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ORIGINAL RESEARCH

Which is More Important, Proposer Identity or Allocation Motive? Event-Related Potential in Economic Decision-Making

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Purpose: Most studies have supported the view that individuals prefer to reward the in-group and discriminate against the out-group in response to unfair offers in the Ultimatum Game. However, the current study advanced a different view, that is, the "black sheep effect", in which in-group members were punished more severely compared with out-group members. This study aimed to incorporate proposer identity and allocation motive as possible explanations for offer rejection.

Methods: In the current study, the in-group and out-group identities were distinguished by their health condition, and the allocation motive was defined according to its benefit maximization. With a total of 89 healthy college student participants, a mixed design of 2 (proposer identity: out-group vs in-group) × 2 (allocation motive: selfish vs random) × 2 (offer type: unfair vs fair) was used in the Ultimatum Game. Event-related potential (ERP) technology was used, and ERPs were recorded while participants processed the task.

Results: The behavioral result showed that the "black sheep effect" was found on the fair offer when a random allocation motive was used. Our ERP result suggested that feedback-related negativity (FRN) and P300 were modulated by proposer identity but not by allocation motive. However, the allocation motive interacted with proposer identity affecting FRN and P300 when the fair offer was proposed.

Conclusion: These findings demonstrated that the "black sheep effect" was related to the experience of the out-group member, such as disadvantage or distress, but it was also modulated by allocation motive. Meanwhile, the out-group (depressed college students) captured more attention because they violated individual expectations, according to the P300. This finding plays an integral role in understanding the mechanism of response to the "black sheep effect".

Plain Language Summary: People prefer to receive fair offers compared to unfair offers, but they are more tolerant to in-group members compared with out-group members when facing unfair offers. However, what would you do if you knew the in-group members were making you the smallest offer possible with a self-interested motive to maximize their own gains? We used the Ultimatum Game (UG) to explore this issue. We invited 89 colleges to participate in this study, and they were randomly divided into in-group member, out-group member, selfish motive, and random motive groups. Then, we used event-related potential (ERP) technology to examine cognitive processing. We found the "back sheep effect" on the fair offer, which means that people prefer to accept the out-group member's offer when they had a random motive. We also found different feedback-related negativity (FRN) and P300 between the in-group and out-group members. In addition, the "black sheep effect" was found in the fair offers when the proposer presented a random motive. This finding plays an important role in understanding the mechanism of response to fair or unfair offers.

Keywords: in-group, out-group, ultimatum game, event-related potential technique, allocation motive, feedback-related negativity, P300

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Introduction

Accumulated experiments have demonstrated people to be self-interested but also averse to unfair allocation.[1,2] Individuals are willing to reject an unfair offer if they are worse off than others, even at the expense of self-interest, to punish those who treat them unfairly. This phenomenon has continually been measured by the well-known paradigm of the Ultimatum Game (UG).[3] The UG includes two roles, the proposer and the responder. During game inception, a particular amount of money is given to the proposer for free allocation, which the responder decides to accept or reject. If the responder chooses to accept, both parties receive the corresponding amount following the actual allocation scheme; upon rejection, they receive nothing.[4]

Assuming knowledge of rationality suggests that the optimal decision for this behavior is to accept any distribution plan wherein the offer is non-zero. However, people's decision-making behavior is not driven by absolute "economic rationality"; rather, it is influenced by the perceived inequity experience.[5,6] Thus, as responders, they will reject the unfair offers in favor of perceptions of equity. However, predicting the social preference is unavailing without understanding the proposer's identity and motive. Converging evidence has shown that participants with a shared identity demonstrate more cooperative behavior.[7,8] In addition, individuals have a lower rejection rate for unfair proposals made by proposers with a common identity,[9,10] which indicates individuals' tendency to reward the in-group and discriminate against the out-group.[11,12] However, the evidence is inconclusive and inconsistent, as other researchers have found the "black sheep effect", in which in-group members were punished more severely compared with out-group members when the behavior deviated from social norms.[13,14] We propose the definition of identity and allocation motive as possible explanations for this inconformity.

The definition of group identity continues to raise questions because individuals' identities may be complicated, conflicting, and overlapping with that of their fellow group members. People may belong to several different social identities at once; for instance, they can simultaneously be a mother, a daughter, a worker, and even a patient. Of course, not all identities that might influence fairness-related social decisions have been investigated in laboratory research. Most of the literature has divided identity into in-group or out-group membership according to criteria such as race or gender or by drawing lots;[10,15] hence, it is unclear how fair decision-making behavior would be affected by a dual identity induced in the UG. Moreover, research indicates that proposers will make the smallest offer to the responder with a self-interested motive to maximize their own gains. People value allocation outcomes but are more interested in how they are generated, that is, whether or not the allocation motive is fair.[16] Thus, we also focus on a particular category of allocation motive, namely, selfish motive, which can affect the decision-making behaviors associated with group identity.[17] We expect mixed results, as the selfish motive promotes in-group functioning but stimulates hostility when an unfair offer is proposed.

