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The Impact of Anxiety on Social Decision-Making: Behavioral and Electrodermal Findings

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Abstract

Anxiety plays an important role in social behavior. For instance, high-anxious individuals are more likely to avoid such social interactions as communicating with strangers. In this study, we investigate the impact of anxiety on social decision-making. The classic Ultimatum Game (UG) paradigm was utilized in concert with skin conductance recording. Behavioral results reveal that when playing as responders, high-trait anxiety (HTA) participants with lower levels of self-esteem, as well as low-trait anxiety (LTA) participants with higher levels of impulsivity, were more likely to accept human-proposed inequitable offers. In addition, HTA participants rejected more computer-proposed inequitable offers than did LTA participants. Moreover, the skin conductance response to inequitable offers was correlated with levels of anxiety in the HTA group, but not in the LTA group. In conclusion, people differing in levels of anxiety showed distinct behavior patterns and autonomic neural responses during social decision-making, while levels of self-esteem, impulsivity and depression might be additional moderating factors. These findings contextualize high-anxious people's avoidance tendency in social interaction.

Keywords

anxiety; social decision-making; Ultimatum Game (UG); fairness; skin conductance responses (SCRs); self-esteem; impulsivity

INTRODUCTION

Anxiety is an unpleasant emotional state or condition characterized by feelings of tension, apprehension, and worry (cited from Beuke, Fischer, & McDowall, 2003). It has been proposed to facilitate avoidance of potential threats (de Visser et al., 2010; Nesse, 2006). Excessive or inappropriate anxiety negatively affects social life. Raffety, Smith, & Ptacek (1997) found that higher levels of anxiety lead to an avoidant coping strategy. Turner (1988) claimed that anxiety undermines the motivation to communicate with other individuals such that high-anxious people are more likely to avoid social interactions. Consistent with this viewpoint, Duronto, Nishida, & Nakayama (2005)'s study indicated that anxiety is a good predictor of avoidance in communication with strangers (see also Samochowiec & Florack,

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2010). Notably, generalized social anxiety disorder (SAD) involves fear/avoidance of social situations (Schneier, 2003; Stein & Kean, 2000). Research on the relationship between anxiety and social behavior has proved beneficial to both clinical and non-clinical research (Heimberg, Mueller, Holt, Hope, & Liebowitz, 1992; Hill, Levermore, Twaite, & Jones, 1996; Rapee & Heimberg, 1997).

Social decision-making involves making choices in the context of a social interaction (Rilling & Sanfey, 2011). These social decisions are those that affect others as well as the social agent (Fehr & Camerer, 2007). In our opinion, investigating anxious people's social decision-making may clarify the influence of anxiety on social interactions. For example, Sripada et al. (2009) observed that activations of medial prefrontal cortex, a key region for mentalizing and social cognition, were diminished in SAD patients participating in a social exchange game called the "trust game."

People's social decisions often deviate from those of a hypothesized rational economic agent (Haselhuhn & Mellers, 2005; Hewig et al., 2011). Studies utilizing the Ultimatum Game (*abbr.* UG) showcase this phenomenon (Güth, Schmittberger, & Schwarze, 1982; Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003). In this game, one of two players (the proposer) is asked to split a sum of money between the two. The other player (the responder) can then either accept or reject the proposer's offer. If he/she rejects, neither player receive any benefit (Boksem & De Cremer, 2010). Researchers have discovered that (a) proposers tend to give responders far more than the prediction of classical economic theory, and (b) responders are unwilling to accept inequitable offers (Camerer & Thaler, 1995; Haselhuhn & Mellers, 2005; Knafo et al., 2008). Pillutla & Murnighan (1996) pointed out that perceived anger strongly predicts rejection of inequitable ultimatum offers (see also Haselhuhn & Mellers, 2005; Sanfey, et al., 2003). Inequitable proposals elicit a greater-magnitude skin conductance response (*abbr.* SCR) (van't Wout, Kahn, Sanfey, & Aleman, 2006) and stronger activity in emotion-related brain regions (Koenigs et al., 2007; Sanfey, et al., 2003). Both of these findings indicate the impact of negative emotions on UG performance.

In the current study, we aimed to examine anxious people's performance in social decision-making games. The classic UG paradigm was utilized. We hypothesized that in the UG, participants with high trait anxiety levels would suggest equitable offers when playing as proposers, and accept inequitable offers when playing as responders. We made this hypothesis because anxious individuals tend to avoid interpersonal rejection and disapproval (Leary & Downs, 1995).

