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Thinking Styles and Risky Decision-Making: Further Exploration of the Affect–Probability Weighting Link

KANCHAN MUKHERJEE*
Decision Sciences, INSEAD, Singapore

ABSTRACT

People usually overweight small probabilities and underweight large probabilities leading to the familiar inverse S-shaped weighting function. This research explores the link between affect and the structure of probability weighting from the perspective of thinking dispositions, a concept central to dual system theories of reasoning. The effects of affective priming and cognitive load on both probability weighting and the value function are also examined. The evidence suggests that thinking styles do have predictive implications for risky decision-making. Participants with a more affective thinking style tend to be more risk-seeking in small probability gambles. However, increasing access to the affective system by affective priming or cognitive load manipulations tend to reduce risk-seeking behavior in small probability gambles as well as reduce risk averse behavior in large probability gambles. Previous research, manipulating the affective nature of lottery outcomes, found evidence for an increase in curvature (more overweighting of small probabilities and more underweighting of large probabilities) of the weighting function for affect-rich outcomes, lending support to a hope-and-fear deconstruction of probability weighting. The present research suggests that increased anticipatory emotions characterized by the elevation of the weighting function (more overweighting at all probabilities) is also important and could sometimes be more significant than hope-and-fear in decision-making under risk. An integrated approach incorporating the impact of affect on all three, the elevation and curvature of probability weighting as well as the curvature of the value function explains the empirical findings. Copyright © 2010 John Wiley & Sons, Ltd.

KEY WORDS probability weighting; dual process systems; affect; anticipatory emotions; hope-and-fear

INTRODUCTION

The psychophysics of probability perception is represented by an inverse S-shaped probability weighting function where small probabilities are overweighted and large probabilities are underweighted (Camerer &

* Correspondence to: Kanchan Mukherjee, INSEAD, 1 Ayer Rajah Avenue, Singapore 138676. E-mail: kanchan.mukherjee@insead.edu

Ho, 1994; Gonzalez & Wu, 1999; Kahneman & Tversky, 1979; Kilka & Weber, 2001; Prelec, 1998; Tversky & Fox, 1995; Tversky & Kahneman, 1992; Wu & Gonzalez, 1996). The sensitivity to changes in probability is markedly higher at the end points, probabilities 0 and 1, than in the middle range away from certainty and impossibility. The purpose of this work is to examine the link between affect and probability weighting by investigating it from the perspective of thinking styles, while keeping the affective nature of the outcomes same. Specifically, do the probability weighting functions of individuals with high affective thinking orientations systematically differ from the probability weighting functions of individuals with low affective thinking orientations? How does affective priming affect probability weighting? The evidence suggests that thinking dispositions do have predictive implications for decision-making under risk.

The notion of thinking styles is central to dual process theories in social psychology which state that there are two fundamentally different ways of processing information, one variously labeled as intuitive, automatic, natural, narrative, and experiential, and the other analytical, verbal, deliberative, and rational. Stanovich and West (2000) refer to the former system collectively as "system 1" and the latter collectively as "system 2." There are several dual process theories (Epstein, 1994; Evans et al., 1996; Hammond, 1996; Hogarth, 2005; Klein, 1998; Levinson, 1995; Pollock, 1991; Reber, 1993; Sloman, 1996; Smith & DeCoster, 2000; Strack & Deustch, 2006) with considerable overlap of content and structure (see Chaiken & Trope, 1999, for a comprehensive review of the field). One important commonality among the different dual process theories is that processing in system 1 is intimately associated with affect and is influenced by mood and emotional states of mind and involves how we *feel* about a particular prospect. System 2 on the other hand is deliberative, analytical, and affect free.

Decision-making behavior is influenced by both systems to varying degrees, depending on the individual and the nature of the outcomes. In general, affect-rich outcomes shift the balance of influence towards system 1. Also, individuals vary in their thinking dispositions and reliable tools have been developed to measure the influence of the two systems. This paper uses the Rational-Experiential Inventory (REI) to measure different thinking styles (Epstein, Pacini, Denes-Raj, & Heier, 1996) and is discussed in the *Method* section.

It should be noted that not all authors agree on the independence of the two systems, for example, in their philosophical treatise on the embodied mind, Lakoff and Johnson (1999) state that "there is no such fully autonomous faculty of reason separate from and independent of bodily capacities such as perception and movement . . . reason uses and grows out of such bodily capacities," (p. 17). However, whether an integration of reason with perception and body movements constitutes a refutation of the various dual process conceptualizations in social psychology is unclear and could be taken up in future research.

