Does the influence of stress on financial risk taking depend on the riskiness of the decision?

von Helversen, Bettina ; Rieskamp, Jörg

Does the Influence of Stress on Financial Risk Taking Depend on the Riskiness of the Decision?

Bettina von Helversen (bettina.vonhelversen@unibas.ch)
University of Basel, Department of Psychology, Missionsstrasse 62a
4055 Basel, Switzerland

Jörg Rieskamp (joerg.rieskamp@unibas.ch)
University of Basel, Department of Psychology, Missionsstrasse 62a
4055 Basel, Switzerland

Abstract

Many decisions under risk and uncertainty are made under physical or emotional stress. Recent research suggests that stress influences decisions between risky options, but that the direction of the influence depends on the characteristics of the gambles. For instance, stress increases risk taking for loss gambles, but decreases risk taking for gain gambles. In the current project we investigate: (1) whether the riskiness of gambles influences the direction of the stress effect and (2) whether changes in risk taking can be linked to changes in attention. Participants who gave relatively more attention to gains than to losses, as indicated by eye-tracking data, were more risk seeking than participants who gave less attention to gains. Stress did not influence participants' attention. However, stressed participants became more risk seeking when considering gambles with relatively low risk, but less risk seeking for gambles with relatively high risk.

Keywords: risk; decision making; stress; cortisol; variance

Introduction

Every day we make decisions involving risk and uncertainty ranging from buying a gamble ticket to investing in stocks, gold, or real estate. Many of these decisions are not made in cold blood, but under physical or emotional stress. How stress and stress-related release of hormones such as cortisol influence risk preferences, however, is far from clear. Research has found that men, but not women, tend to become more risk seeking under stress (Lighthall, Mather, & Gorlick, 2009; Preston, Buchanan, Stansfield, & Bechara, 2007; Starcke, Wolf, Markowitch, & Brand, 2008). Similarly, studies on financial risk taking have found divergent results. For instance, offering participants choices between risky and relatively safe options, Porcelli and Delgado (2009) found that participants became more risk seeking under stress when choosing between options involving losses, but less risk seeking when choosing between options involving gains. In a similar vein, Carr and Steele (2010) found that stereotype threat reduced risk taking in women. Von Dawans, Fischbacher, Kirschbaum, Fehr, & Heinrichs (2012), however, found no influence of stress on decisions between gambles involving gains and losses.

Porcelli and Delgado (2009) argue that stress enhances decision biases such as the reflection effect (i.e., people are more risk seeking in the loss domain than in the gain domain, Kahneman & Tversky, 1979). In the current research we follow up on this result, suggesting that stress enhances preexisting preferences for risk. That is, in decision situations in which people usually are risk seeking, they should become even more risk seeking under stress, whereas in decision situations in which people behave risk averse, they should become even more risk averse. We test these hypotheses in a financial risk-taking task.

As a second goal we aimed to examine the mechanism underlying changes in risky decision making under stress. One mechanism by which stress could enhance preexisting preferences is by narrowing the focus of attention to the piece of information that is considered as most important. In line with this idea stress has been shown to reduce cognitive resources and narrow the focus of attention as well as the amount of information that can be processed (Friedman & Förster, 2010; Kelly, Ashleigh, & Beversdorf, 2007; Wichary & Rieskamp, 2011). Thus, stress could influence risky decision making by changing the amount of attention given to the attributes of the choice options such as the possible outcomes (gains or losses) and the probability of the outcome (Ben Zur & Breznitz, 1981).

Variability in Outcomes as a Measure of Risk

The vast majority of research on financial risk taking involves the choice between gambles; that is, options with various outcomes that occur with a specific probability and that differ in valence (e.g., gains or losses). The risk of a gamble is commonly defined by the variability of the outcomes, with higher variability implying higher risk. For instance, finance models such as the capital-asses-pricing model equate risk with outcome variance (Sharpe, 1964). However, other variability measures such as the coefficient of variation, a measure based on the relative variance of a gamble, have been proposed to measure risk (Weber, Shafir, & Blais, 2004). In sum, if stress amplifies people's risk preferences by narrowing their attention to the subjectively important aspect of the decision situation, then stress should lead to more risk-taking behavior for gambles with little outcome variability and to less risk taking for gambles with high outcome variability.

