

**Tilburg University**

## **Risk Aversion and Emotions**

Nguyen, Y.; Noussair, C.N.

*Publication date:*  
2013

[Link to publication in Tilburg University Research Portal](#)

*Citation for published version (APA):*

Nguyen, Y., & Noussair, C. N. (2013). *Risk Aversion and Emotions*. (CentER Discussion Paper; Vol. 2013-041). Economics.

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

### **Take down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

No. 2013-041

**RISK AVERSION AND EMOTIONS**

By

Yen Nguyen, Charles N. Noussair

17 July, 2013

ISSN 0924-7815  
ISSN 2213-9532

# Risk aversion and Emotions

Yen Nguyen and Charles N. Noussair<sup>1</sup>

Tilburg University

June 2013

Keywords: Risk aversion, emotions, facereading, fear

JEL Codes: C9

## Abstract

We consider the relationship between emotions and decision-making under risk. Specifically, we examine the emotional correlates of risk-averse decisions. In our experiment, individuals' facial expressions are monitored with facereading software, as they are presented with risky lotteries. We then correlate these facial expressions with subsequent decisions in risky choice tasks. We find that the valence of one's emotional state is negatively correlated, and the strength of a number of emotions: fear, happiness, anger, and surprise, is positively correlated, with risk-averse decisions.

## 1. Introduction

The mechanisms that underpin choice under risk have been a major focus of research in economics, psychology, and neuroscience. The traditional approach in economics has been to postulate the existence of a utility function that represents an individual's preferences, and to note that concavity implies a preference for relatively safe lotteries, while convexity corresponds to a preference for relatively risky lotteries. Neuroscientists have documented the physiological correlates of risky decision making. Psychologists and behavioral economists stress the role of emotions such as happiness or fear in guiding individuals' choices in risky situations (see Coget et al., 2011; Loewenstein and Lerner, 2003; Forgas, 1995).

The focus of the work reported here is to better understand the connection between emotions, which are ultimately psychological terms describing profiles of physiological responses, and the level of risk aversion exhibited in financial decision making tasks. We study the physiological manifestation of emotion that accompanies decision making under risk. We report an experiment in which we record

---

We thank Adriana Breaban and Dan Nguyen for research assistance. We thank participants at the 2012 Alhambra Experimental Workshop and the 2012 Xiamen University International Workshop of Experimental Economics. We thank Gary Charness, Shachar Kariv, and Sigrid Suetens for comments. We thank the CentER for Economic Research at Tilburg University for funding for the experimental sessions.

individuals' facial expressions while they are presented with a series of risky lotteries. We then consider whether the emotional response of an individual correlates with her subsequent decisions between risky alternatives. The hypotheses we test originate in previous experimental research and are discussed in section two. These hypotheses are that the levels of (1) fear, (2) happiness, (3) anger, and (4) overall positive affect, the decision maker exhibits when presented with risk lotteries, correlate with the level of observed risk aversion in the subsequent decision task.

We introduce a new research method, face-reading, to economics. The software we employ, Noldus Facereader, analyzes facial expressions, and measures the degree of conformity with the six basic universal emotions catalogued by Ekman (1979). These emotions are fear, happiness, anger, disgust, surprise, and sadness<sup>2</sup> (Ekman and Friesen, 1986; Ekman, 1994; Izard 1994). They are described as universal because the same facial expressions are associated with these emotions in all cultures, the expressions are common to all primates, and they are identical in blind and in sighted people, indicating that they are innate rather than the product of social learning. Facereader also registers an overall measure of emotional valence. Unlike questionnaire data, Facereader records participants' emotional states in nearly real time (Reisenzein, 2000), at a sample rate of five times per second. Compared to other methodologies measuring biological responses, such as Skin Conductance Response registration and fMRI imaging, FaceReader has the advantage that it interprets physiological responses directly in terms of specific emotions.

Some previous research has taken a valence-based approach to affect, focusing on the impact of overall negative or positive emotional state (Isen, 1997; Johnson and Tversky, 1983; Simonsohn, 2007; Capra, 2004). However, DeSteno et al., (2000) and Kugler et al. (2012) argue that it is important to distinguish the various emotions that make up overall valence, and other studies have focused on the role of specific emotions such as fear (Lopes, 1987), anger, and disgust (Fessler et al., 2004). Appraisal theory distinguishes emotions at a more fine-grained level than merely positive or negative (Tiedens and Linton, 2001; Lerner and Tiedens, 2006). We take both approaches here, considering both the predictive power of overall valence, as well as specific emotions, on risk tolerance.

With a few exceptions (e.g., Bruyneel et al., 2009; Fessler et al., 2004; Lerner et al., 2004), studies of the effect of incidental emotions on risk-taking have been limited to risk assessments or hypothetical choices, rather than tasks involving real decision consequences. In this study, we use real incentives, in keeping with the conventional approach in experimental economics. We also depart from

---

<sup>2</sup> Zaman and Shrimpton-Smith (2006) compare data measuring individuals' emotional states from three sources: the results from respondent questionnaires, interviewer loggings of respondent emotions, and FaceReader data from respondent facial expressions. They found that FaceReader output was highly correlated with the other two measures. They noted that FaceReader had the advantage that it operated in real time and could thus register very brief emotional episodes and rapid changes.

the previous literature in that instead of inducing emotions exogenously, we merely measure them and consider how they react to different levels of stimuli over the course of our experimental sessions.

It is important to emphasize the distinction between emotions and moods. Several features distinguish the two concepts. Emotions are shorter-lived, more intense, and typically reactions to specific circumstances (Capra, 2004). Moods, on the other hand, are longer in duration, less intense and not usually linked to a proximate event. Some emotions express themselves in distinctive facial expressions, while moods do not (Ekman, 1994).<sup>3</sup> The issue at hand in the study reported here is whether emotional reactions to specific stimuli correlate with subsequent decisions.

Section 2 describes the experiment, and section 3 lays out our hypotheses. Section 4 reports the results and section 5 contains some concluding remarks.

## 2. The Experiment

The 30 participants in our study were Tilburg University students, who were recruited via online self-enrollment for the experiments through the CenterLab website at Tilburg University. The sample consisted of 13 men and 17 women, all aged between 18 and 25 years. Each session consisted of four segments. Only one subject participated in each session. The experiment was implemented with the online VeconLab software, developed at the University of Virginia, with modified instructions.

