Author's response to reviews

Title: Impaired social decision making in patients with major depressive disorder

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Author's response to reviews: see over
Dear Mr. Carlo Rye Chua,

MS: 1713736401109112

"Impaired social decision making in patients with major depressive disorder"

Thank you very much for your email on December 3, 2013, which provided us with the opportunity to revise our manuscript.

Based on the reviewers’ helpful suggestions, we have revised the manuscript carefully. I have enclosed a revised version of the above paper for submission to *BMC Psychiatry*. We have addressed the comments raised by the reviewers, and the amendments are highlighted in black and bold in the revised manuscript. Point-by-point responses to the reviewers’ comments are listed as follows.

**Reviewer 1: Rene Hurlemann**

**Major issues:**

1) “Abnormal decision-making processes have been observed in patients with major depressive disorder (MDD). However, whether MDD patients show abnormalities in decision making in a social interaction context, in which decisions have actual consequences, is unresolved.” The meaning of “actual consequences” is not deducible from the theoretical background: are you referring to the monetary reward? Please clarify this point, especially regarding the difference between consequences of normal vs. social decision making.

**Response 1:** We apologize for the confusion. The majority of studies (normal decision making) mainly focused on individual or solitary decision-making. In these
situations, the choices made only affect the self-interests of decision makers per se and have no actual consequences for others. However, many real-life decision problems involve social exchanges with other individuals and a certain division of economic outcomes between them, in which the outcome of the interaction has consequences for all parties (van't Wout & Sanfey, 2011). Therefore, the difference in consequences between normal and social decision making is that the decisions made in a normal decision-making task only affect the self-interests of decision makers per se; however, in social decision making the decisions affect both the self-interests of the decision makers per se and those of their partners (van't Wout & Sanfey, 2011).

We have rewritten this sentence. Now it reads as follows:

“However, it is unresolved whether MDD patients show abnormalities in decision making in a social interaction context, in which decisions have actual influences on both the self-interests of the decision makers per se and those of their partners.”

We also made revisions on page 13 in the 12th line to clarify this issue.

2) “Negative bias, an abnormal affection cognition, exists in decision making in a social interaction context in MDD” Please define the term “affection cognition”. As far as I can see, this term is not explained throughout the text.

Response 2: Thank you for your comment. This term used here is not appropriate. We should have used the term “a disturbed affective cognition”, which was used in the Discussion section. This term means that MDD patients tend to attend selectively to negative stimuli in their environment and to interpret neutral or ambiguous stimuli as negative or as less positive (Elliott, Zahn, Deakin, & Anderson, 2010). However, after we revised this manuscript and reread this part, we felt this sentence is not appropriate here, so we revised the description of the Conclusions in the Abstract. Now it reads as follows:

“Conclusions

Depressed patients show abnormal decision-making behavior in a social
interaction context. Several possible explanations, such as increased sensitivity to fairness, negative emotional state and disturbed affective cognition, have been proposed to account for the abnormal social decision-making behavior in patients with MDD. This aberrant social decision-making behavior may provide a new perspective in the search to find biomarkers for the diagnosis and prognosis of MDD.”

Response 3: Thank you for your suggestion. We rewrote this paragraph and combined it with the second paragraph in the Background section to clarify our point of view. Now it reads as follows:

“Major depressive disorder (MDD) is characterized by a persistent and overwhelming feeling of sadness [1]. Emotional processes, including emotional response and feeling states, are an important factor with a prominent impact on decision making [2, 3]. Previous studies have found that the abnormal feeling state in patients with MDD may bias their decision-making behaviors, as evidenced from altered sensitivity to reward and punishment [4-7], reduced experiences of regret [8], and poor decision performance [9]. Despite these important findings in MDD, all these studies have investigated people in non-social interaction contexts, in which actions only have consequences for the self-interests of the participants [4-8]. However, many real-life decision problems involve social exchanges with other individuals and a certain division of economic outcomes among them [10]. The influence of the depressive state on real-life economic decisions has rarely been studied in a social interaction context. Considering that MDD affects up to 20% of the worldwide population
[11, 12], the influence of the depressive state on social-economic decisions is an important research question. Ecologically valid social decision-making paradigms such as the ultimatum game (UG) may help identify suboptimal choices associated with MDD and, thus, may provide a potential bridge for translation research in MDD [13-15].”