Attention in Risky Decision Making

The attention given to positive and negative attributes is an important predictor of decisions under risk. For instance, Ben Zur and Breznitz (1981) found that how often people looked at information about how much they could win or lose was related to their choices. This suggests that if stress narrows attention to the information the participant considers most important, increase in risky choices could be related to more attention being given to gains than to losses, whereas choice of safe options may be related to increased attention to losses over gains.

A non-intrusive way of measuring the relative attention given to gains or losses is by recording eye movements. In general, visual attention is strongly coupled to eye movements (e.g., Hoffman, 1998) and has been successfully used to understand the processes underlying decision making (Glaholt & Reingold, 2011). In particular, two measures of eye movement have been successfully used to predict decisions. First, the time spent looking at an option is positively related to choosing this option (Glaholt, Wu, & Reingold, 2009). Similarly, the time spent looking at specific pieces of information has been linked to the importance assigned to it (Rehder & Hoffman, 2005). Secondly, choices are often reflected by *gaze cascade* effects; that is, over time attention wanders to the preferred option (Glaholt & Reingold, 2011; Fiedler & Glöckner, 2012). In particular, the last focus is related to choice; that is, the option fixated last before making a decision is chosen more frequently than other options (Krajbich, Armel, & Rangel, 2010). Thus in the current study, we considered the time that gains and losses were looked at as well as the last information that was fixated before making a decision.

The Study

We investigated the influence of stress on risk taking with a financial decision-making task consisting of 40 decisions between two gambles that contained positive and negative outcomes. Mixed gambles present an interesting problem, because increased risk taking with cortisol has been shown in particular when high gains and high losses were at stake (Putman, Antypa, Crysovergi, & van der Does, 2010). Within the 40 gambles we varied the variability in the outcomes.

Method

Participants. 70 participants (40 in the stress condition and 30 in the no stress condition, M_{Age} = 24.4, SD_{Age} = 5.3) were recruited at the University of Basel. We expected that for a substantial number (approximately one third) of the participants the cold pressor task would not result in an increase in cortisol. Therefore we collected more participants in the stress condition, to ensure a sufficient sample size in the stress condition. 48 were females. Participants received a participation fee of 20 CHF per hour (approx. 22 US-$). Additionally one of the participant's decisions was randomly chosen and the preferred gamble was played. Participants received/paid 10% of the gamble's outcome. One participant was excluded from the analysis because he always chose the reference gamble. Overall, testing took 1 h and 30 min.

Financial Decision-Making Task. The financial decision-making task consisted of 40 decisions between two gambles. In each trial participants chose between a reference gamble (Gamble A), in which participants could win 15 Swiss Francs (CHF) or lose 5 CHF with a probability of .5 (EV = 5 CHF), and a target gamble (gamble B). The reference gamble was the same in each decision, but there were 40 different target gambles structured in two sets: (1) high outcome gambles (e.g., win/lose 60 with a probability of .5) and (2) low outcome gambles (e.g., win/lose 30 with a probability of .5). For each gamble type (high or low outcome) we created sets of gambles by varying the expected value of the target gamble from -5 to 15/30 in steps of 5. The expected value was varied by changing either (1) the amount that could be won, (2) the amount that could be lost, or (3) the probability with which each outcome could occur (see Table 1 for an overview).

