

Rational Emotions in the Lab

Meir Meshulam^{1,2}, Eyal Winter^{1,3}, Itzhak Aharon¹, Gershon Ben-Shakhar⁴

¹Center for the Study of Rationality, ²Dept. of Cognitive Science, ³Dept. of Economics, and ⁴Dept. of Psychology, The Hebrew University of Jerusalem, Israel

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 to him 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. To that end, we employ psychophysiological measures and questionnaires to study participants’ behavior in an elementary game setting. 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 arousal at low offers relative to high offers, as well as more anger than other participants. Highlighting the multi-level role of rational processes, these results provide a fresh outlook on human decision-making and constitute an important step in the continuing effort to build more complete models of rational decision-making.

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 (1, 2). 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 (3–8). 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 (9–14).

“Mental equilibrium” is a recently proposed model that is based on these findings and suggests a more global approach (15). 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(16). 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 appropriate monetary incentives, an individual can analyze a given situation and respond strategically by genuinely entering a mental state. Here we show that individuals can consciously and directly control their emotions, thereby creating a situation in which these emotions affect the individual’s decision-making processes in a way that is beneficial to the individual.

Kahneman and Frederick partitioned thought processes into two categories, generically named “system 1” and “system 2” (17). 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.”

To illustrate, imagine that your flight home has been delayed to the next day. While everyone walks quietly away you run across a friend who managed to get rerouted to another flight, leaving in a couple of hours, after assertively explaining to the airline’s ground crew that he needs to get home “today.” If you decide to walk up to the desk again, you are likely to be in a very different mental state than if you had not met your friend and were unaware of the option of being rerouted. You are likely not only to display signs of anger but to respond fully to the incentive and actually become angry.

To explore this notion of conscious tuning of mental states, we used a variation of the Dictator Game. As in the original game, a “dictator” was endowed with 10 NIS (\approx \$2.50) and asked to split it with a “recipient.” However, in this version, 90 recipients were randomly assigned to three different treatments ($n=30$ in each) and were given incentives to feel specific emotions when presented with offers they perceived as “good” or “bad.” “Angry” participants were rewarded up to 5 NIS (\approx \$1.20) for feeling angry when presented with “bad” offers; “happy” participants were similarly rewarded for feeling happy when presented with high offers; and “calm” participants were

rewarded for remaining calm in the face of all offers. Recipients' Skin Conductance Responses (SCR, defined as the maximal increase in skin conductance during a specified measurement window), and heart rate (HR, average beats per minute), were recorded during the presentation of two high offers (5,10) and three low offers (0,3), which were collected in advance from DG dictators. The physiological measurements provided an objective measure of the recipients' arousal. In addition, participants answered post-game questionnaires designed to capture the nature of their emotions. These included direct questions about the participants' affective state during and after the game, as well as two measures of punitiveness previously found to be correlated with anger (18, 19). 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, (b) self-reports of heightened emotions during the presentation of relevant offers and immediately after the game, and (c) increased punitiveness in "angry" participants.

Consistent with our hypothesis, "angry" participants demonstrated increased autonomic arousal when presented with low offers, relative to high offers, as indicated by their elevated HR and SCRs. In addition, post-game questionnaires confirmed that "angry" participants felt more anger than other participants, both during the presentation of low offers and after the game was over. Moreover, "angry" participants' increased arousal was the most pronounced within a "long" time window (LW), 0-12s after offer presentation onset, but evident already within a "short" time window (SW), 1-5s after offer presentation. However, these findings generally did not extend to "happy" participants. "Happy" participants' physiological responses and questionnaire answers were mostly identical to those of "calm" recipients, who responded in the same way to "low" and "high" in accordance with their incentive. Our results 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. Thus, we highlight the multi-level role of rational processes in decision-making.

Psychophysiological measures. We computed a difference score Δ for each participant by subtracting the responses to low offers from the responses to high offers. A one-way analysis of variance (ANOVA) performed on these scores computed for SCR amplitude revealed a significant effect of condition in the longer 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 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 HR revealed a highly 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. 2. Notably, across the board, no statistically significant differences were found between the responses of “happy” and “calm” participants ($P > 0.4$).

