Rational Emotions

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Abstract

We present here the concept of rational emotions: emotions may be directly controlled and utilized in a conscious, analytic fashion, enabling an individual to size up a situation, determine that a certain "mental state" is strategically advantageous and adjust accordingly. Building on the growing body of literature recognizing the vital role of emotions in determining decisions, we explore the complementary role of rational choice in choosing emotional states. Participants played the role of "recipient" in the Dictator Game, in which an anonymous "dictator" decides how to split an amount of money between himself and the recipient. A subset of recipients was given a monetary incentive to be angry at low-split offers. That subset demonstrated increased physiological arousal at low offers relative to high offers as well as more anger than other participants. These results provide a fresh outlook on human decision-making and contribute to the continuing effort to build more complete models of rational behavior.

Introduction

Classical models of social decision-making, developed within the framework of game theory, assumed individuals are purely rational beings, striving to maximize their absolute gains. However, this is not always the case, as was compellingly demonstrated by the failure of these models to predict actual human behavior in elementary games (Roth, 1995; Sanfey & Dorris, 2008). Consequently, new models have been proposed, in which individuals are assumed to care about other players' payoffs in addition to their own, taking into consideration specific factors such as inequity and reciprocity (Fehr & Schmidt, 1999; Bolton & Ockenfels, 2000; Rabin, 1993; Nowak, Page & Sigmund, 2000; Camerer & Fehr, 2006). At the same time, emotion and decision research revealed that emotions play a vital role in determining decisions, and began unveiling the involved neural circuits (Bechara, Damasio, Tranel & Damasio, 1997; Sanfey, Rilling, Aronson, Nystrom & Cohen, 2003; Bechara & Damasio, 2005; Sanfey, 2007; Weller, Levin, Shiv & Bechara, 2009; Boskem & De Cremer, 2010).

"Mental equilibrium" is a recently proposed model that is based on these findings and suggests a more global approach (Winter, Garcia-Jurado, Mendez-Naya 2010). While assuming, as classical models do, that individuals care only about their own monetary payoff, it is nonetheless capable of explaining human behavior in various game settings. A hallmark of the model is the assumption that individuals are capable of choosing their own "mental states," adjusting their emotions (e.g., feelings of anger) and preferences (e.g., preferences for fairness). This mental state can be observed by others and thus serve as a "commitment device," locking the individual into a certain course of action (Yamagishi et al., 2009). When all players are endowed with this capability, a "mental equilibrium" can be established in which each individual can maximize his gains by choosing a particular mental state. Specifically, the model brings forward the concept of rational emotions: with the appropriate monetary incentives, an individual can analyze a given situation and respond strategically by genuinely entering a mental state. Thus, an individual can consciously and directly control his emotions, thereby creating a situation in which these emotions affect his decision-making processes in a way that is beneficial to him.

Kahneman and Frederick (2002) partitioned thought processes into two categories, generically named "system 1" and "system 2". An elegant addition to the long chain of "dual processes" theories of cognition, this partition characterizes "system 1" as automatic, effortless, and operating on affective content, as opposed to the controlled and analytic "system 2." This type of distinction is useful in articulating an important property of the current work, namely, that we focus on the issue of exercising cognitive control over emotions, and in particular the deliberate generation of affect. We are not concerned with the immediate valuation and response to affective content mediated by "system 1"; rather, we are interested in the slower, deliberate emotional reaction that is mediated by "system 2."

The Present Study

To explore this notion of conscious tuning of mental states, we used a variation of the Dictator Game (DG) (Forsythe, Horowitz, Savin & Sefton, 1994). As in the original game, a "dictator" was asked to decide how to split an amount of money between himself and a "recipient." However, in this version, recipients were given incentives to feel specific emotions when presented with high or low offers. Recipients' physiological arousal was monitored during the presentation of offers which were collected in advance from dictators. In addition, participants answered post-game questionnaires designed to capture the nature of their emotions. We hypothesized that participants would react to the monetary incentives by developing the appropriate feelings. These would be manifested in (a) higher arousal in the face of relevant offers[1] (Marci, Glick, Loh & Dougherty, 2007), (b) self-reports of heightened emotions during the presentation of relevant offers and immediately after the game, and (c) increased punitiveness in “angry” participants.