Table 1: Overview of the target gambles

No	*p*(win)	Gain	*p*(loss)	Loss	EV	Set
1	.50	60	.50	-70	-5	high
2	.50	60	.50	-60	0	high
3	.50	60	.50	-50	5	high
4	.50	60	.50	-40	10	high
5	.50	60	.50	-30	15	high
6	.50	60	.50	-20	20	high
7	.50	60	.50	-10	25	high
8	.50	30	.50	-40	-5	low
9	.50	30	.50	-30	0	low
10	.50	30	.50	-20	5	low
11	.50	30	.50	-10	10	low
12	.50	30	.50	-0.1	15	low
13	.50	50	.50	-60	-5	high
14	.50	60	.50	-60	0	high
15	.50	70	.50	-60	5	high
16	.50	80	.50	-60	10	high
17	.50	90	.50	-60	15	high
18	.50	100	.50	-60	20	high
19	.50	110	.50	-60	25	high
20	.50	120	.50	-60	30	high
21	.50	20	.50	-30	-5	low
22	.50	30	.50	-30	0	low
23	.50	40	.50	-30	5	low
24	.50	50	.50	-30	10	low
25	.50	60	.50	-30	15	low
26	.50	70	.50	-30	20	low
27	.50	80	.50	-30	25	low
28	.50	90	.50	-30	30	low
29	.46	60	.54	-60	-5	high

30	.54	60	.46	-60	5	high
31	.58	60	.42	-60	10	high
32	.63	60	.37	-60	15	high
33	.67	60	.33	-60	20	high
34	.71	60	.29	-60	25	high
35	.75	60	.25	-60	30	high
36	.42	30	.58	-30	-5	low
37	.58	30	.42	-30	5	low
38	.67	30	.33	-30	10	low
39	.75	30	.25	-30	15	low
40	.83	30	.17	-30	20	low

Note: *p*(win) = probability of receiving the positive outcome (Gain); *p*(loss) = probability of receiving the negative outcome (Loss). EV = gamble's expected value.

The order in which the target gambles were presented was randomized. For half of the participants gains appeared on the left side and for the other half on the right side. Reference and target gambles were presented sequentially to allow better measures of the relative attention given to each attribute (win, loss, probability) of each gamble (see Figure 1 for a screenshot). Each trial started with a fixation cross (100ms). Then the reference gamble was presented until participants pressed the return key. The target gamble appeared until participants made a choice by pressing "1" for the reference gamble or "2" for the target gamble. The task was implemented in Presentation.

Figure 1. Screenshot of a target gamble.

Stress Manipulation. In the stress condition, we induced stress with the cold pressor task (CPT; Lovallo, 1975). The CPT is a standard method to induce a stress response and has been shown to reliably increase subjective stress and cortisol levels (McRae et al., 2006). In the CPT participants immersed their right hand in ice water (0° – 4° C, *M* = 1.86° C, *SD* = 0.67) for as long as possible, up to 3 minutes. In the no stress condition participants immersed their hand in warm water (37° – 40° C, *M* = 38.98° C, *SD* = 0.81).

Measurement of Mood, Arousal, and Stress. We measured mood and arousal with the Self Assessment Mannequins (SAM; Hodes, Cook, & Lang, 1985). To measure the physiological stress response we took saliva samples collected using Salivettes (Sarstedt, Nuembrecht, Germany) to determine cortisol levels. Saliva samples were analyzed at the laboratory of the Technical University Dresden. Salivary free cortisol levels were determined using a chemoluminescence immunoassay (IBL, Hamburg, Germany) with intra- and interassay precision of 2.5% and 4.7%, respectively.

Procedure. After participants arrived we determined whether they met the inclusion criteria for the study and gave them approximately 8 fl. oz. of water to drink. Then, we took the first saliva sample and measured mood and arousal (T1). Following the measurements, participants immediately proceeded with the first session of the financial decision-making task. After that participants gave the second saliva sample and again completed the mood and arousal measures (T2). Next, participants proceeded with the stress manipulation. 15 min after the stress manipulation, so that cortisol levels had time to rise, we took the third saliva sample and measured mood and arousal (T3). Immediately afterwards, participants performed the financial decision-making task again (Session 2). After that we again measured mood and arousal and took the fourth saliva sample (T4). Figure 2 provides a schematic overview of the experimental design.