Existing evidence has been inconclusive in demonstrating whether group identity or allocation motive is more important and responsible for the contribution to decision-making because, in previous studies, group identity and allocation motive have been manipulated in the UG separately.[18–21] The present study aims to investigate how group identity affects decision-making in interpersonal communication to determine whether individuals will discriminate against members of the out-group or show more sympathy to them when out-group members are disadvantaged. Meanwhile, we are also interested in examining the allocation motive and whether it moderates the relationship between group identity and decision-making behavior.

Recently, with the development of neuroscience, more and more researchers have begun to explore the neural mechanisms of fairness preference using event-related potential (ERP) technology. ERP has been regarded as an effective tool to monitor cognitive processes because of its high temporal resolution and its ability to detect the subtle physiological responses in the process of fair judgment. Some studies have found that feedback-related negativity (FRN) and P300 were two important index components in the UG.[21–23] FRN, peaking at approximately 200–350,[24] reflects good or bad outcome assessments in ultimatum tasks and helps individuals to regulate their subsequent behavior.[25] Evidence from studies using functional magnetic resonance imaging (fMRI) showed that FRN generation is related to the anterior cingulate cortex (ACC);[26] therefore, a more negative FRN was reflected in the increased ACC brain activity at frontocentral recording sites. Furthermore, the amplitude of FRN is observed in tasks reflecting the neural processing of a loss or gain, with a larger amplitude elicited in a loss condition than in a gain condition.

Accumulated studies have showed that FRN is associated with both fair concerns and unfair rejections.[23,27,28] Numerous studies using ERP techniques have suggested that unfair offers induce larger FRN wave amplitudes than fair offers,[23,27] reflecting stronger conflicts over social norms, cognitive conflicts, and emotional conflicts.[29] Rather than focusing on observing FRN following the fair versus unfair offer in the UG, this study investigates how FRN is affected by group identity and allocation motive in different offer types. Some studies manipulating proposer identity showed that FRN components existed;[8,30] for example, FRN amplitude induced by in-group proposers was more negative than out-group proposers for both unfair and fair offers. However, in this experiment, the in-group or out-group was simply induced based on membership.[21] We aim to further address whether the overlap and conflict between group identities would be associated with FRN on the acceptance of offers.

The present study used ERP techniques with healthy college students as responders and either depressed college students (out-group) or other healthy college students (in-group) as proposers to examine the fairness-related decision-making associated with these groups. "College student" was a common identity of both the responder and proposer, while a conflicting identity also existed simultaneously (healthy vs depressed). "Empathy-altruism" suggests that individuals experience substantial empathy for people in need or distress, motivating them to develop emotional responses such as compassion, promoting altruistic motivation, and cooperative behavior.[31] Hence, the FRN component of the "black sheep effect" may emerge in this research because empathy-motivated helping could reduce the perceived experience of punishing unfairness to the out-group members.[32] However, the question still remains as to whether the allocation motive would interfere with the outcome of the "black sheep effect" when the depressed college student (out-group) proposed the unfair offer with a selfish motive. In addition, some prior studies found that the fair offer induced larger early processing stage (eg, P200) than the unfair offer in the UG, which reflects individual's equitable motives.[33] However, we expected the more significant result to emerge in P300 than in P200, because participants would experience more complicated and conflicting dilemmas in our task, when they integrated the proposer's identity and motivation, which elicited larger later processing (P300) peaking in the period of 300–600 ms and increasing from frontal to parietal sites, representing allocation of attention or high-level motivation evaluation in social decision-making.[34,35] Previous studies have shown that P300, with increased allocation of attention, is driven by the motivational or emotional significance of the situation.[36] In the current study, the out-group identity was more conflicting compared to that of the in-group, because they were characterized as experiencing distress, causing participants to undergo strong internal struggle over how to choose when faced the fair or unfair offer proposed by the out-group member, which involves cognitive processes related to P300. Then, the analysis of P300 would be beneficial to understand how participants choose during the stage of decision-making.