Fig. 1 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 significant cognitive carryover effects, which include a lasting impact on a wide range of judgments and decisions [20]. 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.

Conclusions. 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.

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 (20-23). However, emotions are often characterized as resistant to direct cognitive control, unlike actions and thoughts (24). While the role of emotions in shaping decisions has long been recognized, the emotional response has typically been referred to 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 (11, 12). Our results indicate the opposite may also be true: rational processes may play an important role in directing that same emotional response. Thus, another level of complexity is added to the interplay of emotional and rational processes.

Notably, while “angry” participants successfully maximized their reward by acting according to the monetary incentive, “happy” participants did not. One way to account for this lack of symmetry is to consider Kahneman and Tversky’s influential prospect theory, according to which losses loom larger than gains (25). Participants may have referred to the average offer (4.5 NIS) 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 (26–28). Moreover, reactions to unfair UG offers have been associated with increased activation in brain areas including the anterior insula, which is associated with negative emotions and autonomic arousal (11, 29).

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.

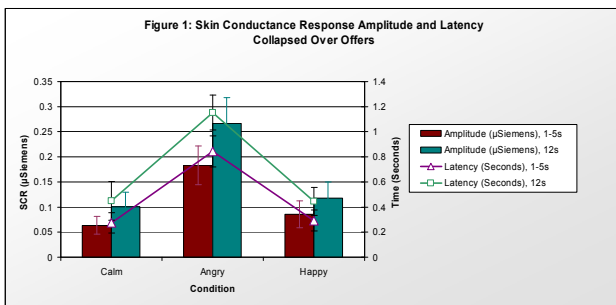


Figure 1: Skin Conductance Response (SCR) amplitude and latency collapsed over offers. Bars represent mean response amplitude of “calm,” “angry,” and “happy” participants, 0-12s and 1-5s after offer presentation onset. Lines represent mean response latency in these time windows. Error bars: \pm S.E.M.

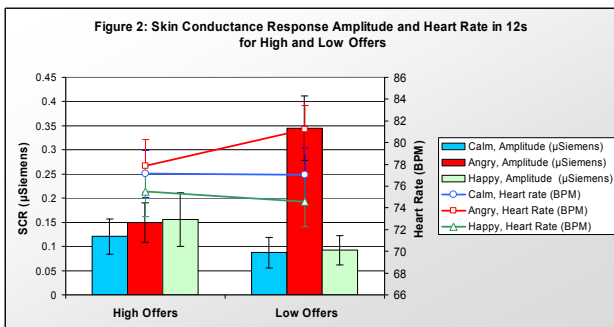


Figure 2: Skin Conductance Response (SCR) amplitude and Heart Rate (HR), 0-12s after offer presentation onset. Bars represent mean amplitude of skin conductance response for high and low offers of participants in each condition. Lines represent mean heart rate during the presentation of high and low offers. Error bars: \pm S.E.M.

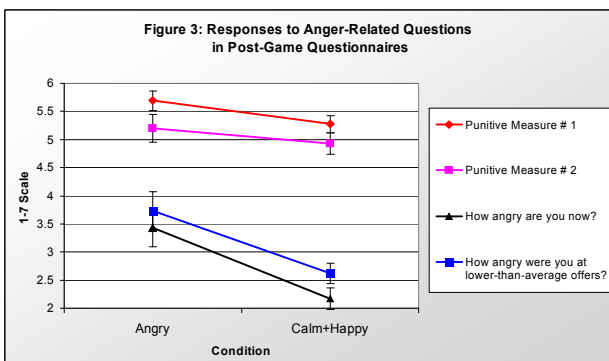


Figure 3: Participants’ responses to anger-related questions in post-game questionnaires. Top two lines represent mean punitive measure scores for “angry” participants and other participants. Bottom two lines represent mean scores of responses to direct questions about anger. Error bars: \pm S.E.M.

