Intuitive Theories of Cognition on Affect and Risk Preferences

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Abstract

Though it is well-understood that beliefs about future emotions (*affective forecasting*) influence decision-making, less is known about where these forecasts come from. Here, we investigate how intuitive theories of cognition (*cognitive forecasting*) influence affective forecasts and, consequently, risk preferences. We found that forecasts of cognitive states—expectations, attention, and information-seeking—are linked to affective forecasts and risk preferences (Study 1). There was great diversity in people's intuitive theories of cognition: One subgroup associated attention and information-seeking with positive emotions for optimists but negative emotions for pessimists, and therefore predicted greater risk-seeking in optimists but not pessimists; the other large subgroup consistently perceived forecasted attention and information-seeking as affectively negative (Studies 2a-b). These results connect behavioral economics and cognitive science by exploring how metacognitive intuitions influence our preferences.

Keywords: affective forecasting; judgment and decision-making; cognitive forecasting; risk preferences; expectations; attention; information-seeking

Introduction

Imagine that our benefactor, Bob Glushko, endowed a game show. On the Glushko Show®, players are selected at random from the population and endowed with a risky gamble, with the outcome only to be revealed in a month, which could pay $10,000—or nothing at all. Two weeks into this time, cognitive scientists probe each player's mind to reveal their most intimate cognitive states: their optimism or pessimism about the gamble (*expectations*), how often they think about the gamble (*attention*), and how often they seek out external information about how likely their gamble will pay off (*information-seeking*).

But you, dear reader, are the true contestant. Your task is to predict, from these cognitive states, how likely each player is to seek out risks in other domains of life. Who is most risk-seeking: Is it Rachel, who is optimistic and barely ever thinks about the gamble? Is it Anne, who is pessimistic and seeks every morsel of information? Stay tuned if you wish to gain a leg up when your name is drawn.

This paper is about *cognitive forecasting*: How our beliefs about our future cognitive states impact our decisions. There is, of course, a large literature on *affective forecasting*—how we (mis)predict our future emotions (Gilbert & Ebert, 2002; Kahneman, 1997; Kahneman & Snell, 1992; Wilson & Gilbert, 2005; Wilson & Gilbert, 2003). We take this work one step further by examining the link between predicted cognition and predicted affect, and how both sets of predictions jointly influence our willingness to take risks.

To provide a framework for predictions, we separately consider two potential links: the link between predicted cognition and predicted affect and between predicted affect and risk preferences. We begin with the latter.

Models in behavioral economics have analyzed why affective forecasts would influence risk preferences (e.g., Caplin & Leahy, 2001; Dawson & Johnson, 2021; Loewenstein, 1987; Loewenstein et al., 2001). Consider a decision-maker at time T_0 who is contemplating a risky gamble to be resolved at a future time T_2, following a waiting period T_1. They would consider both their "consumption utility" (emotions about the positive or negative outcome at T_2) and "anticipatory utility" (dread or savoring experienced during the waiting period T_1). To the extent a person expects to experience more negative emotions during the waiting period (e.g., because they have a pessimistic or ruminative personality), they should be less willing to accept delayed gambles because the gamble's total expected utility is worse (they have lower anticipatory utility as they experience more dread).

What is less well-understood, however, is *how* people forecast their anticipatory utility (emotions at T_1) when they are making decisions (at T_0). In this paper, we consider how three types of cognitive states—expectations, attention, and information-seeking—influence these affective forecasts. Despite mountains of literature on each of these cognitive processes individually (e.g., Donnellan et al., 2022; Johnson et al., 2023; Johnson & Tuckett, 2022; Pashler et al., 2001; Posner, 1980; van Lieshout et al., 2021), this work has generally not examined people's *intuitive theories* of these cognitive states.

We derive predictions both from first principles and from prior research, not on affective *forecasting*, but on experienced affect during waiting periods (Caplin & Leahy, 2001; Golman et al., 2021; Nomikos et al., 1968; Sweeny & Andrews, 2014; Sweeny & Shepperd, 2010; Sweeny et al., 2016; Sweeny, 2018), on the assumption that people might intuit some of these phenomena.