In sum, this study further addresses the current research issue of how decision behavior in the UG is moderated by group identity and allocation motive as indexed by rejection rates, response time, FRN, and P300, by manipulating the offer type (fair vs unfair), group identity (in-group vs out-group), and allocation motive (selfish vs random) simultaneously. At the behavioral level, we predict that the unfair offer will show a higher rejection rate than the fair offer, and participants will respond faster to the fair offer than to the unfair offer, which is consistent with previous findings,[23,27] but we also expect the "black sheep effect", given the empathy-helping drive for the particular identity of the out-group. At the neural level, we predict that, when faced with the selfish motive from the in-group members in the UG, this will stimulate hostility in participants, and the worse-than-anticipated outcome may elicit more negative FRN. Likewise, more negative FRN will be induced when the out-group proposes a fair offer, as participants would not expect such behavior. Meanwhile, the out-group will induce larger P300 amplitude compared to the in-group because the out-group member's particular identity will produce attention and internal conflict due to the nature of the out-group identity as suffering from depression.

Materials and Methods

Participants

G*Power (V3.1.7) was used beforehand for sample size estimation in this study. Since the study's effect size was uncertain, a medium strength effect size ($f = 0.25$, $\alpha = 0.05$, $\beta = 0.95$) was used for sample size estimation. The results showed that the minimum sample size was 76. In current study, a total of 92 right-handed subjects with normal or

corrected vision, aged from 18–25 (mean age [M_{age}] = 20.43, standard deviation [SD] = 1.18; 74 females [80.4%], 18 males [18.5%]) were recruited randomly, using posters on the campus of Guizhou Medical University, to participate in this experiment. In order to exclude depressed disorders or tendencies, they were all asked to complete the Beck Depression Inventory self-rating scale (BDI), a 21-item scale, before participation; scores for the BDI in all subjects were below 10, which was the cut-off point. Three participants were excluded because of excessive EEG artifacts. A final total of 89 participants were included in the statistical analysis, randomly divided into four groups, and each was paid 30 RMB for participation after the experiment. All participants provided written informed consent per the Code of Ethics of the World Medical Association (Declaration of Helsinki). This study was approved by the Ethics Committee of Guizhou Medical University.

Beck Depression Inventory (BDI)

This depression self-assessment questionnaire was developed by the famous American psychologist Beck, along with colleague Beamesderfer,[37] and contains 21 items. Each item is scored on a multiple-choice grade from 0 (not intense) to 3(very intense). The total score, which ranges from 0 to 63, can be used to determine the presence, absence, and severity of depressive symptoms. The cut-off point for no depressive symptoms is below 10 points, while the range of scores for mild depressive symptoms is 10–18, for moderate depressive symptoms is 19–29, and for severe depressive symptoms is over 30. Cronbach's α for this measure was 0.88.

Experimental Design and Stimuli

This study adopted a mixed design of 2 (proposer identity: out-group vs in-group) × 2 (allocation motive: selfish vs random) × 2 (offer type: unfair offer (1/9, 2/8) vs fair offer (4/6, 5/5). Proposer identity and allocation motive were between-group designs, and the offer type was a within-subjects design. The repeated measures analysis of variance (ANOVA) was used to compare the rejection rates (RRs) and response times (RTs) in different conditions, and the ERP components of FRN and P300 were also analyzed.

The experimental stimulus was a text (accept or reject) or number (1/9, 2/8, 4/6, 5/5) image on a black background. Photoshop was used to uniformly process the images to ensure that their pixels, size, background, brightness, contrast, and saturation were consistent.

Procedure

Participants were provided with instructions to follow, which emphasized that the experiment required completing a game with another partner. In this game, ten tokens were allocated to the participant and the proposer in each round, but the proposer would make the allocation, and the responder could choose to accept or reject it. If they chose to accept, each would receive a token following the actual allocation plan; upon rejection, both tokens would go to zero. The experimenter manipulated the proposer's identity and the allocation motive through a guideline. Participants were informed they could not simultaneously finish the game because of the experimental limitation; hence, the experimental assistant collected partners' data beforehand, and the participants were all responders in this game.

Participants playing with an out-group member were told,

The person you are playing with is a college student recruited from our campus counseling center and is currently suffering from depression, so the offer presented here is based on self-profit maximization (or random allocation) by the student after questioning.

Participants playing with an in-group member were told,

The person you completed the game with is a college student recruited using a poster in this college, is healthy, and has no mental illness, so the offer presented here is based on self-profit maximization (or random allocation) by the student after questioning.

