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ORIGINAL RESEARCH

Performance Differences Between High and Low Empathy Ability in Conflicts of Interest: An ERP Study

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Objective: Empathy is negatively correlated with high levels of conflict behaviors, such as aggression. The purpose of this study was to examine whether there were still differences in the performance of high and low empathy ability under the general level of conflict.

Methods: The Chinese version of the Interpersonal Reactivity Index (IRI-C) was distributed to 250 undergraduate students. The subjects were classified as the high-empathy group (n = 38) and the low-empathy group (n = 37). An improved ultimatum paradigm was used to create a relatively realistic general-intensity conflict situation. A total of 29 undergraduate students (15 in the low-empathy group) were subjected to conflicting or non-conflicting proposals. Event-related potential technology was used to record the EEG of the high- and low-empathy groups during the processing of different proposal types.

Results: The high-empathy group had longer response times and lower rejection rates under different proposal types compared to the low-empathy group. The low-empathy group evoked more negative MFN amplitude under conflicting proposals than under non-conflicting proposals, while the difference was not significant in the high-empathy group. The low-empathy group induced greater LPP under non-conflicting proposals than under conflicting proposals, while the difference was not significant in the high-empathy group.

Conclusion: High-empathy individuals showed more altruistic behaviors, and fewer conflict tendencies compared to low-empathy individuals. Low-empathy individuals had greater negative evaluations of conflicting offers, while high-empathy individuals weakened their negative evaluations of conflicting proposals because of their relatively high empathy. Compared to high-empathy individuals, low-empathy individuals showed stronger motivation to converge on non-conflicting proposals.

Keywords: empathy, conflict of interest, altruism, MFN, LPP

Introduction

Conflict is a common interactive behavior in a human social activity that arises from disagreements between the target interests of both parties. Conflict behaviors exist at different levels of intensity,[1] ranging from minor disagreements to physical violence. Empathy is the ability to put oneself in another person's shoes, understand their thoughts and feelings, and accurately infer what they are thinking and feeling.[2,3] It is often considered to be the primary motivation for prosocial behavior.[4] Previous research has suggested that deficits in empathic capacity are a central feature of violent behavior.[5,6] Empathic ability was significantly and negatively correlated with aggression, with higher levels of empathy associated with less aggression.[7–9] Empathy can somewhat inhibit aggression in healthy individuals after provocation.[10]

Compared to high conflict levels of aggression, moderate or low levels of conflict of interest are more common in everyday life. Therefore, it is necessary to explore the decision-making performance and neurophysiological mechanisms of people with different empathic abilities under general conflict-of-interest conditions. When it comes to conflicts of interest between themselves and others, it is often the case that people with higher empathic abilities are more likely to exhibit altruistic behaviors that fulfill others at the expense of their interests.[11–14] Previous ERP studies have found that conflict-of-interest processing is associated with medial frontal negative (MFN) waves, with MFN sources localized in

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the anterior cingulate gyrus,[15] and that unfavorable outcomes evoke more negative MFN wave amplitudes than favorable ones and reach a maximum within 200 to 300 ms after the onset of the feedback stimulus (Boksem & De Cremer, 2010; Hauser et al, 2014; Paul & Pourtois, 2017).[16–18] More negative MFN wave amplitudes respond to unfair cognitive evaluations of social allocation and strong motivational influences of the current stimulus,[19,20] and MFN source analysis identified a brain region associated with the theory of mind processing, the left superior temporal gyrus, suggesting that gaming processes.[16,21] The late positive potential (LPP), an important component of event-related potentials (ERPs), appears approximately 300 ms after stimulus presentation and is a neurophysiological indicator for studying emotional responses.[22] The LPP reflects the arousal of the stimulus to the subject, and positive stimuli with higher motivational intensity induce greater LPP amplitude.[23] Similarly, stronger avoidance motivation for negative stimuli also induces greater LPP amplitude.[24] In the gaming process, speculation about others' intentions instead weakens the differences in LPP evoked by different stimulus types.[25]

In the dictator game subjects are asked to distribute a given amount of money with another player, with the subject acting as the distributor and the other player only accepting unconditionally.[26] In this task, it was found that subjects' affective empathy predicted altruistic sharing.[10,27] However, in the dictator game subjects act as monetary allocators and hold absolute allocative power, and it is unclear whether the empathic ability of individuals as allocated subjects still predicts altruistic behavior when dominance is not in their hands, especially when unfair allocation occurs.