First, we hypothesized that people who are more optimistic about delayed gambles would forecast more positive affect while they wait for such a gamble to be resolved. This is because optimism creates a license to savor the imagined positive outcome, whereas pessimism would lead one to dread the imagined negative outcome. This, in turn, should lead to a greater willingness to accept delayed gambles *in general* (i.e., more risk-seeking) since one would forecast more positive anticipatory emotions.

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Second, we conjectured that this positive effect of optimism (and negative effect of pessimism) would be greater among those who forecast that they will pay more (internal) attention or seek more (external) information while they wait. Attention and information-seeking while waiting imply more frequent or intense thoughts related to the gamble. If the thoughts are optimistic, they should forecast more positive affect when they will experience those thoughts more frequently, but the opposite when the thoughts are pessimistic. Thus, forecast attention or information-seeking should increase risk-seeking among optimists but decrease it among pessimists.

We test these predictions in 3 studies. Study 1 examines participants' forecasts of their own cognitive and affective states in a hypothetical situation and the associations between those forecasts and their general risk-taking disposition. Studies 2a and 2b use experiments to test how people intuit the relationships between *others'* cognitive states and their affect and risk preferences, and to probe individual differences in intuitive theories of cognition.

Study 1

Study 1 provided an initial test of our predictions. Participants were given a hypothetical scenario in which they had to wait to learn the outcome of a risky investment. Participants were asked about their expectations, attention, information-seeking, and emotions during this waiting period, as well as general risk preferences. We anticipated that forecasts of cognitive states would be linked to forecasts of affective states. Since anticipatory emotions such as dread and savoring can affect the utility of delayed risky gambles, we anticipated that these affective forecasts would, in turn, be linked to risk preferences.

Method

We recruited 257 U.S. participants (156 male, 99 female, 2 other, M_{age} = 37) from MTurk; 15 were excluded since they failed a comprehension or attention check (see below).

Participants were asked to imagine that "you are buying a $1,000 futures contract in the stock of a company, meaning that its value depends on the company's stock price in 1 month's time. If the stock's value goes up during the month, you might make a large sum of money, but if the stock's value goes down, you might lose a large sum. As futures contracts are legally binding, you cannot back out of this investment during the month, but instead will have to wait until the end of the month to find out its value."

Participants then completed two comprehension check questions to ensure they understood the scenario and were excluded if they failed either question.

To measure forecasted cognitive and affective states, participants rated the following on 1–5 scales, in this order:

Positive expectations. "… I would keep high expectations about the investment's outcome."

Negative expectations. "…I would keep low expectations about the investment's outcome."

Attention. "…I wouldn't be able to stop thinking about the investment."

Information-seeking. "…I would constantly check the mobile app to track the investment that I made."

Positive affect. "…I would feel excited every time I thought about the investment."

Negative affect. "…I would feel anxious every time I thought about the investment."

As risk measures, participants completed, in this order:

Subjective risk. "Please rate how willing or unwilling you are to take financial risks on a scale from 0 to 10."

Scenario-specific risk. A choice between a sure payment of $50 vs a lottery (50%: 20% futures contract; 50%: nothing), measured on a 1–5 scale.

Objective risk. A series of choices between a sure payment vs a lottery (50%: $450; 50%: $0). Across trials, the sure payment increased/decreased to titrate the participant's indifference point (Falk et al., 2016).

Several additional measures were taken: measures of forecast cognitive and affective states at several time points throughout the one-month waiting period, measures of time preferences, and a measure of trait mindfulness (which included an attention check used to exclude inattentive participants). Demographics were also measured in each study. None of these variables are analyzed further here since they do not test our main research question.

Results

Overall, the results supported our main hypotheses. Cognitive forecasts predicted affective forecasts, which in turn predicted risk preferences.

Cognitive forecasts → Affective forecasts. As shown in Figure 1, higher expectations (the mean of positive expectations and reverse-coded negative expectations) were associated with more positive affect, $r(240) = .54$, $p < .001$, and lower negative affect, $r(240) = -.20$, $p = .009$. When participants indicated that they would pay more attention during the waiting period, they predicted having both more positive, $r(240) = .21$, $p = .006$, and negative affect, $r(240) = .59$, $p < .001$. Similarly, those who indicated they would often seek information by checking the mobile app reported both more positive, $r(240) = .26$, $p < .001$, and negative affect, $r(240) = .30$, $p < .001$. Forecasts of attention and information-seeking were also correlated with one another, $r(240) = .58$, $p < .001$.

