Arousal and Risk Taking: The Moderating Role of Reappraisal

ABSTRACT

Researchers have provided important insight into the cognitive and emotional aspects of risk taking. In the present study we investigated how incidental physiological arousal — an affective component that has received relatively little attention — influences risk taking and cognitive processing. Moreover, to gain further insight into the relation between arousal and risky decision making, we examined the moderating role of the reappraisal strategy of emotion regulation. We found that incidental physiological arousal and intuitive processing predicted a higher likelihood of risk taking, whereas analytical processing predicted a lower likelihood of risk taking. Furthermore, we found that the relationship between physiological arousal and risk taking was stronger among individuals low on habitual cognitive reappraisal. Overall, the present study contributes to dual process theories of decision making and a growing line of research on emotion regulation and risk taking. Implications and directions for future research are discussed.

Keywords:

decision making; affect; emotion regulation; information processing

INTRODUCTION

The current pandemic has forced leaders and organizations into difficult decisions involving risk and emotions. In many cases, such decisions are accompanied by intense affect. Intense affective states can, however, be problematic, as they tend to shut down the kind of systematic reasoning that is needed to resolve trade-offs that involve some kind of risk. In light of the current pandemic and the number of high-stake decisions that leaders must grapple with, we find it important to understand how intense affect and information processing influence risk taking.

Prospect theory and related research on risk taking has extended our understanding of emotions in judgment and decision making. While Kahneman and Tversky identified the different effects of the transient emotions of loss and gain on risk taking, the theoretical explanation of how emotions influence loss aversion and risk taking did not get much further than the famous dictum "losses loom larger than gains" (Kahneman & Tversky, 1979: 279). A large body of research has demonstrated that people often rely on their emotions when making decisions under conditions of risk and uncertainty (Loewenstein et al., 2001; Schwarz & Clore, 1988; Slovic et al., 2005; Västfjäll et al., 2016).

A series of efforts in exploring the emotional backdrop of loss aversion suggest that people form an attachment with the physical good. Researchers hold that the loss aversion comes from the pain of giving up the physical good, which is larger than the pleasure of receiving an alternative good of the same value (Kahneman et al., 1990; Novemsky & Kahneman, 2005; Ariely et al., 2005). This is a discussion about emotional valence; a scale of emotion ranging from psychological pain to pleasure or from negative to positive emotions.

The majority of contemporary theories regarding the relation between active emotions and risk taking either derive from, or are reactions to, one of two seminal approaches to the problem, namely Isen and colleagues' mood maintenance hypothesis, and Johnson and Tversky's (1983) affective generalization hypothesis. The mood maintenance hypothesis holds that individuals in a positive mood will avoid risk in order to maintain their positive mood, while individuals in a negative mood will seek risk in order to break out of their negative mood (Isen & Patric, 1983; Arkes et al., 1988; Isen & Geva, 1987; Isen et al., 1988; Mano, 1992; Nygren et al., 1996). Although this theory is simple and attractive, and has even found some empirical support, recent research suggests that negative and positive emotions do not have a uniform effect on risk taking.

Challenging this model, Lerner and Keltner (2001) found that emotions with the same degree of pleasantness (i.e., valence) can have opposite effects on judgments and decisions involving risk. Indeed, affect is a complex construct that is shaped by several components. Russel's core affect perspective (2003) posits that affective states can be mapped onto two independent dimensions: valence and arousal. Yet, relatively few studies have investigated the role of arousal in risky decision making. In the present paper, we explore how physiological arousal predicts risk taking in the classic Disease Problem (Kahneman & Tversky, 1979). While the valence component of affect has received much attention (Heilman, Miu, & Houser, 2016; Lerner, Valdesolo, & Kassam, 2015), less research has studied the effect of the arousal component. Finally, this study adds to a growing line of research on emotion regulation and decision making involving risk (e.g., Heilman et al., 2010; Miu & Crisan, 2011; Panno et al., 2013; Sokol-Hessner et al., 2009, 2013) by examining how reappraisal moderates the influence of incidental physiological arousal. Insight into the ways in which emotion regulation shapes risk taking can offer important practical implications for organizations.

THEORY AND HYPOTHESES

Our review of the literature is largely restricted to studies that have examined decisions under risk (outcomes with known probabilities) and not ambiguity (outcomes with unknown probabilities). This choice was based on research that has shown that decisions under risk often diverge from decisions under ambiguity (for an in-depth explanation of the description-experience gap, see Rakow & Newell, 2010).

Arousal and Risk

Tversky and Kahneman's (Tversky & Kahneman, 1981) prospect theory describes how decision makers evaluate similar alternatives differently when framed by the transient emotions of loss and gain (Kahneman & Tversky, 1979). When individuals are asked to choose between a risky and a certain option that have equal expected values, most people tend to choose the risky option in the loss frame and the safe option in the gain frame. Later research demonstrated that emotions also play a significant role in influencing these subjective evaluations (Loewenstein et al., 2001; Loewenstein & O'Donoghue, 2004; Naqvi et al., 2006; Slovic et al., 2007). The affect heuristic theory posits that individuals evaluate objective features of objects or events based on the associated valence (i.e., subjective feelings of "goodness" and "badness"). Situations involving limited time or uncertainty can make it difficult to engage in careful analysis. In such conditions, people save time and effort by relying on affective information (Kralik et al., 2012; Slovic et al., 2007).