In addition, the SCRs were recorded during the experiment. The SCR, an important measure of sympathetic activity, is associated with levels of emotional arousal (Canli & Lesch, 2007). It is believed to be related to activities of the behavioral inhibition system, the biological basis of negative affect (Hewig, et al., 2011). To our knowledge, two studies have recording SCRs during the UG task, and both observed greater skin conductance responses in UG responders as a function of increasing inequity (Hewig, et al., 2011; van't Wout, et al., 2006). Higher SCRs to inequitable UG offers indicate stronger negative emotional feelings (Hewig, et al., 2011). In this study, we hypothesized that the impact of anxiety on game performance would also be reflected in the SCRs. Since the HTA participants were expected to accept inequitable offers, we suggested the SCRs in response to inequitable offers would be smaller in the HTA group (see Wilken, Smith, Tola, & Mann, 2000 for similar results).

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METHODS

1. Participants

319 undergraduate students (all Chinese) participated in a mass screening with the Chinese version of the Trait form of Spielberger's State-Trait Anxiety Inventory (STAI-T). This scale has demonstrated good internal consistency, convergent validity, and discriminant validity (Shek, 1993; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Individuals with STAI-T scores in the upper 25% of the distribution were termed high-trait anxiety (HTA) people, while individuals who were in the lower 25% of the distribution were termed low-trait anxiety (LTA) people. From those who were suitable for these criteria, we randomly chose 60 students and asked them to participate in the formal experiment. 57 persons accepted our invitation to be volunteers, but 3 of them were excluded from further analysis: two because the connection between the MP150 and computer was interrupted, while one because the task program crashed during the experiment. In the final sample (54 participants), both the high-trait anxiety (HTA) group and the low-trait anxiety (LTA) group consisted of 27 participants (HTA group: 20 females; LTA group: 16 females).

All participants denied regular use of substances with the potential to affect the central or the sympathetic nervous system. All had normal vision (with or without correction). None were diagnosed as having any psychiatric disorder, and none were taking any psychiatric medication. None had a history of neurological disease. All were right-handed. All participants provided written informed consent prior to the experiment. In addition, they also completed the Chinese version of several psychological questionnaires, including the State form of Spielberger's State-Trait Anxiety Inventory (STAI-S), the Rosenberg Self-esteem Scale (SES) (Cheng & Hamid, 1995; Rosenberg, 1965), the Self-rating Depression Scale (SDS) (Shu, 1993; Zung, Richards, & Short, 1965), the Barratt Impulsiveness Scale (BIS-11) (Patton, Stanford, & Barratt, 1995; Yao et al., 2007), and the Machiavellianism scale (MACH) (Christie & Geis, 1970; Liu, 2008; Wang, Wang, & Ma, 1999).

Independent-samples t tests revealed that the HTA and LTA groups differed significantly in trait-anxiety scores, but not in age. HTA participants revealed significantly lower levels of self-esteem (see also Rosenberg, 1962), but higher levels of state anxiety (Shek, 1993), depression (see also Stavrakaki & Vargo, 1986), impulsivity (see Taylor et al., 2008 for similar results), and Machiavellianism (see Poderico, 1987 for similar results), compared to LTA participants. See Table 1 for details.

2. Procedures

Before the formal task, participants were told that they would play the UG together with three other anonymous players. In fact, there were no other people participating in the game. Participants were told that they would be paid according to their choices in the game.

The formal task consisted of three sessions in which participants acted in the role of either proposers or responders (see also Hewig, et al., 2011 for the task procedure). In the first session (proposer session 1), participants played as proposers and made 24 ultimatum proposals via a PC (see Figure 1a). They were told that their proposals would be collected and stored in the computer, and then would be proposed to the other three players in the second session.

In the second session (responder session), participants played as responders and decided whether or not to accept the offer in each trial (see Figure 1b). This session were divided into four blocks. In two of the blocks (human blocks), participants were told that the offers were proposed by the other three players, while in the other two blocks (computer blocks), the offers were proposed randomly by the computer. Each block consisted of 24 trials (96 trials in total), with each block separated by a short rest. Before the experiment, participants were told that the offers in human blocks were randomly selected from the other three players' proposals, and it would be unable for participants to know which proposer suggested the offer in the current trial. In addition, proposers would not be able to know whether their offers were accepted or rejected by participants (see also Boksem & De Cremer, 2010). Unbeknownst to the participants, all the offers in four blocks were actually proposed by the computer in a predetermined pseudo-random sequence. Each block included 8 equitable trials (50:50), 8 moderate inequitable trials (40:60 and 30:70), and 8 inequitable trials (20:80 and 10:90).

In the third session (proposer session 2), participants were asked to propose 24 ultimatum proposals to the other three players again. Participants were told that these offers were hypothetical, that is, other players would not actually receive these offers. Rather, participants were asked to imagine what they would like to do if they were given the opportunity to act as proposers again. This session was designed to examine whether participants' decision-making strategy would significantly change after the responder session.

