Cognitive-Affective Interactions in Strategic Decision Making

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Abstract. While making a decision to maximize the expected utility is among the prime examples of human intelligence, the ultimatum game showcases a social dilemma where people sacrifice their economic self-interest in the presence of negative emotions. In the present study, we explore human cognitive-affective interactions in strategic thinking from an integrated neurocomputational perspective. We manipulated participants' emotions by inducing incidental affective states in the ultimatum game. We found that participants' rejection rates of unfair offers were significantly lower in positive valence emotions ("happy" and "calm") than in negative valence emotions ("sad" and "anxious"). In addition, the reduction of rejection rates appeared to be independent of the arousal level (high arousal in "happy" and "anxious" versus low arousal in "calm" and "sad"). Our results suggested that positive valence emotions, by broadening people's evaluations of decision perspectives and alleviating the perception of unfairness, may help people regain focus on their economic self-interest.

Keywords: Decision making; social dilemma; ultimatum game; affective induction; fairness preference; valence; arousal.

1 Introduction

Normative theories of judgment and decision-making in economics typically assume people to be rational and self-regarding [e.g., 1]. However, it has been documented that in the context of social interactions, people do not always act to maximize their self-interest according to the utility functions. One prominent example is the ultimatum game, a relatively recent showcase of human "irrationality" in decision making [2]. In a simple form of the game, two players decide how to divide a $10 award. One player (the proposer) makes an offer and the other player (the responder) decides whether to accept the offer. If the responder accepts the offer, the award is split as proposed. If the responder rejects the offer, both players get nothing. Suppose that the proposer may make any offer from $0 through $10, presumably a "rational" (i.e., utility maximizing) responder should accept any non-zero offer, even if the offer is "unfair" (e.g., less than $5), since the alternative is getting nothing. The dominant empirical finding, however, is that the responder often rejects an offer less than 30% of the sum, a clear deviation from the prediction of normative theories [for a review, see 3].

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A straightforward explanation for the rejection behavior in the ultimatum game is that the players' decisions depend on not only their own payoffs but also their perception of fairness, and the rejections of unfair offers reflect people's preference of fairness-seeking [4-7]. Knoch and colleagues [8-10] suggest that self-interest and fairness preferences operate via different systems: self-interest is the more evolutionarily primitive desire but can be suppressed by the fairness preferences in order to enforce social norms. Instead of the fairness perception, other studies emphasize the role of emotions in the ultimatum game. The wounded pride/spite model [11] posits that responders perceive small offers as unfair, and therefore react with anger and spiteful rejections [also see 12]. Pillutla and Murnighan [13] find that rejections were most frequent when responders could evaluate the fairness of the offers and suggest that anger was a better explanation of the rejections than the perception of unfairness. Mikula, Scherer, and Athenstaedt [14] show that injustice elicits anger, disgust, sadness, and other negative emotions. Functional neuro-imaging studies have revealed that unfair offers induce activations in brain regions that are associated with disgust [15, 16].

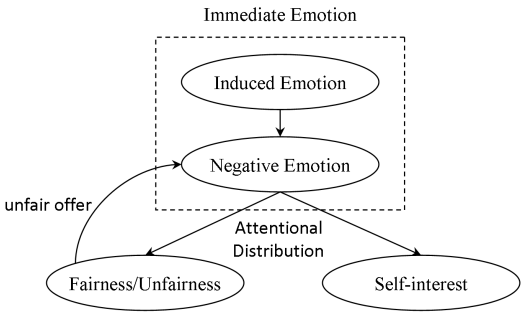

Fig. 1. An attentional distribution network in which perceptions of fairness and self-interest are modulated by the immediate emotion

From an integrated neurocomputational perspective, Wang, Coble, and Bello [17] propose that unfair offers in the ultimatum game lead to cognitive-affective interactions, in which the utility calculation in the posterior cortices is modulated by the affective states represented in the lower-level sub-cortical areas. This account points to a biologically realistic model in which emotional and cognitive processes are integrated into one attentional distribution network (Fig. 1). Specifically, we conjecture that in resolving the conflict between self-interest and fairness, emotions can have a causal effect on decision-making due to their roles in guiding attentional resources. When the players (respondents) consider an offer, they distribute their attentional resources between two preferences, self-interest and fairness, and such attentional distribution is regulated by the players' immediate emotion. When an offer is perceived as unfair, a conflict would arise because seeking for fairness now means rejecting the offer thus hurting self-interest. Because an unfair offer can elicit negative emotions [e.g., 11] and negative emotions tend to narrow the scope of people's

attention [e.g., 18], the players would be entrapped in the loop of focusing too much attention on the fairness preference, and consequently, ignore the aspect of self-interest.