In previous research, Rottenstreich and Hsee (2001) showed that the shape of the probability weighting function depended on the affective nature of the outcomes. Relatively affect-rich outcomes produced a curve

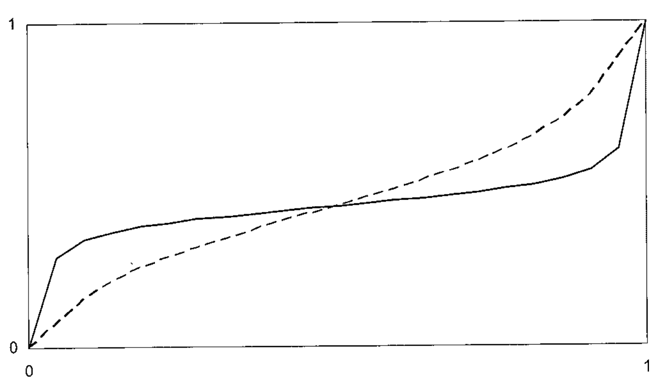

Figure 1. Hypothetical probability weighting functions showing low curvature affect-poor (dotted line) and high curvature affect-rich (solid line) curves with probability on the x-axis and the subjective probability weight on the y-axis. (Adapted from Rottenstreich and Hsee, 2001)

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which was significantly more S-shaped than relatively affect-poor outcomes (Figure 1). Hence, for affect-rich outcomes there is greater overweighting of small probabilities as well as greater underweighting of large probabilities, thereby decreasing sensitivity to intermediate probability levels. One experiment asked participants to price low probability \$500 coupons redeemable for a European vacation (affect-rich) or tuition payments (affect-poor). The European vacation lottery was priced significantly *higher* than the tuition lottery. However, when high probability was used with the same coupons, the affect-rich lottery was valued *lower* than the affect-poor one. The probability weighting curve for affect-rich outcomes is denoted by the solid line and for affect-poor outcomes is denoted by the dotted line in Figure 1.

According to the authors, this affect driven account of probability weighting occurs because affect-rich outcomes "elicit greater degrees of hope and fear and, therefore, larger jumps at the endpoints" (Rottenstreich & Hsee, 2001, p. 186). Their explanation follows from the observation that mental imagery, that often underlies emotion, is insensitive to intermediate probabilities (Elster & Loewenstein, 1992). Hence, the mental image of a car crash is equally frightening whether the probability is 1% or 10% and when affective reactions depend on such mental images, it is conceivable that affect-rich outcomes induce relatively greater jumps at the end points and insensitivity to intermediate probabilities.

Though their results are consistent with the hope-and-fear account, Rottenstreich and Hsee state that their studies focused primarily on the left side of the probability scale and could not rule out an alternative account based on anticipatory emotions, under which greater affect does not lead to more S-shaped probability weighting but rather to greater elevation of the curve. In this account, greater affect gives rise to more savoring for gains and more dread for losses and leads to more overweighting of all probabilities. Indeed, the present results support an account based on *both* anticipatory emotions and hope-and-fear.

It may be helpful to understand the preceding discussion with the help of the two parameter probability weighting function, $w(p) = \delta p^{\gamma}/\delta p^{\gamma} + (1-p)^{\gamma}$, used by several researchers (Gonzalez & Wu, 1999; Kilka & Weber, 2001; Lattimore, Baker, & Witte, 1992; Tversky & Fox, 1995). Here p is the stated probability in a gamble and $w(p)$ represents the transformation of p which drives behavior. The parameters of the non-linear transformation, δ and γ, represent the elevation and curvature of the probability weighting curve, respectively. Gonzalez and Wu (1999) gave the parameters a psychological interpretation, where δ, the elevation, represents the attractiveness of gambling or the *level* of over or underweighting of probabilities, and γ, the curvature, represents the *diminishing sensitivity* to changes in probability on moving away from certainty or impossibility. Hence, as elevation increases, $w(p)$ increases for all values of p, while as curvature increases, $w(p)$ increases for p near 0 and decreases for p near 1. Note that curvature increases as value of γ decreases. In our present discussion, a change in δ represents the account based on anticipatory emotions and a change in γ represents the account based on hope-and-fear.

Research hypotheses

Consistent with the hope-and-fear account, keeping the affective nature of the outcomes constant, individuals who have a higher affective orientation in their thinking should exhibit a more pronounced S-shaped probability weighting pattern. Hence, a higher degree of affective processing should produce probability weighting consistent with affect-rich outcomes and vice-versa. If higher degrees of hope and fear induced by affect-rich outcomes produce the greater S-shaped probability weighting pattern, then it is reasonable to expect that people with high experiential thinking who are more susceptible to feelings would exhibit a similar pattern of behavior. Furthermore, assuming system 1 and system 2 thinking are orthogonal, and system 2 is affect-free, there should be no systematic effect of system 2 thinking on probability weighting. Stated formally:

Hypothesis 1. Higher the salience of system 1 thinking, greater will be the overweighting of small probabilities.

