pashler & Wagenmakers, 2012; Shanks et al., 2013; 2015), these results might lead to a more circumspect evaluation of the role subtle, unconscious influences play in our behaviour.

[5]One notable finding is that the size of the BF_{10} favouring the *presence* of an interaction in Experiment 1 (5.37) is approximately the same magnitude as the one favouring the *absence* of the interaction in the analysis that combined responses on the four original scenarios from Experiments 1 and 2 (0.21; i.e. they indicate that data are about five times more likely under the alternate and the null, respectively). Note that this latter analysis included 55 participants per cell, which accords with the '2.5× the original sample size' rule of thumb advocated by Simonsohn (2014) for replication studies (see the Appendix for further details).

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APPENDIX

A1. DECISION TASKS

Vignettes 1–4 are the original four used by EBH and in Experiments 1 and 2. Scenarios 5–9 are the additional ones used in Experiments 2 and 3. They were based (loosely) on subdomains of risk preference identified in the DOSPERT scale (Blais & Weber, 2006). Note that scenarios 1, 2, 6 and 7 were reverse scored so that higher numbers on the 1–9 scale always indicated preference for the risky option.

Participants read the following:

You will now read through four scenarios. Each scenario involves a person who must choose between two types of action. This task requires you to imagine you are in the position of this person. Please express your preference on a scale from 1-9. 1 being definitely the first choice of action and 9 being definitely the second choice of action.

1. Mrs Y from Freiburg has spent her holiday in Southern Italy. She now finds herself travelling home on the train. In Naples, she learns that the train line with the shortest connection home might go on strike. Alternatively, she can choose a longer train connection, which will certainly not go on strike. The decision to take the shortest connection carries the danger—if there is indeed a strike—that the trip home will possibly last up to 2 days longer than planned. On the other hand, if she takes the longer connection, then the trip home will certainly last 14 hours longer than planned. Imagine that you are Mrs X. Which choice would you tend to make?

1	2	3	4	5	6	7	8	9
Shorterconnection								*Longer connection*

2. An electronics company is experiencing difficulties. The board of directors is considering whether to reduce the product range to those which are profitable or, on the other hand, to expand the range. The agreement of the board is necessary for both of these projects.

A reduction of the product range would mean that approximately half of the jobs in the firm would have to be lost. On the other hand, the company would have good chances of survival. The expansion of the product range would allow all the jobs to be kept. Nevertheless, the risk remains that the company will go under. Imagine that you are a member of the company board. Which choice would you tend to make?

1	2	3	4	5	6	7	8	9
Expand production								*Reduce production*

3. Mr Z needs a new car. Two used-car salesmen have each made him a different offer. The first salesman offers him a car (sale price 5000) with a year's guarantee for major spare parts. For another model of the same type, the second salesman does not offer him any guarantee but offers a price that is 700 lower. Imagine that you are in Mr Z's position. Which choice would you tend to make?

1	2	3	4	5	6	7	8	9
Car withguarantee								*Car withoutguarantee*

4. This Sunday, Mr X decides to go betting on horses at the town racecourse. Having seen the odds proposed for the horses about to race, he has two possible choices to make. He can decide to bet on the favourite, whose chances of winning are the best. On the other hand, the odds offered on this horse are only 2 to 1 (for 10 placed, Mr X would receive 20). If he decides to bet on the outsider, the chances of winning are lower. On the other hand, the odds offered on this horse are 7 to 1 (for 10 placed, Mr X would receive 70). Imagine that you are in Mr X's position. Which choice would you tend to make?

1	2	3	4	5	6	7	8	9
Thefavourite								*The outsider*

5. Financial

Mrs A reads about a stock that she believes will give her a high return in the coming year. However, her hunch is not based on any proven corporate track record or lengthy dividend history. She contemplates investing 5% of her income into the stock. Imagine you are in Mrs A's position.

Which choice would you tend to make?

Not invest at all (1)—*Invest 5% of income into stock* (9)

6. Health/safety

After a party, Mrs E does not want to catch public transport back home because she lives far away and buses do not come regularly. Mrs E asks her friend if she can sleep over at his house, which is a few streets away. The friend agrees but has already left the party. The house is in a dangerous part of town, and Mrs E will have to walk alone. Imagine you are in Mrs E's position.

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Which choice would you tend to make?