Method

Participants

A total of 106 participants were recruited through advertisements in the Hebrew University campus at Mt. Scopus and via the Dept. of Psychology's on-line subject recruitment system. The final sample consisted of ninety subjects (27 males) with a mean age of 24.5 (S.D. 3.8). Technical problems prevented the collection of physiological data from 16 participants, who were excluded from all analyses. Participants received either 10 NIS (≈ $2.50) or academic credit as participation fee.

Stimuli

DG offers were collected in advance from 42 students of Hadassah College Jerusalem who played the role of "dictators". Each indicated how he would split a sum of 10 NIS between himself and an anonymous recipient. Four offers (10, 5, 3, & 0 NIS) were used as stimuli and the average offer (4.5 NIS) was made known to participants.

[1] For "angry" participants: an increase in both autonomic measures used (skin conductance and heart rate). For "happy" participants: an elevation in heart rate only.

Procedure

Participants played the role of recipients in a DG variant. They were randomly assigned to three different treatments (n=30 in each) and were given incentives to feel specific emotions when presented with high or low split offers. “Angry” participants were given a bonus of up to 5 NIS (≈ $1.20) for feeling angry when presented with low offers. “Happy” participants were similarly rewarded for feeling happy when presented with high offers. A third group of “calm” participants was rewarded for remaining calm in the face of all offers. The reward to “Calm” participants was offered in order to avoid differences in arousal due to passivity. A constant voltage (0.5V) system (Atlas Researches, Hod-Hasharon) recorded Skin Conductance Level (SCL) and ECG while offers were presented.

Skin Conductance Responses (SCRs), defined as the largest increase in SCL within a time window were extracted from the SCL measurement. SCR amplitude (in μSiemens) and latency (defined as the time, in seconds, until the beginning of the SCR) were computed for a “long” time window (LW), 0-12s after offer presentation onset, and a "short" time window (SW), 1-5s after offer presentation onset. Heart rate (mean BPM) was extracted from the ECG signal recorded in the 0-12s (“long”) time window. Subsequently, a difference score Δ for each participant was computed by subtracting the responses to low offers from the responses to high offers.

Participants were informed that their bonus would be computed based on the physiological data collected during the game. Participants in the “angry” and “happy” conditions received full bonus (5 NIS) if larger SCR amplitude (LW) and increased HR were recorded during low/high offers than during all other offers. If increased responses were observed in only one of these measures, participants received a partial bonus (2 NIS, ~0.5$), otherwise they received no bonus. In the “Calm” condition, subjects received the full bonus if their HR during low (≤3) and high (≥5) offers were within ±1 BPM of each other, partial bonus if they were within ±2 BPM of each other, and no bonus otherwise.

After reading the rules of the game participants were connected to the electrodes and left alone in the room in front of a 17" CRT computer screen for the duration of the game. Six offers were presented to each participant. Responses to the first offer (5NIS, equal split), used to familiarize the participants with the mechanism, were omitted from all analyses. The rest of the offers were presented in random order. Participants were informed that, in addition to the bonuses and a participation fee, they would be paid the amount of money offered to them in two randomly selected offers.

Afterwards, the participants were left alone in another room and asked to fill out a short questionnaire, which would not affect their payoff. The questionnaire included two vignettes, adapted from Lerner, Goldberg & Tetlock (1998) and Hamilton & Sanders (1981), titled "Case: Used Car Salesman" and "Case: Construction Worker". Both vignettes described a harm resulting from the negligence of a person, with the first describing monetary harm to an anonymous costumer and the second hypothetical bodily harm to the participant himself. Following each vignette, participants completed five Likert 7-point scales ranging from 1 to 7, assessing their punitiveness toward the worker described in the vignette, as described in the abovementioned papers. The items were collapsed across each vignette to create two independent punitive measures with a Cronbach's alpha of 0.81 for the first vignette and 0.92 for the second. The results of these scales were used as proxies for participants' level of anger, in accordance with the finding of Lerner, Goldberg & Tetlock (1998) that, relative to neutral emotion, anger activated more punitive attributions (e.g. amount of blame) and harsher punishment. Finally, participants were asked direct questions about their emotions and attention level at the moment of answering and throughout the game.