After the participants finished all these three sessions, they completed two self-rating questionnaires about their feeling about each offer type in the responder session: one for the feeling of fairness (from 1/ extremely unfair to 7/fair) (see also Knoch, Pascual-Leone, Meyer, Treyer, & Fehr, 2006), and the other for the subjective rating of emotional valence (from 1/highly negative to 9/highly positive) (see also Hewig, et al., 2011).

3. Skin Conductance Recording and Quantification

Skin conductance responses were sampled at 100 Hz using the Biopac (Goleta, CA) MP150/ GSR100C system (i.e., constant voltage of 0.5 V, using a DC amplifier with low-pass filtering at 1 Hz), with Ag–AgCl electrode leads positioned over the thenar and hypothenar eminences of the left hand. The gain was set at 5 μS/V with a resolution of 0.00015 μS. After the electrodes were placed, participants were asked to sit quietly and relax during a 5-minute habituation period. After this period, baseline SCL was recorded for two minutes, during which no stimulus was presented and participants were instructed not to move or talk. Two nonspecific elicitors of SCR, a hand clap (delivered about 30 cm from the participants' left ear without warning) and deep inhalation by the participants, were used to assess the integrity of the dermoelectrical system following the baseline recording (Dawson, Schell, & Filion, 2004). The galvanic skin response (GSR) signal was recorded during all sessions, but only the data collected in the responder session was entered into further analyses.

The data were analyzed by AcqKnowledge 4.1.0 software for the MP150 system (Biopac system, Inc., Goletta, CA, USA) and Matlab R2009a (The MathWorks, Inc., Natick, MA, USA). The procedure of data analysis was consistent with the instructions from the manual of Acq Knowledge software. Through visual inspection, electrodermal activity (EDA) data that contained large environmental noise was manually deleted. The phase EDA was derived from tonic EDA using baseline smoothing (time window width: 8 sec). The event-related SCRs were automatically detected by a two-step approach. First, the onsets of potential SCRs were detected as the first positive sample on the phase EDA signal 1 ~ 4 sec after the presentation of the offers. The end of the potential SCR was considered as the first negative sample following the onset point or the disappearance of the offers (8 sec) when no negative sample was detected. After all of the potential SCRs have been located, we determined the overall maximum amplitude of the phasic EDA signal within all potential SCRs, and then constructed a threshold level T as 10 percent of this value. Only the SCRs for which the maximum phasic EDA exceeded T were marked as valid SCRs. The amplitude of each SCR was determined by the change in the tonic EDA amplitude from the time of SCR onset to the maximum tonic EDA amplitude achieved during the SCR, and then the associated logarithm (SCR + 1.0) was calculated (Venables & Christie, 1980). The SCR amplitude of each condition was calculated as the mean value computed across only those trials in which valid SCRs occurred (cited from Cacioppo, Tassinary, & Berntson, 2004).

4. Data analysis

The offers from proposer session 1 and 3 were calculated as means for each participant and were then analyzed using a two-way Sequence (session 1 vs. session 3) × Anxiety (HTA vs. LTA) ANOVA test.

The acceptance rate and the acceptance threshold in the responder session were analyzed using three-way Proposer (human vs. computer) × Equity (5 levels: 10:90, 20:80, 30:70, 40:60, 50:50) × Anxiety (HTA vs. LTA) ANOVA tests.

In the responder session, EDA data (SCR amplitude) following the presentation of proposal were analyzed using three-way Proposer (human vs. computer) × Equity (2 levels: equitable, inequitable) × Anxiety (HTA vs. LTA) ANOVA tests, in which 50:50 was labeled as an equitable offer whereas 10:90 and 20:80 were labeled as inequitable offers. Moderate inequitable offers (30:70 and 40:60) were excluded as these are often perceived as fair proposals by many people (see also Halko, Hlushchuk, Hari, & Schurmann, 2009; Hewig, et al., 2011; van’t Wout, Chang, & Sanfey, 2010).

Fairness ratings and emotional feelings (collected from self-rating questionnaires) were analyzed using three-way Proposer (human vs. computer) × Equity (5 levels: 10:90, 20:80, 30:70, 40:60, 50:50) × Anxiety (HTA vs. LTA) ANOVA tests.

A strong theoretical relationship between anxiety and depression has been widely recognized (Clark & Watson, 1991; Stavrakaki & Vargo, 1986). In order to control the potential influence of depression on the results, the SDS score was entered into the ANOVA tests as a covariate whenever significant anxiety group effects were detected.

In addition, regression analyses were conducted to evaluate the effect of (a) self-reported measures on electrodermal activities, and (b) self-reported measures and electrodermal activities on behavior performance. Self-reported scales being considered were scores of STAI-T, SES, SDS, BIS-11, and MACH (STAI-S score was not entered into analyses, because the current study focuses on the effect of individual personalities rather than transient levels of arousal; see Bekker, Legare, Stacey, O’Connor, & Lemyre, 2003).