In summary, the present study applied ERP techniques to explore the decision processing of high and low empathic ability individuals under conflicting and non-conflicting offers created by the ultimatum paradigm,[28] during which EEG signals were recorded from both groups of subjects. Based on the evidence provided in the available literature, the present study proposed the following hypotheses for the experimental results: (1) the low empathic group evoked greater MFN wave amplitude under conflicting offers than under non-conflicting offers, while the difference was not significant in the high empathic group; (2) the low empathic group evoked greater LPP wave amplitude under non-conflicting offers than under conflicting offers, while the difference was not significant in the high empathic group.

Methods

Participants

The Chinese version of the Interpersonal Reactivity Index (IRI-C) was created by a Taiwanese scholar, based on the original English version of the Interpersonal Reactivity Index.[29] IRI-C questionnaires were distributed to 250 undergraduate students from non-psychology and non-economics majors, and 238 valid answers to the questionnaires were collected.

The empathy scores of the valid questionnaires were ranked from low to high, and the mean empathy score of the subjects was 52.87 with a standard deviation of 14.45. The subjects who scored one standard deviation above the mean score (≥68) were classified as the high-empathy group (n=38), and those who scored one standard deviation below the mean score (≤38) were classified as the low-empathy group (n=37). A total of 29 subjects volunteered to participate in the ERP experiment, 15 in the low-empathy group (female=6, M_{age}=20.13, SD_{age}=1.30) and 14 in the high-empathy group (female=9, M_{age}=20.21, SD_{age}=1.12). All subjects signed the informed consent, and this study was approved by the Ethics Committee of Tianjin Normal University.

Experimental Materials

Referring to a previous study,[21] a variation of the ultimatum paradigm was used, two individuals participating in an experimental task were asked to divide¥100. Numerous studies have shown that when respondents receive only about 20% of the total amount of money, they perceive it as a relatively unfair proposal and act in a rejection manner.[30] Therefore, this study created 20 relatively unfair proposals as conflicting proposals varying from¥1-20 and 20 relatively fair proposals as non-conflicting proposals varying from¥31-50. In order to create contextual realism, this study also included 10 relatively intermediate proposals (¥21-30). Since previous research has shown that different individuals have different perceptions of the fairness of the distribution between¥21-30,[31] the 10 relatively intermediate proposals were not included in the subsequent data analysis. In this experiment, seven doctoral and master students in psychology were

asked to rate the experimental material by answering a self-administered conflict intensity questionnaire after completing the ultimatum experimental task to ensure the validity of the conflict situation creation, which included the question "When the other person makes an offer to give you less money and leave you more money, how much conflict do you feel with the other person? " The Likert 5 scale was used, ranging from "not at all" to "very strong" on a scale of 1 to 5. Analysis of the scores of the seven psychology professionals on the questionnaire showed that M=3.43>3, SD=0.53, indicating that the experimental material was effective as a conflict-creating material.

Experimental Design

A mixed design of 2 (empathy: high-empathy vs Low-empathy) × 2 (proposal type: conflicting vs non-conflicting) was used in this study, with empathy as a between-subject variable and proposal type as a within-subject variable. Subjects' reaction time, rejection rate and subjects' EEG components during the response phase were used as dependent variables.