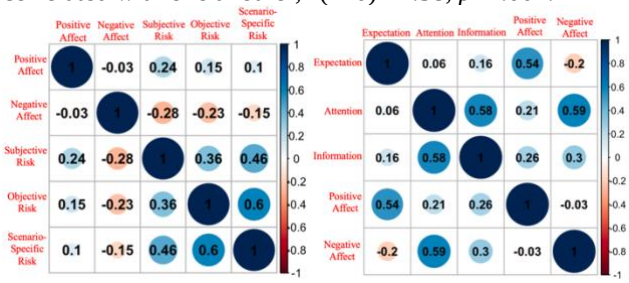

Figure 1: Correlations between Cognitive Forecasting and Affective Forecasting, between Affective Forecasting and Risk Preferences from Study 1.

Affective forecasts → Risk preferences. As shown in Figure 1, affective forecasts during the waiting period predicted some of the risk measures, though not always significantly. People who predicted more positive affect were higher in subjective risk, $r(240) = 0.24$, $p < .001$, objective risk, $r(240) = 0.15$, $p = .068$, and scenario-specific risk, $r(240) = 0.10$, $p = .26$, with the latter not reaching significance. Conversely, people who predicted more negative affect were lower in less subjective risk, $r(240) = -0.28$, $p < .001$, objective risk, $r(240) = -0.23$, $p < .001$, and scenario-specific risk, $r(240) = -0.15$, $p = .068$.

Cognitive forecasts → Affective forecasts → Risk preferences. To test the indirect effect of cognitive forecasts on risk preferences via affective forecasts, we conducted a series of mediation analyses using the 'mediation' package in R (v4.5.0; Tingley et al., 2014). For example, the relationships between (i) expectations and positive affect and (ii) positive affect and objective risk preferences together resulted in a significant indirect effect of expectations on objective risk preferences, $b = 0.48$, $p = .026$, 95% CI [0.06, 1.02].

We anticipated that this mediation pattern would hold for all combinations of cognitive and affective variables with significant relationships in Figure 1. We conducted all possible mediation analyses using each cognitive forecasting variable (expectations, attention, information-seeking), each affective forecasting variable (positive and negative affect), and two different risk measures (subjective and objective risk preferences). Every one of these mediations revealed a significant indirect effect

Interactions among cognitive forecasts. We had predicted that the cognitive forecasting variables might interact, such that higher levels of attention and information-seeking would exacerbate the effects of expectations. We found some evidence for this idea.

Table 1: Regression Table from Study 1

Predictors	Positive Affect	Negative Affect
Expectation	0.50 (0.05)***	-0.23 (0.05)***
Attention	0.15 (0.06)*	0.62 (0.06)*
Information	0.08 (0.07)	-0.02 (0.06)
Expectation x Attention	0.11 (0.06) †	0.2 (0.06)
Expectation x Information	-0.19 (0.05)***	-0.00 (0.05)

Note. * $p < .05$, ** $p < .01$, *** $p < .001$. The coefficient marked with † is marginally significant at 0.10 level.

Table 1 reports regression analyses predicting positive and negative affect from the cognitive forecasting variables (standardized) and their interactions. For positive (but not negative) affect, there was a trend for expectations to have a larger effect for those higher in attention (slopes of 0.61 vs. 0.39 for +1 vs. –1 SD on attention). The corresponding effect for information-seeking was significant in the opposite direction, with a larger effect of expectations for those lower in information-seeking (slopes of 0.31 vs. 0.69 for +1 vs. –1 SD on information-seeking).

Discussion

Overall, Study 1 supported our main predictions: (i) Participants' cognitive forecasts were associated with their affective forecasts. Higher expectations were associated with higher forecasted positive affect (and lower negative affect). Higher forecasted attention and information-seeking were both linked to higher forecasted positive *and* higher negative affect. There was also some evidence that the effect of expectations interacted with that of attention. (ii) Participants' affective forecasts were linked to their risk preferences. Participants who forecast more positive and less negative affect were more prone to risk-taking. (iii) These relationships led to an indirect effect of cognitive forecasts on risk preferences via affective forecasts.