In the present study, we examine whether emotion actually regulates the attentional distribution by inducing a range of incidental affective states (e.g., positive vs. negative valence, high vs. low arousal) that are independent of the fairness of offers. In the two experiments reported here, we manipulated the participants' immediate emotions with classic music clips [19, 20] as the main affect stimulus, enhanced by life event recall [19]. Our main focus was to compare participants' rejection rates in two sets of opposite emotional states: "happy" (positive valence and high arousal) versus "sad" (negative valence and low arousal) in Experiment 1, "calm" (positive valence and low arousal) versus "anxious" (negative valence and high arousal) in Experiment 2. Based on the documented functionalities of positive and negative emotions [19], we predict that compared with negative valence emotions ("sad" or "anxious"), positive valence emotions ("happy" or "calm") would make participants less distracted by the aspect of fairness thus focus more attention on self-interest, and consequently, lead to fewer rejections of unfair offers. Moreover, in dissociating valence and arousal, we speculate that the perception of fairness or unfairness would be more strongly associated with the valence than the arousal dimension of emotions.

2 Experiment 1

2.1 Participants

Seventeen participants (9 females and 8 males) participated in the experiment as responders, all of whom were graduate students or postdoctoral fellows in the Texas Medical Center (the mean age was 33.8 years with a standard deviation of 8.79 years).

2.2 Stimuli for Affective Inductions

Ten classical music clips from 18th, 19th, and 20th century Western composers were selected, five for each of the "happy" and "sad" affective inductions. These clips have been empirically validated to induce the corresponding affective states [20]. To enhance the inductions, we instructed the participants to silently recall into details of a happy or sad life event while listening to the music. Life-event recall, combined with music, has been used to successfully induce affect [19]. The standard ultimatum game involves only gains. Wang et al. [17] add a loss framing, in which the proposer and the responder split a cost of $10, and rejecting a proposal means both players having to each pay $10. It is possible that people's immediate emotion could interact with the perception of gain or loss. For example, one might feel "happier" considering a potential gain than considering a potential loss. For this reason, we adopted this two-frame game in the current experiment.

2.3 Design and Procedures

We used a 2 (affect conditions: "happy" and "sad") x 2 (framings: gain and loss) x 11 (offer amounts: $0, $1, $2…, $10) within-subject design. For each participant, the trials were grouped into 4 blocks (2 affect conditions x 2 framing conditions), and the orders of framing and affective conditions were counter-balanced between subjects. Within each block, each level of offer amount was repeated 3 times, resulting in 11 x 3 = 33 trials, and the order of trials was randomly shuffled.

The experiment was programmed in E-Prime and conducted on a PC with a 20 inch LCD monitor. After giving informed consent, participants were given instructions and practices of the game. They were told that they would play against individual anonymous proposers from a large online network, a new proposer for each game. At the beginning of each block, participants were instructed to develop a particular mood by listening to the music clips through the headsets for 5 minutes, followed by silently recalling in detail mood-appropriate events from their past. They were then instructed to rate their mood on a 9x9 grid by selecting a square that best exemplified their current mood in terms of valence (from "extremely sad" on the left to "extremely happy" on the right) and arousal (from "extremely low energy" at the bottom to "extremely high energy" at the top).

At the beginning of each game trial, participants were first prompted with a screen stating "New round! Connecting to a new partner …" for 2 seconds. This was to emphasize that each trial was a one-shot game with a different proposer such that the factor of reputation should not play a role here. In other words, rejecting the offer in the current trial would not serve as the means of punishing a unfair proposer in the previous trial. Then, depending on the framing condition, either "You get" or "You lose" was displayed for 1 second, which was followed by the amount of offer. Participants made a response by clicking either one of the mouse buttons to accept (left button) or reject (right button) the offer.

2.4 Experiment 1 Result

All 17 participants' data were included in data analyses. To examine whether affective inductions were effective, we first checked participants' self-reported ratings on emotional valence and arousal. Both ratings corresponded well to the intended affective states (see Table 1 and Figure 2). Compared with the "sad" condition, the "happy" condition resulted in higher ratings on both valence (mean difference = 4.03, paired $t(16) = 8.63$, $p < .01$) and arousal (mean difference = 2.53, paired $t(16) = 6.01$, $p < .01$).