4) The 2-round UG game, as mentioned on page 4, lacks an explanation.

Response 4: Thank you for your suggestion. The UG can be played and studied, either as a single-round (participants only play one round with the same opponents) or a multi-stage game (participants play multiple rounds with the same opponents). Agay et al. (2008) used a simple multi-stage version (only two rounds) (Agay, Kron, Carmel, Mendlovic, & Levkovitz, 2008). So we rewrote the sentence as follows:

“Agay et al. (2008) used a two-stage UG paradigm, in which participants played two rounds with the same anonymous opponents, to compare the bargaining behavior of schizophrenic patients with that of MDD patients and of a healthy control group.”

5) To me the sample size of N=33 (14MDD; 19NC) seems quite small considering the chosen 2x2x2x3 design and might therefore not allow a sufficient statistical power to detect existing effects. This point should be included in the discussion of limitations.

Response 5: We thank the reviewer for giving us the opportunity to improve the quality of our manuscript. We rephrased the corresponding paragraph within the discussion on page 17. In this study, we found that (1) the acceptance rates of the patients were significantly lower than those of the normal controls, (2) significant differences in acceptance rates of unfair proposals were observed in the NC group while comparing their response to offers from humans with those from computers, and (3) no differences in acceptance rates of unfair proposals were observed in the
MDD group while comparing their response to offers from humans with those from
computers. To explore how likely the above-mentioned group effect (result (1)) and
proposer effects (result (2) and result (3)) we observed are reliable, we conducted
Bayesian t-tests for acceptance rates in different conditions using a Bayes factor
calculation (Rouder, Speckman, Sun, Morey, & Iverson, 2009). Using Bayesian
statistics, researchers can express preference for either the null hypothesis or the
alternative. All the evidence from the data is expressed in the ratio of marginal
likelihoods of the null and alternative hypotheses. This ratio is termed the Bayes
factor and is denoted by $B_{01}$. In practice, $B_{01}=1.0$ represents a position that favors
neither the null hypotheses nor the alternative hypotheses, $B_{01}>1.0$ represents a
position that favors the null hypotheses, and $B_{01}<1.0$ represents a position that favors
the alternative hypotheses. It is suggested that ratios greater than 3 be considered
“some evidence”, ratios greater than 10 be considered “strong evidence”, and ratios
greater than 30 be considered “very strong evidence” for one hypothesis over another
(Rouder et al., 2009).

Through the analysis of Bayesian t-tests, the resulting values were $B_{01}=0.50$ for the
group contrast, which means that the alternative hypothesis of a group effect on
acceptance rate was 2.0 times more likely to be true than the null hypothesis of no
group effect. The values were $B_{01}=0.24$ vs. $B_{01}=2.83$ for the proposer contrast when
the offers were low and most unfair in the NC group and in the MDD group,
respectively. This means that the alternative hypothesis of a proposer effect on
acceptance rate was 4.2 times more likely to be true than the null hypothesis of no
proposer effect in the NC group, while the null hypothesis of no proposer effect on
acceptance rate was 2.8 times more likely to be true than the alternative hypothesis of
a proposer effect in the MDD group. These Bayes factors provide some additional
evidence for the group difference in acceptance rates of UG and distinguishing
between unfair proposals from computer partners and human partners in the NC group
but not the MDD group. We also addressed these results when discussing limitations
in the second paragraph of Strengths and limitations. We wrote as follows:

“First, our sample size was small. To explore how likely the difference in
acceptance rates between the two groups and those between human and computer proposers in each group is reliable, we conducted Bayesian $t$-tests for acceptance rates in different conditions using a Bayes factor calculation [68]. Our results revealed that the alternative hypothesis of a group effect on acceptance rate was 2.0 times more likely to be true than the null hypothesis of no group effect. In addition, we found that the alternative hypothesis of a proposer effect on acceptance rate was 4.2 times more likely to be true than the null hypothesis of no proposer effect in the NC group, while the null hypothesis of no proposer effect on acceptance rate was 2.8 times more likely to be true than the alternative hypothesis of a proposer effect in the MDD group. These results provide additional evidence for the group difference in acceptance rates of UG and distinguishing between unfair proposals from computer partners and human partners in the NC group but not the MDD group. Although the Bayes factor calculation showed some statistical power to detect existing effects, our findings still need to be validated repeatedly by future studies with larger sample sizes.”