Experimental Procedure

In order to make the subjects think that this is a real interactive situation, the subjects were informed upon entering the laboratory that they would be working with another partner to complete an interactive game of money distribution, and that there would be a real money reward at the end of the game. In fact, the proposer of the money distribution was the experimental assistant, and to eliminate gender differences, the experimental assistants were matched according to the subject's gender. During the experiment, the subjects only acted as respondents to the money allocation proposal and were informed that they and the proposer would play the game in two separate labs via networked computers. Then, a "+" sign appeared on the computer screen (500 ms), and a 500 ms blank screen was followed by a money proposal (1500 ms), with the top amount representing the amount of money to be distributed to the subject and the bottom amount representing the amount of money left by the opponent, and the subject's task was to choose to accept or reject the offer and to make keystroke response. If accepted, the subject receives the amount of money on the proposal, and if rejected, both parties have no gain in this round, and the subject's choice will affect the final bonus amount (see Figure 1).

Before the formal experiment, subjects were told to sit in a comfortable position, keep their head, face, and body posture as still as possible, focus their attention on the task and lightly place the index fingers of each hand on the keys. The whole task was divided into 2 blocks, each block containing 100 trials, ie 50 different penny proposals each repeated 2 times. After completing each block, there was an appropriate rest period, which was controlled by the subjects. The SCAN software automatically recorded the EEG of the subjects during the formal experiment, and the main subjects observed and recorded the subjects during the experiment. The whole experiment lasted about 15 minutes. At the end of the EEG experiment, a self-administered conflict intensity questionnaire was given to the subjects to rate the intensity of the conflict triggered by this experimental paradigm.

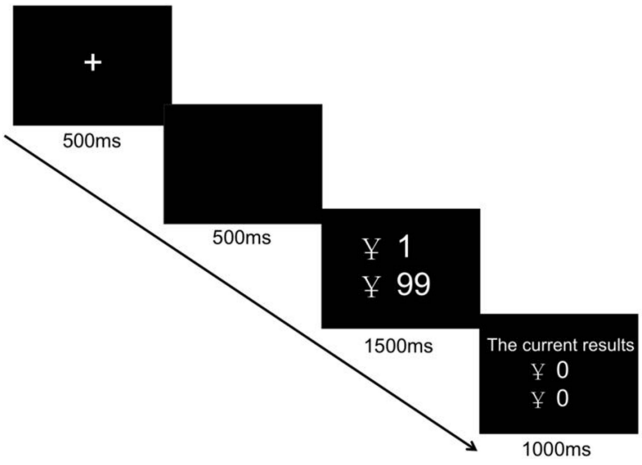

Figure 1 Flowchart of a single round of the experiment.

ERP Recording

An EEG acquisition and analysis system with SynAmps2 amplifiers from Compumedics NeuroScan (Melbourne, VA, Australia) was used to record EEG signals with Quik-Cap electrode caps, which have a 64-lead Ag/AgCl electrode expanded by the international 10–20 system. The left mastoid (M1) was used as the reference electrode during the experiment, whereas for offline analysis, the average of the bilateral mastoid was used as a reference. With the forehead grounded, left and right lateral orbital horizontal electrooculogram and left-eye vertical electrooculogram were recorded simultaneously. The AC sampling rate was 1000 Hz, the filtered bandpass was 0.05–100 Hz, and the scalp resistance and interelectrode impedance were below 5 kΩ.

Scan4.5 software was used to analyze the data offline, and EEG data from −100 to 800 ms were selected, with the first 100 ms of stimulus appearance as the baseline. Artifacts caused by blinking, large eye movements, and body shaking were excluded, and the filtered bandpass was 0.05–30Hz to exclude other artifact signals with wave amplitudes greater than ±100 μV. Ocular artifacts were corrected using a regression procedure implemented in the Neuroscan software.[32] Concerning previous studies[33–35] and observations of the data, 220–350 ms and 500–800 ms were selected as the time windows for analysis, and F3, Fz, F4, FC3, FCz, FC4, C3, Cz, C4, CP3, CPz, CP4 as the analysis electrodes, with the wave amplitude within each time window as the dependent variable, and a 2 (empathy: high-empathy/low-empathy) × 2 (proposal types: conflicting/non-conflicting) × 12 (electrodes) repeated measures ANOVA, using the Greenhouse-Geisser to correct the results of ANOVA. Behavioral data such as subject response time and rejection rate were collected using E-prime 2.0. During the experiment, four subjects who showed substantial body or head shaking resulting in prolonged artifacts were excluded; two subjects were excluded because the effective trial number after artifact removal did not reach 70%. Finally, data from 23 subjects (13 in the low-empathy group) were entered into statistical analysis.