On participants' rejection rates, we first examined the effects of affective conditions ("happy" vs. "sad") and framing domains (gain vs. loss) by repeated-measure ANOVA. Overall, affective conditions had a significant effect. Combining the corresponding columns in Table 2 (Experiment 1), it reveals that the overall rejection rate in the "happy" condition (22.9%) was significantly lower than in the "sad" condition (32.0%), with a mean difference of 9.1% ($F(1,16) \approx 7.03$, $p < .05$).

Table 1. Mean ratings on valence and arousal under each affective condition. Both ratings are scored in the range of [–4, 4] with 0 being neutral. Standard errors (over 17 participants in Experiment 1 and 12 participants in Experiment 2) are listed in parentheses. Column "Difference" is the absolute mean difference of valence or arousal ratings between "Sad" and "Happy" (Experiment 1), or, "Anxious" and "Calm" (Experiment 2), respectively. **: paired t-test, $p < .01$; *: $p < .05$.

Exepriment 1

	Happy	Sad	Difference
Valence rating	2.29 (0.27)	– 1.74 (0.35)	4.03 **
Arousal rating	1.82 (0.31)	– 0.71 (0.38)	2.53 **

Experiment 2

	Calm	Anxious	Difference
Valence rating	1.75 (0.26)	– 0.67 (0.61)	2.42 **
Arousal rating	– 0.58 (0.49)	0.88 (0.42)	– 1.46 *

Table 2. Mean rejection rates in percentage under each affect and framing conditions. Standard errors (over 17 participants in Experiment 1 and 12 participants in Experiment 2) are listed in parentheses. The bottom row lists the difference in rejection rates between "happy" and "sad" (Experiment 1), and, between "calm" and "anxious" (Experiment 2). In each framing condition, offers are split into sub-columns depending on whether they are less or greater than \$5: offers less than \$5 in the gain domain and greater than \$5 in the loss domain are considered "unfair" (in bold fonts).

Experiment 1

	Gain		Loss	
	< \$5 (unfair)	> \$5	< \$5	**> \$5 (unfair)**
Happy	**51.0 (7.2)**	3.9 (1.9)	0 (0)	**45.1 (7.1)**
Sad	**67.5 (7.8)**	4.3 (2.9)	2.4 (1.6)	**62.7 (8.8)**
Diff.	**16.5**	0.4	2.4	**17.6**

Experiment 2

	Gain		Loss	
	< \$5 (unfair)	> \$5	< \$5	**> \$5 (unfair)**
Happy	**52.8 (9.6)**	0.6 (0.6)	5.6 (4.4)	**42.2 (10.2)**
Sad	**60.6 (7.9)**	2.2 (1.7)	13.3 (6.9)	**53.3 (9.7)**
Diff.	**7.8**	1.6	7.7	**11.1**

The effect of framing and its interaction with the affective conditions were not significant ($F(1,16) \approx 1.90$, $p \approx .19$; $F(1,16) \approx 0.07$, $p \approx .80$, respectively). In addition, Table 2 (Experiment 1) shows that between the gain and loss domains, the rejections rates were almost symmetrically distributed across affective conditions. Since we

were particularly interested in whether the induced emotional states would alter participants' perception of fairness or unfairness, we separately examined two situations in which an offer was either "unfair" (less than $5 in the gain domain and greater than $5 in the loss domain) or "more-than-fair" (greater than $5 in the gain domain and less than $5 in the loss domain). The effect of affective conditions was statistically significant for "unfair" offers ($F(1, 16) \approx 10.30$, $p < .01$) but was not statistically significant for "more-than-fair" offers ($F(1, 16) \approx 0.36$, $p \approx .56$). The last row in Table 1 (Experiment 1) shows that the difference in the rejection rates between two affective conditions was always in the same direction across all columns (lower rejection rates in "happy" than in "sad"), but the magnitude was the greatest for unfair offers in both framing domains.

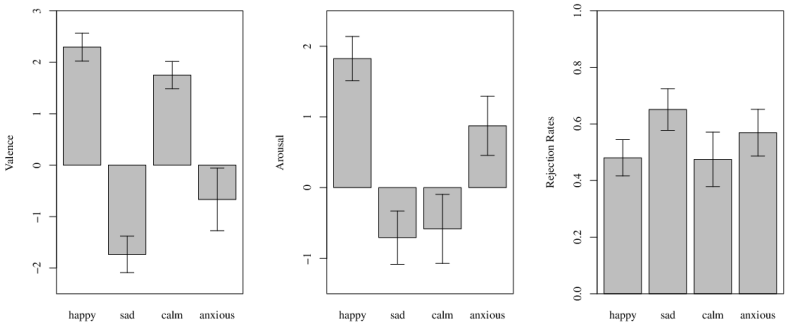

Fig. 2. Self-reported ratings on affective valence and arousal and rejection rates for unfair offers (gain and loss combined) in comparing "happy vs. sad" (Experiment 1) and "calm vs. anxious" (Experiment 2). Error bars represent one standard error above and one standard error below the mean.