6) The design and importance of the WAIS-RC’s subscales should be elucidated more precisely. From my point of view, the Digit Symbol test primarily measures memory and speed of processing, but not so much speed of “reaction”.

Response 6: Thank you for your suggestion. We added descriptions to precisely elucidate the design and importance of the WAIS-RC’s subscales. It reads as follows:

“Decision making encompasses a complex set of processes that requires various higher-order cognitive functions [42]. Previous studies have shown that patients with MDD have impaired cognitive function, although the conclusions are inconsistent [43]. To exclude the potential impact of cognitive dysfunction on decision-making behavior in MDD, a cognitive assessment of all subjects was conducted before the UG task. The Digit Symbol and Information subtests of the Wechsler Adult Intelligence Scale-Chinese Revision (WAIS-RC) were
used. The Digit Symbol subtest requires that subjects write down symbols that correspond with figures 1 to 9 in 90 seconds, which reflects a person’s memory and speed of processing. The Information subtest requires participants to answer some common questions, which reflects a person’s range of general information. A similar cognitive assessment was performed in a previous study [13].”

In addition, we changed “the speed and accuracy of reaction” to “memory and speed of processing”, as suggested, both on page 8 in the 7th line and on page 10 in the 28th line.

7) To prevent misunderstandings, it might help to change 90s to 90 seconds (P.7)

Response 7: Thank you for your suggestion. We have changed 90s to 90 seconds.

8) Please provide a more precise description of your clinical population, for example regarding the patient’s profile, history of depressive episodes, and medication.

Response 8: Thank you for your suggestion. We provided some additional descriptions of our clinical population in the Participants section, which is as follows:

“All the clinical participants were inpatients, except one who was an outpatient. Four of the participants were patients with first-onset MDD, and others were in the relapse phase. The mean frequency of episodes was 1.43 (SD=0.65) times. The mean age of onset was 28.8 (SD=15.5) years old. The mean duration of illness was 46.1 (SD=55.7) months. In the MDD group, only one patient did not take any psychotropic medication; the other patients received antidepressant medications (SSRIs and/or SNRIs), with four patients additionally taking low-dose benzodiazepines and one patient receiving neuroleptics.”

9) “Major depressive disorder patients (MDD) and normal controls (NC) were significantly similar in terms of gender composition, age, and educational level
(p’s > .05).” There is no ‘significantly similar’; please provide a statistically correct statement.

Response 9: Thank you for your suggestion. We rewrote this sentence as follows:
“The major depressive disorder patients (MDD) and normal controls (NC) did not show significant differences in terms of gender composition, age, and educational level (all $p > .05$).”

10) "(p’s <.05)": "p’s" would indicate a genitive case and is not an appropriate abbreviation for several p-values. Please replace by "p < .05".

Response 10: Thank you for your suggestion. We have replaced all the “p’s” with "p".

11) “Our study showed that persistent sadness seemed to alter the behavioral pattern of MDD patients in their social interactions, a finding which provides further evidence supporting the role of emotion in decision making” There are no data mentioned, substantiating the conclusion of a relation between sadness and social interacting behavior (page 13). Please provide details on your operationalization of sadness and your statistical analysis, respectively.

Response 11: Thank you for giving us this chance to improve our manuscript. In this study, we did not manipulate sadness, which is one of major characteristics of MDD (APA, 2000). We should have emphasized the possible role of background negative emotional state in the social interaction behavior of MDD patients. However, in the original version we expressed our meaning in an inappropriate way. In the revised version, we replaced “persistent sadness” with “the background negative emotional state”. We hope this revision makes our opinion clearer. Now it reads as follows:
“Our study showed that the background negative emotional state seemed to alter the behavioral pattern of MDD patients in their social interactions, a
finding that provides further evidence supporting the role of emotion in
decision making.”

12) “Particularly, Moretti et al. (2009) found that ventromedial prefrontal cortex (vmPFC) patients substantially reduced their acceptance rate of unfair offers from a human partner compared with controls [47].” “vmPFC” is not a formal diagnosis, please clarify which disorder or disease you refer to (I assume you talk about patients with lesion in vmPFC).