The Ultimatum Game Task

The E-prime software program was used to stimulate and record data experimentally. A 500-ms white gaze dot was presented at the computer screen center before each trial, and a 500–800-ms blank screen appeared after the gaze dot disappeared.[38] Subsequently, the allocation scheme of 1/9, 2/8, 4/6, or 5/5 was randomly presented, with the number of tokens before the slash being allocated to the participant and the number of tokens after the slash being retained by the proposer.[30] The allocation scheme was presented for 1200 ms, followed by another 500 ms blank screen. At the end of the blank screen, participants were required to make a 1-accept or 3-reject decision, and the trial moved on to the next round after the choice was made or after the previous round had been presented for 3000 ms and a 500–800-ms blank screen was presented. Each allocation scheme was repeated 36 times, and the entire experiment was completed in two blocks of 72 trials each.[30] Participants were required to complete nine practice trials before the formal experiment to ensure a complete understanding of the experimental requirements.[39] The keystroke approach was counterbalanced among the participants (see Figure 1).

EEG Signal Acquisition and Preprocessing

The Brain Product ERP recording and analysis system was used to record and acquire EEG according to the 10–20 system with 64 conductive electrode caps, keeping the scalp resistance of all electrodes below 10 kΩ, filtering bandpass 0.01–100 Hz, with a sampling rate of 1000 Hz/conductor. Offline analysis was performed after completing continuous EEG recording. The EEG data were preprocessed using the EEGLAB tool of Matlab (2013b) software. Participants with excessive EEG artifacts were excluded following the behavioral data and data results from the preliminary preview of EEG waves. The mean value of bilateral mastoids was used for re-referencing; low-pass filtering below 30 Hz was performed to profile 200 ms before the proposed protocol presentation to 800 ms after stimulus presentation and 200 ms before the stimulus was used as the baseline. Independent component analysis was performed to correct for oculomotor artifacts. Waveform amplitudes exceeding ± 80 μV were automatically rejected as artifacts using the ERPLAB tool and then averaged by superposition following the experimental conditions. Finally, based on the total waveform map features, we extracted the average waveform amplitude values for FRN (N250~350 ms) and P300 (360~380 ms). Some studies have revealed that FRN or P300 had the largest wave amplitude in the sagittal midline,[40] and that the frontal lobe is related to decision-making.[41] Therefor, the frontal midline electrodes (Fz, FCz, Cz) were selected for this study's analysis.

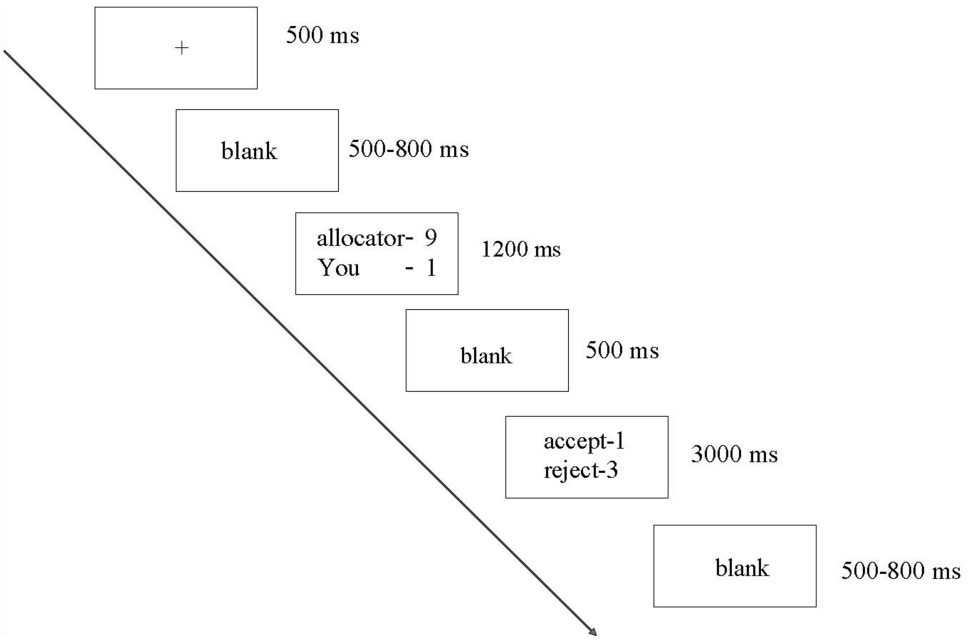

Figure 1 A single trial of the experimental procedure.

Results

Behavioral Results

A repeated measures ANOVA of 2 (proposer identity: out-group vs in-group) × 2 (allocation motive: selfish vs random) × 2 (offer type: unfair vs fair) was conducted on the rejection rate and reaction times. The mean rejection rate and response times (RTs) of the choices on different conditions were analyzed.