The first and second segments each consisted of 10 trials. In the first segment, individuals were presented with a payoff level in each trial. The level was either: 1, 3.5, 6, 8.5 or 12 Euros in a given trial.<sup>4</sup> Each value appeared exactly twice within the 10-period segment. We display each stimulus more than once and average the response across the two identical trials. This is a typical procedure in neuroeconomic studies involving physiological measures. It reduces the influence of noise, here in the form of incidental face movements, on the data. Such one-time face movements can greatly affect an individual trial, but would have less of an impact if multiple trials are averaged. Each subject was required to wait for 30 seconds after the payoff level for the current trial appeared on her screen. After the 30 seconds had elapsed, she could click on a button and proceed to the next trial.

The second segment, which also consisted of ten trials, was similar, except that the individual was presented with various risky lotteries. Each lottery yielded  $6 + \varepsilon$  Euro with probability .5 and  $6 - \varepsilon$  Euro with probability .5. The value of  $\varepsilon$  varied between 1 and 5 by trial, with each value appearing twice within the 10 trials. Thus, in each trial the individual faced a lottery with an expected value of 6 Euro, but with a

---

<sup>3</sup> For instance, when many facial expressions of anger are observed, one can infer that that person is in an irritable mood. However, conversely “there is no distinctive facial expression of irritability itself, nor is there for any other mood, or for that matter for emotional traits, or affective disorders” (Ekman, 1994).

<sup>4</sup> Throughout the session, the payoffs were denominated in terms of experimental dollars (E\$), which were convertible to Euro at a rate of  $2E\$ = 1$  Euro.

variance that differed across trials. In both the first and the second segments, the stimuli were presented in a random order that differed by subject.

In the third segment, subjects made ten pairwise choices between a safe and a risky alternative. The ten choices were made in sequence so that each decision constituted one trial. The choices are given in table 1, and the sequence of the ten tasks was random and differed for each individual. In each of the tasks, subjects chose between a sure 6 Euro and the lottery indicated in the column labeled “Risky Alternative”. Each of the two outcomes indicated in the column occurred with probability .5. For example, in task 1, subjects chose between a sure 6 Euro and a lottery that paid 7 Euro with probability .5, and 5 Euro with probability .5.

The fourth segment was the risk aversion task originally studied by Holt-Laury (2002). This task involves a series of ten choices between two lotteries of the form  $p \cdot x_1 + (1-p) \cdot x_2$  and  $p \cdot y_1 + (1-p) \cdot y_2$ , where  $y_2 > x_2 > x_1 > y_1$ , and  $p$  varies monotonically from .1 to 1 in increments of .1 in the ten different choices. These were presented sequentially so that the segment consisted of ten trials. A risk neutral agent would choose the relatively safe lottery  $p \cdot x_1 + (1-p) \cdot x_2$  in four of the ten instances (for  $p \leq .4$ ). A risk averse (risk seeking) agent would choose the safe lottery in more than (less than) four of the ten trials. In the experiment  $(x_1, x_2, y_1, y_2) = (4, 5, .25, 9.63)$  Euro.

All participants received financial compensation for their participation. At the end of the session two random draws occurred that determined the remuneration for the participant. The first determined which of the four segments would count toward subjects’ payment. The second determined which trial within the segment would count. Thus, only one trial overall counted toward each subject’s payment and which trial this was differed by subject. Earnings averaged 8 Euro (approximately \$US10) per subject. Session length averaged 35 minutes.

During the first two segments, subjects were videotaped and the images analysed by Facereader in real time. Facereader operates in the following manner. The position of the face in the videocamera’s image is found using a method called the Active Template Method (ATM). This method places a template over an image and calculates the most likely position of the face. A second algorithm for face finding, the Viola Jones cascaded classifier algorithm, takes over when the Active Template Method cannot locate a face.

**Table 1: The 10 Decision Tasks in Segment Three of the Experiment**

<b>Task</b>	<b>Risky Alternative (payoffs in Euro, each realized with prob. .5)</b>	<b>Percentage choosing risky alternative</b>	<b>Mean Payoff (in Euro)</b>	<b>Standard Deviation of Payoff (in Euro)</b>
1	(7, 5)	63	6	.56
2	(8, 4)	43	6	.93
3	(9, 3)	30	6	1.16
4	(7.5, 5)	73	6.18	.77
5	(9, 4)	67	6.34	1.48
6	(10.5, 2.5)	70	6.35	2.26
7	(8,5)	83	6.42	1.02
8	(10,4)	87	6.87	2.09
9	(12,3)	70	7.05	2.81
10	(14,2)	70	7.40	3.74

A model called the Active Appearance Model (AAM) is then applied. It describes the location of 55 key points in the face and the facial texture of the convex hull defined by these points. The model uses a database of annotated images and calculates the main sources of variation found in the images. Principal Component Analysis is used to reduce the model's dimensionality. The classification of the facial expressions is done with an artificial neural network, which takes the vector of 55 locations on the face as input. The network was trained with roughly 2000 images to classify the six basic or universal emotions of happiness, sadness, anger, surprise, fear, disgust, the six basic emotions described by Ekman (1970), as well as a neutral state.

The output of Facereader is a vector of values for the happiness, surprise, neutrality, anger, disgust, sadness and fear and an overall valence of emotions. The values of each emotion range from 0 to 1, and valence ranges from -1 to +1. The values are registered at intervals of approximately 1/20<sup>th</sup> of a second. Facereader identifies the intended emotion of an individual with a high degree of success (Uyl and Kuilenberg, 2005), and corresponds closely to observers' evaluations (Terzis et al., 2010)

### 3. Hypotheses

#### 3.1. Valence and Risk

Fessler et al. (2004) argue that the majority of contemporary theories regarding the relationship between risk taking and active emotions either derive from, or are reactions to, one of two approaches. These are the mood maintenance hypothesis of Isen and Patrick (1983), and the affective generalization hypothesis of Johnson and Tversky (1983). The mood maintenance hypothesis states that individuals in a positive mood decide against gambling because losing could undermine their positive mood. Thus, individuals in a negative mood would display more risk-taking behavior by seeking out risks that might improve their mood than those individuals in a positive mood. The evidence for mood maintenance is mixed (Arkes et al., 1988; Mano, 1992; Nygren et al., 1996; Rusting and Nolen-Hoeksema, 1998; Kring, 2000).

The affective generalization hypothesis of Johnson and Tversky (1983) concerns the role of affect in judgments of probabilities. They argue that negative emotions trigger more pessimistic risk assessments, while positive emotions evoke more positive risk assessments, and this leads individuals in a more positive mood to take more risk, even if the source of the emotion has no relation to the target risks. Most previous evidence is consistent with this hypothesis (Lerner et al., 2004, Kugler et al 2012). We thus hypothesize that a more positive emotional valence when an individual is presented with risky lotteries predicts less risk-averse decisions.