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Hypothesis 2. Higher the salience of system 1 thinking, greater will be the underweighting of large probabilities.

Hypothesis 3. System 2 thinking has no systematic effect on probability weighting.

If the access to system 1 is enhanced by priming or cognitive load manipulations, then, in addition to hypothesis 1–3, we can expect an increase in the over- and underweighting of small and large probabilities respectively across all levels of system 1 thinking. Hence, increasing access to system 1 should produce greater S-shaped probability weighting at the aggregate level. Stated formally:

Hypothesis 4. Increasing access to system 1 will result in greater overweighting of small probabilities.

Hypothesis 5. Increasing access to system 1 will result in greater underweighting of large probabilities.

Hypotheses 1–3 explore probability weighting at the individual level and hypotheses 4 and 5 explore probability weighting at the aggregate level.

Affect and the value function

It should be noted that, in addition to probability weighting, affect has been shown to have systematic effects on the value function. Hsee and Rottenstreich (2004) examined the effect of magnitude or scope of a stimulus on its perceived subjective value. They proposed that people value stimuli by two psychological processes—"valuation by calculation" and "valuation by feeling." They showed that people were less sensitive to the magnitude of the stimulus when they relied on their feelings for decision-making, that is, the value functions were more concave in an affect-rich context. The marginal value declined more rapidly with the magnitude of the stimulus when an affective priming task, similar to the one used here, was employed in an experiment. This is also generally consistent with results obtained by other researchers in related studies (Baron & Greene, 1996; Desvousges et al., 1993; Finucane, Alhakami, Slovic, & Johnson, 2000; Frederick & Fischhoff, 1998; Kahneman, Ritov, & Schkade, 2000; Slovic, Finucane, Peters, & MacGregor, 2002). The literature, so far, has treated affect-driven changes in the probability weighting and value functions separately. However, this article shows that an integrated approach accounting for changes in both the probability weighting and value functions simultaneously may better account for decision-making behavior. Empirical results showing the effect of priming on the value function is reported in Experiment 2.

EXPERIMENT 1

Method

The participant pool consisted mainly of University of Paris students attending the Sorbonne campus with age ranging from 19 to 26 years. The experiment design consisted of three conditions. Condition 1 was the "base case" where 184 participants took the REI questionnaire followed by the probability weighting questionnaire consisting of four questions designed to assess over- and underweighting of small and large probabilities, respectively. Conditions 2 and 3 were manipulations designed to increase relative access to system 1. Condition 2 was the "affective priming" manipulation where 165 participants took the REI questionnaire, followed by the affective priming questionnaire and finally the probability weighting questionnaire. Condition 3 was the "cognitive load" manipulation, where 141 participants took the REI questionnaire, which was followed by the cognitive load manipulation before they finally responded to the

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probability weighting questionnaire. The questions were administered via a computer interface and in a random order. Each participant received a fixed payment of a movie coupon worth €7 redeemable at the nearest movie theatre.

REI questionnaire

The REI is a 40-point self-report questionnaire, based on the Cognitive Experiential Self Theory (CEST), which measures the rational (system 2) and experiential (system 1) predisposition of an individual's thinking style. See Pacini and Epstein (1999), Epstein et al. (1996), and Pacini, Muir, and Epstein (1998) for details of the development and validity of the scale and a comparison with other measures of personality and thinking styles. The rational (based on the Need for Cognition scale developed by Cacioppo & Petty, 1982) and experiential thinking scales are composed of two subscales each, Rational/Experiential Ability and Rational/Experiential Engagement, with the 40 items evenly distributed among the four subscales. According to Pacini and Epstein (1999):

> Rational Ability refers to reports of a high level of ability to think logically and analytically (e.g., "I have no problem thinking things through carefully"). Rational Engagement refers to reliance on and enjoyment of thinking in an analytical, logical manner (e.g., "I enjoy thinking in abstract terms"). Experiential Ability refers to reports of a high level of ability with respect to one's intuitive impressions and feelings (e.g., "When it comes to trusting people, I can usually rely on my gut feelings"). Experiential Engagement refers to reliance on and enjoyment of feelings and intuitions in making decisions (e.g., "I like to rely on my intuitive impressions"). (p. 974)

Participants evaluate each item and indicate how true each statement is about oneself on a 5-point scale ranging from 1 (*completely false*) to 5 (*completely true*). The rational and experiential scales are obtained by simply summing the two respective subscales. Higher the score, higher is the disposition towards that thinking dimension. In this research, a French version of the REI questionnaire was used, previously validated and used by de Stadelhofen, Rossier, and Rigozzi (2004). We are more interested in experiential engagement as it measures inclination to rely on feelings while making decisions and more closely parallels the paradigm of affect-rich versus affect poor outcomes than experiential ability which measures the efficacy of experiential thinking.