The results of rejection rate showed that the main effects of proposer identity [$F_{(1,85)}$ =0.23, p = 0.63, η_p^2=0.003] and allocation motive were not significant [$F_{(1,85)}$ =1.08, p = 0.30, η_p^2=0.013], the main effect of the offer type was significant [$F_{(1,85)}$ = 536.3, p < 0.001, η_p^2=0.84]. The rejection rate of unfairness (79.48%) was significantly higher than that of fairness (14.95%). The interaction between offer type and proposer identity was significant [$F_{(1,85)}$ =8.12, p < 0.01, η_p^2=0.10]. Post multiple comparison test results revealed that the rejection rate when the proposer was a depressed college student proposing a fair offer (9.54%) was significantly lower than when the proposer was a healthy college student (20.34%), [$F_{(1,85)}$ =6.45, p < 0.05, η_p^2=0.07] and the rejection rate of unfair offers was significant higher than fair offers when the proposer was a depressed college student [$F_{(1,85)}$ =216.10, p < 0.001, η_p^2=0.75] or healthy college student [$F_{(1,85)}$ =176.60, p < 0.001, η_p^2=0.68]. The interaction between offer type and allocation motive was significant [$F_{(1,85)}$ =7.64, p < 0.01, η_p^2=0.09], and the simple effect results indicated that the rejection rate of a fair offer was significantly higher in the random motive (21.40%) than in the selfish motive condition (8.50%±3.00%) [$F_{(1,85)}$ =9.21, p < 0.01, η_p^2=0.10]. The interaction between proposer identity, allocation motive, and offer type was marginally significant [$F_{(1,85)}$ =4.61, p < 0.05, η_p^2=0.06], and post multiple comparisons indicated that when fair offers were presented in a random motive, the rejection rate for depressed college student proposers (11.67%) was significantly lower than that of health college student proposers (31.11%) [$F_{(1,85)}$ =10.62, p < 0.01, η_p^2=0.11]; when the proposer was a healthy college student, the rejection rate of a fair offer for selfish motives was lower than the rejection rate of a fair offer for a random motive [$F_{(1,85)}$ =13.95, p < 0.001, η_p^2=0.14] (see Table 1 and Figure 2 for details). ANOVA on RTs of the choices revealed that the main effect of the offer type and other interaction effects were not significant.

EEG Results

ANOVA was conducted considering the factors of proposer's identity, allocation motive, and offer type for FRN and P300 components. Besides this, the Fz/FCz/Cz electrodes were assessed in terms of amplitudes and latency and were calculated in the 250~350ms and 360~380ms time windows, respectively. For each component, a 2 (proposer identity: out-group vs in-group) × 2 (allocation motive: selfish vs random) × 2 (offer type: unfair vs fair) × 3 (electrode location: Fz/FCz/Cz) repeated measures analysis was performed. Significant Fisher LSD post hoc analysis was used for comparisons; the significance level was α=5%, and only the significant main effect or interaction effect was reported.

FRN

The ANOVA for FRN amplitude (250~350ms) revealed that the main effect of proposer identity was significant [$F_{(1,85)}$ =5.14, p < 0.05, η_p^2=0.06]. The amplitude evoked by the depressed college student (1.90 μV±0.34) was significantly higher than by the healthy college student (0.83 μV±0.32). The main effect of the electrode was significant [$F_{(2,84)}$ =44.26, p < 0.001, η_p^2=0.51], and the amplitude increased gradually from the frontal to central lobes.

Table 1 ANOVA Results with Main Effect and Interaction for Rejection Rate in the Behavioral Analysis, Showing F Criteria (*F*), *p*-value (*p*), and Partial Effect Size (η_p^2)

Factors	*F*	*p*	η_p^2
Proposer identity	0.23	0.63	<0.01
Allocation motive	1.08	0.30	0.01
Offer type	536.3	< 0.001	0.84
Offer type × proposer identity	8.12	0.005	0.10
Offer type × allocation motive	7.64	0.007	0.09
Offer type × allocation motive × proposer identity	4.61	0.03	0.06

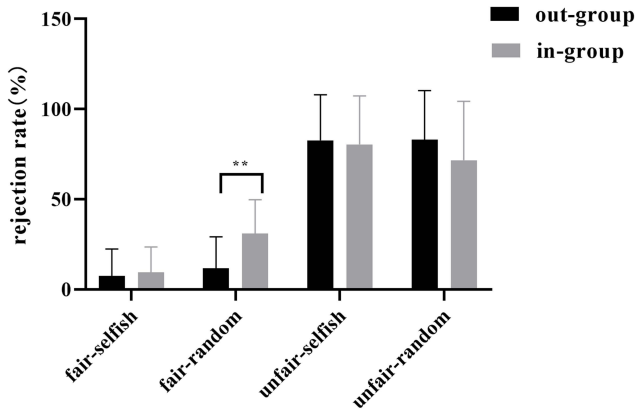

Figure 2 Rejection rate of unfair offers and fair offers in different conditions. Error bars represent standard deviation, **p<0.01.