Walk to friend's house (1)—*Use public transport* (9

7. Recreational

Mr D is asked if he would like to go bungee jumping with his friend. Mr D is told that he is going to jump off one of the tallest bridges in the country. He considers going to watch his friend or going bungee jumping with him. Imagine you are in Mr D's position.

Which choice would you make?

Go bungee jumping (1)—*Watch friend* (9)

8. Ethical

Mr B finds a wallet on the train home. At a glance, he sees that there is $200 cash inside the wallet. There is no one else in his carriage, and no one has seen the wallet. Imagine you are in Mr B's position.

Which choice would you tend to make?

Hand in wallet (1)—*Take the $200 from the wallet* (9)

9. Social

Mr C has been climbing the ranks of his job for a decade. He is content with the money he makes and his workplace environment. He is in his mid-thirties now and is thinking about a career change based on a hobby of his. He will have to go back to university and gain some work experience.

Imagine you are in Mr C's position.

Which choice would you tend to make?

Stay in current job (1)—*Try career change* (9)

A2. Awareness questions (Experiment 2)

1. How many words can you recall from the ranking of word frequency task? Please type them in the space below.
2. 'Which of the following most resemble a particular pattern or theme to the words that were included?'
   Multiple choice options—risk-related, emotions, activities and no theme.
3. How confident are you that words on the ranking of word frequency/card sorting task affected how you answered the decision scenarios and survey questions that followed?

Not confident (1)—*Very confident* (9)

4. If you thought the ranking of word frequency/card sorting task affected your decision making, when do you think you realised a possible influence?

- During the scenario questions
- During the questions regarding your likelihood to engage in perceived benefits and perceived risk for the list of activities
- During these questions about your experience
- During the word frequency/card sorting task
- Never
- During the question: 'How do you see yourself: are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?'

5. How do you think the ranking of word frequency/card sorting task affected your choices on the decision scenarios and survey questions that followed?

More inclined to choose the safer option (1–4)—*No influence* (5)—*More inclined to choose the riskier option* (6–10)

A3. Priming Stories used in Experiment 3

Risk-seek story:

Danny is an adventurous, courageous, and enterprising person, who is fond of new experiences, likes thrills and does not hesitate to take risks. On his last holiday, he went to Turkey and, in one evening, he decided to go betting at a casino. He entered the casino with $4,000 and, as suitable for a daring person, decided to play roulette, a game with a high risk factor. He was lucky that day, and collected $30,000. Danny left the casino satisfied by the initiative he had taken. He decided to celebrate with a fancy dinner at the hotel's bar, and afterwards went up to his room happy and satisfied.

Risk-averse story:

Danny is a responsible, reasonable, and reliable person, who is trustworthy and level-headed. On his last holiday, he went to a Greek island. On the first evening, he decided to join a guided tour provided by his hotel for the visitors. During the tour, the visitors arrived at a casino. While the visitors decided to bet at the casino, Danny decided to avoid betting, and go sightseeing instead. When he reunited with the visitors that went to the casino he found out that they lost a lot of money, and will therefore have to end their vacation sooner than they planned. Danny was satisfied with his reasonable decision not to go to the casino, his prudence made the rest of his joyful stay at the island possible, in contrast to the rest of the group.

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Neutral:

Danny has been described as being polite, orderly, clever yet deceitful and disagreeable at times. In his last journey, Danny went to the Greek islands and Turkey. During his tour, he enjoyed a mixture of sightseeing and gambling at the casino. He was liked by some of the group who thought he was adorable in his mannerisms. However some of the group found him to be conceited at times. Danny felt satisfied with his trip and his decisions to participate in activities he liked.

A4. Additional analyses

A4.1

In Experiment 1, the NHST analyses including scenario as a within-subjects factor found a main effect for scenario, $F(3, 288) = 20.82$, $p < .0001$, $\eta^2 = .178$, but scenario did not interact with prime type, $F(3, 288) = 2.42$, $p = .084$, $\eta^2 = .023$, nor with reminder, $F(3, 288) = 1.23$, $p = .299$, $\eta^2 = .013$. The three-way interaction was also non-significant: $F(3, 288) = 1.18$, $p = .318$, $\eta^2 = .012$. In Experiment 2, a similar pattern emerged: a main effect for scenario, $F(8, 1392) = 29.22$, $p < .0001$, $\eta^2 = .144$, but scenario did not interact with prime type, $F(8, 1392) = .975$, $p = .481$, $\eta^2 = .011$, nor with reminder, $F(8, 1392) = .497$, $p = .859$, $\eta^2 = .003$. The three-way interaction was also non-significant: $F(8, 1392) = 1.31$, $p = .320$, $\eta^2 = .013$. Owing to the complexity of considering all possible models (at each level of the within-subjects factor), we do not report the Bayesian results in full, but the conclusions from them accord with those of NHST analyses—scenario has a main effect, but there is no evidence for the inclusion of an interaction of scenario with either variable.