Response 12: Thank you for your suggestion. We have replaced “ventromedial prefrontal cortex (vmPFC) patients” with “patients with a lesion in the ventromedial prefrontal cortex (vmPFC)”. We rewrote the discussion about the findings in patients with a lesion in the vmPFC on page 16. Now it reads as follows:

“Additionally, we noted that our results obtained in the patients with MDD were similar to those obtained in patients with a lesion in the ventromedial prefrontal cortex (vmPFC), who also did not distinguish unfair offers from human and computerized opponents [10]. Considering that vmPFC is a brain region that is necessary for valuing social information in social interaction and decision-making [10, 64], Moretti et al. think that the ability to value social information is important for the discriminate treatment of human proposers and computer proposers [10]. Abnormal structure and function in the vmPFC have been consistently reported in patients with MDD [65-67]. Therefore, it is possible that the indiscriminate treatment of human and computer proposers in MDD is related to the impaired functions which should be served by the vmPFC, such as valuing social information during interactive decision making.”

13) More importantly, the discussion on the neural substrates of decision-making should incorporate more recent studies on functional imaging data. For instance,... Scheele et al. (2012) demonstrated that an intact amygdala is required for a
“normal” behaviour in the UG.

**Response 13:** Thank you for your suggestion. We cited the article by Scheele et al. (2012) on page 15 in the 17th line. It reads as follows:

“Neuroimaging studies have indicated that specific regions associated with deliberative processes, cognitive conflict and emotional processing, such as the insula, the dorsolateral prefrontal cortex, the anterior cingulate cortex and the amygdala [2, 23, 53, 54], may underlie the neural basis of a responder’s decision behavior in the UG.”


**14) Please cite and discuss the article by Scheele et al. (2013) A negative emotional and economic judgment bias in major depression.**

**Response 14:** Thank you for your suggestion. We cited the article by Scheele et al. (2013) on page 3 in the 20th line, page 4 in the 24th line and page 5 in the 7th line of the Background section; on page 8 in the 10th line of the Methods section; and on page 13 in the 21th and 27th lines of the Discussion section. It reads as follows:

In the Background section:

“Ecologically valid social decision-making paradigms such as the ultimatum game (UG) may help identify suboptimal choices associated with MDD and, thus, may provide a potential bridge for translation research in MDD [13-15].”

“To our knowledge, four studies have addressed this issue, but the results were inconsistent [13, 31-33].”

“However, in a recent study Scheele et al. (2013) found that compared with healthy controls depressed patients rejected significantly more moderately unfair offers in the UG and rated emotional stimuli as more negative [13].”

In the Methods section:
“A similar cognitive assessment was performed in a previous study [13].”

In the Discussion section:

“Previous studies have observed mixed findings in the social decision-making behavior of depressed patients in the UG task. Both decreased and increased acceptance rates by depressed patients have been reported [13, 31-33].”

“In our study and the other three studies [13, 31, 33] that reported statistically or numerically decreased acceptance rates in depressed groups, the patients were from a purely clinical population, and most of the patients were taking antidepressant medications.”


**Minor issues:**

15) P. 3: “A universal in human social interaction is the tendency to respond with immediate aggression to a perceived threat or unfairness”

I do not understand the exact meaning of this sentence.

**Response 15:** We apologize for the confusion. This sentence may not be written correctly. Originally, we wanted to express the meaning that fairness is a very important aspect of social interaction. However, after we reread this paragraph, we think this sentence was not necessary. Therefore, we deleted this sentence and directly elicited the ultimatum game, which has been commonly used to investigate social interaction. It reads as follows:

“The UG is a commonly used paradigm to study the process of decision-making in a social interaction context [16].”

16) P. 5: therefore this possibility has been never explored

Please change to “has never been explored”.

Please change to “has never been explored”.
Response 16: Thank you for your suggestion. We revised the description of this part and this sentence has been deleted in the revised manuscript.

17) The term “social interaction context” is not used consistently (e.g. “social interactive context”, P. 12).

Response 17: Thank you for your suggestion. We have checked the whole manuscript and replaced “social interactive context” with “social interaction context”.

18) “abnormal affection cognition”: the term’s meaning remains unclear.

Response 18: Thank you for your comment. This term is not appropriate. We have rewritten the sentence, including this term. Please see Response 2 to Reviewer 1.