The affect heuristic, and similar models like the risk-as-feelings model (Loewenstein et al., 2001), focus on the role of affect experienced at the moment of decision making - in other words, integral affect. Emotions can also carry over from unrelated situations into the decision making-process - known as incidental affect (for a review of integral and incidental affect in judgment and decision making see Västfjäll et al., 2016)). In an early study by Johnson and Tversky (1983), incidental negative affect induced by reading a newspaper article increased subsequent risk estimates. Likewise, Keller et al. (2006) found that presenting participants with frightening images increased subsequent risk estimates. Västfjäll et al. (2014) demonstrated that incidental negative affect amplified reliance on the affect heuristic leading to higher risk perceptions. While these studies have provided important insight into the role of incidental affect in decision making processes, they share a common feature; namely, the adoption of a valence-based approach. Valence is one of several components that make up affect and emotions. Other components include appraisals (Lerner & Keltner, 2000) and arousal (Russell, 2003). According to Russell's core affect construct (Posner et al., 2005; Russell, 2003), affective states can be mapped onto two independent dimensions; valence and arousal. While valence refers to the individual's general assessment of his or her current emotional state (positive vs. negative), arousal refers to the psychological experience of energy, activity, and alertness (Russell & Barrett, 1999). The dimension of arousal ranges from low activation (calm) to high activation (stress or excitement). Arousal is associated with physiological responses triggered by activity in the autonomic nervous system, which in turn alters the individual's bodily experience (Russell, 2003). Overall, laboratory findings suggest that arousal, regardless of the associated valence, is associated with a higher propensity to engage in risky behavior (Ariely & Loewenstein, 2006; Fedorikhin & Patrick, 2010; Knutson et al., 2008; Mano, 1992; Porcelli & Delgado, 2009, 2017;

Starcke et al., 2008). However, this line of research has mainly investigated integral arousal (e.g., the somatic marker hypothesis; Damasio et al., 1996). According to the excitation-transfer theory (Zillmann et al., 1972), the arousal resulting from a specific situation is longer lasting than the emotion itself, and is therefore capable of intensifying the emotional experience in a situation that occurs immediately after. For instance, in a recent study, participants who were exposed to arousing images demonstrated higher levels of subsequent risk taking in the gain frame (Jahedi et al., 2017).

Support for the relationship between incidental arousal and risk taking can also be drawn from literature on stress. Although not synonymous, arousal and stress are closely related (Boucsein, 2012). Buckert et al. (2014) used a decision-making task under risk where participants choose between a safe choice and a risky gamble with known probabilities. Their study found that incidental stress, induced using a social stress task, increased risk taking in the gain frame but not in the loss frame. This is consistent with our understanding that arousal reduces cognitive capacity due to its interference with the PFC. We elaborate on this point in the section that follows. Taken together, we expect a positive relationship between arousal and risk taking. Since physiological reactions, neural activations, and self-report indices are similar for positive and negative arousal (Codispoti et al., 2008; Reich & Zautra, 2002; Stark et al., 2005), we expect that risk taking will be similarly impacted by positive and negative arousal. Further, we expect arousal to predict risk taking more strongly than valence. Taken together, we arrive at the following hypothesis:

Hypothesis 1. Incidental physiological arousal is positively related to risk taking.

Cognitive Processing and Risk Taking

Research suggests that decisions result from two different modes of information processing (Kahneman, 2011; Stanovich & West, 2000). The first (Type 1) is an intuitive type of thinking, while the second mode (Type 2) is an effortful and analytical kind of reasoning. Type 2 closely matches economists' early definition of rationality - it is a controlled way of thinking characterized by systematic comparison of different alternatives. Type 1, in contrast, is quick, automatic, and effortless. Existing literature suggests that arousal generally reduces analytical processing and increases intuitive processing (Fedorikhin & Patrick, 2010). Indeed, intuition, by its nature, is strongly linked to affect. In fact, these two terms are often used interchangeably. According to Dane and Pratt (2007), intuitions are ‘‘affectively-charged judgments that arise through rapid, nonconscious, and holistic associations” (p. 40). Much of existing research suggests that arousal restricts the individual’s information processing capacity (Hanoch & Vitouch, 2004), increases cognitive depletion (Ariely & Loewenstein, 2006; Fedorikhin & Patrick, 2010), and reduces attention to information (Fernandes et al., 2011). For instance, participants typically look at arousing images for longer durations than non-arousing images, regardless of the valence (Lang et al., 1993). In a study by Schimmack and Derryberry (2005), participants were instructed to ignore arousing images (both negative and positive valence) while carrying out cognitive and attentional tasks. Higher levels of arousal, regardless of valence, impaired performance on both tasks. Research on arousal and memory lend support to these findings. Corson and Verrier (2007) found that arousal, but not valence, generated more false memories. Similarly, Porter et al. (2003) found that high levels of incidental negative arousal increased susceptibility to misinformation. Finally, stress, which encompasses arousal, impairs cognitive functioning of the prefrontal cortex and activates brain regions responsible for emotional processing, such as the amygdala (Arnsten, 2009). In stressful conditions, attention “switches from thoughtful ‘top-down’ control by the PFC that is based on what is most relevant to the task at hand, to ‘bottom-up’ control by the sensory cortices” (Arnsten, 2009, p. 4). In other words, these changes in the brain’s responses correspond to the aforementioned Type 1 (fast and intuitive) and Type 2 (effortful and analytical) model of cognitive processing. Based on these findings, we expect intuitive processing to increase risk taking and analytical thinking to decrease risk taking. This leads us to the following set of hypotheses:

Hypothesis 2. Intuitive processing is positively related to risk taking.