Results

Results of Questionnaires

Statistical analysis of the IRI-C questionnaire revealed that the high-empathy group scored significantly higher (75.87 ±3.30) than the low-empathy group (27.84±5.91) in terms of total empathy score, t=43.59, p<0.01. Specifically, the high-empathy group (18.42±0.95) scored significantly higher than the low-empathy group (6.65±2.06) in terms of perspective taking (PT) score, t=31.96, p<0.001, indicating that the high-empathy group was higher than the low-empathy group in their propensity or ability to adopt the views of others. Fantasy Scale(FS) scores were greater in the high-empathy group (21.11±1.43) than in the low-empathy group (9.46±3.15), t=20.71, p<0.001, indicating that the high-empathy group had a greater tendency to transform or identify with fictitious roles. On the Empathic Concern (EC) score, the high-empathy group scored higher (22.24±1.40) than the low-empathy group (7.05±2.82), t=29.65, p<0.001, indicating that the high-empathy group had a stronger tendency to feel the warmth and concern of others under negative experiences. The difference between the two groups in the dimension of Personal Distress (PD) was not significant (See Table 1).

Statistical analysis of the scores of the 23 subjects on the self-administered conflict intensity questionnaire (5-point scale) showed that the subjects in the low-empathy group had M=3.23 > 3, SD=0.73, and the subjects in the high-empathy group had M=3.20>3, SD=0.63, and the difference between the two groups was not significant, $t(21)$= 0.11, p > 0.05, indicating that the experimental material caused the subjects to effectively perceive a certain intensity of the conflict.

Table 1 Comparison of Empathy Scores of High- and Low-Empathy Groups (M±SD)

	High-Empathy (n=38)	Low-Empathy (n=37)	t
Total score	75.87 ± 3.30	27.84 ± 5.91	43.59**
PT	18.42 ± 0.95	6.65 ± 2.06	31.96***
FS	21.11 ± 1.43	9.46 ± 3.15	20.71***
EC	22.24 ± 1.40	7.05 ± 2.82	29.65***
PD	14.11 ± 2.31	4.83 ± 2.02	18.50

Note: **p < 0.01, ***p < 0.001.
Abbreviations: PT, perspective taking; FS, fantasy; EC, empathy concern; PD, personal distress.

Behavioral Outcomes

A 2 (empathy: high-empathy/low-empathy) × 2 (proposal types: conflicting/non-conflicting) repeated measures ANOVA was used to compare the reaction times and rejection rates of subjects in the high- and low-empathy groups in different conflict situations, and the results are shown in Table 2.

From the statistical analysis, it can be seen that there was a significant difference in response time between individuals with different empathy abilities for different types of conflicting offers, $F(1, 21) = 5.76$, $p < 0.05$, with the response time of the high-empathy group being longer than that of the low-empathy group; the main effect of offer type was borderline significant, $F(1, 21) = 3.93$, $p = 0.06$, response time under non-conflicting proposals is slightly longer than that under conflicting offers; the interaction between the group and proposal types was not significant, $F(1, 21) = 0.001$, $p > 0.05$. The rejection rate differed significantly between individuals with different empathy abilities, $F(1, 21)=18.19$, $p<0.001$, with the low-empathy group having a greater rejection rate than the high-empathy group; the main effect of proposal types was significant, $F(1, 21) =165.07$, $p<0.001$, and the rejection rate of conflicting proposal was higher than that of non-conflicting proposal; the interaction between the group and proposal type was not significant, $F(1, 21)=1.27$, $p > 0.05$.