The following tables report the means (Table A1) and the NHST (Tables A2 and A4) and Bayesian analyses (Tables A3 and A5) when only the original four scenarios are considered in Experiment 2 and when the conditions and measures common to both experiments are combined in a single analysis. Tables A6 – A7 display analyses from Experiment 3.

Table A1. Means and *SD* for mean preference averaged across the four original scenarios in Experiment 2, and for the analysis pooling data from the four conditions and scenarios common to both experiments

	Reminder		No reminder	
	Expt 2	Combined	Expt 2	Combined
Risk seeking	3.89 (1.39)	3.54 (1.25)	3.06 (1.27)	3.52 (1.32)
Risk averse	3.30 (1.22)	3.53 (1.26)	3.32 (1.33)	3.41 (1.25)
Risk neutral	3.58 (1.24)	N/A	3.47 (1.49)	N/A

Note: Preferences were on a 1–9 scale with higher numbers indicating preference for the risky option.

Table A2.Analysis of variance on mean risk preferences averaged across four original scenarios in Experiment 2

Cases	Sum of squares	*df*	Mean square	*F*	*p*
Prime type	1.609	2	.805	.499	.608
Reminder	4.201	1	4.201	2.604	.108
Prime type * Reminder	6.188	2	3.094	1.918	.150
Residual	280.704	174	1.613		

Note: Type III sum of squares.

Table A3. Bayesian model comparison on mean risk preferences averaged across four original scenarios in Experiment 2

Models	P(M)	P(M|data)	BF_M	BF_{10}	% error
Null model	.200	.592	5.798	1.000	5.886e−6
Reminder	.200	.318	1.864	.537	.008
Prime type	.200	.051	.215	.086	1.536
Reminder + Prime type	.200	.027	.110	.045	2.153
Reminder + Prime type + Reminder * Prime type	.200	.013	.051	.021	

Note: See Table 1b for explanation of column headers.

Table A4. Analysis of variance on mean risk preferences averaged across four original scenarios in experiments 1 and 2 ($N = 220$)

Cases	Sum of squares	*df*	Mean square	*F*	*p*
Prime	.207	1	.207	.128	.721
Reminder	.273	1	.273	.168	.682
Prime * Reminder	.125	1	.125	.077	.781
Residual	350.580	216	1.623		

Note: Type III sum of squares.

Table A5. Bayesian model comparison on mean risk preferences averaged across four original scenarios in Experiments 1 and 2 ($N = 220$)

Models	P(M)	P(M|data)	BF_M	BF_{10}	% error
Null model	.200	.744	11.616	1.000	
Prime	.200	.116	.526	.156	.042
Reminder	.200	.119	.538	.159	.039
Prime + Reminder	.200	.018	.072	.024	1.211
Prime + Reminder + Prime * Reminder	.200	.004	.015	.005	2.458

Note: See Table 1b for explanation of column headers.

Table A6. Analysis of variance on mean risk preferences averaged across four original scenarios in Experiment 3

Cases	Sum of squares	*df*	Mean square	*F*	*p*
Prime	.791	2	.395	.259	.772
Reminder	.416	1	.416	.272	.603
Prime * Reminder	.704	2	.352	.231	.794
Residual	186.173	122	1.526		

Note: Type III sum of squares.

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Table A7. Bayesian model comparison on mean risk preferences averaged across four original scenarios in Experiment 3

Models	P(M)	P(M|data)	BF_M	BF_{10}	% error
Null model	.200	.751	12.034	1.000	
Prime	.200	.070	.302	.094	.024
Reminder	.200	.162	.774	.216	.050
Prime + Reminder	.200	.015	.060	.020	1.236
Prime + Reminder + Prime * Reminder	.200	.002	.009	.003	3.487

Note: See Table 1b for explanation of column headers.

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