For all the analyses, the significance level was set at 0.05. Greenhouse–Geisser corrections were used whenever appropriate. Post-hoc testing of significant main effects was conducted using the LSD method. Significant interactions were analyzed using simple-effects models. Only significant effects are reported hereafter.

RESULTS

1. Behavioral performance in proposer sessions

The mean number of participants’ offers to other players was 39.5 ± 0.8; participants preferred to offer a equitable share when acting as proposers (Haselhuhn & Mellers, 2005; Nowak, Page, & Sigmund, 2000). No significant main effect or interaction was detected, either before or after the responder session.

2. Behavioral performance in responder session

2.1 Acceptance rate—The main effect of the Proposer factor was significant ($F(1, 52) = 78.73$, $p < 0.001$), with the acceptance rate being higher when participants receiving offers proposed by the computer (80.8 ± 2.7 %) than by human beings (56.5 ± 2.4 %). The main effect of the Equity factor was also significant ($F(4, 208) = 164.53$, $p < 0.001$). Post-hoc analyses indicated significant differences between each condition such that the acceptance rate increased as levels of equity increased. The Proposer × Equity interaction was significant ($F(4, 208) = 28.37$, $p < 0.001$); the main effect of the Equity factor was stronger in the human proposer condition ($F(4, 212) = 193.10$, $p < 0.001$) than in the computer condition ($F(4, 212) = 38.58$, $p < 0.001$). The Proposer × Anxiety interaction was significant ($F(1, 52) = 6.63$, $p = 0.013$); HTA participants accepted fewer offers than LTA participants in the computer condition ($F(1, 52) = 6.86$, $p = 0.012$), but not in the human proposer condition ($p > 0.05$). The Proposer × Equity × Anxiety interaction was significant ($F(4, 208) = 2.43$, $p = 0.049$); compared to LTA participants, HTA participants accepted less computer-proposed inequitable (10:90 and 20:80) offers ($p < 0.05$) (see Figure 2). Finally, when adding depression as a covariate in the ANOVA test, the Proposer × Anxiety interaction remained significant ($F(1, 51) = 4.48$, $p = 0.039$); the Proposer × Equity × Anxiety interaction failed to reach significance ($F(4, 204) = 2.34$, $p = 0.056$).

2.2 Acceptance threshold—The behavioral data revealed that many participants set an "acceptance threshold" when playing as responders. Offers lower than participants' thresholds were usually rejected (Wallace, Cesarini, Lichtenstein, & Johannesson, 2007). In order to investigate the acceptance threshold, we recorded the smallest offers that each participant accepted during the responder session. The results were entered into a two-way Proposer (human vs. computer) × Anxiety (HTA vs. LTA) ANOVA test. The main effect of the Proposer factor was significant ($F(1, 52) = 31.50$, $p < 0.001$); the acceptance threshold was higher in the human proposer condition (23.2 ± 1.6) than in the computer condition (15.0 ± 1.1). The Proposer × Anxiety interaction was significant ($F(1, 52) = 7.88$, $p = 0.007$); the group effect was not significant in the human proposer condition ($p > 0.05$), but significant in the computer condition ($F(1, 52) = 7.90$, $p = 0.007$), with the acceptance threshold being higher in the HTA group (18.5 ± 1.7) than in the LTA group (11.9 ± 1.7). When adding depression as a covariate in the ANOVA test, the Proposer × Anxiety interaction failed to reach significance ($F(1, 51) = 3.39$, $p = 0.072$).

3. SCRs Amplitude

The main effect of the Equity factor was significant ($F(1, 52) = 4.24$, $p = 0.044$); the SCR amplitude was higher in response to inequitable offers (0.024 ± 0.004 μV) than equitable offers (0.017 ± 0.003 μV) (see also Hewig, et al., 2011; van't Wout, et al., 2006 for similar results). No other significant main effect or interaction was detected.

4. Self-rating questionnaires

The ANOVA test on the fairness rating revealed a significant main effect of the Proposer factor ($F(1, 52) = 22.60$, $p < 0.001$) with higher fairness ratings being reported for offers proposed by the computer (5.0 ± 0.1) than for offers proposed by human beings (4.4 ± 0.1). This finding was consistent with the pattern of the acceptance rate and with participants' acceptance threshold. The main effect of the Equity factor was also significant ($F(4, 208) = 588.03$, $p < 0.001$); fairness ratings increased as levels of equity increased. The Proposer × Equity interaction was significant ($F(4, 208) = 23.66$, $p < .001$); fairness ratings were weakened for human-proposed offers 10:90, 20:80, and 30:70 ($ps < 0.005$) compared to those proposed by the computer.