3 Experiment 2

To dissociate the two dimensions of emotion, valence and arousal, we conducted the second experiment in which we compared two different affective states, "calm" (positive valence and low arousal) and "anxious" (negative valence and high arousal).

3.1 Participants and Procedure

Twelve participants (6 females and 6 males) who were not included in Experiment 1 participated in Experiment 2, all of whom were graduate students or postdoctoral fellows in the Texas Medical Center (the mean age was 35.5 years with a standard deviation of 7.44 years). Experiment 2 followed the same design and procedure as Experiment, except that we used classical music clips from [19], combined with life-event recall, to induce "calm" and "anxious" affective states.

3.2 Experiment 2 Result

All 12 participants' data were included in data analyses. Again, participants' self-reported ratings on emotional valence and arousal corresponded well to the intended affective states (see Table 1 and Figure 2). Compared with the "anxious" condition, the "calm" condition resulted in higher ratings on valence (mean difference = 2.42, paired $t(11) = 3.87$, $p < .01$) but lower ratings on arousal (mean difference = – 1.46, paired $t(11) = – 2.59$, $p < .05$). Compared with Experiment 1, the differences on both valence and arousal ratings between the two target emotional states were in smaller magnitudes. Nevertheless, in terms of dissociating valence and arousal, we have obtained an obvious contrast: Figure 2 shows that in contrast to the "happy-sad" comparison, the "calm-anxious" comparison was in the same direction on valence ratings, but in the opposite direction on arousal ratings.

Comparing two experiments, despite the reversed contrast on arousal ratings, rejection rates were similar between "happy" and "calm", and between "sad" and "anxious", respectively (both between-subjects comparisons were not statistically significant) (see Table 2 and Figure 2). Specific to Experiment 2, participants under the "calm" condition were more likely to accept offers than under the "anxious" condition. For example, combing the corresponding columns in Table 2 (Experiment 2), it reveals that the overall rejection rate in the "calm" condition (23.1%) was lower than in the "anxious" condition (30.0%) (mean difference = 6.9%, $F(1,11) \approx 4.62$, $p \approx .05$).

4 Discussion

The ultimatum game showcases the potential conflict between two of the main motives underlying social decision making: self-interest and fairness [21]. In the present study, we examined the effects of emotions in resolving such a conflict in two emotional dimensions, valence (positive vs. negative) and arousal (high vs. low), in four emotional states, "happy", "sad", "calm", and "anxious". We found that participants were more likely to accept offers in positive valence emotions ("happy" and "calm") than in negative valence emotions ("sad" and "anxious"), and the reduction of rejection rates was more apparent for "unfair" offers than "fair" offers. In addition, the reduction of rejection rates appeared to be independent of the arousal levels (high arousal in "happy" and "anxious" versus low arousal in "calm" and "sad").

In general, our findings supported our hypotheses that emotion as a separate input can causally affect decision-making, and emotional states with positive valence can alter people's attentional distribution between the fairness preference and self-interest by alleviating the perception of unfair treatment. That is, under the influence of positive valence emotions, participants were less likely to be distracted by the unfair treatment and more likely to make decisions based on their self-interest. Our results were congruent with the recent findings in both neurological and psychological research which posits that emotions can serve as a separate information input to directly shape the decision process [19, 22-25]. There is a convergence of opinions emerging from recent cognitive and affective sciences pointing toward the reciprocal causal links between the cognitive, behavioral, and somatic mechanisms, where

emotions are considered as self-perpetuating emergent systems [26], and positive affects can enhance evaluations and empower potential responses [27, 28]. Together, it is indicated that positive valence emotions, by broadening people's evaluations of decision perspectives and alleviating the perception of unfairness, may help people regain focus on their economic self-interest.