The correlation between rational and experiential thinking was $r\,(490) = -.07$ (n.s.), which is consistent with other studies (Epstein, 2003, and references therein) and confirms the orthogonality of the two thought systems. The internal consistency of the measures was satisfactory at $\alpha = .84$ for rational thinking and $\alpha = .87$ for experiential thinking.

The research hypotheses in this paper are explored using choice tasks. In order to further ascertain whether the experiential thinking measure addresses affective considerations in a choice task, 164 participants, in a separate exercise, were asked the following question:

> In a choice between any 2 options, A and B, if A feels better but logical analysis tells you that B is better, then you should choose B.

Participants selected a response on an eight point scale ranging from 0 (*strongly disagree*) to 7 (*strongly agree*) to indicate their level of agreement with the above statement. Indeed, it was found that experiential thinkers agree less with the notion that logical analysis rather than feeling good about a choice option should dictate choice, $r\,(164) = -.43$, ($t = 5.98$, $p \sim 0$), consistent with the notion of affect being an integral part of experiential thinking.

Probability weighting questionnaire

There were two choice based questions for each end of the probability scale. The left-hand side of the scale was investigated using choices between 1% (5%) chance of €500 (€100) and €10 for sure. The right-hand

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side of the probability scale was explored using choices between 99% (95%) chance of €500 (€100) or €490 (€90) for sure. Choice questions were used instead of pricing questions as it was found that participants found choice questions simpler to understand and easier to evaluate. Choice questions are also less susceptible to issues of incentive compatibility and immune to complications arising from whether buying, selling, or fair pricing tasks are used.

Note that the sure amount is greater than the expected value of the lotteries in the first two questions and lower in the last two. Choosing the lottery in the first two questions would imply overweighting of low probabilities, also called the impossibility effect, and choosing the sure thing in the last two would imply underweighting of large probabilities, also called the certainty effect. A measure of overweighting of small probabilities is the number of lottery choices made by the individual. Hence, a participant who chooses the lottery in both the choices is assumed to overweigh small probabilities more than a participant who chooses the sure thing in one or both the choices. On the other hand, at the certainty end of the probability scale, a participant who chooses the sure thing in both the choices is assumed to underweight large probabilities more than a participant who chooses the lottery at least once. Hence, the mean number of lottery choices in the low probability questions provides an aggregate measure of the impossibility effect, while the mean number of sure amount choices in the high probability questions provides an aggregate measure of the certainty effect.

Affective priming manipulation

Participants were primed experientially by asking them five questions designed to evoke feelings and imagery about affect rich entities, for example: "What do you feel when you hear the name "Nikolas Sarkozy"? Please use a word or sentence to describe your predominant feeling." It is assumed that the affective priming used increases access to the experiential system of thought. Similar priming has been used in Hsee and Rottenstreich (2004). See appendix for the full affective priming questionnaire.

Cognitive load manipulation

It has been established that people have limited cognitive capacity, which when loaded should increase the relative use of the experiential system. In related research, using a dual process paradigm, Baumeister and Vohs have shown that over-riding affective motivations require an exertion of effort by the rational system. This "willpower" is in limited supply and usage in one task makes it less available for another successive one (Baumeister & Vohs, 2003). One way to operationalize cognitive load is to tax the working memory, which is the ability to store small amounts of information during cognitive processing, and has been used successfully by Shiv and Fedorikhin (1999) in a study linking cognitive load with self-control.

In this study, the cognitive load manipulation consisted of displaying a nine-digit number on the computer screen for 15 seconds. The participants were told that they would receive a gift (portable radio worth €2) if they could recall the number correctly at the end of the experiment. Care was taken to make sure that the participants did not use any memory aid. This manipulation is assumed to increase relative accessibility to the experiential system by loading and thereby suppressing accessibility to the rational system.