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The ANOVA test on emotional feeling revealed a significant main effect of the Proposer factor ($F(1, 52) = 14.23$, $p < 0.001$) with more positive feelings being reported for offers proposed by the computer (5.7 ± 0.2) than for offers proposed by human beings (5.1 ± 0.1). The main effect of the Equity factor was also significant ($F(4, 208) = 231.90$, $p < .001$). Post-hoc analyses indicated significant differences between each condition such that the level of emotional valence increased as levels of equity increased. The Proposer × Equity interaction was significant ($F(4, 208) = 17.90$, $p < 0.001$); compared to the computer condition, more negative feelings were reported for offers 10:90, 20:80, and 30:70 ($ps \leq 0.001$), and more positive feelings were reported for the 50:50 offer ($F(1, 53) = 5.58$, $p = 0.022$) in the human proposer condition. Finally, the Equity × Anxiety interaction was significant ($F(4, 208) = 5.38$, $p < 0.001$); compared to LTA participants, HTA participants had more negative feelings about the 10:90 offer ($F(1, 52) = 4.92$, $p = 0.031$) (see Figure 3). When adding depression as a covariate in the ANOVA test, the Equity × Anxiety interaction was marginally significant ($F(4, 204) = 3.16$, $p = 0.05$).

5. Regression analysis

5. 1 Analysis on skin conductance responses—A step-wise regression analysis was carried out to investigate the SCRs in inequitable offer (10:90 and 20:80) conditions. The predictor variables were participants' personalities. The entry criterion was set at p-value < 0.05 whereas the removal criterion was set at p-value > 0.10.

In the HTA group, trait anxiety turned out to be a predicting variable ($F = 6.44$, $p = 0.018$) such that SCRs increased as levels of anxiety increased ($\Delta R^2 = 0.205$); in the LTA group, no predicting variable was found.

5. 2 Analysis on acceptance rate—A step-wise regression analysis was carried out to investigate the acceptance rate in inequitable offer (10:90 and 20:80) conditions. The predictor variables included participants' personalities, skin conductance responses, and self-rating questionnaires in corresponding conditions. The entry criterion was set at p-value < 0.05 whereas the removal criterion was set at p-value > 0.10. The major findings were listed below (see Table 2 for details).

- **a.** For human-proposed inequitable offers, self-rated fairness feeling was a predicting variable in both groups such that the acceptance rate increased as fairness ratings increased; for computer-proposed inequitable offers, the effect of fairness rating was observed in the LTA group, but not in the HTA group.
- **b.** For human-proposed inequitable offers, self-esteem (measured by SES scores) was a predicting variable in the HTA group such that HTA participants' acceptance rate decreased as levels of self-esteem increased; opposite results were observed for computer-proposed inequitable offers in the whole sample, where the acceptance rate increased as levels of self-esteem increased.
- **c.** For human-proposed inequitable offers, impulsivity (measured by BIS-11 scores) was a predicting variable in the LTA group such that LTA participants' acceptance rate increased as levels of impulsivity increased; the effect of impulsivity was also observed for computer-proposed inequitable offers in the whole sample.
- **d.** For computer-proposed inequitable offers, depression (measured by SDS scores) and SCRs were negatively associated with the acceptance rate in the whole sample.

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DISCUSSION

Using the classic UG task paradigm, our results replicated the well-documented behavioral pattern that participants' acceptance rate depend on the level of equity of proposals (Güth, et al., 1982; Sanfey, et al., 2003; van't Wout, et al., 2006). In addition, compared to computer-proposed offers, lower acceptance rates and higher acceptance thresholds were observed when participants received human-proposed offers, suggesting that participants expected higher levels of equity from human proposers than from the computer (see also Sanfey, et al., 2003). Also, the results of retrospective questionnaires reveal that self-rated fairness feelings increased as levels of equity increased, supporting the idea that the core of fairness is inequity aversion (Fehr & Schmidt, 1999; Knoch, et al., 2006).

The current study aimed to investigate whether levels of anxiety influence social decisions. The results reveal that the HTA and LTA groups showed different behavioral patterns during the task, but the effect of anxiety was more complicated than our hypothesis. When participants played as proposers, no significant result was detected. In addition, they tended to propose equitable offers to other players. Accordingly, we suggest the UG proposers' decisions were driven mainly by reciprocity motive (Bruni, Gilli, & Pelligra, 2008, see also Knoch, et al., 2006; Nowak, 2006). We believe that anxiety did not significantly modulate reciprocity motive in the proposer context because anxiety levels have past been linked to individual differences in negative reciprocity norms, which is associated with anger and revenge behavior, but not with positive reciprocity norms (Eisenberger, Lynch, Aselage, & Rohdieck, 2004). Given that positive reciprocity and negative reciprocity are observed on UG proposers and responders, respectively (see also Fehr & Gachter, 2000), we expected significant effect of anxiety in the responder session. Consistent with this viewpoint, when participants played as responders, the impact of anxiety on task performance was evident in both the human-proposer and computer conditions.