Results

Psychophysiological measures

A one-way analysis of variance (ANOVA) of Skin Conductance Response (SCR) amplitude revealed a significant effect of condition in the "long" time window (LW: $F(2,87) = 7.914$, $P=0.001$, SW: $F = 2.997$, $P=0.055$). Pairwise comparisons showed that "angry" participants responded more strongly to low offers than to high offers, relative to both "calm" (LW: $P<0.006$, Bonferroni corrected) and "happy" participants (LW: $P=0.001$). A one-way ANOVA of SCR latency revealed a significant effect of condition for both the "long" and "short" time windows (LW: $F = 7.470$, $P = 0.001$, SW: $F=4.439$, $P=0.015$). Pairwise comparisons showed "angry" participants responded more slowly to low offers than to high offers, relative to "happy" participants (LW: $P=0.001$, SW: $P=0.023$, Bonferroni corrected). However, the difference between the response latencies of "angry" and "calm" participants only approached significance (LW: $P=0.064$, SW: $P=0.057$). Moreover, an analysis of heart rate revealed a significant effect of condition (LW: $F(2,87) = 9.851$, $P<0.001$). Pairwise comparisons showed "angry" participants' HR was more elevated in low offers than in high offers, relative to both "happy" ($P<0.001$, Bonferroni corrected) and "calm" participants ($P=0.003$). A summary of these findings is displayed in Fig. 1. Notably, across the board, no statistically significant differences were found between the responses of “happy” and “calm” participants ($P>0.4$).

Fig. 2 displays the average response during the presentation of all offers. The results of an ANOVA performed on these data were similar to those mentioned above.

Post-game questionnaires

As expected, “angry” participants were found to be more punitive according to the first punitiveness measure ($N=30$, $M=5.69$, $SD=0.95$) than were “calm” and “happy” participants ($N=60$, $M=5.28$, $SD=1.19$). The difference was statistically significant (t-test, $P<0.05$, one-tailed). However, this result was not replicated in the second measure (“angry”: $M=5.20$, $SD=1.38$, “calm” and “happy”: $M=4.93$, $SD=1.48$, t-test, $P>0.2$, one-tailed).

“Angry” participants’ reported feeling levels of anger after the game ($M=3.43$, $SD=1.85$) were higher than those of other participants ($M=2.17$, $SD=1.51$). The difference was significant (t-test, $P=0.001$, one-tailed). However, “happy” participants’ happiness level after the game ($N=30$, $M=4.33$, $SD=1.27$) was undifferentiated from that of other participants ($N=60$, $M=4.33$, $SD=1.53$), (t-test, $P>0.9$, one-tailed). There was also no effect of condition on participants’ reported level of concentration (one-way ANOVA, $F(2,87) = 0.389$, $P>0.6$). This lasting anger of “angry” participants fits well with previous research associating anger with considerable cognitive carryover effects, which include a lasting impact on a wide range of judgments and decisions (Larsen, 2000). In addition, “angry” participants reported feeling more angry at low offers ($M=3.73$, $SD=1.86$) than other participants ($M=2.62$, $SD=1.42$). The difference was significant (t-test, $P=0.003$, one-tailed). Conversely, “happy” participants’ reported level of happiness when presented with high offers (M=5.37, SD=1.27) was not significantly higher than that of other participants (M=5.07, SD=1.79), (t-test, P>0.1, one-tailed). A summary of these findings is displayed in Fig. 3.

Discussion

Taken together, our results show that "angry" participants felt more anger than other participants when presented with low offers in the DG, developing a "rational emotion" that influenced their cognitive processes even after the game was over. Impressively, they managed to rapidly up- and down-regulate their level of arousal at will, summoning the affective reaction as needed. However, these findings generally did not extend to other participants, who responded in the same way to "low" and "high" offers. Thus, we provide evidence for a primary link in the chain of events leading to an emotionally influenced decision, namely, the decision to enter consciously an emotional state.

Emotions have been shown to play an important role in shaping economic decisions. For instance, anger has been found to underlie "altruistic punishment" in the public goods game, in which the group benefits the most when all participants cooperate. Individuals punish those who do not cooperate, even when the punishment is costly to them and yields no material gain (Fehr & Gächter, 2002). Angry people have also been demonstrated to choose economically inferior 'long shot' gambles over superior 'safe-bet' gambles (Leith & Baumeister, 1996). The notion that emotion may be regulated in a conscious manner is well grounded in the psychological literature, though little work was published on the generation of emotions outside the context of expectations (Larsen, 2000; Ochsner & Gross, 2005; Gross & Thompson, 2007; Delgado, Gillis & Phelps, 2008).