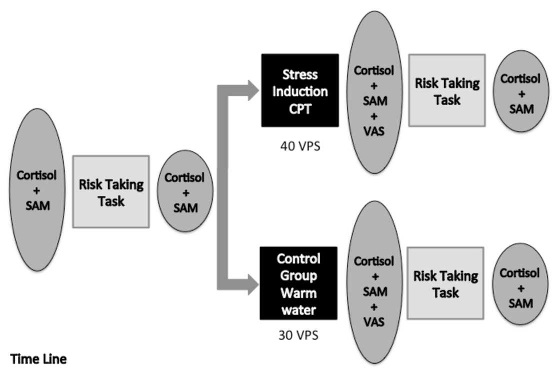

Figure 2. Overview of the experimental design. The abbreviations are explained in the text.

Eye Movements. We recorded participants' eye movements while they solved the financial decision-making task by using a remote eye-tracking device (SensoMotorics Instruments LLC), using the iViewX software and a remote binocular sampling rate of 120Hz. The stimulus material was presented on a screen with a resolution of 1680×1050 pixels and a refresh rate of 60Hz. The eye tracker was calibrated before the decision-making task and calibration was checked and if necessary repeated after each decision (20 pixel tolerance). Further analysis was done in Matlab. Fixations were identified using a 20 pixel tolerance (i.e., added max-min deviation for x- and y-coordinates) and a minimum fixation time threshold of 50 ms (see Fiedler & Glöckner, 2012 for a similar procedure).

We defined areas of interest (AOI) as circles with a radius of 120 pixels around each piece of information;

that, is the potential loss and gain, and the probability with which a loss or gain would occur (see Figure 1).

Results

Mood, Arousal, and Stress Response. First we analyzed whether the stress manipulation influenced participants' mood, arousal, and cortisol levels (for means and *SD* see Table 2).

Table 2: Descriptive statistics (Means and *SD*s) for mood, arousal, and cortisol by stress condition

Measure	T1	T2	T3	T4
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Stress				
Mood	2.85	3.08	2.95	3.03
	(1.00)	(1.19)	(1.11)	(1.10)
Arousal	6.38	6.38	6.03	6.9
	(1.29)	(1.63)	(1.95)	(1.28)
Cortisol	12.50	10.16	17.92	14.21
(nmol/l)	(10.04)	(7.13)	(10.86)	(11.12)
No Stress				
Mood	3.17	3.07	3.10	3.03
	(1.10)	(1.16)	(1.32)	(1.10)
Arousal	6.03	6.10	6.86	6.76
	(1.57)	(1.70)	(1.62)	(1.86)
Cortisol	12.09	9.95	8.12	7.40
(nmol/l)	(7.50)	(5.68)	(3.79)	(3.53)

Note: $N_{stress} = 40$; $N_{no\ stress} = 29$; lower numbers indicate more positive mood and higher arousal

Mixed analyses of variance (ANOVAs) on mood, arousal and cortisol with measurement time (T1-T4) as within-subject factor and stress condition as between-subjects factor showed that arousal and cortisol levels increased in the stress group but not in the no stress group. In the no stress group cortisol and arousal decreased, suggesting that participants' initial excitement decreased during participation. This was indicated by significant interactions of measurement time and stress condition, Arousal: Greenhouse-Geisser corrected $F(3,166) = 6.15$, $p = .01$; Cortisol: Greenhouse-Geisser corrected $F(3,90) = 18.23$, $p < .001$. We did not find an effect of stress on mood, that is there was no interaction between measurement time and stress condition, $F(3, 201) = 0.87$, $p = .46$, nor main effects of time or stress condition (all *ps* > .65).

The Influence of Stress on Decisions under Risk. We measured risk taking as the proportion of trials in which the risky option (i.e., the target gamble) was chosen. On average participants chose the risky option in 44% of the choices in the first session and in 46% in the second session, indicating that participants were rather risk averse (a risk neutral decision maker who always chose the option with the higher expected value should have chosen the target gamble in 67.5% of the trials). In a first step we analyzed whether stress influenced the proportion of risky choices with a mixed ANOVA with session (before/after the stress induction) as within-subject factor and stress condition as between-subjects factor. We did not find a main effect of session ($F(1,67) = 0.89$, $p = .35$) or stress ($F(1,67) = 0.43$, $p = .51$), nor an interaction between them ($F(1,67) = 0.10$, $p = .75$; for means and *SD* see Table 3).