Study 2a

Whereas Study 1 provided initial correlational evidence for the hypothesized relationships, Study 2 sought to manipulate cognitive forecasts in order to establish causal relationships. In addition, there was considerable heterogeneity in the Study 1 forecasts but no clear way to categorize participants according to their intuitive theories of cognition. Thus, Study 2 adopted a within-subjects design in which participants read about *other* people's cognitive states, which could be manipulated through vignettes. Participants' forecasts of others' affective states could then be used to categorize their intuitive theories and study their associated beliefs about risk preferences. Study 2a manipulated expectations and attention, whereas Study 2b manipulated expectations and information-seeking.

Method

We recruited 145 U.S. participants (83 male, 62 female, $M_{age} = 38$) from MTurk. Participants were instructed to:

> Imagine that a group of people were selected at random…for a high-stakes experiment.
>
> In the first phase… they were given $1,000 to invest in what is called a *futures* contract… that depended on the value of a company's stock in 1 month's time. If the stock's value went up during the month, they might have made thousands of dollars, but if it went down, they might have lost the whole investment. As futures contracts are legally binding, they couldn't back out of this investment during the month but had to wait until the end of the month to find out its value…
>
> In the last phase of the experiment, participants were given an opportunity to choose between a variety of gambles. Five questions were asked, aiming to reveal the maximum amount people would risk…

Participants were then told their task would be to predict how the imaginary participants were feeling during the first

phase (affective forecasts) and how they behaved in the second phase (risk preferences).

Then, they were presented with four participants (Lynda, Anne, Rachel, and Sam; counterbalanced with condition), whose cognitive states were manipulated within-subjects (high/low expectations and high/low attention). For example, when both expectations and attention were high:

> Lynda reported the following in answer to our questions:
>
> i. On a scale from 0 to 10, how optimistic are you that the investment will yield a large profit? (0 = *Very pessimistic, 10 = Very optimistic*)
>
> Lynda's response: **9 – I am very optimistic.**
>
> ii. On a scale from 0 to 10, how often do you think about the outcome of the investment? (0 = *Almost never, 10 = Almost always*)
>
> Lynda's response: **8 – I can't stop thinking about the investment.**

When expectations were low, the first response instead read: "**2 – I am very pessimistic**," and when attention was low, the second response instead read, "**2 – I almost never think about the investment.**"

For each condition, participants forecast affective states:

> **How do you think Lynda answered the following questions we asked her?**
>
> **Positive affect.** i. On a scale from 0 to 10, how excited are you about the investment?
>
> **Negative affect.** ii. On a scale from 0 to 10, how anxious are you about the investment?

Participants then forecast **risk preferences**:

> In the second phase of the experiment, Lynda had the opportunity to make a series of bets where she could either play it safe and accept smaller amounts, or risk it all for the possibility of larger amounts. **To what extent do you think that Lynda played it safe or took risks?** *(rated from 0 to 10)*

Results

We find, for the sample as a whole, that both expectations and attention have positive effects on forecasts of affect and risk preferences. However, there were dramatic individual differences in intuitive theories of how attention and expectations combined to yield affect. Examining each subgroup separately revealed different sets of beliefs about how cognitive states influence risk preferences.

Forecast affect. For individuals with high (vs low) expectations, participants forecasted more positive affect, $t(144) = 20.62$, $p < .001$, and less negative affect, $t(144) = -7.76$, $p < .001$. For individuals with high (vs low) attention, participants forecasted both more positive affect, $t(144) = 11.57$, $p < .001$, and more negative affect, $t(144) = 14.57$, $p < .001$. The interactions between expectation and attention on affect were significant for both positive $t(144) = 4.13$, $p < .001$ and negative affect $t(144) = -3.91$, $p < .001$.

Forecast risk preferences. As shown in Figure 2, at the group level, participants forecasted more risk-seeking for individuals who had high (vs low) expectations, $t(144) = 10.62$, $p < .001$. Participants also forecasted more risk-seeking for individuals who were high (vs low) in attention, $t(144) = 3.80$, $p < .001$. Contrary to our hypotheses and unlike Study 1, the interaction was not significant, $t(144) = 1.18$, $p = .23$. That is, the effect of attention on forecast risk preferences was similar regardless of expectations.