Moreover, the interaction of the offer type, proposer identity, and allocation motive was significant [$F_{(1,85)}$ =7.40, p < 0.05, η_p^2=0.08]. Post hoc analysis showed that the amplitude induced by the fair offer from depressed college students (2.61 μV ±0.62) was significantly greater than that by the healthy college students (0.15 μV±0.56) when they adopted the random allocation motive[$F_{(1,85)}$ =8.63, p < 0.01, η_p^2=0.10]. In addition, the interaction between electrode sites, proposer identity, and offer type was significant [$F_{(2,84)}$ =7.92, p < 0.001, η_p^2=0.16]. Simple effects analysis showed that the amplitudes evoked in FCz (p=0.009), Fz (p=0.005), and Cz (p=0.03) electrode locations were significantly greater in the fair condition when the proposer was a depressed college student than when the proposer was a healthy college student. Other main effects and interactions were not significant (see Figures 3 and 4).

P300

As presented in Figure 2, the EEG data were analyzed using the ANOVA for P300 (360~380ms), elicited by the different conditions. P300 identified a main effect of proposer identity with a larger P300 amplitude elicited by the depressed (3.38 μV±0.46) compared with the healthy college students (2.00 μV±0.43) [$F_{(1,85)}$ =4.72, p < 0.05, η_p^2=0.06]. However, the main effects of allocation motive and offer type were not significant [$F_{(1,85)}$ =0.63, p = 0.80, η_p^2=0.001]. Furthermore, the interaction between allocation motive, proposer identity, and the offer type for P3 amplitude was not significant [$F_{(1,85)}$ =4.30, p=0.07, η_p^2=0.05]. Results showed that the interaction between offer type, proposer identity and electrode location was marginally significant [$F_{(1,85)}$ =3.25, p=0.044, η_p^2=0.07]. The simple test revealed that on the FCz location, the P3 amplitude elicited by depressed college students (4.00μV±0.59) was larger than that elicited by healthy college students (2.21μV±0.55) when they proposed fair offers (see Figure 3 and Figure 5).

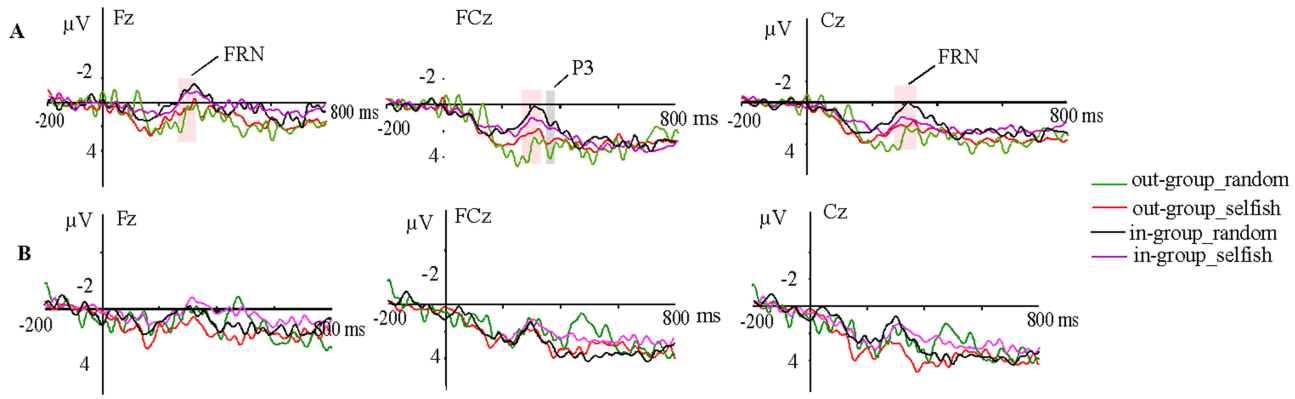

Figure 3 Event-related potential waveform average for fair offer(**A**) and unfair offer (**B**) interactions at different electrode points. The 250–350 ms and 360–380 ms time windows were for calculating the mean amplitudes of the FRN and P300.