References

1. A.E. Roth, in *Handbook of Experimental Economics*, J. Kagel, A.E. Roth, Eds. (Princeton Univ. Press, 1995).
2. A. Sanfey, M. Dorris, in *Neuroeconomics: Decision Making and the Brain*, P.W. Glimcher, C.F. Camerer, E. Fehr, R.A. Poldrack, Eds. (Academic Press, London, 2008), chap. 6.
3. E. Fehr, K. Schmidt, *Q. J. Econ.* **1**, 817-868 (1999).
4. G.E. Bolton, A. Ockenfels. *Am. Econ. Rev.* **90**, 166-193 (2000).
5. M. Rabin, *Am. Econ. Rev.* **83**, 1281 (1993).
6. M.A. Nowak, K.P. Page, K. Sigmund. *Science* **289**, 1773-1775 (2000).
7. C.F. Camerer, E. Fehr, *Science* **311**, 47-52 (2006).
8. E. Fehr, H. Bernhard, B. Rockenbach. *Nature* **454**, 1079-1084 (2008).
9. A. R. Damasio, *Descartes' Error: Emotion, Reason, and the Human Brain* (Harper Collins, New York, 1995).
10. A. Bechara, H. Damasio, D. Tranel, A. Damasio, *Science* **275**, 1293-1295 (1997).
11. A.G. Sanfey, J.K. Rilling, J.A. Aronson, L.E. Nystrom, J.D. Cohen, *Science* **300**, 1755-1758 (2003).
12. A. Bechara, A.R. Damasio, *Games and Economic Behavior* **52**, 336-372 (2005).
13. A. Dijksterhuis, M.W. Bos, L.F. Nordgren, R.B. van Baaren, *Science* **311**, 1005-1007 (2006).
14. A.G. Sanfey, *Science* **318**, 598-602 (2007).
15. E. Winter, I. Garcia-Jurado, J. Mendez-Naya, L. Mendez-Naya, "Mental Equilibrium" (Discussion Paper no. 521, Center for the Study of Rationality, The Hebrew University of Jerusalem, 2009; http://ratio.huji.ac.il/dp_files/dp521.pdf).
16. T. Yamagishi, Y. Horita, H. Takagishi, M. Shinada, S. Tanida, K.S. Cook. *Proc. Natl. Acad. Sci.* **106**(28), 11520-11523 (2009).
17. D. Kahneman, S. Frederick, in *Heuristics and Biases: The Psychology of Intuitive Judgment*, T. Gilovich, D. Griffin, D. Kahneman, Eds. (Cambridge Univ. Press, New-York, 2002) pp. 49-81.
18. J.S. Lerner, J.H. Goldberg, P.E. Tetlock, *Pers. Soc. Psych. Bull.* **24**, 563-574 (1998).
19. J.S. Lerner, L.Z. Tiedens, *J. Behav. Decis. Mak.* **19**, 115-137 (2006).
20. R.J. Larsen, *Psych. Inq.* **11**, 129-141 (2000).
21. K.N. Ochsner, J.J. Gross, *TICS* **9**, 242-249 (2005).
22. J.J. Gross, R.A. Thompson, in *Handbook of Emotion Regulation*, J.J. Gross, Ed. (Guilford, New York, 2007) pp. 3-26.
23. M.R. Delgado, M.M. Gillis, E.A. Phelps, *Nat. Neurosci.* **11**, 880-881 (2008).
24. R.F. Baumeister, K.D. Vohs, C.N. DeWall, L. Zhang, *Pers. Soc. Psych. Rev.* **11**, 167-203 (2007).
25. D. Kahneman, A. Tversky, *Econometrica* **47**, 263-291 (1979).
26. M.M. Pillutla, J.K. Murnighan, *Org. Behav. Hum. Dec. Proc.* **68**, 208-224 (1996).
27. M. van 't Wout, R. S. Kahn, A. G. Sanfey, A. Aleman, *Neuroreport* **16**, 1849 (2005).
28. H.A. Chapman, D.A. Kim, J.M. Susskind, A.K. Anderson, *Science* **323**, 1222-1226, (2009).
29. H.D. Critchley, R. Elliot, C.J. Mathias, R.J. Dolan, *J. Neurosci.* **20**, 3033-3040 (2000).