Emotions may be manipulated indirectly, for example when a person recalls emotionally laden life events (George et al., 1995, 1996). However, emotions are often characterized as resistant to direct cognitive control, unlike actions and thoughts (Baumeister, Vohs, DeWall & Zhang, 2007). Typically, the emotional response has been characterized as impulsive, regulated – if at all – only when already in progress. A prominent example is the influential "somatic marker hypothesis," which contends that bodily states and immediate emotional responses play a fundamental role in driving choice behavior (Bechara & Damasio, 2005). Our results indicate the opposite may also be true: rational processes may play an important role in directing that same emotional response.

Previous studies have shown that the outward expression of emotion, anger in particular, may be used strategically by an individual to gain an edge, for example in bargaining (Sinaceur & Tiedens, 2006). Furthermore, Tamir and colleagues have recently shown that, when a certain emotional state may help subjects achieve a certain goal, they prefer engaging in an activity likely to bring them to that emotional state (Tamir, Mitchell & Gross, 2007; Tamir, 2009). We show that such adjustment, complete with physiological components, can be achieved in a direct manner and demonstrated in a standard game setting. Thus, another level of complexity is added to the interplay of emotional and rational processes.

Importantly, while "angry" participants successfully maximized their reward by acting according to the monetary incentive and getting the bonus, "happy" participants did not. Admittedly, measurements of arousal may capture anger better than happiness: the increase in HR that has been associated with happiness is weaker than that associated with anger, and no effect on SCR was expected (Larsen, 2000). However, “happy” participants' written reports also did not reveal increased happiness. Before turning to possible explanations of these findings, we wish to point out that this lack of physiological response provides support for the internal validity of the measurement, which reflects a genuine state rather than participants' attempts to "cheat" (i.e. use techniques to artificially increase their arousal).

One way to account for the lack of symmetry between “angry” and “happy” participants' responses is to consider Kahneman and Tversky’s influential prospect theory, according to which losses loom larger than gains (Kahneman & Tversky, 1979). Participants may have referred to the average offer (4.5NIS) as a reference point, considering lower offers as “losses” and higher offers as “gains.” Consequently, they were more sensitive to low offers and became more easily emotional about them. Indeed, negative emotions have previously been associated with receiving low offers in the related Ultimatum Game (Guth, Schmittberger, & Schwarze, 1982; Pillutla & Muringhan, 1996; van't Wout, Kahn, Sanfey & Aleman, 2006; Chapman, Kim, Susskind & Anderson, 2009). Moreover, reactions to unfair UG offers have been associated with increased activation in brain areas including the anterior insula, which has been associated with negative emotions and autonomic arousal (Sanfey, Rilling, Aronson, Nystrom & Cohen, 2003; Critchley, Elliot, Mathias & Dolan, 2000). Pillutla and Muringhan (1996) concluded that although anger did not predict all of the rejections in their UG experiment, the similarity of anger and rejection results emphasized anger's importance in subjects' decisions.

Another possible explanation for this asymmetry is that the development and demonstration of negative emotions, anger in particular, is constantly inhibited (for example, by social norms) and that in our experiment, only “angry” participants were given a (socially legitimate) reason to relax their control and succumb to anger. Hence, it is only ongoing emotion regulatory processes, rather than the plethora of possible mental states, that may be consciously controlled in a given situation. An important conclusion from these analyses is that the ability to choose and enter a mental state may be limited, with deviations from a certain “menu” of available emotional options being difficult or even impossible.

Finally, this work may be viewed as a preliminary “proof of concept” of rational emotions. For now, important questions such as the scope of the concept, the neural correlates associated with it, and its implications beyond the theoretical framework of “mental equilibrium” remain open.