Hypothesis 3. Analytical processing is negatively related to risk taking.

Reappraisal and Risk Taking

While emotions have a strong influence on decision making, people often use various strategies to downregulate unwanted feelings. Proposed by Gross and John (2003), the two-factor model distinguishes between antecedent-focused and response-focused strategies. An example of an antecedent-focused strategy is cognitive reappraisal (henceforth referred to as “reappraisal”), which involves reinterpreting an emotion-eliciting situation or distancing oneself from the situation before the emotional response unfolds. Expressive suppression is a response-focused strategy which involves the suppression of emotional responses that have already developed. These two strategies of emotion regulation, namely, reappraisal and expressive suppression, have received a great deal of attention in judgment and decision-making research (Heilman et al., 2016; Lerner et al., 2015). Because reappraisal occurs at an early stage on the emotional response timeline, it creates an early activation in the prefrontal cortex and consequently reduces the activation of amygdala and insula (Drabant et al., 2009), both of which serve broad functions in emotional processing (Paulus & Stein, 2006; Zald, 2003). On the other hand, emotion suppression has been linked with late activation of the prefrontal cortex and thus increased activation of the amygdala and insula (Dunn et al., 2009; Goldin et al., 2008). Thus, reappraisal may free up the cognitive capacity needed to engage in analytical processing. Indeed, emotionally intense situations place similar demands on the capacity to engage in analytical processing and reappraisal. Such situations reduce individuals' capacity to reappraise successfully due to greater recruitment of cognitive resources (Ford & Troy, 2019; Milyavsky et al., 2019).

As a result of the distinct effects of the two emotion regulation strategies on reducing the experience of negative emotions, these strategies should also influence decision making in different ways. Indeed, a growing body of literature suggests that reappraisal and suppression are differentially related to risk taking. Using an experience-based task, Panno et al. (2013) found that habitual reappraisal use was related to increased risk taking whereas habitual expressive suppression was related to decreased risk taking. Other studies have manipulated reappraisal and suppression in laboratory settings by instructing participants to engage in one of the strategies while, for instance, viewing aversive images or videos (e.g., Heilman et al., 2010). Using a description-based task, Cheung and Mikels (2011) examined the influence of integral emotion regulation on risky decision making by presenting participants with scenarios framed as losses and gains. As predicted, the authors found that reappraisal during the decision making task reduced risk taking for both gain and loss frames. Similarly, Miu and Crisan (2011) compared integral reappraisal and expressive suppression in framing effects. Reappraisal, but not suppression, reduced susceptibility to framing effects and increased positive affect after the decision task. According to the authors, reappraisal may have reduced susceptibility to framing effects by using less cognitive resources (Miu & Crişan, 2011). Applying an effortful strategy such as expressive suppression is cognitively costly and may have interfered with analytical reasoning that is needed to overcome framing effects. In other words, expressive suppression may enhance the intuitive type of reasoning that underlies susceptibility to framing effects (Kahneman, 2003).

Studies have also examined the impact of incidental emotion regulation and risk taking. Heilamn et al. (2010) manipulated fear and disgust using videos, and instructed participants to either reappraise the emotional stimuli, suppress their emotions, or to simply watch without applying any strategy. Participants in the reappraisal condition exhibited significantly lower risk taking. Yet, much less is known about the role of arousal, with the exception of a study by Sokol-Hessner et al. (2009) who found that integral reappraisal reduced loss aversion by decreasing physiological arousal. But how exactly reappraisal moderates the relationship between incidental arousal and risk taking has yet to be studied. Thus, we arrive at the following hypothesis:

> *Hypothesis 4. The positive relationship between physiological arousal and risk taking is moderated by reappraisal, such that the relationship is stronger for individuals low on habitual reappraisal.*

EXPERIMENT 1

In our first experiment, we set out to compare the predictive strength of physiological arousal and valence. We hypothesized that arousal would show a stronger influence on risk taking than valence. Further, we wanted to test the effectiveness of our emotion manipulation before proceeding with our next experiment.

Participants and Design

Seventy-eight participants (52.6% male) were recruited from BI Norwegian Business School. Participants were randomly assigned to one of two conditions, in which they were presented with images that varied in terms of arousal and valence. Participants in the high arousal and negative valence condition saw a picture of a snake attacking. Participants in the control condition (low arousal and medium valence condition) saw a picture of green leaves. Once participants had taken their seats, they were connected to Biogauge Sudologgers (Tronstad et al., 2008) which measure electrodermal activity (EDA) by applying a very small electric current (30 mV) to the skin beneath three electrodes connected to palm and forearm of participants' non-dominant hand. The Biogauge Sudologger recorded electrodermal responses (EDRs) at a sampling frequency of 1.1111 Hz (i.e., every 0.9 second). Participants were presented with one out of two images that were obtained from the International Affective Picture System (IAPS) (Lang et al., 2008). These pictures are validated in terms of valence and arousal and provide a simple and fast way of inducing emotion in laboratory settings. See Table 3 for an overview of the pictures and their associated arousal and valence.