**Hypothesis 1: Individuals, who exhibit more positive valence when presented with lotteries in segment two, make less risk-averse decisions in segments three and four.**

#### 3.2 Specific emotions and risk

Emotions are distinct from moods in that they are short term in duration and occur in reaction to specific experiences. An emotion contains a prototypic form of, typically facial, expression (Izard, 1977), along with a pattern of consistent autonomic changes and a distinct state of subjective feeling. For example, the emotion of fear is characterized by a distinctive facial expression in which the eyebrows are raised and drawn together, the lower lip is tensed, the lips are stretched backwards and the eyes are opened widely (Ekman and Friesen, 1975). At the same time, fear is also associated with marked autonomic changes, including an increase in skin conductance response and an increase in heart rate (Ekman et al., 1983). Finally, fear involves a characteristic experiential state in which the individual feels scared, nervous, frightened, and apprehensive (Izard, 1977; Watson and Clark, 1992). Fear is a reaction to situations of perceived danger or risk and motivates various behaviors (e.g. flight) that are designed to escape from or eliminate that danger.



The intensity of an emotion depends on a number of variables, which are present in the construal of the situation that gives rise to the emotion in the first place (Ekman, 1994). Ortony et al. (1988) propose that such appraisals are based on three kinds of cognitive structures – goals, standards and attitudes that underlie a given emotional episode. Frijda et al. (1992) distinguish between multiple dimensions of emotional intensity. In particular, the amplitude of a reaction is distinct from its duration. Goal importance may influence the overall emotional impact of a situation through the duration of an emotional reaction, as well as through its momentary amplitude (Sonnemans, 1991). Pfennig et al. (1991) show that the more that a stimulus is relevant to one's goals, the greater the duration of the emotional reactions that result.

Tsai and Young (2004) argue that anger is associated with greater personal control and less situational control than fear, though they often occur in the same situations.<sup>5</sup> The Appraisal Tendency Framework of Lerner and Keltner (2001), suggests that judgment and choice are influenced differently by emotions of the same valence. According to Lerner and Tiedens (2006), the emotions fear and anger differ on the control and uncertainty dimensions. Anger is associated with appraisals of certainty about what has happened and individual control over negative events. Anger can lead to more optimistic risk estimates. Fear on the other hand, is associated with appraisals of uncertainty about what has happened and situational control of negative events. Fear leads to more pessimistic risk estimates. The consequence is that angry people take more risk, whereas fearful people are more risk averse. In a similar vein, Tsai and Young (2010) write “Angry individuals will perceive lower risk inherent in their initial decision, whereas fearful individuals will perceive higher risk inherent in their initial decision, which in turn will lead to different levels of escalation of commitment.” Empirically, Sitkin and Weingart (1995), as well as Lerner and Keltner (2006), find that fear can have a significant influence on judgments of risk. Self-reported anger leads to more risk taking and fear to less risk taking.

Tiedens and Linton (2001) note that, like anger, happiness is accompanied by a feeling of certainty, understanding what is happening in the current situation and feeling able to predict what is going to happen next. If this is the case, then a greater degree of happiness would also lead to more risk taking.

Some previous research has connected emotion to risk-aversion using different methods. Kugler et al. (2012) examine the effects of anger and fear, which were created using exogenous induction procedures, on risk-taking behavior in tasks involving lottery choice as well as a task involving person-based risk with real financial payoffs. They find that fearful participants are more risk averse than angry

---

<sup>5</sup> People typically report becoming mildly to moderately angry anywhere from several times a day to several times a week (Averill, 1982). Ekman (2007) writes “Anger is not an emotion that is felt alone for long. Fear often follows and precedes anger, fear of the harm the target of anger may inflict or fear of one's own anger, of losing control, of inflicting harm.”

participants in lottery choice tasks. Lerner and Keltner (2006) find that happiness induction leads to greater risk taking. Our study differs from these in that emotions are endogenous rather than exogenously induced. Nonetheless, these studies seem to be the closest guide for what we might expect in our experiment, and we use them to advance the following hypotheses.

**Hypothesis 2: Greater fear in segment two correlates positively with more risk-averse decisions in segments three and four.**

**Hypothesis 3: Greater anger in segment two correlates positively with less risk-averse decisions in segments three and four.**

**Hypothesis 4: Greater happiness in segment two correlates positively with less risk-averse decisions in segments three and four.**

To measure the magnitudes of fear, anger, or happiness exhibited in segment two, we the average level of each of the three emotions is registered over the first five seconds of each of the ten trials in the segment. The first five seconds are used because after that time interval, the emotional state can be most plausibly be directly connected to the cue.

## **4. Results**

### **4.1 General Patterns in the Data**

Table 2 shows the levels of anger, fear, surprise, and happiness of individuals, as well as the overall emotional valence, in segment two, averaged across all individuals and trials. The upper panel corresponds to segment 1. Each row denotes one of the five possible payoff levels in a trial, ranging from 1 – 11 Euros. Each column describes valence of one of the emotions. The lower panel reports the data for segment 2. Each row in the panel corresponds to one of the levels of risk that appeared in the segment, with spreads ranging from 2 - 10 Euros. The data in the table are averaged over all of the participants and over the two trials in which the condition was in effect.

In the panel corresponding to segment 2, the asterisks indicate the results of paired difference tests between the conditions described in the same and the row that immediately follows. An asterisk in the row corresponding to payoff level 11 Euros means that the level of the emotion indicated in the column significantly differs from the amount for payoff level 1 Euro. An asterisk in the row for  $\varepsilon = 5$  Euro, indicates that the level of the emotion under  $\varepsilon = 5$  differs from that when  $\varepsilon = 1$  Euro. The row labeled  $\rho$  indicates the correlation between the riskiness of the lottery displayed, as measured by  $\varepsilon$ , and

the average level of emotion that subjects exhibit. The last row of the table, labeled p-value, indicates the level at which the correlation is significantly different from zero.

**Table 2: Average Emotion in Segments 1 and 2 in Response to Different Stimuli**

Segment 1					
Payoff (In Euro)	Valence	Fear	Happiness	Anger	Surprise
1	0.078628936	0.18599725	0.255079247	0.098443811	0.034087778*
3.5	0.050147083	0.185054758	0.261014004*	0.080414694	0.025010994
6	0.057747919	0.158690026	0.23537792	0.058540814	0.016645676
8.5	0.055993111	0.196352394	0.25340451	0.105081731	0.039999087
11	0.072740459	0.183439353	0.269562606	0.084539531	0.030117167
Segment 2					
$\epsilon$ (in Euro)	Valence	Fear	Happiness	Anger	Surprise
1	-0.22238938	0.024992545	0.102318908	0.223266878	0.112041034
2	-0.299467343**	0.039302619	0.048915371**	0.183566308	0.104303184
3	-0.267909967	0.041122629	0.053694732	0.205713879	0.104007311
4	-0.293977323	0.03426188	0.063072217	0.248993622	0.102485191
5	-0.294359032a*	0.05082006	0.055388719a**	0.204790079*	0.087902391a**
rho	-0.082008269	0.055551926	-0.10471856	0.024482639	-0.049246142
p-value	0.159	0.250	0.103	0.383	0.275

\*sig. at 5% level, \*\*sig at 1% level.