Reviewer 2: Zsolt Unoka

1) However, one area that could be improved is the theoretical context provided in the beginning of the introduction. Specifically, we felt that the discussion of a social cognitive model of the Ultimatum Game and altruistic punishment and its relevance for MDD was missing. Since one of the main novel findings of the research is that no differences in acceptance rates to unfair proposals were observed in the MDD group while comparing their response to offers from humans with those from computers the whole paper overall could benefit from further elaboration and reference to the specific theoretical conceptualizations of social cognition and how they specifically relate to decision making in social interaction context in MDD. We also think the reader would benefit from a more specific description of social-cognitive deficits in MDD.

Response 1: Thank you for your suggestions. We added a description of the UG
models in a paragraph on page 5 when introducing human and computer partners in the UG. This description reads as follows:

“Additionally, no previous studies have investigated whether patients with MDD discriminate between unfair proposals from human partners or computer partners. Studies conducted in healthy populations have found that healthy participants often reject an unfair offer from a human partner but tend to accept the same unfair offer from a computer partner [19, 23]. The discriminative responses for unfair proposals from computer partners and human partners argue against the equity model, which holds that subjects' sense of fairness only depends on whether the distribution is equal [34, 35], but they provide a strong evidence for the reciprocity model [36, 37]. The reciprocity model posits that a strong reciprocator will punish norm violation behavior to consolidate fairness norms in the social group [36, 37], but when the distributor is a computer, the social quality of the interaction is missing, and thus, the reciprocity effect disappears [38]. This indicates that decisions in the UG not only depend on material gains but also on considerations of other agents’ outcomes and intentions [39]. This view has been supported by neuroimaging evidence, which suggests that successful discrimination in responses regarding unfair proposals from computer partners and human partners depends on the intact social cognitive ability, especially the ability to understand and respond to the thoughts and feelings of others [40]. Therefore, a paradigm that includes both human and computer partners may be helpful to improve our understanding of impaired social cognition in patients with MDD. However, in previous MDD studies the participants only played the game with human partners, not with computer partners, leaving unresolved the problem of whether MDD patients can discriminate between unfair proposals from human partners or computer partners.”

We also made some revisions in a paragraph on page 15 when discussing the findings of this aspect. For details, please see Response 6 to Reviewer 2.
Response 2: Thank you for giving us this chance to improve this paper. In this study, patients with MDD were diagnosed independently by two qualified psychiatrists according to DSM-IV criteria. These psychiatrists had received DSM-IV training and passed the assessment of consistency prior to the implementation of this research. Thus, we added one sentence in the Participants section to describe the psychiatrists’ professional skills, which is as follows:

“The patients satisfied the DSM-IV criteria for a major depressive episode, as diagnosed independently by two qualified psychiatrists who interviewed the patients personally. The psychiatrists had received DSM-IV training for the diagnosis of mental disorders and passed the assessment of consistency prior to the implementation of this study.”

Regarding the assessment of the controls’ mental state, they were free of any known psychiatric condition and had never taken any form of antidepressant medication, as screened by a self-reporting questionnaire. Additional exclusion criteria adopted for the normal controls were the same as those for the MDD group. We also assessed the depressed state of controls through HDRS, which further confirmed that the normal controls did not have problems related to depression. We revised the description of the assessment of the controls’ mental state in the main context, which is as follows:

“Nineteen healthy participants were recruited via advertisement as a control group. The control subjects were free of any known psychiatric condition and had never taken any form of antidepressant medication, as screened by a self-reporting questionnaire. Additional exclusion criteria adopted for the normal controls (NC) were the same as those for the MDD group. Immediately before the UG task, the depressive symptoms of the participants were rated by an experienced research physician using the 24-item Hamilton Depression Rating Scale (HDRS; [41]).”
3) With regard to the procedures section, the authors should provide more details about the following: Were participants run in groups or individually? Were participants able to discuss the research experience with other participants, especially MDD patients from the same department? Socio-economic status and average salary (in #) of the participant were not reported. These are all important pieces of information that need to be described.

Response 3: We thank the reviewer for pointing out these very important issues. In the following, we will address these issues point-by-point. First, this task was conducted individually, so participants were unable to discuss the research experience with each other. We added one sentence in the Ultimatum game section to clarify this issue, which is as follows:

“The UG task was conducted individually, so participants were unable to discuss the research experience with each other.”