In the next step we tested whether the difference in outcomes of the gambles influenced how stress affected risky decision making. We focused on the choices where target gambles offered a higher expected value than the reference gamble (i.e., EV>10), to account for participants' overall risk aversion. A mixed ANOVA with session and gamble type as within-subject factors and stress condition as between-subjects factor showed that participants chose the target gamble more frequently for the low outcome gambles than the high outcome gambles, $F(1,67) = 70.96$, $p < .001$. Additionally we found a three-way interaction between stress condition, session and gamble type, $F(1,67) = 5.87$, $p = .02$. As illustrated in Figure 3, repeated measurement ANOVAs for stressed and not stressed participants separately showed an interaction between time and gamble type for participants in the stress condition, $F(1,39) = 7.53$, $p = .01$, but not in the no stress condition, $F(1,28) = 0.76$, $p = .39$. This suggests that in the second session compared to the first session participants in the stress condition—but not participants in the no stress condition—took more risks with low outcome gambles, but less risk with high outcome gambles.

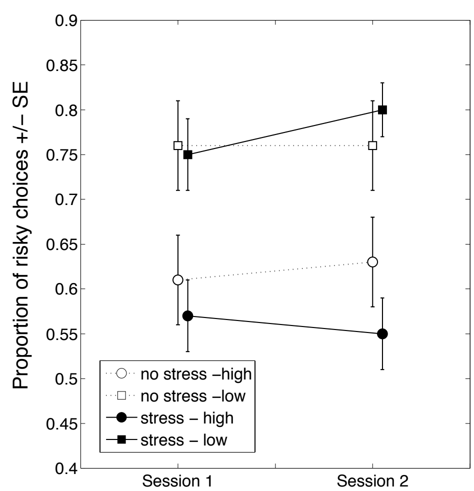

Figure 3. Proportion of risky choices for gambles with high and low outcomes in the stress and no stress group

Because previous literature has shown that men and women react differently to stress (e.g., Lighthall et al., 2009), we ran additional analyses including gender as a further between-subjects factor. We found a main effect of gender in that women chose the risky option less frequently than men (M_{men} = .79, SE = .05, M_{women} = .63, SE = .03, $F(1,65) = 7.15$, $p = .01$). However, gender did not interact with the gamble type, nor affect the results of stress on high and low outcome gambles.

Table 3: Descriptive statistics for risky decision making and measures of eye movement by stress condition

Measure	Stress		No stress	
	M	*SD*	*M*	*SD*
Risky Choices (Session 1)	0.43	0.17	0.46	0.19
Risky Choices (Session 2)	0.45	0.18	0.47	0.22
FixationGainLoss (High 1)	0.08	0.09	0.08	0.10
FixationGainLoss (High 2)	0.07	0.11	0.08	0.10
LastGainLoss (High 1)	0.20	0.27	0.19	0.31
LastGainLoss (High 2)	0.19	0.37	0.18	0.30
FixationGainLoss (Low 1)	0.08	0.10	0.08	0.11
FixationGainLoss (Low 2)	0.06	0.11	0.08	0.11
LastGainLoss (Low 1)	0.17	0.36	0.25	0.26
LastGainLoss (Low 2)	0.15	0.38	0.27	0.31

Eye Movements. Can the influence of stress on risk-taking be explained by the relative attention given to gains and losses? To answer this question, we considered two measures of eye movements: (1) the relative duration with which gains were fixated compared to losses (FixationGainLoss) and (2) the relative proportion of trials on which the last fixation before making a decision was to the gain information or the loss information (LastGainLoss). We calculated the measures for high and low outcome gambles separately. Because the reference gamble was always the same, we focused on the target gambles. The FixationGainLoss was calculated by measuring the duration of fixations in each AOI (gains, losses and probabilities) for each trial. Next, we computed how long gains were fixated relative to losses and calculated the average for trials with high and low outcome gambles with an expected value of 10 or higher. The LastGainLoss was calculated by taking the difference between the proportion of trials with high and low outcome gambles with an expected value of 10 or higher in which the last focus was to the gain AOI relative to the loss AOI; see Table 3 for means and SD.