1. Human-proposer condition

For human-proposed offers, the acceptance rate was negatively associated with levels of self-esteem in the HTA group, but it was positively associated with levels of impulsivity in the LTA group. Self-esteem plays an important role in social decision-making (Lu & Argyle, 1991), including in the UG (Zhang, 2009). Individuals with lower self-esteem have stronger concerns about social exclusion and avoid doing things that might undermine social acceptance (Leary & Downs, 1995). An inverse relationship between anxiety and self-esteem level has long been established (Patten, 1983; Rosenberg, 1962), which is also revealed in the current study. Anxious people hesitate to be involved in social activities, partly because interpersonal rejection or disapproval threatens their self-esteem (see also Leary & Downs, 1995). In our opinion, people with higher anxiety and lower self-esteem tend to be more receptive to other's proposals when making social decisions (see also Wray & Stone, 2005). Thereby, they accepted more human-proposed unfair offers in the UG.

Impulsivity is characterized by rapid responding and enhanced sensitivity to immediate reward (Martin & Potts, 2004; Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Individual differences in response to reinforcing stimuli (e.g., food, drug, and money) are linked to impulsive personality dimensions (Jiang et al., 2009; Joseph, Liu, Jiang, Lynam, & Kelly, 2009). We suggest that participants with low anxiety and high impulsivity are prone to maximize their economic benefit regardless of fairness considerations, resulting in higher acceptance rates. Meanwhile, impulsive people are more likely to make choices without forethought or conscious judgment (Chen & Vazsonyi, 2011; Kjome et al., 2010), which might also played a role in our findings.

2. Computer condition

For computer-proposed offers, the HTA group rejected more computer-proposed inequitable offers (10:90 and 20:80) compared to the LTA group, indicated by lower acceptance rates and higher acceptance thresholds. Recently, similar results were discovered from the comparison between depressed patients and normal adults (Zhou & Li, unpublished materials). Self-rated fairness feelings predicted the likelihood to accept computer-proposed inequitable offers in the LTA group, but not in the HTA group. Accordingly, we suggest that HTA participants' low acceptance rates did not stem from fairness considerations. Below we propose two hypotheses to explain this phenomenon.

The first possibility is that compared to the LTA group, HTA participants had stronger negative feelings when receiving inequitable proposals. Ferdig & Mishra (2004) claimed "in both human-human and human-computer interactions, unfair offers encouraged feelings of unfairness, anger, and spite" (see also Mishra, 2006). Seeing that levels of anxiety have been reported to correlate with anger (Ewbank et al., 2009; Spielberger, Jacobs, Russell, & Crane, 1983), it is possible that HTA participants rejected computer-proposed inequitable offers out of stronger feelings of angry. Regarding the skin conductance response to inequitable offers, levels of anxiety were positively associated with SCR magnitudes in the HTA group, but not in the LTA group. In addition, the acceptance rate in the computer condition decreased as SCR magnitudes increased. However, the intergroup difference of the SCR magnitude was not significant, which limits the validity of this explanation.

In order to maximize monetary benefit, UG responders should try to control their anger and spite in the computer condition. Our second hypothesis is that HTA participants were not able to suppress their negative feelings as well as LTA participants did. High-anxious individuals have more difficulties in suppressing the disturbance of emotional information (Mogg & Bradley, 1998; Mogg, Bradley, Williams, & Mathews, 1993), indicating emotion regulation deficits (Huang et al., 2009; Mennin, Heimberg, Turk, & Fresco, 2002; Sanz, Molina, Martin-Loeches, Calcedo, & Rubia, 2001). We suggest the intergroup difference in acceptance rates implies that HTA participants failed to regulate negative emotions generated by computer-proposed inequitable offers. Abnormality of emotion regulation function during social interactions might be a key to understand anxious people's social decision-making strategies such as their tendency toward irrational avoidance behavior (Amstadter, 2008; Canli & Lesch, 2007).

To sum up, when dealing with human beings, the impact of anxiety on social decision-making was modulated by levels of self-esteem and impulsivity; when dealing with the computer, HTA participants made more sub-optimal decisions than LTA ones, possibly reflecting exaggerated emotional feelings or emotion regulation deficits. In our opinion, compared to LTA participants, HTA participants had more negative feelings about inequitable offers (this idea is supported by the results of self-rating emotional feeling. See also Maner & Schmidt, 2006; Mitte, 2007): anxious people have stronger negative feeling to economic loss). In the human-proposer condition, the group effect on acceptance rates was not significant, because HTA participants were hesitate to show disagreement to other players, possibly due to low levels of self-esteem; in the computer condition, HTA participants were more likely to express their anger, resulting in lower acceptance rates. We suggest these findings clarify high-anxious people's social behavior patterns.