Dependent Variable

We used the Asian Disease Problem to measure risk taking (Tversky & Kahneman, 1981). In this decision task, participants are presented with a brief scenario and are asked to make a choice between two alternative programs to combat the disease. Participants read that Program A will save 200 people and that Program B has a one-third probability of saving everyone but a two-thirds probability of saving nobody. The original scenario has two frames: a gain frame and a loss frame. The gain frame is formulated in terms of lives saved, while the loss frame is formulated in terms of lives lost. Previous research has shown that an overwhelming majority of people choose the risky option in the loss frame. Because the loss frame has little variability, we chose to use the gain frame only.

Independent Variables

Physiological arousal. As a measure of physiological arousal, we recorded participants' skin conductance response (SCR), which is a particular type of EDA that refers to the skin's ability to conduct electricity when an external direct current of constant voltage is applied to the skin (Figner & Murphy, 2011). Skin conductance is typically divided into tonic and phasic phenomena. The primary difference between these two relate to their time scale and their relationship to the evoking stimulus. For the analysis of skin conductance activity, we used Ledalab 3.4.9 (www.ledalab.de), a software written in MATLAB. Continuous Decomposition Analysis (CDA) was performed to decompose the data into phasic and tonic components (Benedek & Kaernbach, 2010). The advantage of using CDA lies in its ability to control for baseline dependency, or participants' skin conductance level at the very beginning of the experiment. Without this type of control, SCR increases only to a certain level when starting at a high level. For our final analysis, we used the ISCR, which involves the integration of the SCRs over a specified response window (Benedek & Kaernbach, 2010). In line with recommendations in psychophysiological research, we selected the first five seconds of the response (Benedek & Kaernbach, 2010). This provides us with greater certainty that changes in phasic activity are caused by the stimuli.

Subjective arousal and valence. Perceived valence and arousal were measured using the self-assessment manikin (SAM), a non-verbal pictorial self-assessment technique commonly used to assess individuals' emotional reactions to various stimuli, including pictures (Bradley & Lang, 1994). Participants were asked to choose the number of the figure that best represented the level of valence and arousal that they experienced during the picture presentation. The values ranged from 1 (unhappy) to 9 (happy) for valence, and 1 (calm) to 9 (excited) for arousal.

RESULTS

Manipulation Checks

A series of between subject t-tests were conducted to compare the effect of the high arousal (vs. low arousal) condition on self-reported valence, self-reported arousal, and physiological arousal. There was a significant difference in mean self-reported valence, $t(76) = 6.46$, $p < .001$, $d = 1.45$ and in mean self-reported arousal, $t(76) = -2.33$, $p = .022$, $d = .52$. However, results revealed no significant difference in physiological arousal among participants in the two groups $t(77) = -.146$, $p =.884$, $d = .03$. See Table 1 for an overview of experiment conditions and observed means.

Insert Table 1 about here

Incidental Physiological Arousal and Risk Taking

A three-stage hierarchical binary logistic regression was conducted with risk taking as the dependent variable. In step 1, we added gender, response time during the decision task, and condition (0 = positive valence low arousal, 1 = negative valence high arousal). This part of the model was not significant [$X^2(3, N = 77) = 3.93$, $p = .27$]. In step 2, we added subjective valence and subjective arousal, which resulted in a significant model [$X^2(5, N = 77) = 12.00$, $p = .03$]. Finally, in step 3 we added physiological arousal, which improved the fit of the model [$X^2(6, N = 77) = 15.30$, $p = .02$]. The final model explained between 18% (Cox and Snell R square) and 25% (Nagelkerke R squared) of the variance in risk seeking.

Insert Table 2 about here

EXPERIMENT 2

Overall, the results in our first experiment supported our first hypothesis regarding the positive relationship between physiological arousal and risk taking. In our second experiment we examined cognitive processing and the moderating role of habitual reappraisal. We predicted a positive relationship between intuitive processing and risk taking, and a negative relationship between analytical processing and risk taking. Moreover, we predicted that the positive relationship between physiological arousal and risk taking is moderated by reappraisal, such that the relationship is stronger at low levels of reappraisal. Finally, we extended the design of our second experiment to include more variation in affect to cover the extremes of positive and negative valence, as well as low, medium, and high arousal.

Participants and Design

157 participants (52 males) were recruited for our second experiment. The majority of participants (84%) were students at academic institutions in Norway, and more than half (55%) of these participants were bachelor students. The average age of the participants was 24.9 years. Three participants were dropped in further analyses due to missing data on central variables. Participants were randomly assigned across five conditions that differed only with respect to the target affective state. The images were selected based on the core affect construct (Russell, 2003), covering the four main combinations of valence and arousal. Specifically, we used five pictures

to manipulate arousal and valence. The images were obtained from the International Affective Picture System (IAPS) (Lang et al., 2008). Participants took their seats and were connected to the Biogauge Sudologgers (Tronstad et al., 2008). Electrodermal responses (EDRs) were recorded at a sampling frequency of 1.1111 Hz (i.e., every 0.9 second). Each participant saw one of the five pictures. See Table 3 for an overview of the pictures and their associated arousal and valence. Participants first saw a black screen and were instructed to relax for one minute before they were presented with the picture. Immediately after the relaxation phase, a picture appeared on the screen for 15 seconds. Next, participants were presented with the decision-making task. Finally, participants completed the questionnaires measuring cognitive processing, habitual emotion regulation, subjective arousal and valence, gender, and age.