We then investigated whether the two measures of eye movements were related to the proportion of risky choices. Correlations indicated that the longer gains were fixated compared to losses and the more often the last fixation was to the gain AOI relative to the loss AOI, the more participants chose the risky option, particularly in the high outcome gambles (see Table 4).

To investigate whether the attention to gains and losses changed with stress, we conducted two mixed ANOVAs with session and variance as within-subject factors and stress condition as between-subjects factor.

We did not find an effect of session, stress condition or variance for the relative time gains and losses were looked at (all *p*s > .18). The analysis on the location of the last fixation before making a decision also showed no main effects of session, gamble type or stress condition (all *p*s > .45), but indicated a significant interaction between gamble type and stress condition, $F(1,67) = 4.09$, $p = .05$.

Follow-up analyses for participants in the stress condition and the no stress condition separately showed an effect of gamble type in the no stress condition, $F(1,28) = 4.24$, $p = .05$, indicating that the participants more frequently looked to gains compared to losses for the low outcome gambles than for the high outcome gambles (see Table 3). In the stress condition, however, we did not find an effect of session or gamble type (all *p*s > .37).

Table 4: Correlation between measures of eye movement and risk taking

	Risky Choice (H1)		Risky Choice (H2)	
	r	*p*	*r*	*p*
FixationGainLoss (H1)	.33	.005	.37	.002
FixationGainLoss (H2)	.35	.003	.34	.004
LastGainLoss (H1)	.34	.004	.38	.001
LastGainLoss (H2)	.30	.01	.30	.02

Note: $N = 69$; H1 = high outcome gambles, session 1; H2 = high outcome gambles, session 2

Discussion

The effect of stress on decisions under risk seems to depend on the risk the decision involves. Whereas we did not find an overall influence of stress on Although taking, a detailed analysis showed that the influence of stress depended on the variability in the gambles' outcomes. After immersing their hand in ice-cold water, participants chose the risky gamble more frequently when the difference between outcomes was relatively low, but less frequently when the difference between outcomes was high. This suggests that the influence of stress on risk taking depends on the riskiness of the decision-making task, resonating with research showing that stress increases risk taking in the loss domain but decreases risk taking the gain domain (Porcelli & Delgado, 2009). These results can help reconcile the diverse effects of stress on risky decision making in the literature by showing that to understand the influence of stress it is necessary to take task characteristics such as the involved risk of a decision into account.

A second goal of the research was to investigate whether the relative attention given to gains and losses is a potential mechanism underlying the influence of stress. Overall, participants who gave relatively more attention to gains than to losses tended to choose the risky option more frequently. This resonates with previous work suggesting that the time spent on information is related to its importance for the choice (e.g., Ben Zur & Breznitz, 1981; Glaholt et al., 2009). Additionally we found that the last fixation before making a choice was related to risk taking, dovetailing with research on gaze cascade effects in risky decision making (e.g., Fiedler & Glöckner, 2012). Moreover, it suggests that gaze cascade effects extend to the attribute that was most important in determining choice.

We did not find any evidence, however, that stress changed the relative attention given to gains over losses or the last information looked at. This could suggest that the influence of stress is not mediated by the attention given to gains and losses. On the other hand, the effect of stress could have been masked by noise given to the relatively few gambles in our task.

In sum, our results suggest that stress changes how risky decisions are made. Although the mechanism by which stress exerts its influence requires further research, it becomes clear that the effect of stress can only be understood when considering the characteristics of the decision task.

Acknowledgments

This research was supported by research grants from the Swiss National Science Foundation (100014_130192/1 and CRSII1_136227).

References

Ben Zur, H., & Breznitz, S. J. (1981). The effect of time pressure on risky choice behavior. *Acta Psychologica*, *47*, 89–104.