The table illustrates the following patterns. The association between the payoff levels in the trials of segment 1 and emotional valence, as well as with the specific emotions of fear, happiness, anger, and surprise, is weak and inconsistent, though surprise is greater when the smallest possible payoff is presented. For segment 2, a decrease from the second lowest to the lowest possible level of risk triggers an increase in happiness and in valence. Valence and happiness are significantly greater for the lowest level of risk than for the second lowest, while anger and surprise are lower. However, the data in the row labeled  $\rho$  reveal that none of the emotions are correlated with risk on an overall basis.

The behavioral data from segment three are shown in table 1 and those from segment four are illustrated in figure 1. The data in table 1 show that individuals are more likely to choose the risky alternative, the greater its expected value and the lower its variance. The distribution of decisions, shown in figure 1, reveals that most individuals are risk averse, in that they make more than four safe choices. Indeed, only 13.3% of individuals are risk neutral or risk seeking, while 86.7% are risk averse. The average number of safe choices is 6.13, which is modestly greater, though comparable, to the typical level that is found in previous studies (see for example Holt and Laury, 2002).

We now turn to the relationship between emotions in segment two and decisions in segments three and four. Figures 2 – 4 relate the emotions of fear, anger and happiness to decisions in segment four. The horizontal axes indicate the intensity with which an individual’s facial expression reflects the emotion in question. In figures 2 and 3, this is expressed in terms of natural logarithm to make the data points more distinguishable. Those individuals who express the emotion most strongly are given toward the right of the figures. The vertical axes indicate the number of safe choices in segment four.

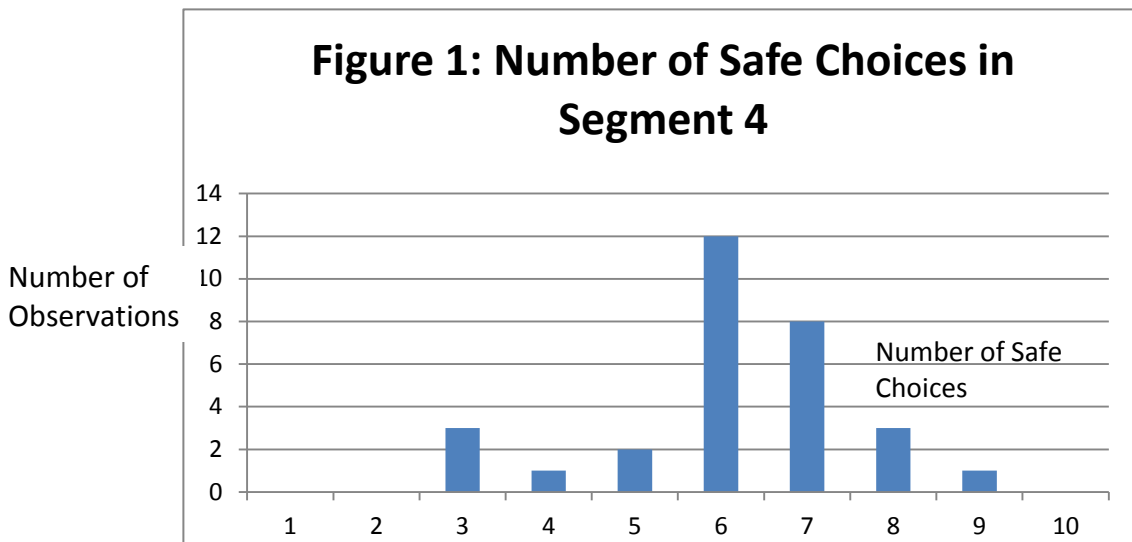


Figure 2 indicates that the level of fear exhibited in section two is correlated with the number of risk-averse decisions in segment four, for both men and women. The more fear exhibited in segment two, the more risk averse decisions are in segment four. This pattern is consistent with hypothesis 2. Figure 3 suggests that happiness is uncorrelated with risk aversion for women, but positively correlated for men, which runs counter to hypothesis 3. Figure 4 shows no strong relationship between anger and risk aversion, for either gender. In figures 4 and 5, the emotional variables are expressed as logarithms of the facereader output, for the sake of visual clarity.

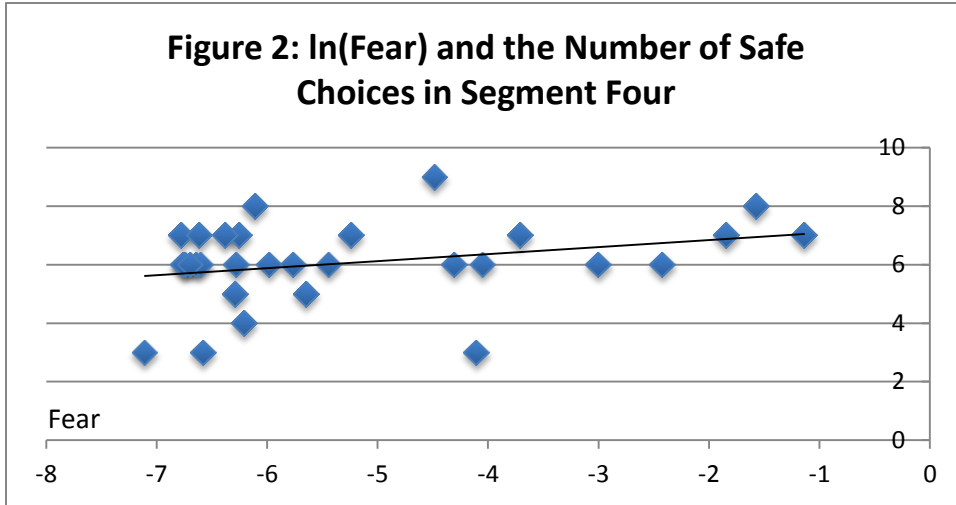
#### 4.2. Tests of Hypotheses

We now consider the hypotheses advanced in section two more rigorously, by estimating a number of regression specifications in which a number of other factors that might influence decisions are controlled for. The results are given in table 3. In the first three columns, the dependent variables are whether a safe or risky choice was made in segment 3. Each decision in each segment by each subject is an observation, for a total of 300 observations. Probit specifications are used in these equations, and

errors are clustered by subject. The remaining columns of table 3 report estimates for the data of segment 4. The columns contain data from Poisson count regressions, in which the number of safe choices in segment 4 of each individual is the dependent variable, so that there are a total of 30 observations, one for each subject.