Note on sample size and power

Input for appropriate sample sizes was taken from Cohen (1992, Table 2, p. 158). The N for medium effect size at power = .80 and $\alpha = .05$ for tests of mean difference and significant r are listed as 64 and 85, respectively. While I made sure that the sample sizes in the studies reported here were all greater than 85, the actual sample sizes were constrained by budget and time considerations.

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Results and discussion

The correlation data between experiential thinking and risky choice behavior is shown in Table 1. The pattern that emerges from the data is that there is a significant positive correlation between experiential thinking and degree of risk-seeking behavior at small probabilities, primarily driven by the correlation with the experiential engagement dimension. The certainty effect, however, had no significant correlations with experiential thinking in any of the conditions. All three conditions, which are like three different studies in this case, yield the same pattern of results.

It is conceivable that an especially strong affective manipulation, like some kind of an emotional shock, could result in uniformly high experiential engagement across all participants temporarily, causing the correlations at the impossibility end to reduce or disappear altogether. The manipulations used in the experiment cannot be described as nearly strong enough to significantly reduce or eliminate the variance in experiential thinking among the participants. It seems more likely that the priming and cognitive load manipulations brought about a small to moderate increase in experiential thinking across all participants, thereby preserving the variance in experiential thinking among the participants.

In order to see how the value function can influence decision-making in this context, consider the choice between the gamble (p, x) and y for sure. Assuming, for simplicity, a power value function, $v(x) = x^{\alpha}$, where $\alpha \in (0, 1)$ for concave value functions, the gamble is preferred if $w(p)v(x) > v(y)$ or $w(p) > (y/x)^{\alpha}$. If affect increases the concavity of the value function, then α should reduce with increasing influence of affect. This would result in an increase in the right-hand side of the inequality because $y/x < 1$. Hence, the effect of affect on the value function is to increase the attractiveness of the sure thing. However, in the experiment, since y/x is close to 1 when p is large and close to zero when p is small, choice behavior will be more sensitive to small changes in α at the impossibility end. The greater concavity of the value function due to affect is likely to have negligible effect on choice behavior at the certainty end.

In the case of small probabilities, the existence of a significant positive correlation between experiential engagement and the propensity to choose the gamble, when affect-driven changes in the value function

Table 1. Correlations between experiential scores from the REI and number of lottery choices in the impossibility effect and number of sure choices in the certainty effect

		Impossibility effect			Certainty effect		
Study	N	E_{ab}	E_{eng}	E	E_{ab}	E_{eng}	E
Base case	184	.10	.28***	.21**	−.08	−.07	−.08
Affective priming	165	.16*	.27***	.25**	.01	.05	.04
Cognitive load	141	.15	.31***	.25**	.05	.04	.05

Note: E_{ab} = experiential ability; E_{eng} = experiential engagement; E = experiential aggregate.
*$p < .05$.
**$p < .01$.
***$p < .001$, (two-tailed).

Table 2. Correlations between rationality scores from the REI and number of lottery choices in the impossibility effect and number of sure choices in the certainty effect

		Impossibility effect			Certainty effect		
Study	N	R_{ab}	R_{eng}	R	R_{ab}	R_{eng}	R
Base case	184	−.09	−.02	−.07	−.01	.02	.01
Affective priming	165	−.07	.04	−.02	.02	.04	.03
Cognitive load	141	−.05	.01	−.02	.03	−.13	−.06

Note: R_{ab} = rational ability; R_{eng} = rational engagement; R = rational aggregate.

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should increase the attractiveness of the sure thing, lends support to hypothesis 1. In the case of large probabilities where the effect of the value function due to affect is negligible, the lack of significant correlations leads to a rejection of hypothesis 2.

The correlation data between rational thinking and risky choice behavior is shown in Table 2. There was no correlation between rational thinking and either the impossibility effect or the certainty effect, thus supporting hypothesis 3. Aside from the low correlation values, there is no consistency in the sign of the correlations with half of the 18 correlations reported in Table 2 being positive and the other half being negative.