Carr, P. B., & Steele, C. M. (2010). Stereotype threat affects financial decision making. *Psychological Science*, *21*, 1411-1416.

Fiedler, S., & Glöckner, A. (2012). The dynamics of decision making in risky choice: an eye-tracking analysis. *Frontiers in Psychology*, *3*, 335.

Friedman, R. S., & Förster, J. (2010). Implicit affective cues and attentional tuning: An integrative review. *Psychological Bulletin*, *136*, 875–893.

Glaholt, M. G., & Reingold, E. M. (2011). Eye movement monitoring as a process tracing methodology in decision making research. *Journal of Neuroscience, Psychology, and Economics*, *4*, 125–146.

Glaholt, M. G., Wu. M., & Reingold, E. M. (2009). Predicting preference from fixations. *PsychNology Journal, 7*(2), 141–158.

Hodes, R. L., Cook III, E. W., & Lang, P. J. (1985). Individual differences in autonomic response: conditioned association or fear? *Psychophysiology*, 22, 545–560

Hoffman, J. E. (1998). Visual attention and eye movements. In H. Pashler (Ed.), *Attention* (pp. 119–153). Hove, United Kingdom: Psychology Press.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47,* 263–291.

Kelly, I., Ashleigh, H., & Beversdorf, D. Q. (2007). Effect of the cold pressor test on memory and cognitive flexibility. *Neurocase*, 13, 154–157.

Krajbich, I., Armel, C., and Rangel, A. (2010). Visual fixations and the computation and comparison of value in simple choice. *Nature Neuroscience, 13*, 1292–1298.

Lighthall, N. R., Mather, M., & Gorlick, M. A. (2009). Acute stress increases sex differences in risk seeking in the balloon analogue risk task. *Plos One*, *4, e6002*.

Lovallo, W. (1975). The cold pressor test and autonomic function: a review and integration. *Psychophysiology*, *12,* 268–82.

McRae, A. L., Saladin, M. E., Brady, K. T., Upadhyaya, H., Back, S. E., & Timmerman, M. A. (2006). Stress reactivity: biological and subjective responses to the cold pressor and Trier Social stressors. *Human Psychopharmacology*, *21*(6), 377-385.

Porcelli, A. J., & Delgado, M. R. (2009). Acute stress modulates risk taking in financial decision making. *Psychological Science*, *20*, 278.

Preston, S. D., Buchanan, T. W., Stansfield, R. B., & Bechara, A. (2007). Effects of anticipatory stress on decision making in a gambling task. *Behavioral Neuroscience*, *121*, 257-263.

Putman, P., Antypa, N., Crysovergi, P., & van ver Does, W. A. J. (2010). Exogenous cortisol acutely influences motivated decision making in healthy young men. *Psychopharmacology*, *208*, 257–263.

Rehder, B., & Hoffman, A. B. (2005). Thirty-Something categorization results explained: Selective attention, eyetracking, and models of category learning. *Journal of Experimental Psychology: Learning Memory, and Cognition*, *31*, 811– 829.

Sharpe, W. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance, 19,* 425.

Starcke, K., Wolf, O. T., Markowitsch, H. J., & Brand, M. (2008). Anticipatory stress influences decision making under explicit risk conditions. *Behavioral Neuroscience*, *122*(6), 1352-1360.

Von Dawans, B., Fischbacher, U., Kirschbaum, C., Fehr, E., & Heinrichs, M. (2012). The social dimension of stress reactivity: acute stress increases prosocial behavior in humans. *Psychological Science*, *23*, 651–660.

Weber, E. U., Shafir, S., Blais, A-R. (2004). Predicting risk sensitivity in humans and lower animals: Risk as variance or coefficient of variation. *Psychological Review, 111*, 430-445.

Wichary, S., & Rieskamp, J. (2011). Probabilistic inferences under emotional stress. In L. Carlson, C. Hoelscher, & T. F. Shipley (Eds.), *Proceedings of the 33rd Annual Conference of the Cognitive Science Society* (pp. 1872-1877). Austin, TX: Cognitive Science Society.