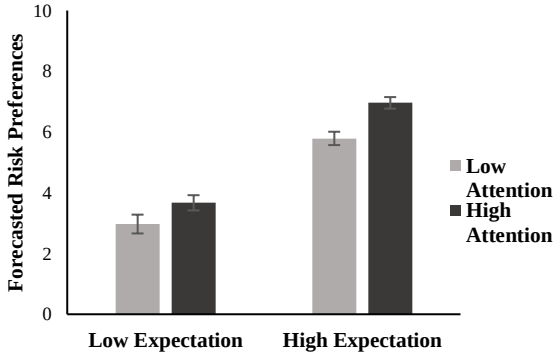

Figure 2: All participants' risk preferences across experimental conditions for expectation and attention in Study 2a. Error bars show standard errors.

Individual differences in intuitive theories of attention and affect. We anticipated that the group-level results might mask substantial heterogeneity across participants. (Even within our authorship team [$N = 3$], two of us had opined that attention would be a boon to affect for optimists but a bane for pessimists, as we suggested in the introduction while one had insisted that attention was an unwavering road to misery).

To probe different intuitive theories about the relationship between attention and affect, we first created a net affect variable (positive affect – negative affect) for each condition. Then, for each participant, we separately calculated the forecast impact of attention on affect for optimists (net affect in the high-expectations/high-attention condition – high-expectations/low-attention condition) and for pessimists (net affect in the low-expectations/high-attention condition – low-expectations/low-attention condition). Each participant is plotted on these two axes in Figure 3.

Participants were not distributed randomly across the four quadrants, $X^2(3, N = 145) = 48.18$, $p < .001$, with the vast majority in two groups. The largest group (group 4, 45%) forecasted that increased attention would lead to more negative affect, regardless of whether they were optimists or pessimists. The second largest group (group 2, 32%) forecast in line with our initial hypothesis, that attention would cause more positive affect for optimists but more negative affect for pessimists. The two remaining groups together composed only 23% of the sample. When we analyze forecasts about risk preferences across these four groups, we find greater consistency with our hypotheses. We focus here on the two large groups.

For Group 2 (who believed that attention leads to positive affect for optimists but negative affect for pessimists), the results resembled those of Study 1. Participants in this group showed both the main effects of expectations, $t(46) = 6.93$, $p < .001$, and attention, $t(46) = 2.35$, $p = .022$, as in the overall analysis above. However, for this sub-group, the interaction was significant, $t(46) = 3.29$, $p = .002$. Among optimists, high attention was associated with more risk-seeking, $t(46) = 4.03$, $p < .001$, but not among pessimists, $t(46) = 0.15$, $p = .87$ (Figure 4).

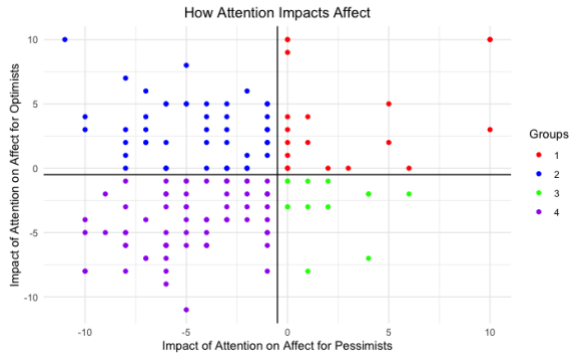

Figure 3: The four quadrants the participants were located, showing different intuitive theories of cognition (expectation and attention) on affect from Study 2a.

Group 4 (who believed that attention leads to negative affect regardless of optimism or pessimism) showed the main effect of expectation, $t(64) = 7.62$, $p < .001$, but a marginal effect of attention, $t(64) = 1.99$, $p = .050$. For this group, the interaction between expectation and attention was not significant, $t(64) = 0.43$, $p = .66$ (Figure 4).