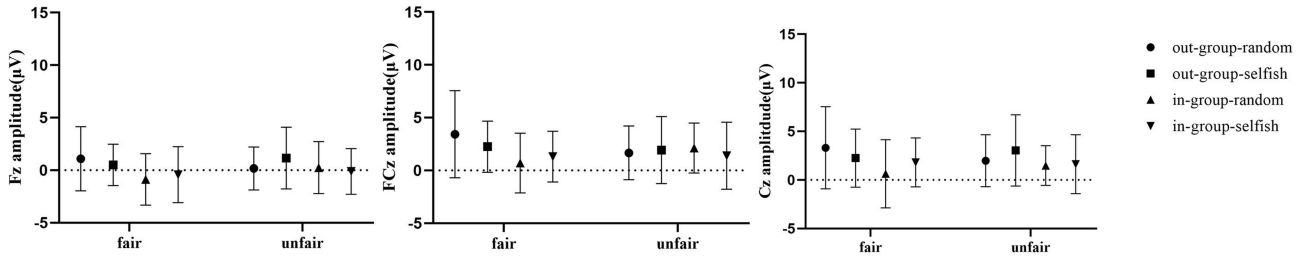

Figure 4 Scatter chart of FRN mean amplitudes for different experimental conditions at Fz, FCz, Cz.

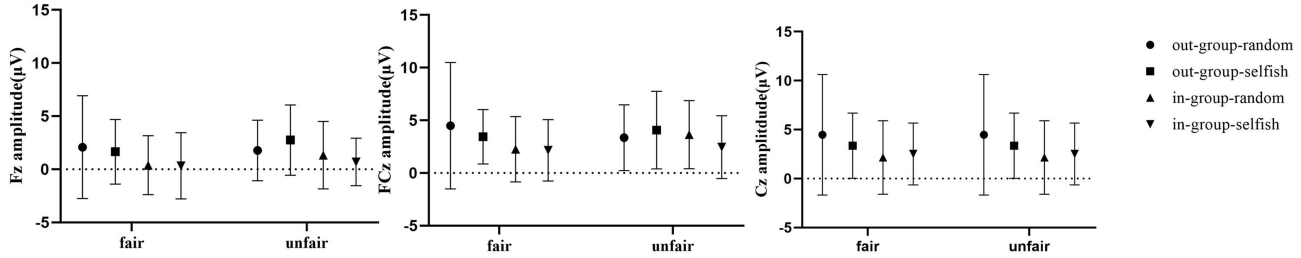

Figure 5 Scatter chart of P300 mean amplitudes for different experimental conditions at Fz, FCz, Cz.

Correlation Analysis

There was no significant correlation between the rejection rate of fair or unfair offers and FRN or P3 amplitudes.

Discussion

ERP technology was used in this study to explore how behavioral and neural responses in the UG are influenced by group identity and allocation motive and which one plays a more important role in the effect.

According to social identity theory, which suggests that people would identify more with a proposer sharing a common identity,[42] responders may have a lower rejection rate toward unfair offers from in-group members, as they share the same identity. This study used "healthy college students" as the in-group and "depressed college students" as the out-group. However, the result of the participants' behavior contradicted social identity theory, as the "black sheep effect" was found. This study's result showed that the rejection rate of fair offers made by out-group members was significantly lower than that of in-group members. This is inconsistent with previous studies,[39] possibly because of different proposers' identities. Though participants held a different identity than out-group members in the UG task, the distressing experience of out-group members may have made individuals altruistically motivated, reducing the perceived experience of punishing unfairness. This explanation is supported by the "empathy-altruism" theory, showing that individuals experience substantial empathy for people in need or distress, motivating them to develop emotional responses such as compassion, thus promoting altruistic motivation and cooperative behavior.[31]

FRN is associated with motivational judgment reflecting undesirable outcomes.[43] It also precisely reflects the evaluation of negative emotions triggered by unfair proposals violating social norms.[44] Interestingly, this study found that, in the unfair offer, there was no difference between in-group and out-group in all electrode sites, which was inconstant with some research,[21,39] given that their particular identities both diminished the perceived experience of unfairness. The common group identity reduces the negative emotions generated by the inequitable offer,[8,9] while the identity of out-group members as a disadvantaged group may generate altruistic motives in participants, weakening the sense of betrayal to promote cooperation.[45] Therefore, the rejection rate of unfair proposals when the proposer is a depressed college student (out-group) versus a healthy college student (in-group) may not significantly differ in the FRN component.