The combined effect of curvature (hope-and-fear account) and elevation (anticipated emotions account) can help in explaining the results obtained in the correlation analysis. It is proposed that people with a higher predisposition towards experiential thinking, have higher curvature, reflecting greater susceptibility to hope and fear, as well as higher elevation, reflecting greater involvement of anticipated emotions. Both higher curvature and higher elevation imply higher overweighting of small probabilities and we see this in the positive correlation between the impossibility effect and experiential thinking. On the other hand, higher curvature increases and higher elevation decreases underweighting of large probabilities, thereby leading to opposite effects at the certainty end of the probability scale. These two opposing forces, if comparable in magnitude, will remove any systematic effect of experiential thinking on the certainty effect, as indicated by the absence of any correlation between experiential thinking and underweighting of large probabilities. Consider, as a simple numerical example, the probability weighting of individual L who is low on experiential thinking and individual H who is high on experiential thinking. Assuming the two-parameter probability weighting function, let L have elevation $\delta_L = 0.8$ and curvature $\gamma_L = 0.5$ and H have higher elevation $\delta_H = 0.9$ and higher curvature $\gamma_H = 0.47$ (note that lower parameter value implies greater curvature). These parameter values yield probability weightings of $w_L(.01) = .07$, $w_L(.05) = .16$, $w_L(.95) = .78$, and $w_L(.99) = .89$ for L and $w_H(.01) = .09$, $w_H(.05) = .18$, $w_H(.95) = .78$, and $w_H(.99) = .89$ for H. Note that H overweighs small probabilities more than L but underweighting of large probabilities is the same. This would lead to a positive correlation of experiential thinking with the impossibility effect but no systematic relationship with the certainty effect.

The aggregate probability weighting data for the three conditions is shown in Table 3. The data represents the mean number of lottery choices in the impossibility effect and mean number of sure amount choices in the certainty effect. As a quick validity check for the data, note that, consistent with the subcertainty hypothesis ($w(p) + w(1-p) \leq 1$) of prospect theory (Tversky & Kahneman, 1986), the certainty effect is more prevalent than the impossibility effect.

The data indicate a reduction in risk-seeking behavior at small probabilities as well as a reduction in risk averse behavior at large probabilities when access to the experiential thought system is enhanced. The reduction in the certainty effect was not significant in the affective priming condition but was directionally consistent with the other manipulation. Combining the two manipulations, we obtain significant reduction in the certainty effect, from $M = 1.45$, SD $= 0.77$ in the base case to $M = 1.27$, SD $= 0.78$ in the combined affective priming and cognitive load conditions, $t(588) = 2.48$, $p < .05$.

Table 3. Summary statistics of risky choice behavior in the three conditions

		Impossibility effect		Certainty effect	
Condition	*N*	*M*	SD	*M*	SD
Base case	184	0.96	0.88	1.45	0.77
Affective priming	165	0.75*	0.84	1.31	0.81
Cognitive load	141	0.76*	0.87	1.23*	0.76

Note: The data represents the mean number of lottery choices in the impossibility effect and mean number of sure amount choices in the certainty effect. Statistical significance is based on comparison with the base case.
*$p < .05$, (two-tailed).

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These results seem inconsistent with the hope-and-fear account where increase in curvature predicts an effect opposite to the one obtained. However, one can explain the findings by assuming an increase in the curvature and elevation of probability weighting, with rise in elevation being greater than the rise in curvature, if we also account for the potential effect of these manipulations on the value function.

In the case of small probabilities, if affective priming and cognitive load increase both curvature and elevation of probability weighting then overweighting increases and this has the effect of making the lottery more attractive than in the base case. However, as discussed earlier, since there is a big difference in the lottery outcome (for example, €500) and the sure outcome (for example, €10) in the choice questions, sufficient increase in concavity of the value function can reduce the relative attractiveness of the lottery enough to offset the increased value due to increased curvature and elevation of probability weighting, thereby making it less attractive than the sure outcome. This could explain the reduction in the propensity to choose the lottery in the affective priming and cognitive load conditions compared to the base case. As a simple numerical example to illustrate this effect, let individual B belong to the base case participant pool and individual P belong to the primed participant pool. Assuming the two parameter probability weighting function, let B have elevation $\delta_B = 0.7$ and curvature $\gamma_B = 0.5$ and a linear value function $v(x) = x$. It can be shown easily that this individual has a certainty equivalent of €13.8 for the lottery, 5% chance of €100, otherwise nothing. Now, let P have higher elevation $\delta_P = 1$, higher curvature $\gamma_P = 0.48$, as well as more concave value function, $v(x) = x^{0.8}$. Under these conditions P would have a certainty equivalent of €13 for the same lottery. Hence, if priming affects the parameters in the proposed way, the attractiveness of the gamble reduces leading to a reduction in the impossibility effect as observed in the experiment.