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Figures

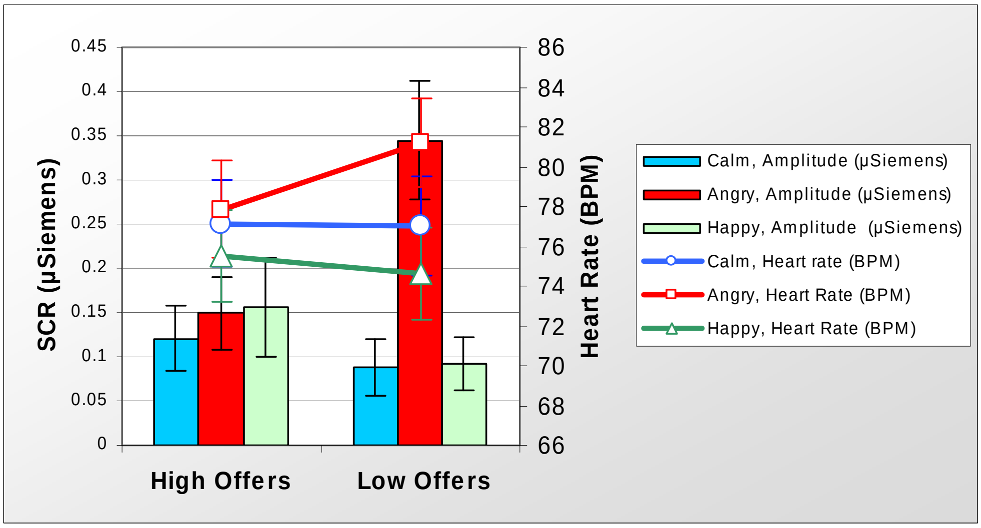

Figure 1: Skin Conductance Response (SCR) amplitude and Heart Rate (HR), 0-12s after offer presentation onset. Bars represent mean amplitude of skin conductance response for high and low offers of participants in each condition. Lines represent mean heart rate during the presentation of high and low offers. Error bars: ±S.E.M.

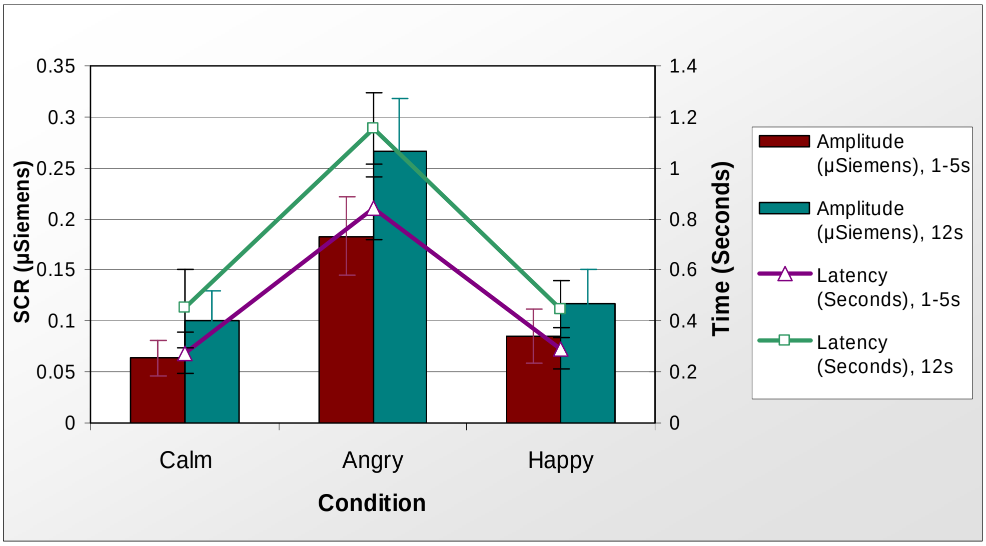

Figure 2: Skin Conductance Response (SCR) amplitude and latency collapsed over offers. Bars represent mean response amplitude of “calm,” “angry,” and “happy” participants, 0-12s and 1-5s after offer presentation onset. Lines represent mean response latency in these time windows. Error bars: ±S.E.M.