EEG Results

The time window of 220–350 ms was chosen for the analysis with the intention of analyzing MFN evoked by different proposal types in the ultimatum task. There was a significant negative deflection in wave amplitude between 220–350ms for both the high- and low-empathy groups. A three-factor (empathy, proposal types, electrode points) repeated measures ANOVA on MFN revealed a significant main effect of offer type on MFN wave amplitude, $F (1, 21) = 4.83$, $p < 0.05$, and MFN wave amplitude under conflicting proposal (M=1.30μV, SD=4.06) than under non-conflicting proposal (M=2.34μV, SD=3.84) was more negative, with a significant main effect of electrodes, $F (11, 231) = 2.83$, $p = 0.06$, and a more negative MFN amplitude in the frontal area than in the central area; the interaction between other variables and variables was not significant ($p > 0.05$). A further repeated measures ANOVA of 2 (proposal types) × 12 (electrodes) was conducted separately for the mean wave amplitude at 220–350 ms for individuals with different empathy abilities, and the results revealed a borderline significant main effect of proposal types for the low-empathy group, $F(1, 12)=3.24$, $p=0.09$, with conflicting proposals inducing more negative MFN than non-conflicting proposals; the main effect of proposal type for the high-empathy group was not significant, $F (1, 9) =1.79$, $p>0.05$ (See Figure 2).

A repeated measures ANOVA was conducted on the LPP components evoked by the subjects during the task response phase by selecting 500–800 ms as the time window for analysis. The results showed a significant main effect of proposal types, $F (1, 21) = 9.54$, $p < 0.01$, greater LPP was induced under non-conflicting proposals (M=5.75 μV, SD=4.67) than under conflicting proposals (M=4.25 μV, SD=4.44), a significant main effect of electrode, $F(11, 231)=8.12$, $p<0.001$, and central LPP amplitude of electrodes increased sequentially from the frontal to the central region; significant interaction of proposal type with electrodes, $F (11, 231) =4.19$, $p<0.01$, and significant differences in wave amplitude between proposal types in the frontal and central regions within this window (F3, Fz, F4, FC4, Cz, C4, CP3, CPz) (ps < 0.05), the main effect of empathy groups was not significant, $F(1, 21)=0.03$, $p > 0.05$; the interaction of groups, proposal types and electrode was significant, $F(11, 231)=3.23$, $p < 0.5$. Further analysis revealed that, in low-empathy group, the difference between different proposal types was widely distributed in frontal and central regions (Fz, F4, FCz, FC4, C3, Cz, C4, CP3, CPz) (ps < 0.05), and in the high-empathy group, the differences between proposal types were mainly distributed in F3, Fz, F4 (ps < 0.05) (see Figure 3).

Table 2 Reaction Time and Rejection Rate of Subjects in High- and Low-Empathy Groups in Different Conditions (M±SD)

Groups	Proposal Type	RT (ms)	Rejection Rate (%)
Low-empathy	Non-conflicting	575±86.39	46.25±16.00
	Conflicting	538±81.00	91.63±30.00
High-empathy	Non-conflicting	636±75.66	14.75±13.69
	Conflicting	598±60.76	68.88±19.06