Anxiety is a complex emotion that has been linked to a variety of other personality dimensions (Clark, Watson, & Mineka, 1994; Schwartz & Weinberger, 1980). In the current study, self-esteem and impulsivity have demonstrated their influence on the relationship between anxiety and social behavior. In addition, depression appeared to modulate the effect of anxiety when added as a covariate. Regarding the high correlation between these

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psychological measures, it might be necessary to apply additional grouping criteria in further studies. For instance, the sample may be divided into more subgroups according to participants' levels of anxiety and other personality traits, so as to dissociate their effects on task performance. It is also worth noting that some factors that could potentially affect social behavior, such as women's menstrual cycle (Rapkin, Pollack, Raleigh, Stone, & McGuire, 1995), were not statistically controlled in the current study. Future studies that are interested in gender differences should take this into account.

Finally, we suggest brain-imaging work might be competent to reveal the underlying neural mechanism involved in anxiety and social decision-making. The role of the insula, which is an important region for emotional experience and self-awareness of emotional states, is worth noting. Inequitable proposals significantly activate the (anterior or posterior) insula, possibly due to strong negative feelings (Grecucci, Giorgetta, Van't Wout, Bonini, & Sanfey, 2012; Harle, Chang, van 't Wout, & Sanfey, 2012; Sanfey, et al., 2003). On the other hand, insula hyperactivity is considered to be a common feature of individuals with elevated anxiety level (Paulus & Stein, 2010; Simmons, Strigo, Matthews, Paulus, & Stein, 2006). It would be interesting to see if insula activation modulates anxious people's social decisions in the UG.

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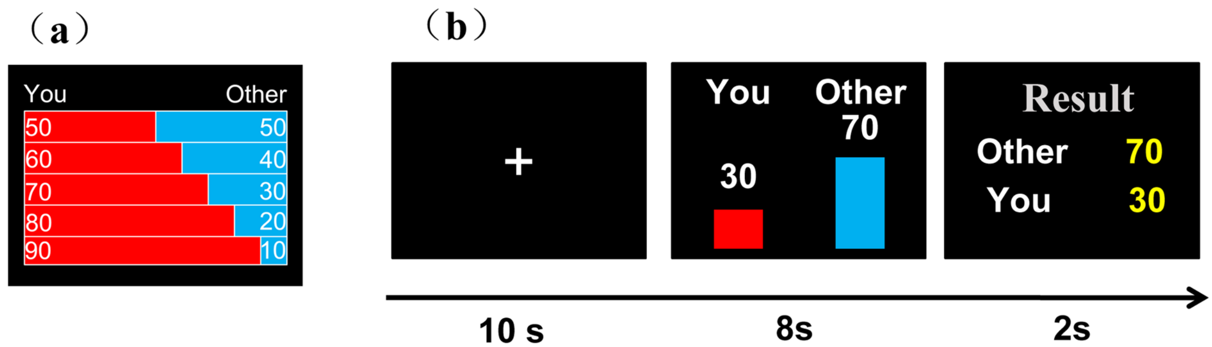

Figure 1.
Task procedures in the proposer sessions (a) and the responder session (b). In each trial of the proposer sessions (sessions 1 and 3), participants were asked to split 100 bonus points between themselves and a pseudo-player with one of five distributions (50:50, 60:40, 70:30, 80:20, or 90:10). In each trial of the responder session (session 2), a central fixation cross was presented for 10 s. Thereafter, a proposal made by a pseudo-player or the computer was presented for a time window of 8 s, during which participants could decide whether to accept the proposal. Finally, the result of the current trial was presented for 2 s.

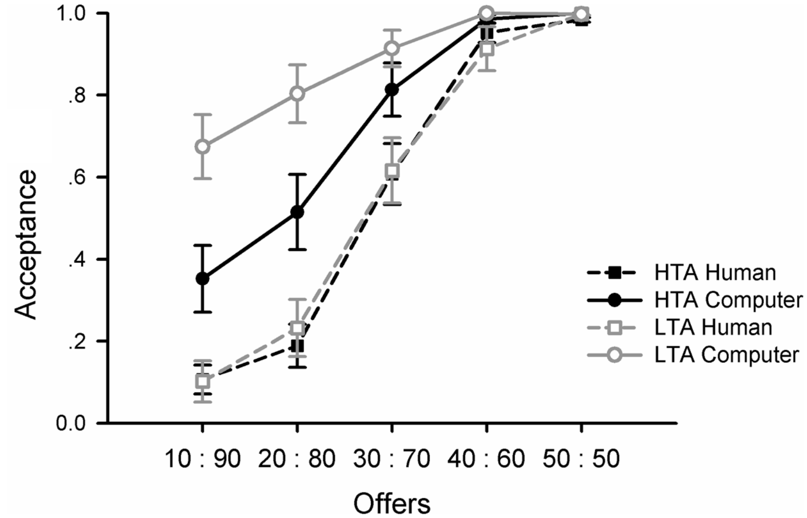

Figure 2.