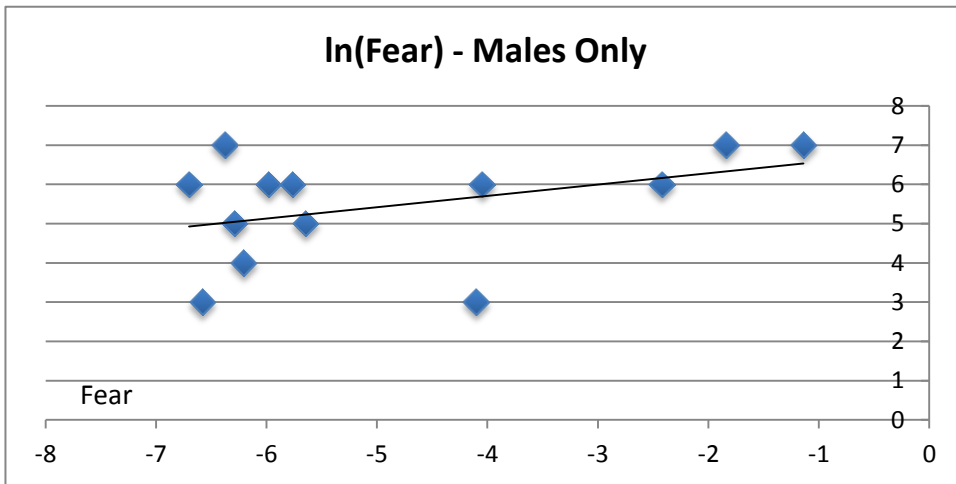
The sample used in a regression is either all participants, or only the subsets of male or female participants. In specifications in which all participants are used, gender is included as an independent variable. This is done because gender is a known determinant of risk aversion, with women being more risk averse than men (Eckel and Grossman, 2008). Because gender may interact with the other emotions, we estimate models with both genders separately, in addition to for the pooled data. The independent variables of valence and the individual emotions are the average values over the totality of segment two.  $FS2 - FS1$  is the difference in average fear between segments one and two, where all trials in each of the segments are used in computing the average.  $FS2 - FS1$  measures the change in fear when risky payoffs are displayed over when certain payoffs are.  $EPRisky\_EPSafe$  is the difference in expected payoff between the safe and the risky options in segment 3.  $Variance\_Risky$  indicates the variance of the risky option in segment 3.