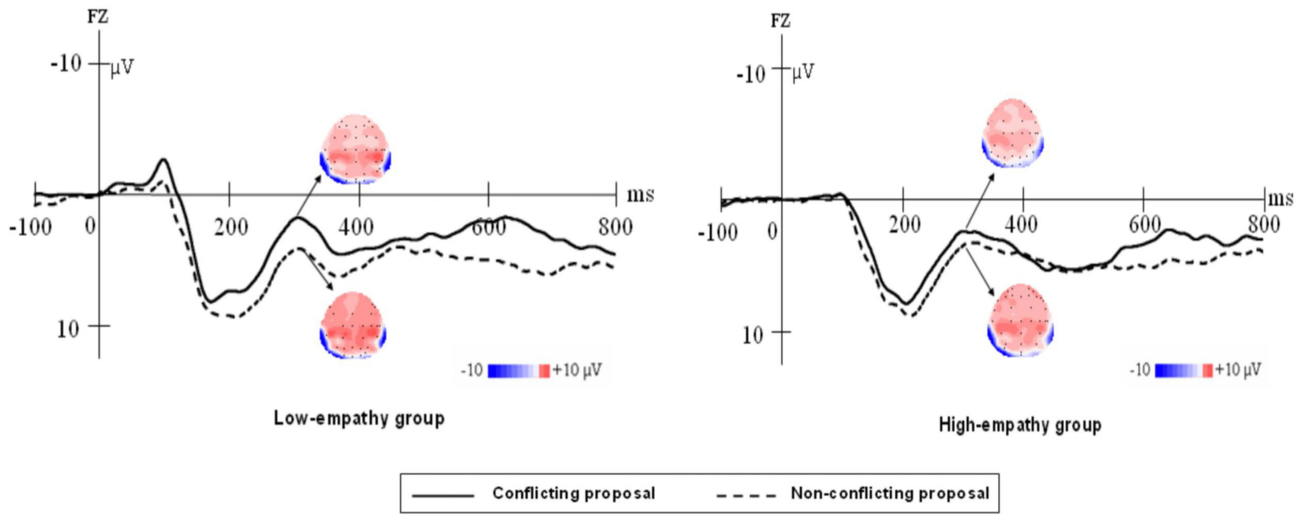

Figure 2 Total mean ERP waveforms and brain topographies of the high- and low-empathy groups at the Fz point under different conditions.