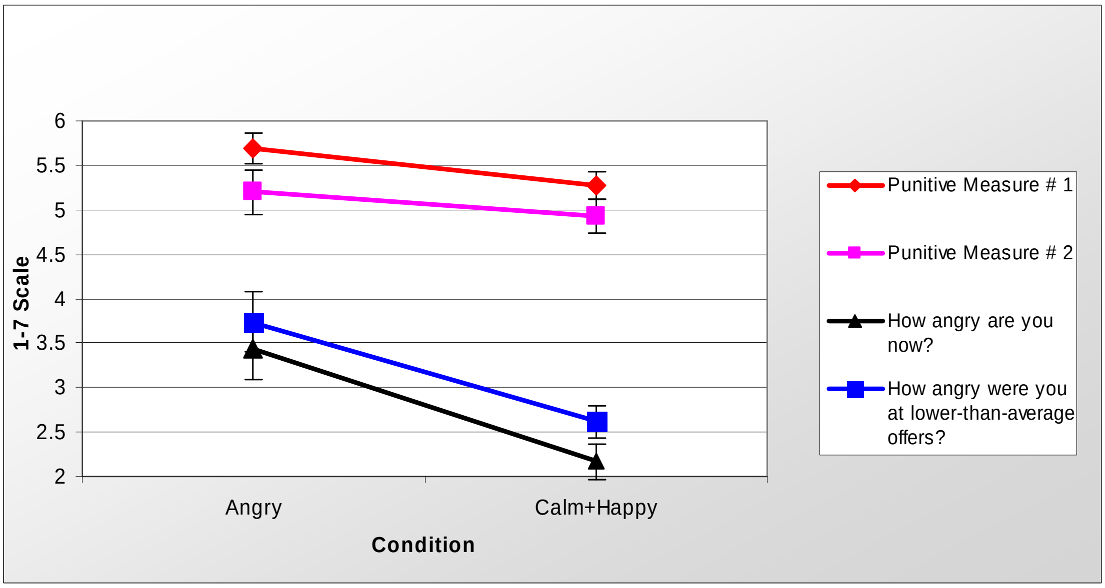

Figure 3: Participants' responses to anger-related questions in post-game questionnaires. Top two lines represent mean punitive measure scores for "angry" participants and other participants. Bottom two lines represent mean scores of responses to direct questions about anger. Error bars: ±S.E.M.

References

Baumeister, R.F., Vohs, K.D., DeWall, C.N., & Zhang, L. (2007). How emotion shapes behavior: feedback, anticipation, and reflection, rather than direct causation. *Personality and Social Psychology Review*, *11*, 167-203.

Bechara, A, & Damasio, A.R. (2005). The somatic marker hypothesis: a neural theory of economic decision. *Games and Economic Behavior, 52*, 336-372.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A. (1997). Deciding advantageously before knowing the advantageous strategy. *Science, 275*, 1293-1295.

Boksem, Maarten A. S. & De Cremer, David (2010). Fairness concerns predict medial frontal

Bolton, G.E., & Ockenfels, A. (2000). Erc: A theory of equity, reciprocity, and competition. *American Economic Review*, *90*, 166–193.

Camerer, C.F., & Fehr, E. (2006). When does “economic man” dominate social behavior? *Science 311*, 47-52.

Chapman, H.A., Kim, D.A., Susskind, J.M., & Anderson, A.K. (2009). In bad taste: evidence for the oral origins of moral disgust. *Science 323*, 1222-1226.

Critchley, H.D., Elliot, R., Mathias, C.J., & Dolan, R. (2000). Neural activity relating to generation and representation of galvanic skin responses: a functional magnetic resonance imaging study. *The Journal of Neuroscience 20,* 3033-3040.

Delgado, M.R., Gillis, M.M., & Phelps, E.A. (2008). Regulating the expectation of reward via cognitive strategies. *Nature Neuroscience 11*, 880-881.

Fehr, E. & Gächter, S. (2002). Altruistic Punishment in humans. *Nature 415* (137-140).

Fehr, E., & Schmidt, K.M. (1999). A theory of fairness, competition, and cooperation*. The Quarterly Journal of Economics 114,* 817–868.

Forsythe, R., Horowitz, J. L., Savin, N. E. & Sefton, M. (1994). Fairness in simple bargaining experiments. *Game Econ. Behav. 6*, 347−369.

George, M.S., Ketter, T.A., Parekh, P.I., Herscovitch, P. & Post, R.M. (1996). Gender Differences in Regional Cerebral Blood Flow during Transient Self-Induced Sadness or Happiness. *Biological Psychiatry 40*, 859-871.

George, M.S., Ketter, T.A., Parekh, P.I., Horowitz, B. *et al.* (1995). Brain activity during transient sadness and happiness in healthy women. *The American Journal of Psychiatry 152,* 341-351.

Gross, J.J., & Thompson, R.A. (2007). Emotion Regulation: Conceptual foundations. In J.J. Gross (Ed.), Handbook of emotion regulation (pp. 3-24). New York: Guilford.