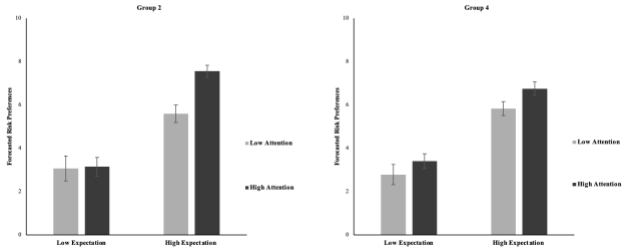

Figure 4: Those in Group 2 and Group 4's risk preferences across experimental conditions for expectation and attention in Study 2a. Error bars show standard errors.

Study 2b

Method

We recruited 243 U.S. participants (146 male, 91 female, 6 other, $M_{age} = 39$) from MTurk; 14 were excluded because they failed a comprehension check after the instructions.

The procedure was nearly identical to Study 2a, except information-seeking rather than attention was manipulated:

> ii. On a scale from 0 to 10, how often do you think about the outcome of the investment? (0 = *Almost never*, *10 = Almost always*)

Responses were either "**8 – I constantly check the mobile app to track the investment**" (high information-seeking) or "**2 – I almost never check the mobile app to track the investment**" (low information-seeking).

Results

Similar to Study 2a, both expectations and information-seeking had main effects on forecasts of affect and risk preferences at the group level, but these masked large heterogeneity in intuitive theories of how expectation and information-seeking combined to yield affect.

Forecast affect. For individuals with high (vs low) expectations, participants forecasted more positive affect, $t(228) = 29.95$, $p < .001$, and less negative affect, $t(228) = -11.19$, $p < .001$. For individuals high (vs low) in information-seeking, participants forecasted both more positive, $t(228) = 11.20$, $p < .001$, and more negative affect, $t(228) = 19.77$, $p < .001$. The interaction between expectation and information-seeking on affect was significant for positive affect $t(228) = 2.48$, $p = .013$, but not for negative affect $t(228) = -1.74$, $p = .08$.

Forecasted risk preferences. As shown in Figure 5, at the group level, participants forecasted more risk-seeking for individuals with high (vs low) expectations, $t(228) = 15.58$, $p < .001$, and for individuals high (vs low) in information-seeking, $t(228) = 2.40$, $p = .017$. The interaction was not significant, $t(228) = 1.55$, $p = .12$.

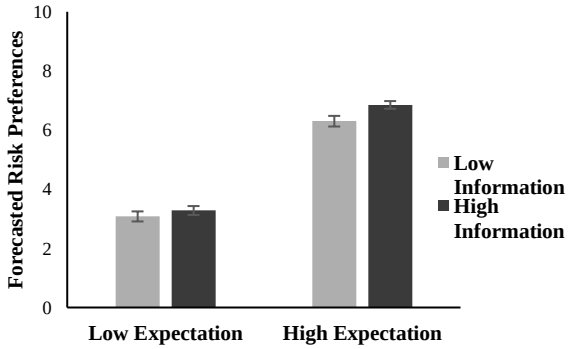

Figure 5: All participants' risk preferences across experimental conditions for expectation and information-seeking in Study 2b. Error bars show standard errors.

Individual differences in intuitive theories of information-seeking and affect. As in Study 2a, we constructed axes reflecting the extent to which participants believed that information-seeking led to more positive net affect for optimists and for pessimists. Figure 6 shows that participants were not distributed randomly among the quadrants, $X^2(3, N = 243) = 78.51$, $p < .001$. The two largest groups were like those in Study 2a; the largest predicted negative effects of information-seeking among both optimists and pessimists (Group 4, 50%) and the second-largest predicted that information-seeking was positive for optimists but negative for pessimists (Group 2, 21%). As in Study 2a, when we analyze subgroups separately, we find greater consistency with our hypotheses.

Participants in Group 2 (i.e., information-seeking is positive for optimists but negative for pessimists) showed the main effect of expectations on risk preferences, $t(47) = 7.21$, $p < .001$, but not of information-seeking, $t(47) = 0.63$, $p = .52$. Crucially, the interaction was significant, $t(47) = 3.02$, $p = .004$. Among optimists, information-seeking was associated with more risk, $t(47) = 2.77$, $p = .007$, but not among pessimists, $t(47) = -1.63$, $p = .10$ (Figure 7).