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References

1. Camerer, C.F., Fehr, E.: When does "economic man" dominate social behavior? Science 311(5757), 47–52 (2006)
2. Güth, W., Schmittberger, R., Schwarze, B.: An experimental analysis of ultimatum bargaining. Journal of Economic Behavior and Organization 3(4), 367–388 (1982)
3. Camerer, C.F.: Behavioral game theory: Experiments in strategic interaction. Russell Sage Foundation, New York (2003)
4. Zhou, X., Wu, Y.: Sharing losses and sharing gains: Increased demand for fairness under adversity. Journal of Experimental Social Psychology 47(3), 582–588 (2011)
5. Handgraaf, M.J.J., et al.: Evaluability of outcomes in ultimatum bargaining. Organizational Behavior and Human Decision Processes 95(1), 97–106 (2004)
6. Nowak, M.A., Page, K.M., Sigmund, K.: Fairness versus reason in the Ultimatum Game. Science 289(5485), 1773–1775 (2000)
7. Rabin, M.: Incorporating fairness into game theory and economics. The American Economic Review 83(5), 1281–1302 (1993)
8. Knoch, D., et al.: A neural marker of costly punishment behavior. Psychological Science 21(3), 337–342 (2010)
9. Knoch, D., et al.: Diminishing reciprocal fairness by disrupting the right prefrontal cortex. Science 314(5800), 829–832 (2006)
10. Knoch, D., et al.: Disrupting the prefrontal cortex diminishes the human ability to build a good reputation. Proceedings of the National Academy of Sciences 106(49), 20895–20899 (2009)
11. Straub, P.G., Murnighan, J.K.: An experimental investigation of ultimatum games: Information, fairness, expectations, and lowest acceptable offers. Journal of Economic Behavior & Organization 27(3), 345–364 (1995)
12. Blount, S.: When social outcomes aren't fair: The effect of causal attributions on preferences. Organizational Behavior and Human Decision Processes 63(2), 131–144 (1995)
13. Pillutla, M.M., Murnighan, J.K.: Unfairness, anger, and spite: Emotional rejections of ultimatum offers. Organizational Behavior and Human Decision Processes 68(3), 208–224 (1996)
14. Mikula, G., Scherer, K.R., Athenstaedt, U.: The role of injustice in the elicitation of differential emotional reactions. Personality and Social Psychology Bulletin 24(7), 769–783 (1998)
15. Sanfey, A.G.: Social decision-making: Insights from game theory and neuroscience. Science 318(5850), 598–602 (2007)

16. Sanfey, A.G., et al.: The neural basis of economic decision-making in the ultimatum game. Science 300(5626), 1755–1758 (2003)
17. Wang, H., Coble, C., Bello, P.: Cognitive-affective interactions in human decision-making: A neurocomputational approach. In: Sun, R., et al. (eds.) Proceedings of the Twenty-eighth Annual Meeting of the Cognitive Science Society, pp. 2341–2346. Lawrence Erlbaum, Hillsdale (2006)
18. Fredrickson, B.L.: The broaden–and–build theory of positive emotions. Philosophical Transactions of the Royal Society of London 359(1449), 1367–1377 (2004)
19. Jefferies, L.N., et al.: Emotional valence and arousal interact in attentional control. Psychological Science 19(3), 290–295 (2008)
20. Mitterschiffthaler, M.T., et al.: A functional MRI study of happy and sad affective states induced by classical music. Human Brain Mapping 28(11), 1150–1162 (2007)
21. van Dijk, E., Vermunt, R.: Strategy and fairness in social decision making: Sometimes it pays to be powerless. Journal of Experimental Social Psychology 36(1), 1–25 (2000)
22. Bechara, A., et al.: Insensitivity to future consequences following damage to human prefrontal cortex. Cognition 50(1-3), 7–15 (1994)
23. Weber, E.U., Johnson, E.J.: Mindful judgment and decision making. Annual Review of Psychology 60(1), 53–85 (2009)
24. Damasio, A.R.: Fundamental feelings. Nature 413(6858), 781 (2001)
25. Kringelbach, M.L.: The human orbitofrontal cortex: linking reward to hedonic experience. Nature Reviews Neuroscience 6(9), 691–702 (2005)
26. Garland, E.L., et al.: Upward spirals of positive emotions counter downward spirals of negativity: Insights from the broaden-and-build theory and affective neuroscience on the treatment of emotion dysfunctions and deficits in psychopathology. Clinical Psychology Review 30(7), 849–864 (2010)
27. Clore, G.L., Huntsinger, J.R.: How emotions inform judgment and regulate thought. Trends in Cognitive Sciences 11(9), 393–399 (2007)
28. Burgdorf, J., Panksepp, J.: The neurobiology of positive emotions. Neuroscience & Biobehavioral Reviews 30(2), 173–187 (2006)