Dependent Variable

Similar to the first experiment, we employed the Asian Disease Problem as our measure of risk taking. Again, all participants were only presented with the gain frame.

Independent Variables

Habitual emotion regulation. We measured participants' habitual use of reappraisal and expressive suppression using the 10-item emotion regulation questionnaire (ERQ) developed by Gross and John (2003). Example items include "when I want to feel less negative emotion, I change the way I'm thinking about the situation" and "when I am feeling negative emotions, I make sure not to express them". Participants rated the extent to which they agreed with self-descriptive statements on a 7-point Likert scale, from 1 (strongly disagree) to 7 (strongly agree). A confirmatory factor analysis (CFA) showed that the 10 items loaded on three factors. After closer inspection of the communalities and pattern matrix, we removed one item (item 5), which resulted in a 2-factor solution. The expressive suppression and reappraisal scales had Cronbach alphas above .70.

Cognitive Processing. Analytical and intuitive cognitive processing were measured using the cognitive processing questionnaire (CPQ) (Bakken et al., 2016). The CPQ is a 22-item scale that captures two analytical dimensions: rational (5 items) and control (6 items); and three intuitive dimensions: urgency (4 items), affective (3 items), and knowing (4 items). Example items include “I evaluated systematically all key uncertainties” and “I made the decision because it felt right to me”. All items were rated on a scale from 1 (strongly disagree) to 5 (strongly agree).

Subjective arousal and valence. Subjective arousal and valence were measured using the self-assessment manikin (SAM), a non-verbal pictorial self-assessment technique commonly used to assess individuals’ emotional reactions to various stimuli, including pictures (Bradley & Lang, 1994). Participants were asked to choose the number of the figure that best represented the level of valence and arousal that they experienced during the picture presentation. The values ranged from 1 (unhappy) to 9 (happy) for valence, and 1 (calm) to 9 (excited) for arousal.

Physiological arousal. As in our first experiment, we used Continuous Decomposition Analysis (CDA) to decompose the data into phasic and tonic components (Benedek & Kaernbach, 2010). For our final analysis, we used the SCR amplitude, which is the difference between the baseline and the highest SCR level obtained during the first five seconds after the onset of the emotion-inducing images (Benedek & Kaernbach, 2010). A constant of one was added to the variable to obtain non-negative numbers.

RESULTS

Manipulation Checks

For self-reported arousal, a one-way ANOVA was conducted to investigate the effect of condition (positive high arousal, positive medium arousal, positive low arousal, negative medium arousal, negative high arousal). There was a significant difference in mean self-reported valence between the conditions, $F(4,149)=58.69$, $p < 0.001$, $\eta_{\rho}^2 = .61$. Planned contrast analysis showed that subjects in the two negative valence conditions reported significantly more negative valence than subjects in the two positive valence conditions [$t(149) = 13.14$, $p < .001$] and the control condition (positive low arousal) [$t(149) = -11.88$, $p < .001$]. There was a significant difference in self-reported arousal between conditions $F(4,149)=3.32$, $p < 0.05$, $\eta_{\rho}^2 = .08$. Subjects in the two high arousal conditions showed significantly higher self-reported arousal than subjects in the two medium arousal conditions [$t(149) = 2.27$, $p = .02$] and the control (positive low arousal) condition [$t(149) = 3.50$, $p = .001$]. For physiological arousal, the results revealed no significant main effect of condition, *F*(4, 149) = .186, *p* = .945, η_p^2 = .005. Nevertheless, there was a significant difference in physiological arousal between the medium arousal conditions and the control condition [*t*(149) = 2.02, *p* = .045]. Unexpectedly, physiological arousal was higher in the medium arousal conditions (smiling baby and starving child) compared to the high arousal conditions (skysurfing and injured soldier). While these expected levels of arousal were based on validations of the images in previous research, the medium arousal images seem to have been processed more intensely than the high arousal images. See Table 3 for an overview of means and standard deviations across conditions and Table 5 for an overview of results from the ANOVA tests and direct contrasts.

Insert Table 3 about here

Insert Table 4 about here

We recorded response time as an indication of the validity of the cognitive processing measure. Response time is the amount of time (in milliseconds) participants use to choose an option in the Asian disease problem. Longer response time should correlate negatively with intuitive processing (Bakken, 2013). In our study intuition correlated negatively with longer response time (*r* = -.29; *p* < .001). In a complex problem-solving task, Bakken (2013) found that longer response time correlated positively with more analytical processing. In our Asian Disease judgment task, created for intuitive decision making (Kahneman, 2011), we found only a small insignificant positive correlation between response time and analytical processing (*r* = .06; *p* = .48).