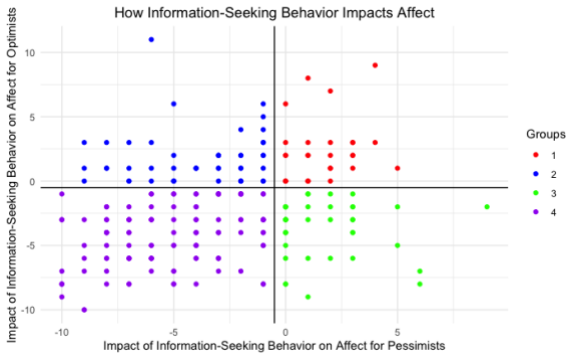

Figure 6: The four quadrants the participants were located, showing different intuitive theories of cognition (expectation and information-seeking) on affect from Study 2b.

Group 4 (information-seeking always negative) showed the main effect of expectations, $t(113) = 13.94$, $p < .001$, but not information-seeking, $t(113) = 1.07$, $p = .28$. Their interaction between expectations and information-seeking was not significant, $t(113) = 1.02$, $p = .30$ (Figure 7).

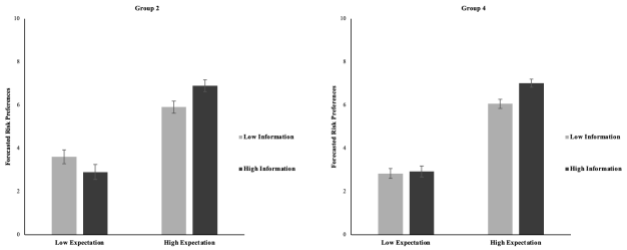

Figure 7: Those in Group 2 and Group 4's risk preferences across experimental conditions for expectation and information-seeking in Study 2b. Error bars show standard errors.

Discussion

Studies 2a and 2b replicated the findings from Study 1 that higher expectations are linked to more positive and less negative affect, while attention and information-seeking are linked to both more positive and more negative affect.

Findings were more mixed for risk preferences, but subgroup analyses revealed that this was due to different intuitive theories of cognition. In both studies, one group believed that attention (Study 2a) or information-seeking (Study 2b) led to more positive affect for optimists and more negative affect for pessimists, and these participants showed the predicted interaction effect, such that attention and information-seeking were linked to greater risk-seeking among optimists but not pessimists. Other groups did not show this effect.

General Discussion

Why are some people more willing to take risks than others? In part, risk-takers appear to be better able to cope emotionally with the waiting period between a decision and its outcome (e.g., Dawson & Johnson, 2021).

Our studies revealed three main findings. First, people who expect to be optimistic during a waiting period forecast more positive (and less negative) affect while waiting and were therefore more attracted to risks generally. Second, people who expect to pay more attention and seek more information forecast more positive *and* more negative affect, which had mixed and somewhat inconsistent effects on risk preferences. Third, there was substantial heterogeneity in individuals' intuitive theories of cognition. Some people believed that attention and information-seeking were affectively positive for optimists but negative for pessimists, and these people also tended to think that attention and information-seeking would lead to greater risk-seeking for optimists but not pessimists. Many others believed that attention and information-seeking are generally affectively negative, and these participants did not show this interaction effect.

These studies do have limitations. Study 1 was correlational, so alternative causal orders cannot be ruled out, while Study 2 focused on intuitive theories of *others'* cognition, which could differ from their beliefs about how their own minds work (Pronin et al., 2002). However, given that one study's weakness was the other study's strength, we think a reasonable degree of confidence is appropriate for results that were consistent across studies.

We aim to build on this research in several ways. First, our theory makes predictions about time preferences that can also be tested (and which we began to test using the intertemporal choice measures in Study 1, which were not reported in this brief write-up). Second, since we found individual differences in Study 2, it would be useful to understand what traits—such as mindfulness or emotion regulation strategies (Feldman et al., 2007; Gross, 2014) —are linked to these intuitions. Third, future work might examine what *causal* theories people have about the relationships among cognitive states. For example, a person who believes that people are attentive *because* they are optimistic or pessimistic might make different inferences about risk preferences compared to one who believes these processes are independent.

Overall, we hope this work can begin to bridge the gap between behavioral economics and cognitive science by understanding how and why our metacognitive intuitions shape our preferences.

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