In the case of large probabilities, if the manipulations lead to a greater increase in anticipated emotions (elevation) than hope-and-fear (curvature), then this would reduce underweighting making the lottery more attractive than in the base case. However, in contrast with the case of small probabilities, the increased concavity of the value function has negligible effect since the lottery outcome (for example, €500) and the sure outcome (for example, €490) are very close. This account can explain the reduction in the certainty effect in both the manipulation conditions compared to the base case. As an illustrative example, assume that our friends B and P are now making decisions at the certainty end of the probability scale. Keeping their respective parameters the same, B has a certainty equivalent of €75.3 for the lottery, 95% chance of €100, otherwise nothing. On the other hand P has a higher certainty equivalent of €76.2 for the same lottery. Hence, priming can increase the attractiveness of the high probability gamble according to the proposed mechanism thereby reducing the certainty effect as observed in the experiment. Note that the effect of priming on anticipatory emotions (elevation) needs to be substantially higher than on hope-and-fear (curvature) for this mechanism to be consistent with the experimental results.

The preceding analysis assumes that affect reduces scope sensitivity and increases concavity of the value function. This is tested empirically in Experiment 2 which finds support for the results in Hsee and Rottenstreich (2004) and extends the results to the cognitive load manipulation.

EXPERIMENT 2

Method

The participants ($N = 323$) were mainly University of Paris students attending the Sorbonne campus with mean age of 22 years. They were randomly assigned to one of six conditions in a 2 (stimulus magnitude) × 3 (priming) between-subjects design. In the priming conditions, 104 participants were administered the affective priming questionnaire identical to the one used in Experiment 1, 115 participants experienced the same cognitive load manipulation as in Experiment 1 and 104 participants were not primed in any way. Each participant received a choice of gifts valued at about €2.

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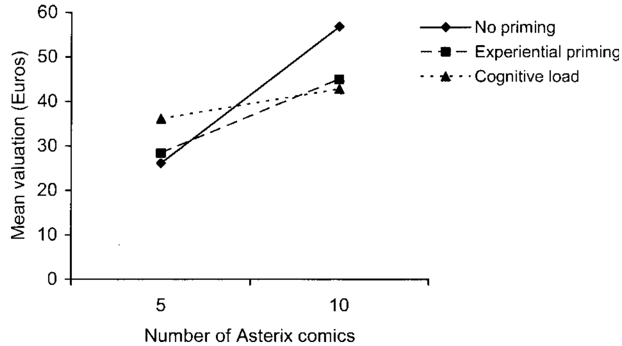

Figure 2. Interaction of mean valuation of Asterix comics between stimuli magnitude and priming conditions

All participants answered the following question from among a set of unrelated questions: "Imagine that a book store is selling a set of 5 (10) Asterix comics. What is the maximum amount that you are willing to pay for this set of 5 (10) comics?"

Results and discussion

In the no priming condition, the maximum willingness to pay was significantly greater for the 10-comic set than for the 5-comic set ($M = 56.83$, SD = 41.60, and $M = 26.10$, SD = 16.03, respectively), $t(102) = 4.97$, $p < .001$. In the affective priming condition as well, the maximum willingness to pay was significantly greater for the 10-comic set than for the 5-comic set ($M = 45.00$, SD = 30.65, and $M = 28.36$, SD = 22.49, respectively), $t(102) = 3.15$, $p < .01$. However, the difference between the valuations of the 10- and 5-comic set was much reduced in the priming condition. In the cognitive load condition, the sensitivity of the valuation to the stimulus magnitude was no longer significant ($M = 42.83$, SD = 35.02 for the 10-comic set, and $M = 36.05$, SD = 55.07 for the 5-comic set), $t(113) = 0.78$, (n.s.).

The interaction between stimulus magnitude and priming from analysis of variance (ANOVA) is shown in Figure 2. The two-way ANOVA between the no priming and affective priming conditions show a marginally significant interaction effect, $F(1, 204) = 3.01$, $p = .08$, a significant main effect of stimulus magnitude, $F(1, 204) = 33.99$, $p \sim 0$, but no significant main effect of priming, $F(1, 204) = 1.38$, (n.s.). The two-way ANOVA between the no priming and cognitive load conditions show a significant interaction effect, $F(1, 215) = 4.94$, $p < .05$, a significant main effect of stimulus magnitude, $F(1, 215) = 12.11$, $p < .001$, but no significant main effect of the thinking manipulation, $F(1, 215) < 1$, (n.s.). Finally, there were no significant effects between the affective priming and cognitive load conditions. Hence, the data supports the idea that affect leads to greater scope insensitivity and consequently more concave value functions.

DISCUSSION AND CONCLUSION

The evidence in this article and in the literature suggests that affect has systematic effects on both the probability weighting function and the value function. For positive outcomes, greater presence of affect can increase the curvature of the weighting function which involves an increase in the overweighting of small probabilities brought about by greater hope and a simultaneous increase in the underweighting of large probabilities brought about by greater fear. Greater affect can also increase the elevation of the weighting function which involves an increase in the weighting function across the entire probability scale brought about by greater anticipatory emotion like savoring. Experiment 1 revealed a positive correlation between the affective orientation of ones' thinking style and risk-seeking behavior at small probabilities. However, no systematic correlation was

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observed at the high probability end. This suggests that the more a participant was affectively predisposed in her thinking, the more she tended to overweight small probabilities but was no different at high probabilities.