Regarding the socio-economic status and average salary of the participants, we did not collect these data. According to the data from the local Bureau of Statistics, the average annual income of citizens was ¥26451 in the year we performed this experiment (Statistical Information of Hunan, 2012). We converted RMB into U.S. dollars and listed its equivalent cost here. ¥10≈$1.60, which is equivalent to the cost for a lunch meal, ¥4≈$0.64, which is equivalent to the cost for a breakfast meal. The two stake sizes, even though they seem to have little difference on the surface, may have different meanings for these participants. The lack of data on socio-economic status and average salary of the participants is a shortcoming of this study. We added some discussion for this limitation on page 18 in the Strengths and limitations section. It reads as follows:

“Second, it is a flaw that we did not collect the data about socio-economic status and average salary of the participants and did not explicitly assess the meanings of each stake size for participants. However, according to the average annual income and living standards of local people [69], the two stationary offer sizes we used, even though they seem to have little difference on the
surface, may have different meanings for these participants. Our finding that the offer size affected the rejection rate of unfair proposals supports this possibility and suggests a magnitude effect of offer size. In order to reach a firm conclusion about the magnitude effect of offer size, future studies should collect the data about socio-economic status and average salary of the participants, explicitly assess the meanings of stake size for participants and/or increase the differences in magnitude between offer sizes.”

4) In reading the authors’ description of the UG task, two questions came to mind. First, what was the rationale for that the participants were given an unlimited amount of time to decide in UG task? Second, what was the rationale for presenting 18 rounds? Although the UG is a well-known paradigm, this specific paradigm has not yet been utilized so the authors need to be clear about the scientific rational at each step of the procedures.

Response 4: We thank the reviewer for giving us this chance to improve this paper. We gave an unlimited amount of time to make decisions in the UG task because we did not want the participants to decide in a hurry, although the participants did not, in fact, take long to make their choices. From our data, we found the range of the response time in the NC group was 895 ms - 4200 ms, and the mean value was 1948 ms; these values were 913 ms - 3456 ms and 2216 ms, respectively, in the MDD group. All the participants gave their feedback in time. An independent sample T-test showed that there was no significant difference in the response time between the two groups ($p = 0.315$). We also added this result at the end of the Acceptance rates of UG section. It reads as follows:

“For the response time in the UG task, an independent sample T-test showed that there was no significant difference in response time between the two groups ($t(31) = -1.02, p = .315, \text{Cohen’s } d = .360$).”

Regarding the number of rounds set in our UG task, we choose to present 18 rounds in each proposer condition based on the following considerations. In the current study,
two offer sizes (¥10, ¥4) were proffered, and the offers fell into one of three “fairness” categories: 50%-40% of the stake (fair), 33%-25% of the stake (unfair), or 20%-10% of the stake (most unfair). Thus, there are six combinations of offer size and fairness in each proposer condition, and 3 rounds were set for each combination. Thus, we had 18 trials in each proposer condition. The number of rounds in each fairness condition is comparable with several previous studies (Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003; Shamay-Tsoory, Suleiman, Aharon-Peretz, Gohary, & Hirschberger, 2012). In the main context, we also added some descriptions to clarify this step of the procedures. It reads as follows:

“Each responder received 36 offers, 18 of which were supposedly from playing the game with human partners and 18 with computer partners. The offers from the computer partners were identical to those from the human partners, and the rounds were presented randomly. To keep the monetary reward constant and avoid making participants feel bored, we independently manipulated fairness and basic monetary reward (offer size) by varying both the offer amount and the stake size across the trials (Table 1). Two offer sizes (¥10, ¥4) were proffered, and the offers fell into one of three “fairness” categories: 50%-40% of the stake (fair), 33%-25% of the stake (unfair), or 20%-10% of the stake (most unfair). Thus, there are six combinations of offer size and fairness in each proposer condition, and 3 rounds were set for each combination. Thus, we had 18 trials in each proposer condition. The number of rounds in each fairness condition is comparable with several previous studies [23, 47].”

5) It needs explanation why they did not report the highly relevant results about the propositions that made by the patients in the proposer role.