**Figure 2:  $\ln(\text{Fear})$  and the Number of Safe Choices in Segment Four**



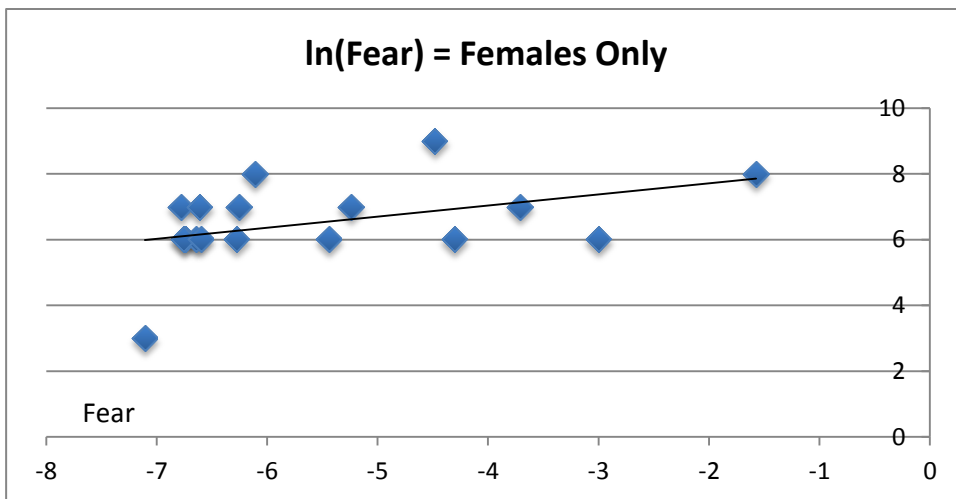
Number of safe choices, segment 4

**$\ln(\text{Fear})$  - Males Only**



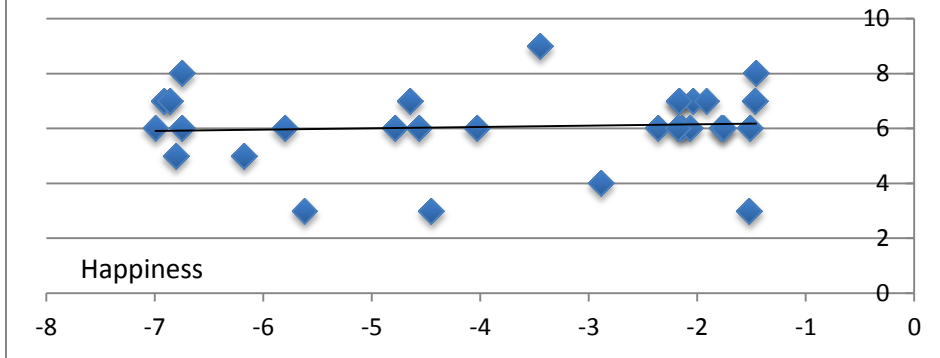
Number of safe choices, segment 4

**$\ln(\text{Fear})$  = Females Only**



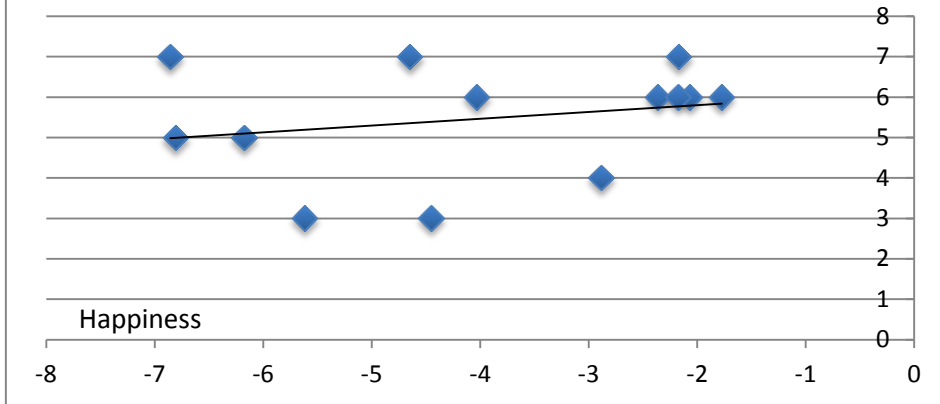
Number of safe choices, segment 4

**Figure 3: In(Happiness) and the Number of Safe Choices in Segment Four**



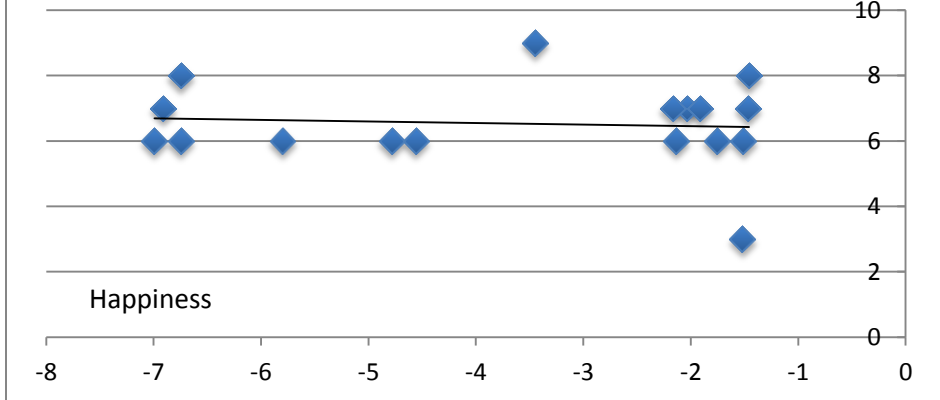
Number of safe choices, segment 4

**In(Happiness) - Males Only**



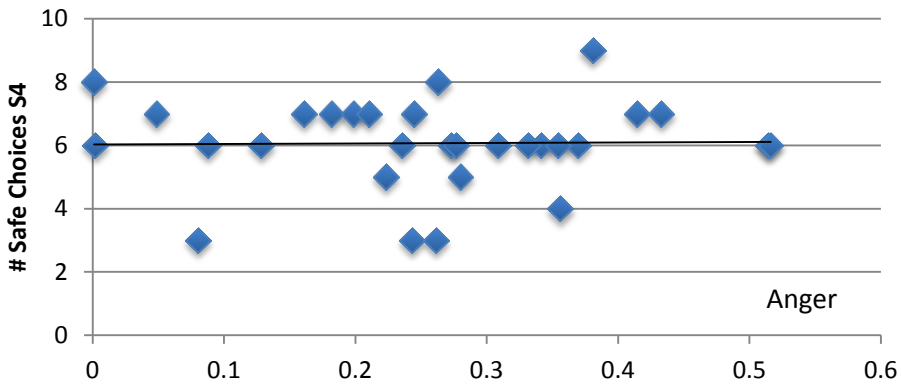
Number of safe choices, segment 4

**In(Happiness) - Females Only**

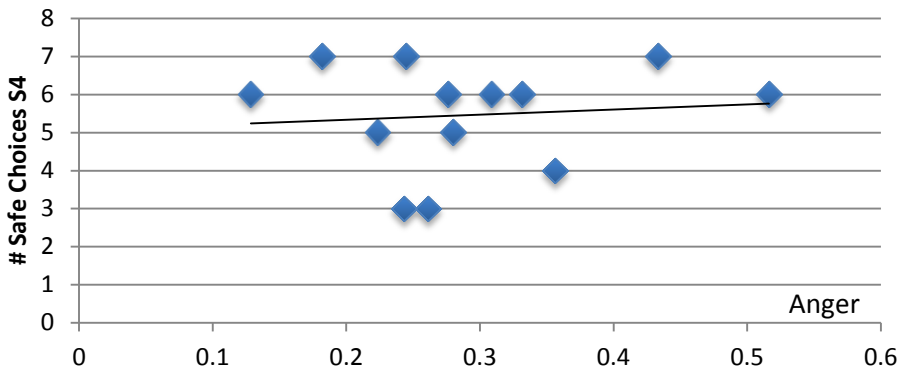


Number of safe choices, segment 4

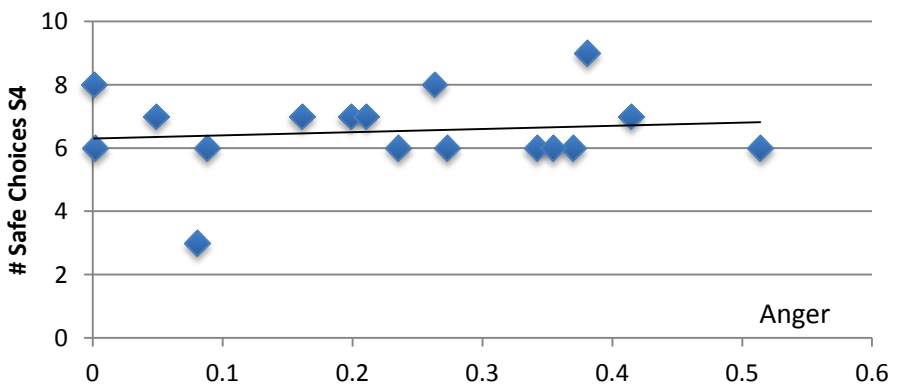
**Figure 4: Anger and the Number of Safe Choices in Segment Four**



**Anger - Males Only**



**Anger - Females Only**





**Table 2: Emotions, Gender, and the Number of Safe Choices in Segments Three and Four**

Independent Variable	Safe Choices S3	Safe Choices S3	Safe Choices S3	Safe Choices S4	Safe Choices S4	Safe Choices S4	Safe Choices S4	Safe Choices S4	Safe Choices S4, Females Only	Safe Choices S4, Males Only
<b>Valence</b>	-.610 (.395)*							-2.66*** (.331)		
<b>Gender</b>	.145 (.210)	-.060 (.262)	-.214 (.311)	.675* (.192)	.671* (.184)	1.127*** (.145)	.752*** (.173)	.586*** (.159)		
<b>Fear</b>		-.258 (1.164)	-1.991 (1.518)	1.034 (.870)			1.962*** (.780)		5.025*** (1.914)	.647 (.896)
<b>Happiness</b>		1.283 (1.707)	-1.482 (1.532)	1.942** (1.161)	2.865* (1.205)		2.875*** (1.017)	4.242*** (1.007)	5.066*** (.903)	2.849 (3.570)
<b>Anger</b>		1.258* (.706)	1.231 (.890)	4.052* (.624)	2.773* (.791)		4.053*** (.485)	2.360*** (.773)	5.548*** (.444)	5.349*** (.772)
<b>Disgust</b>			-.449 (1.298)	.503 (.791)	-.283 (.817)					
<b>Sadness</b>			-.666 (1.472)	-.130 (.889)	-.731 (.919)					
<b>Surprise</b>			3.465** (1.270)	1.708* (.749)	1.450* (.705)					
<b>FS2_FS1</b>					1.276** (.4345)			1.342*** (.372)		
<b>FS2</b>										
<b>EPrisky_EPsafe</b>			1.545*** (.294)							
<b>Variance Risky</b>			-.024*** (.005)							

\*significant at 5% level, \*\*significant at 1% level

The table reveals a number of interesting patterns. Recall that hypothesis 1 asserted that positive valence was negatively correlated with risk-averse decisions. The first and sixth regressions in the table indicate that the effect of valence on the number of safe choices is significantly negative, supporting for the hypothesis. If these two regressions are conducted without gender included in the specification, the results are similar. Therefore, we find strong support for hypothesis one.