The illustration of the Proposer × Equity × Anxiety interaction revealed in the acceptance rate. The group effect was evident in computer-proposed inequitable offers (10:90 and 20:80).

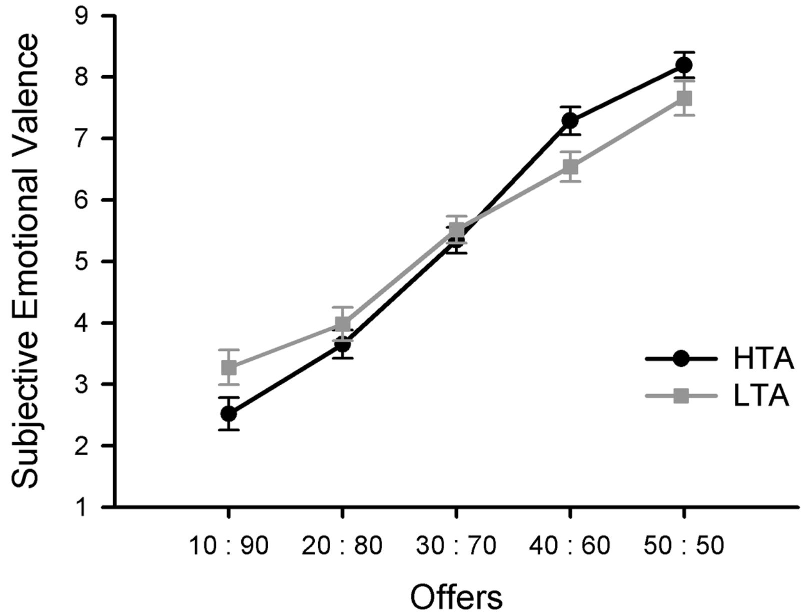

Figure 3.
The Equity × Anxiety interaction revealed in the subjective rating of emotional valence. The group effect was evident in the 10:90 offer.

Table 1

Participant demographics and psychological measures of the two groups

	HTA	LTA	*p* value
N	27 (20 females)	27 (16 females)	
Age	20.89 ± 0.35	21.30 ± 0.39	> 0.05
STAI-T	58.15 ± 0.72	26.48 ± 0.60	< 0.001
STAI-S	42.89 ± 2.27	26.44 ± 0.97	< 0.001
SES	27.03 ± 0.91	34.04 ± 0.62	< 0.001
SDS	0.51 ± 0.02	0.35 ± 0.01	< 0.001
BIS-11	62.07 ± 1.87	51.37 ± 1.40	< 0.001
Mach	74.96 ± 2.53	65.22 ± 2.77	= 0.012

Table 2

The results of regression analysis on participants' acceptance rates when receiving inequitable (10:90 and 20:80) offers

Proposer	Cronbach's alpha	Group	1	2	3	4	Model
Human	**0.837**	**Overall**	**Fairness:** $\Delta R^2 = 0.395$ ($\beta = 0.178$; $p < 0.001$)				$F = 33.921$ ($p < 0.001$)
		HTA	**Fairness:** $\Delta R^2 = 0.312$ ($\beta = 0.141$; $p < 0.001$)	**SES:** $\Delta R^2 = 0.180$ ($\beta = -0.019$; $p = 0.008$)			$F = 11.600$ ($p < 0.001$)
		LTA	**Fairness:** $\Delta R^2 = 0.567$ ($\beta = 0.298$; $p < 0.001$)	**BIS-11:** $\Delta R^2 = 0.073$ ($\beta = 0.011$; $p = 0.037$)			$F = 21.310$ ($p < 0.001$)
Computer	**0.907**	**Overall**	**SDS:** $\Delta R^2 = 0.075$ ($\beta = -1.972$; $p = 0.002$)	**BIS-11:** $\Delta R^2 = 0.100$ ($\beta = 0.026$; $p < 0.001$)	**SCR:** $\Delta R^2 = 0.068$ ($\beta = -3.550$; $p = 0.006$)	**SES:** $\Delta R^2 = 0.058$ (β 0.033; $p = 0.012$)	$F = 9.970$ ($p < 0.001$)
		HTA					
		LTA	**Fairness;** $\Delta R^2 = 0.245$ ($\beta = 0.095$; $p = 0.009$)				$F = 8.105$ ($p = 0.009$)