Insert Table 5 about here

Incidental Arousal, Reappraisal, and Risk taking. To test our hypotheses, we ran a three-stage hierarchical binary logistic regression with risk taking as the dependent variable. Gender, decision response time, and conditions were entered as control variables in the first step. This part of the model was not significant [X^2(7, N = 154) = 8.36, p = .21]. In Step 2 we added the variables of interest; valence, subjective arousal, physiological arousal, reappraisal, and the two modes of cognitive processing (intuitive and analytical). This part of the model was also insignificant, X^2(12, N = 154) = 18.22, p = .11. In step 3 we added the interaction between physiological arousal and reappraisal. This model was significant, X^2(15, N = 154) = 28.18, p = .01. The final model explained 23% (Nagelkerke R squared) of the variance in risk taking. As shown in Table 6, intuitive processing was positively related to risk taking whereas analytical processing was negatively related to risk taking, thus supporting Hypothesis 2 and 3. The results from the three regression models are presented in Table 6.

Insert Table 6 about here

The interaction between physiological arousal and reappraisal was significant (B = -0.72, p = .01). We probed the interaction using simple slopes analysis at high and low levels of habitual reappraisal (1 standard deviation above/below the mean). Simple slopes analysis revealed that physiological arousal was significantly and positively related to risk taking at low levels of reappraisal (B = 0.72, p = .02), but negatively related to risk taking at high levels of reappraisal (B = -0.77, p = .03). This supports Hypothesis 4, in which we predicted that the positive relationship between physiological arousal and risk taking would be stronger among people with lower levels of habitual reappraisal (see Figure 1).

Insert Figure 1 about here

As shown in Figure 1, at low levels of physiological arousal, reappraisers are more likely to take risks. On the other hand, at high levels of arousal, reappraisers are less likely to take risks. Finally, intuitive processing was positively associated with risk taking ($B = .82$, $p = .03$), whereas analytical processing was negatively associated with risk taking ($B = -.54$, $p = .09$). These results support the notion that risk taking is driven by intuitive and emotional processing rather than deliberate and reflective thinking.

GENERAL DISCUSSION

The purpose of the present study was to examine the relationship between physiological arousal and risk taking. To better understand this relationship, we also examined the moderating role of habitual reappraisal. The study made several discoveries, with interesting theoretical, methodological, and practical implications.

Theoretical Implications

Our two experiments extended our understanding of affect and risky decision making in several ways. First, they build on previous research that has mainly studied integral arousal (Ariely & Loewenstein, 2006; Fedorikhin & Patrick, 2010; Knutson et al., 2008; Mano, 1992; Porcelli & Delgado, 2009; Starcke et al., 2008) by showing that physiological arousal can also “carry-over” to shape risky decision making in an unrelated subsequent task. As predicted, we found that incidental physiological arousal was positively associated with risk taking. This is consistent with the findings reported by Jahedi et al. (2017), where the authors found a positive impact of incidental arousal (elicited through images) on subsequent risk taking in the gain frame. Yet, the study was limited in a couple of ways. First, the study did not include measures of physiological arousal. Second, their study was restricted to sexual arousal. Our studies address these limitations and extend them with physiological measures of arousal and by including a wider range (low, medium, high arousal) and valence (positive vs. negative) of arousal. Overall, psychophysiological measures appear to be reliable predictors of risk taking and we encourage researchers to incorporate such measures in future studies. However, the study of arousal is not without its complexities. A somewhat unexpected discovery that we would like to draw attention to is the mismatch between physiological and subjective arousal in our experiments. Subjective arousal was associated with reduced risk taking whereas physiological arousal was associated with greater risk taking. This lack of convergence supports the need for a broader conceptualization and operationalization of arousal as proposed by Russell (2003). The extent to which physiological arousal and self-reported arousal match may depend on other factors such as individuals' metacognitive measures. As pointed out by McCall et al. (2015), "individuals differ in the degree to which physiological signals cohere with self-report" (p. 61). Thus, the convergence of these two measures may depend on how in tune individuals are with their bodily senses.

Regarding our predictions about the relationship between cognitive processing and risk taking, the results of this study were consistent with dual process frameworks. More specifically, intuitive processing was positively related to risk taking, whereas analytical processing was negatively related to risk taking. In light of recent calls to uncover the cognitive processes involved in organizational decision making (George & Dane, 2016), we interpret these findings as highly relevant and important for judgment and decision-making scholars. Moreover, our self-reported measure of cognitive processing allowed us to measure several components of cognitive processing, thereby overcoming the limitations of other indicators such as response time. The main contribution of this paper, however, is the observed moderating role of reappraisal. Specifically, we found that physiological arousal predicted increased risk taking among individuals low on reappraisal. Placing this finding in a dual process framework, one can draw parallels between "rational" processing (Type 2) and the reappraisal strategy of emotion regulation. Both of these are associated with cognitive control and reduce the influence of emotions on cognition. Thus, the present study adds to a burgeoning line of research on the relationship between reappraisal and judgment and decision making. This growing line of research indeed suggests a robust relationship between emotion regulation and decision making under risk and uncertainty (Cheung & Mikels, 2011; Heilman et al., 2010; Miu & Crişan, 2011; Panno et al., 2013; Sokol-Hessner et al., 2009, 2013). Yet, this line of research is still in its nascency and we see many opportunities for studies that can help uncover the complexity of the relationship between emotion regulation and decision making. Our study has taken one step in that direction by examining how people's tendency to engage in reappraisal impacts the extent to which physiological responses carry over to shape their risk taking in an unrelated task. In short, those who regularly engage in reappraisal to regulate their emotions appear to be less influenced by incidental affect in their decisions.