Güth, W., Schmittberger, R., & Schwarze, B. (1982). An Experimental Analysis of Ultimatum Bargaining. *Journal of Economic Behavior and Organization 3*, 367–388.

Hamilton, V.L. & Sanders, J. (1981). The effect of roles and deeds on responsibility judgment: The normative structure of wrongdoing. *Social Psychology quarterly, 44*, 237-254.

Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. In T. Gilovich, D. Griffin & D. Kahneman (Eds.), Heuristics and Biases: The Psychology of Intuitive Judgment (pp. 49-81). Cambridge: Cambridge University Press.

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

Larsen, R.J. (2000). Toward a science of mood regulation. *Psychological Inquiry 11*, 129-141.

Leith, K.P., & Baumeister, B.F. (1996). Why do bad moods increase self-defeating behavior? Emotion, risk taking, and self-regulation. *Journal of Personality and Social Psychology 71,* 1250–1267.

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,* 115-137.

Lerner, J.S., Goldberg, J.H., & Tetlock, P.E. (1998). Sober second thought: the effects of accountability, anger and authoritarianism on attributions of responsibility. *Personality and Social Psychology Bulletin 24,* 563-574.

Marci, C.D., Glick, D.M., Loh, R., & Dougherty, D.D. (2007). Autonomic and prefrontal cortex responses to autobiographical recall of emotions. *Cognitive, Affective & Behavioral Neuroscience 7***,** 243–250.

negativity amplitude in ultimatum bargaining. *Social Neuroscience* 5, 118-128.

Nowak, M.A., Page, K.M., & Sigmund, K. (2000). Fairness versus reason in the ultimatum game. *Science 289*, 1773–1775.

Ochsner, K.N., & Gross, J.J. (2005). The cognitive control of emotion. *Trends in Cognitive Neuroscience 9*, 242-249.

Pillutla, M.M., & Murnighan, J.K. (1996). Unfairness, anger, and spite: emotional rejections of ultimatum offers. *Organizational Behavior and Human Decision Processes 68*, 208-224.

Rabin, M. (1993). Incorporating fairness into game-theory and economics. *American Economic Review 83*, 1281–1302.

Roth, A.E. (1995). Bargaining Experiments. In J. Kagel & A. Roth (Eds.), Handbook of Experimental Economics (pp. 253-348). Princeton: Princeton University Press.

Sanfay, A.G., Rilling, J.K., Aronson, J.A., Nystrom, L.E., & Cohen, J.D. (2003). The neural basis of economic decision-making in the ultimatum game. *Science 300*, 1755–1758.

Sanfey, A., & Dorris, M. (2008). Games in Humans and Non-human Primates: Scanners to Single Units. In P.W. Glimcher, C.F. Camerer, E. Fehr & R.A. Poldrack (Eds.), Neuroeconomics: Decision Making and the Brain (pp. 63-80). London: Academic Press.

Sanfey, A.G. (2007). Social decision-making: insights from game theory and neuroscience. *Science 318*, 598-602.

Sinaceur, M., & Tiedens, L. Z. (2006). Get mad and get more than even: When and why anger expression is effective in negotiations. *Journal of Experimental Social Psychology 42* (314-322).

Tamir, M. (2009). What do people want to feel and why? *Current directions in Psychological Science 18*:101-105.

Tamir, M., Mitchell, C., & Gross, J.J. (2008). Hedonic and instrumental motives in anger regulation. *Psychological Science, 19*, 324–328.

van't Wout, M., Kahn, R.S., Sanfey, A.G., & Aleman, A. (2006). Affective state and decision-making in the ultimatum game. *Experimental Brain Research*, 169, 564-568.

Weller, J.A., Levin, I.P., Shiv, B. and Bechara, A. (2009). The Effects of Insula Damage on Decision-Making for Risky Gains and Losses. *Social Neuroscience 4*, 347-358).

Winter, E., Garcia-Jurado, I. and Mendez-Naya, L. (2010). Mental equilibrium. Discussion Paper no. 521, Center for the Study of Rationality, The Hebrew University of Jerusalem. http://www.ratio.huji.ac.il/dp_files/dp521.pdf

Yamagishi, T. et al. (2009). The private rejection of unfair offers and emotional commitment. *Proceedings of the National Academy of Sciences*, 106, 11520-11523.