The absolute level of fear exhibited in segment two is a positive and significant explanatory variable for the number of safe choices in segment four for the whole sample of participants, as well as for females considered separately. An increase in the level of fear of .113 corresponds to increasing the number of safe choices from 4 to 5. An increase of .0903 is sufficient for an increase from 5 to 6 safe choices. For males, the coefficient is positive, though not significant. Furthermore, the variable FS2\_FS1, which measures the increase in fear an individual expresses during segment two compared to segment one, is positive and significant. Fear is not a significant explanatory variable for segment three. On balance however, we find support for hypothesis two, that the level of fear an individual expresses when presented with risky lotteries predicts how risk averse her subsequent choices will be.

Happiness is a significantly positive correlate of the number safe choices in segment four. Increases in happiness of .078 and .063 are associated with changes from 4 to 5 and 5 to 6 safe choices respectively. Thus, we soundly reject hypothesis three, which asserts that happiness correlates negatively with risk aversion. Anger<sup>6</sup> follows a similar pattern. It has a positive and significant coefficient in almost all specifications, including for segment three, in which it is the only emotion that is significant. In segment 4, increases of .055 and .045 in anger are associated with differences between 4 and 5, and 5 and 6 safe choices respectively. Therefore, we also reject hypothesis four.

Greater surprise predicts more risk-averse decisions in both segments three and four. The fact that a facial expression of surprise is a good predictor of decisions suggests one of two possible interpretations: The first is that it is a relevant emotion that predicts decisions in many situations. This is plausible since, unlike anger, fear, and happiness, its role in risky decision making has not been explored other than as a reaction to an outcome (Berns et al, 2008; Mellers, 2013). The second interpretation is that the facial expression that Facereader classifies as surprise may reflect a different emotion, other than the universal emotions, which is correlated with risk attitude.

The facial expressions are better predictors of decisions in segment four than in segment three. This is somewhat surprising since the format of segment two is more similar to segment three than to four. Segment three also occurred at a moment closer in time to the facial expression measurement than segment four. We do not yet have a satisfactory explanation for the difference in the predictive power of facial expressions between segments three and four. Nevertheless, as indicated in table 3, decisions in segment three do have the features that they trade off mean and variance in a manner reflecting risk averse decision making. The greater the mean payoff of the risky lottery compared to the sure payment,

---

<sup>6</sup> It has been claimed that when an individual is concentrating on a task, that his expression is similar to that when angry (Zaman and Shrimpton-Smith, 2006). This would mean that Facereader would not be able to distinguish between anger and concentration.

the more likely it is to be chosen, while the greater the variance of the payoff of the risky lottery the less likely it is to be selected.

## 5. Conclusion

In this study, we have introduced a new methodology, face reading, to economics. We have applied it to a simple question: can facial expressions in reaction to the presentation of lotteries, when fitted to psychological constructs such as anger, fear and happiness, predict the level of risk aversion an individual exhibits? We obtain two principal conclusions.

The first conclusion is that *more positive emotional valence is associated with greater risk tolerance*. This pattern is consistent with the affective generalization hypothesis, under which positive emotions promote more risk taking. This remains the case if we control for gender, where we replicate the result that women are more risk averse than men. This positive relationship between risk tolerance and emotional state can account for the relationship between positive emotion and asset prices (Andrade et al. 2012; Lahav and Meer, 2010; Hargreaves-Heap and Zizzo, 2012), and the relationship between risk aversion and high bids in first-price sealed bid auctions (Bosman and Riedl, 2003).

The second is that *stronger emotions are associated with more risk-averse decision making*. Greater fear, anger, happiness and surprise are all significant predictors of risk-averse decisions. All of these emotions are associated with more risk aversion. Those who remain relatively emotion-free when presented with lotteries, make decisions closer to risk neutrality. Nevertheless, after controlling for emotional state, women remain more risk averse than men. This means that differences in emotion do not account for the often observed gender difference in risk-aversion.

The finding that anger and happiness correlate with more risk averse decisions does run counter to some of the previous studies discussed in section two, and the discrepancy may be accounted for by the very different protocols and methods of measuring emotions. Nonetheless, our findings, along with those of many other studies, underscore the connection between emotions and economic decisions. In our view, the fact that risk aversion can be predicted in the absence of choice with face reading software is especially interesting. This ability may be useful for the design of financial products and investment vehicles, since it can reveal at minimal cost, which individuals might be suited for relatively low-and high-risk products.

## References

Arkes H.R., Herren L.T., Isen A.M., 1988. The role of potential loss in the influence of affect on risk-taking behavior. *Organizational Behavior and Human Decision Processes*, 42: p. 181-193