Response 5: Thank you for your comment. After completing the UG task, we asked the participants to make offers as proposers with different stake sizes, and we told them that their proposals would be used in the subsequent study. In reality, the participants’ proposals were not used beyond their function as a cover story. This
manipulation was just to increase the degree of their involvement in this experimental situation and the current study did not focus on the behavior of the participants in the proposer role. However, we also analyzed the data and presented the results here. An independent sample T-test showed that there was no significant difference between the two groups in the proportion allocated to others ($p = 0.082$, the mean value and standard error in the MDD group were 45.9% and 4.4%, respectively; these values were 49.2% and 5.7%, respectively, in the NC group).

6) In the top of page 15, the authors fail to discuss that the most unfair offers made by the human partners were accepted at a significantly lower rate than the same offers made by the computer partners in the NC group when the offer size was smaller, but no differences between human and computer partners were found when the offer size was bigger. The social-cognitive relevance of the indifference to the proposer’s status (human versus computer) in MDD is not discussed appropriately. Fairness and cooperation in depression is highly relevant topic.

Response 6: Thank you for your comment. We added some discussion regarding the reciprocity model of UG and the social cognition of others, as suggested. This paragraph on page 15 is now as follows:

“Another important finding in the present study is that the MDD group showed no differences in acceptance rates between human and computer partners, unlike the normal controls who accepted the most unfair (20%-10% of the stake size) offers with a lower offer size at a significantly lower rate when they were proposed by human partners than when the same offers were proposed by computer partners. This indicates that MDD patients merely care about offer fairness regardless of whether the proposer was a computer or human and seem not to consider reciprocity. In a healthy population, more seems to be tolerated in terms of behavior and actions from agent actors (computers) than from human actors [55]. For the indiscriminate treatment of unfair proposals from human partners and computer partners in the MDD group, we proposed several
possible explanations. First, this abnormal decision behavior we observed may be related to the disturbed affective cognition, which is a major characteristic of patients with MDD (for reviews, see [56-60]). Specifically, MDD patients tend to attend selectively to negative stimuli in their environment and to interpret neutral or ambiguous stimuli as negative or as less positive. This negative bias has been observed in facial emotion processing, memory and attention, and the social and moral emotion of patients with MDD (for a review see [59]). We speculate that the negative bias also exists in decision making in a social interaction context in MDD. It is possible that negative bias is activated by unfair proposals, causing negative cognition to be automatically induced. This negative cognition thus makes patients with MDD neglect the non-social information of the computer and focus on the inequality per se. Thereby, they may interpret proposals from computer partners as negatively as they do those from human partners. Second, impaired social cognition may also play a role in the indiscriminate treatment of unfair proposals from human partners and computer partners in the patients with MDD. Researchers have found that intact social cognition, especially theory of mind, plays a critical role in distinguishing between unfair proposals from computer partners and human partners [40]. Participants need to understand and respond to the thoughts and feelings of others in the human proposer condition, while they do not need to conjecture the intentions of computers in the computer proposer condition. Previous studies exploring the social cognition of MDD have shown that depressed subjects showed impaired ability to conjecture the intentions of others [61-63]. It is possible that the dysfunction in social cognition makes MDD patients treat the human proposer and computer proposer indiscriminately. Additionally, we noted that our results obtained in the patients with MDD were similar to those obtained in patients with a lesion in the ventromedial prefrontal cortex (vmPFC), who also did not distinguish unfair offers from human and computerized opponents [10]. Considering that vmPFC is a brain region that is necessary for valuing social information in social
interaction and decision-making [10, 64], Moretti et al. think that the ability to value social information is important for the discriminate treatment of human proposers and computer proposers [10]. Abnormal structure and function in the vmPFC have been consistently reported in patients with MDD [65-67]. Therefore, it is possible that the indiscriminate treatment of human and computer proposers in MDD is related to the impaired functions which should be served by the vmPFC, such as valuing social information during interactive decision making. These speculations also need to be tested in future studies.”

In addition, we have made other minor revisions throughout the paper, which are highlighted in black and bold in the revised manuscript. The manuscript was edited for grammar, spelling, vocabulary, and sentence structure by American Journal Experts (AJE, http://www.journalexpert.com), a professional English-language editing service.

Thank you very much for your considerations and assistance. We look forward to your feedback.

Sincerely,

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References