Practical Implications

The findings of our study may offer useful implications for decision making in organizations. In general, they shed light on the importance of affective experiences in shaping decisions involving risk. We found that even small increases in physiological arousal unrelated to the task at hand predicted decision makers' risk taking. A key finding from our study that we believe has important practical implications is that individuals' general tendency to regulate their emotions through reappraisal significantly reduced the influence of incidental physiological arousal. This is a highly relevant finding since leaders and employees alike are continuously exposed to emotionally intense situations. Most notably perhaps is the current COVID-19 pandemic. Leaders around the globe have dealt with this crisis in different ways, resulting in different decisions with far reaching outcomes. Whether risk taking in any given situation is the rational course of action is of course not a question we can answer here. Nevertheless, our study does suggest that in such intense situations where risk taking is not desirable, decision makers can be trained to regulate their emotions through reappraisal.

Limitations and future research

Our study is limited in several important ways that we would like to highlight. First, our experiments were conducted in controlled laboratory settings with college students responding to a hypothetical decision scenario. While these experiments provide the type of control needed to isolate and manipulate specific factors like arousal, they nevertheless lack realism and are far from the complex nature of decision making in organizations. As noted by George and Dane (2016), decision making in organizations is a highly complex process shaped by many different contextual factors where the consequences of any decision can be substantial. We therefore hope that future researchers will test our findings in organizational settings.

Second, our manipulation failed to create the conditions that we aimed for. There was no main effect of the manipulation on risk taking in our second experiment. In addition, while the manipulation produced significant differences in valence and subjective arousal, there was no difference in physiological arousal. This is perhaps not very surprising as subjective arousal levels were also rather low. Although meta-analytic evidence suggests that static images from validated databases such as IAPS, yield the strong effect sizes in emotion and risk research (e.g., Wake et al., 2020), other methods, like videos, may be better suited to induce high levels of arousal. Overall, we are unable to draw any causal conclusions from our experiments as the observed associations are only correlational. Nevertheless, we believe that these findings are interesting and have contributed to a better understanding of the relationship between affect and decision-making involving risk.

A third limitation is that we used one measure of physiological arousal, namely, electrodermal activity (EDA). The inclusion of other measures would have provided us with a more detailed and holistic understanding regarding the influence of physiological arousal. Finally, our study measured individual differences in reappraisal. Future studies could attempt to replicate our findings by manipulating reappraisal. This can be done by, for instance, instructing participants to regulate their emotions through reappraisal while viewing high-arousal images before completing a decision-making task. Moreover, reappraisal is a general emotion regulation strategy that subsumes specific tactics. A growing number of studies have started to explore the *distancing* tactic of reappraisal (Powers & Labar, 2019). There is suggestive evidence that distancing is more effective (Denny & Ochsner, 2014) and requires less cognitive effort (Moser et al., 2017) than the general reappraisal strategy and other tactics of reappraisal. This makes distancing a particularly interesting tactic in relation to information processing because it might free up more space for analytical processing. Future studies can broaden our understanding of emotion regulation in risky judgment and decision making by putting these predictions to empirical testing.

CONCLUSION

How do decision makers' physiological responses to emotionally intense situations influence their decisions involving risk? Ever since the pandemic broke out in early 2020, leaders around the globe have had to make difficult decisions involving risk and uncertainty. Closing the workplace and lay-offs are just a couple of examples. Naturally, such situations may be heavily charged with emotions. Our study sought to better understand how physiological arousal influences risk taking and whether this relationship is moderated by habitual reappraisal. Across two experiments, we found that physiological arousal was positively associated with risk taking, but only at low levels of habitual reappraisal. The high reappraisers demonstrated decreased risk taking under conditions of high physiological arousal. We interpret this finding in light of dual process theories, suggesting that reappraisal may be conceived of as a type of analytical ("Type 2") information processing mode. Indeed, we found that both reappraisal and analytical processing were associated with lower risk taking. Intuitive processing, on the other hand, was associated with more risk taking.

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APPENDIX A

TABLE 1

Means (and SDs) of manipulation checks across conditions.

Condition	Perceived valence	Perceived arousal	Physiological arousal	Picture description
Control: Positive valence, low arousal	6.24 (1.22)	2.71 (1.58)	4.45 (1.93)	Green leaves
Experimental: Negative valence, high arousal	4.27 (1.43)	3.61 (1.92)	4.51 (1.77)	Snake

APPENDIX B

TABLE 2

Hierarchical binary logistic regression. N = 78.