This pattern of findings suggests that affective thinking systematically affects both the curvature and the elevation of probability weighting. This can be understood by noting that the increase in the curvature and elevation at small probabilities both cause an upward shift in probability weighting in what can be termed "constructive interference." In contrast, the increase in the curvature and elevation at high probabilities causes a downward and upward shift in probability weighting respectively thereby cancelling each other out in what can be termed "destructive interference." Consequently, we observe a positive correlation between affective thinking and risk-seeking at small probabilities and no correlation at high probabilities because the changes in the curvature and elevation of probability weighting are in the same direction at the low end of the probability scale and in opposite directions at the high end of the scale.

Experiment 1 also revealed that increasing access to the affective system by the direct manipulation of affective priming or the indirect manipulation of cognitive load reduced risk-seeking behavior at small probabilities and had a weak effect of reducing risk averse behavior at high probabilities. This seems to suggest that affect reduces overweighting of small probabilities which goes against the earlier finding with thinking dispositions. The apparent paradox can be resolved if one incorporates the impact of affect on the value function as well. Earlier research and Experiment 2 in this article shows that increased affect tends to reduce scope sensitivity and increases the concavity of the value function. The key point to note here is that the increased concavity of the value function due to affect has significant effect in low probability gambles but little effect in high probability ones. This is due to the large difference that is likely in the outcome of a low probability gamble and its certainty equivalent, for example, the certainty equivalent of a 5% chance of $100 is likely to be between $0 and $15 which is small compared to the gamble outcome. However, the increased concavity is likely to have negligible impact for high probability gambles as the corresponding certainty equivalents would be close to the gamble outcomes, for example, a $90 certainty equivalent for a 95% chance of a $100.

In the case of small probability gambles, if affective priming and cognitive load increase the concavity of the value function sufficiently, then this can override the simultaneous increase in the overweighting of small probabilities to produce a net increase in risk averse behavior. At the high probability end, the effect on value function has negligible effect and we do see weak results which could be due to a marginally stronger effect of the manipulations on the elevation rather than curvature of probability weighting. The preceding analysis shows that decision-making under risk involves the consideration of both value and probability perceptions and an analysis of behavior under risk needs to take both into account.

Affect is an integral part of human existence and so is risk and uncertainty. A better understanding of how affect influences decision-making under risk can have important implications in a wide variety of human endeavours such as designing promotion plans for risk related products, complex negotiation deals, choosing among risky ventures, and making career choices. For example, the affective content of promotions for insurance, mutual fund, and casino products can be manipulated to influence the risk-taking behavior of potential customers. Similarly, the affective content of messages in a negotiation may impact risk attitudes and consequently the outcome of the negotiation. Additionally, people whose thinking is more affectively oriented are more likely to make higher estimates of the value of an entrepreneurial venture and consequently choose a risky career over a more secure one. Further research is required to establish the robustness of the findings reported in this article, isolate the specific impacts of anticipatory emotions and hope-and-fear, subject the practical implications to rigorous testing, and investigate the influence of affect in the field amidst real world settings.

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APPENDIX

Affective priming questionnaire

Please use your feelings to answer the five questions that follow.

1. When you hear the name ‘‘Nicolas Sarkozy,’’ what do you feel? Please use a word or sentence to describe your predominant feeling.
2. When you hear the word ‘‘baby,’’ what do you feel? Please use a word or sentence to describe your predominant feeling.
3. When you hear the word ‘‘marriage,’’ what do you feel? Please use a word or sentence to describe your predominant feeling.
4. When you hear the word ‘‘revolution,’’ what do you feel? Please use a word or sentence to describe your predominant feeling.
5. When you hear the word ‘‘poverty,’’ what do you feel? Please use a word or sentence to describe your predominant feeling.

Authors' biography:

Kanchan Mukherjee is a post-doctoral research fellow at the Centre of Decision Making and Risk Analysis, INSEAD. His research interests lie in behavioral decision making which he explores from both theoretical and empirical perspectives. His recent research topics include decision making under risk & uncertainty, inter-temporal probability judgments, overconfidence and performance motivation and incentives.

Authors' address:

Kanchan Mukherjee, INSEAD, 1 Ayer Rajah Avenue, Singapore 138676.

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