Notably, significant differences in FRN amplitudes due to the proposer identity emerged for the fair offer, as evidenced by significantly higher FRN amplitudes induced when the proposer was an out-group member than when the proposer was an in-

group member. FRN is believed to indicate the occurrence of an unexpected outcome or event, whether better or worse than anticipated. The differential FRN response to depressed college students and healthy college students in the fair offer condition suggests the violation of individual expectations. Studies show that depression affects cooperative behavior.[46] For example, a study found that depressed patients' "lack of pleasure" (anhedonia)[47] made it challenging for them to maintain reciprocal cooperation in the prisoner's dilemma game.[48] Thus, in UG game, when the proposer belonging to an out-group offered a fair solution that deviated from participants' expectations, the greater the expected deviation, and the larger the FRN wave amplitude.[27]

Furthermore, this study found that proposer identity interacted with allocation motive and affected FRN amplitude. Results showed that when a random motive was used to propose a fair offer, the wave amplitude induced by the out-group was significantly larger than that induced by the in-group; however, there was no significant difference between the two groups when a selfish motive was used. "Selfish motive" directly indicates the other person's attitude and aim without further mental reasoning or processing, and weak cognitive processing leads to a non-significant difference in FRN wave amplitude. In contrast, "random motive" implies uncertainty and requires more cognitive resources to speculate on the other party's intentions and purposes. Compared to healthy college students, depressed college students' cognitive, emotional, and decision-making behaviors are more complex and ambiguous, requiring more mental reasoning and processing resources. Hence, the induced FRN amplitude by proposer was different, with out-group members (depressed college students) eliciting greater FRN amplitude than in-group members (healthy college students). This suggests that FRN reflects the input and consumption of cognitive resources in the decision-making process.[29]

We also examined P300, which is regarded as a measure used to investigate the motivational significance and allocation of attention when an individual appraises the outcome. Some studies have sustained that decision-making in complex social contexts is usually embodied in the P300 component.[49] In current study, we found that a larger P300 was elicited when the proposer was an out-group member compared to an in-group member. The effect only appeared in the fair offer context rather than the unfair offer context, which is consistent with previous research.[50] Our results suggest that out-group members elicit more cognitive processing resources from individuals, motivating them to value out-group over in-group in order to avoid impulsive decisions. As mentioned above, participants differed in their identity compared to depressed college students as out-group members, which meant that participants might be less familiar with them and pay more attention to out-group members. In addition, P300 is also related to processing affective evaluation. The stronger P300 responses to out-group members than in-group members might suggest that participants in the current study attached more commiserative or altruistic significance to the out-group because they were experiencing depressed emotional states.

Although this study indicated that disadvantaged groups could increase cooperation when fair offers were presented with a random motive, some limitations must be acknowledged. First, we did not obtain a significant difference in unfair offers between the in-group and out-group, and this may be due to a lack of stronger power, as the proposer was manipulated by instruction. It may be that a real person could have a stronger effect. Second, most researchers focused on the unfair offer (1:9 or 2:8) and fair offer (5:5 or 4:6) rather than the modestly unfair (3:7); the same is true for the current study. Compared to the extremely unfair offer, the modestly unfair offer may increase the time it takes a participant to make a decision because it is more complex and induces stronger cognitive conflict than other kinds of offers. Focusing on modestly unfair offers would better investigate the complex cognitive conflict between different identity groups and allocation motives.

Conclusions

Taken together, this study found the "black sheep effect" when the out-group member was at a disadvantage or in distress. Although the behavior decision was observed in some previous studies, there is no evidence to interpret whether the allocation motive could affect the responses of the "black sheep effect." Therefore, we revealed in the unfair offer that the "empathy-helping" motive toward an out-group member and the perception of belonging to an in-group eliminate the feeling of unfair treatment. This result was not affected by the allocation motive. On the other hand, in the fair offer, the "black sheep effect" was moderated by the randomized motive because "randomized motive" implies uncertainty and requires more cognitive resources to speculate an out-group member's intentions and purposes. This finding plays an integral role in understanding the responses to fair or unfair offers in different group identity and allocation motive contexts.

Abbreviations

ACC, anterior cingulate cortex; ANOVA, analysis of variance; BDI, Beck Depression Inventory; EEG, electroencephalogram; ERP, event-related potential; fMRI, functional magnetic resonance imaging; FRN, feedback-related negativity; UG, Ultimatum Game.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Guizhou Medical University (protocol code 2023 [129]) for studies involving humans.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. Written, informed consent has been obtained from the participants to publish this paper if applicable.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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