- J. Averil, 1982. *Anger and Aggression: An essay on emotion*. Springer-Verlag, New York.
- Bechara A., 2004. The role of emotion in decision-making: Evidence from neurological patients with orbitofrontal damage. *Brain and Cognition*, p. 30-40
- Berns, G., C. M. Capra, S. Moore, and C. N. Noussair, 2008. Neurobiological regret and rejoice functions for aversive outcomes, *Neuroimage* 39, 4, p. 1472 – 1484.
- Bruyneel S.D., Dewitte S., Frances P.H., Dekimpe M.G., 2009. I felt low and my purse feels light: Depleting mood regulation attempts affect risk decision making. *Journal of Behavioral Decision Making*, vol. 22: p. 153-170.
- Capra, C. M., 2004. Mood-driven behavior in strategic interactions, *American Economic Review* 94, 2, p. 387 – 372.
- Clore G.L., Ortony A., 1991. What more is there to emotion concepts than prototypes. *Journal of Personality and Social Psychology*, 60: p. 48-50
- Coget J.F, Haag C., Gibson D.E., 2011. Anger and fear in decision-making: The case of film directors on set. *European Management Journal*, vol. 29: p. 476-490
- DeSteno D., Petty R.E., Rucker D.D., Wegener D.T., 2000. Beyond Valence in the Perception of Likelihood: The Role of Emotion Specificity. *Journal of Personality and Social Psychology*, vol. 78:3, p. 397-416
- Eckel C. and P. Grossman. 2008. Men, Women and Risk Aversion; Experimental Evidence, in Handbook of Experimental Economic Results, Elsevier Publishers.
- Ekman, P., W.V. Friesen, (1975). *Unmasking the Face*. Englewood Cliffs, NJ: Prentice-Hall, New Jersey.
- Ekman P., Levenson R.W., Friesen W.V., 1983. Autonomic nervous system activity distinguishes between emotions. *Science*, 221: p. 1208-1210
- Ekman P., Friesen W.V., 1986. A new pan cultural expression of emotion. *Motivation and Emotion*, 10: p. 159-168
- Ekman, P., R.J. Davidson, 1994. *The Nature of Emotion: Fundamental Questions*. Oxford University Press, New York.
- Ekman P., 1994. Strong evidence for universals in facial expressions: A reply to Russell's mistaken critique. *Psychological Bulletin*, 115: p. 268-287
- Ekman, P., W.V. Friesen, J.C. Hager (2002), *The Facial Action Coding System*. Weidenfeld & Nicolson, London.
- Ekman, P. (2007), *Emotions Revealed. Second Edition: Recognizing Faces and Feelings to Improve Communication and Emotional Life*. Henry Holt and Company, New York.
- Elster J., 1998. Emotions and Economic Theory. *Journal of Economic Literature* 36: p. 47-74

- Fessler D.M.T., Pillsworth E.G., Flamson T.J., 2004. Angry men and disgusted women: An evolutionary approach to the influence of emotions on risk taking. *Organizational Behavior and Human Decision Processes* 95: p. 107.
- Forgas J.P., 1995. Mood and judgment: The affect infusion (AIM). *Psychological Bulletin*, vol. 117: p. 39-66.
- Holt C., and S. Laury, 2002. Risk Aversion and Incentive Effects, *American Economic Review* 92, 5, p 1644 – 1655.
- Isen A.M., Patrick R., 1983. The effect of positive feelings on risk taking: When the chips are down. *Organizational Behavior and Human Decision Processes*, 31: p. 194-202
- Isen, A.M., 1997. Positive affect and decision making. In: Goldstein,W.M., Hogarth, R.M. (Eds.), *Research on Judgment and Decision Making*. Cambridge University Press, Cambridge, UK
- Izard C., 1994. Innate and universal facial expressions: Evidence from developmental and cross-cultural research. *Psychological Bulletin*, 115: p. 288-299
- Johnson E.J., Tversky A., 1983. Affect, generalization, and the perception of risk. *Journal of Personality and Social Psychology*, 45: p. 20-31
- Kring A.M., 2000. Gender and Anger. In A.H. Fischer (Ed.), *Gender and emotion: Social psychological perspectives. Studies in emotion and social interaction*. Second series, p. 211-231. Cambridge University Press, New York.
- Kugler T., Connolly T., Ordonez L.D., 2012. Emotion, Decision, and Risk: Betting on Gambles versus Betting on People. *Journal of Behavioral Decision Making*, 25: p. 123.
- Lerner J.S., Keltner D., 2001. Fear, Anger and Risk, *Journal of Personality and Social Psychology*, 81, 1. 146-159
- Lerner J.S., Small D.A., Loewenstein G., 2004. Heart strings and purse strings: Carryover effects of emotions on economic decisions. *Psychological Science*, 15: p. 337-341
- Lerner J.S., Keltner D., 2006. Portrait of the angry decision maker: How appraisal tendencies shape anger's influence on cognition. *Journal of Behavioral Decision Making*, 19: p. 115-137
- Lerner J.S., Tiedens L.Z., 2006. Portrait of the Angry Decision Maker: How Appraisal Tendencies Shape Anger's Influence on Cognition. *Journal of Behavioral Decision Making*, 19: p. 115-137
- Loewenstein G., Lerner J.S., 2003. The role of emotion in decision making. In Davidson R., Scherer K., Goldsmith H. (Eds.), Handbook of affective science, p. 619-642
- Lopes L.L., 1987. Between Hope and Fear: the Psychology of Risk. *Advances in Experimental Social Psychology*, 20: p. 255
- Mellers B., K. Fincher, C. Drummond, and M. Bigony (2013). Surprise: A Belief or an Emotion? In Decision Making Neural and Behavioural Approaches, V. S. Chandrasekhar Pammi and N. Srinivasan eds. Elsevier Publishers, Vol. 202 p. 3 – 19.

- Mano H., 1992. Judgments under distress: Assessing the role of unpleasantness and arousal in judgment formation. *Organizational Behavior and Human Decision Processes*, 52: p. 216-245
- Noldus L.P.J.J., Grieco F., Loijens L.W.S., Zimmerman P.H., 2005. The FaceReader: Online facial expression recognition. *Proceedings of Measuring Behavior*, p. 589-590
- Nygren T.E., Isen A.M., Taylor P.J., Dublin J., 1996. The influence of positive affect on the decision rule in risk situations: Focus on outcome (and especially avoidance of loss) rather than probability. *Organizational Behavior and Human Decision Processes*, 66: p. 59-72
- Reisenzein R., 2000. Exploring the Strength of Association between the Components of Emotion Syndromes: The Case of Surprise. *Cognition & Emotion*, 14:1, p. 1-38
- Russel J.A., 1994. Is there universal recognition of emotion from facial expression? A review of cross-cultural studies. *Psychological Bulletin*, 115: p. 102-141
- Rusting C.L., Nolen-Hoeksema S., 1998. Regulating responses to anger: Effects of rumination and distraction on angry mood. *Journal of Personality and Social Psychology*, 74: p. 790-803
- Scherer K.R., Tannenbaum P.H., 1986. Emotional experiences in everyday life: A survey approach. *Motivation and Emotion*, vol. 10: p. 295-314
- Sitkin S.B., Weingart L.R., 1995. Determinants of risky decision-making behavior: A test of the mediating role of role perceptions and propensity. *Academy of Management Journal*, vol 38: p. 1537-1592
- Tiedens L.Z., Linton S., 2001. Judgment Under Emotional Certainty and Uncertainty: The Effects of Specific Emotions on Information Processing. *Journal of Personality and Social Psychology*, vol. 81:6, p. 973-988
- Tsai M.H., Young M.J., 2010. Anger, fear, and escalation of commitment. *Cognition and Emotion*, 24:6, p. 962-973
- Den Uyl M.J., van Kuilenburg H., 2005. The FaceReader: Online facial expression recognition. *Proceedings of Measuring Behavior*, p. 589-590
- Zaman B., Shrimpton-Smith T., 2006. The FaceReader: Measuring instant fun of use. *NordiCHI*, p. 457-460