	Model 1		**Model 2**		**Model 3**	
	B	SE(B)	B	SE(B)	B	SE(B)
Constant	-0.56	0.75	1.74	1.64	0.72	1.76
Gender	-0.33	0.50	-0.36	0.53	-0.36	0.54
Response time	0.01	0.01	0.01	0.01	0.01	0.01
Condition	-0.92†	0.51	-0.94	0.68	-1.35†	0.74
Valence			-0.16	0.21	-0.16	0.21
Subjective arousal			-0.46*	0.18	-0.50**	0.19
Physiological arousal					0.33†	0.19
Summary statistics						
Nagelkerke R^2	.07		.20		.25	
X^2 (df)	3.93 (3)		12.00* (5)		15.28* (6)	
$\Delta\ \chi^2$ *(df)*			8.07 (5)		3.28 (6)	

Note: Condition = low arousal positive valence (0), high arousal negative valence (1).
Coding D.V.: Risk taking; 0 = risk averse, 1 = risk taking.
† $p < 0.10$, * $p < 0.05$, ** $p < .01$.

APPENDIX C

TABLE 3

Mean (SD) for physiological arousal, subjective arousal, and valence in each condition.

Condition	**Physiological arousal**	**Subjective arousal**	**Valence**
Sky-surfer	0.87 (0.87)	5.03 (2.07)	5.60 (1.77)
Happy baby	1.11 (1.33)	3.90 (1.62)	6.68 (1.51)
Leaves	1.00 (0.65)	3.37 (2.06)	6.57 (1.36)
Starving child	1.04 (1.42)	3.74 (1.73)	2.87 (1.23)
Soldier	0.98 (0.47)	4.06 (1.84)	2.73 (1.23)

APPENDIX D

TABLE 4

Bivariate correlations between continuous variables.

Variable	**1**	**2**	**3**	**4**	**5**	**6**
1. Response time						
2. Subjective arousal	.04					
3. Subjective valence	.08	-.09				
4. Physiological arousal	-.12	.05	-.03			
5. Intuitive processing	-.29**	.23**	.07	.07		
6. Analytical processing	.06	-.18*	-.05	-.12	-.05	
7. Reappraisal	.06	.04	-.15†	.04	-.05	.01

APPENDIX E

TABLE 5

Results from ANOVA and direct contrasts between conditions.

	Perceived valence	**Perceived arousal**	**Physiological arousal**
Overall difference between conditions	$F(4,149)=58.69$, $p <$ 0.01, $\eta_\rho^2 = .61$	$F(4,149)=3.32$, $p <$ 0.05, $\eta_\rho^2 = .08$	$F(4, 149) = .21$, $p =$ .95, $\eta_\rho^2 = .006$
Direct contrasts			
(1) Negative valence vs. positive valence	$t(149) = 13.14$, $p <.01$	$t(149) = 1.70$, $p = .14$	$t(149) = -.191$, $p = .92$
(2) Negative valence vs. control	$t(149) = -11.88$, $p < .001$	$t(149) = -1.29$, $p = .20$	$t(149) = -.048$, $p = .96$
(3) Positive valence vs. control	$t(149) = -1.19$, $p = .24$	$t(149) = 2.46$, $p < .01$	$t(149) = -.034$, $p = .97$
(4) High arousal vs. medium arousal	$t(149) = -2.50$, $p < .01$	$t(149) = 2.27$, $p < .05$	$t(149) = -.81$, $p = .42$
(5) High arousal vs. control	$t(149) = -7.56$, $p < .001$	$t(149) = 2.81$, $p < .01$	$t(149) = -.32$, $p = .75$
(6) Medium arousal vs. control	$t(149) = 6.76$, $p < .001$	$t(149) = 7.04$, $p < .001$	$t(149) = 2.02$, $p < .05$

Note: Negative valence = starving child and injured soldier, Positive valence = smiling baby and sky surfer, High arousal = sky surfer and injured soldier, Medium arousal = smiling baby and starving child, Control = green leaves.

APPENDIX F

TABLE 6

Logistic binary regression model predicting risk taking.

	Model 1	**Model 2**	**Model 3**
Constant	-0.56 (0.40)	-0.70 (0.52)	-0.83 (0.53)
Gender	0.26 (0.37)	0.30 (0.39)	0.42 (0.42)
Response Time	0.39* (0.18)	0.02* (0.01)	0.03** (0.01)
Skysurfer	0.46 (0.52)	0.77 (0.68)	0.85 (0.71)
Baby	-0.52 (0.56)	-0.50 (0.78)	-.51 (0.79)
Leaves	-0.31 (0.54)	-0.21 (0.76)	-0.29 (0.77)
Starving Child	-0.12 (0.53)	-0.09 (0.55)	-0.01 (0.58)
Valence		-0.02 (0.13)	-0.03 (0.11)
Subjective arousal		-0.23* (0.11)	-0.27* (0.11)
Physiological arousal		0.02 (0.12)	-0.03 (0.18)
Reappraisal		0.28 (0.19)	0.19 (0.20)
Intuitive processing		0.52 (0.34)	0.82* (0.37)
Analytical processing		-0.48 (0.31)	-0.54† (0.32)
Phys. arousal*Reappraisal			-0.72* (0.42)
Summary statistics			
Nagelkerke R^2	0.07	0.15	0.23
X^2	8.36	18.22	28.18
$\Delta_x{}^2$		9.86	9.96

Note: All continuous variables are mean-centered. Coding D.V.: Risk taking; 0=risk averse, 1=risk seeking.

† $p < .10$, * $p < .05$, ** $p < .01$.

APPENDIX G

FIGURE 1

Interaction plot: Significant moderation by habitual reappraisal (low = 1 SD below the mean; high = 1 SD above the mean). All predictors and control variables are mean-centered.