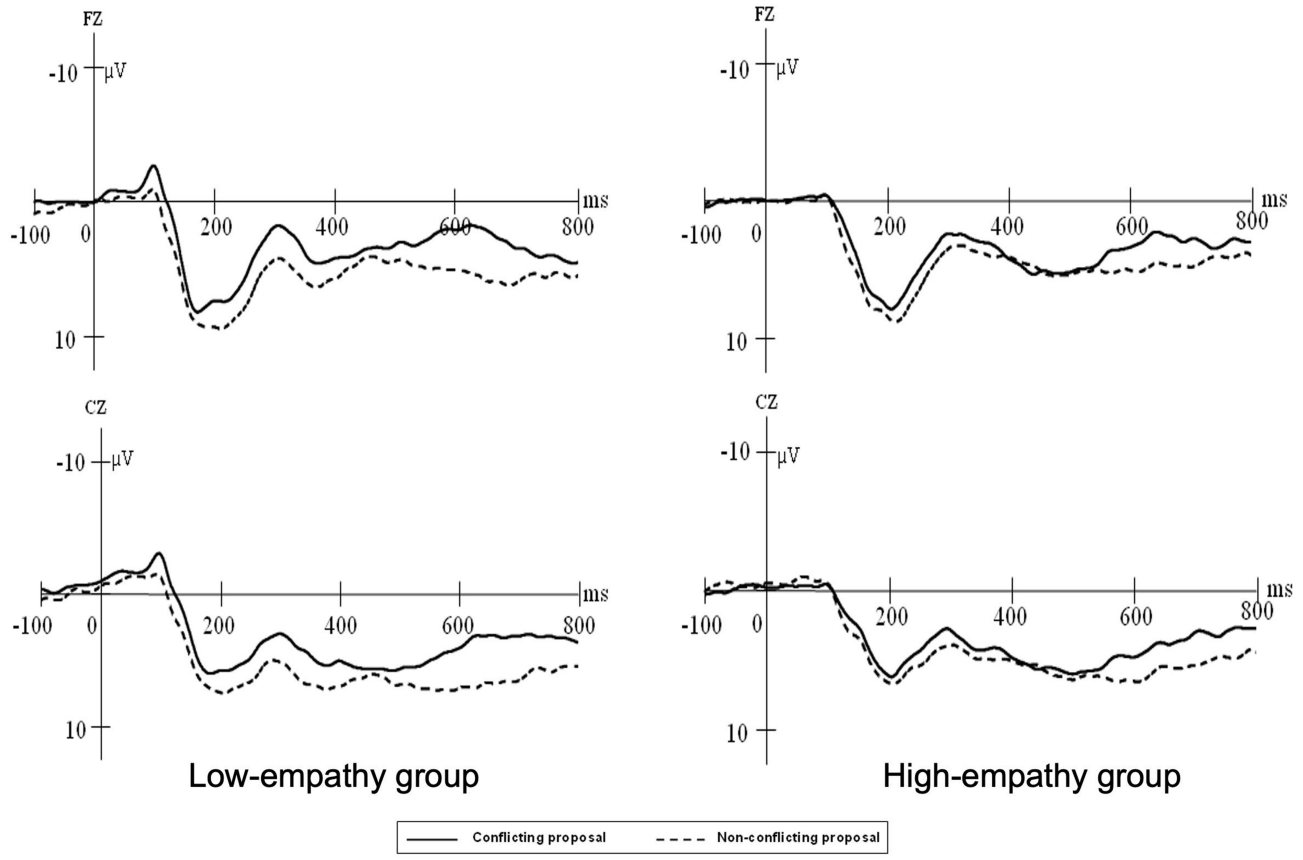

Figure 3 Total mean ERP waveforms of high- and low-empathy groups under different conditions.

Discussion

The current study used a high temporal resolution ERP technique to explore the differences in decision-making between high and low empathic ability individuals under different conflict of interest conditions. It was found that individuals with high empathic ability would show more altruistic behaviors of sacrificing themselves for others and exhibit fewer conflict

tendencies than individuals with low empathic ability. The amplitude of MFN evoked under conflicting proposals was greater than under non-conflicting proposals, in line with previous findings.[16,21] MFN reflects motivational evaluations of negative outcomes.[15,16] In addition to reflecting on whether the outcome meets expectations, MFN also appears in the cognitive process of evaluating contextual information that is contrary to social norms of morality (eg, an unfair money-sharing proposal).[16,21] Conflicting proposals can induce stronger negative emotions and decisional conflicts relative to non-conflicting proposals.[36] The present study found that the low-empathy group induced more negative MFN waves with conflicting proposals than with non-conflicting proposals, whereas the difference was not significant in the high-empathy group. Conflicting proposals indicate that the other person receives more than 80% of the benefit while he or she receives less than 20%, this condition often triggered subjects to think that they were being treated unfairly, interpreting others' gains as their own losses,[37,38] and then expressed their dissatisfaction by refusing the proposal to punish them for their selfish behavior. The low-empathy group induced greater MFN in response to conflicting proposals, suggesting that low-empathy individuals treated divergent interests with greater negative evaluations, whereas high-empathy individuals did not show similar differences under the two proposal types, potentially indicating a buffering function of empathy. ERP studies have found that empathic ability is positively related to prosocial behavior.[39] Thus, high-empathy individuals have relatively weaker negative evaluations of conflicting proposals. The behavioral data from the present study found that subjects in both groups had higher rejection rates for conflicting proposals than for non-conflicting proposals, suggesting that people were generally motivated to punish violations of cooperative behavior. Previous research found that this motivation activated reward-related brain regions,[40] suggesting that people are able to derive satisfaction from such altruistic punishment.

In addition, the present study found that non-conflicting proposals induced greater LPP than conflicting proposals; in the low-empathy group, non-conflicting proposals induced greater LPP than conflicting proposals, whereas, in the high-empathy group, the difference in proposal type was not significant. LPP was related to the arousal of the stimulus, and the more the stimulus was able to stimulate the motivational nature of the subject, the greater the LPP it induced.[41] During social interactions, people usually show a tendency to avoid harm and a preference for fairness, and non-conflicting proposals are consistent to maximize self-interest, whereas conflicting proposals are the opposite, so this result suggests that the low-empathy group shows a stronger motivation to converge on non-conflicting proposals. In contrast, although the LPP induced by individuals with high empathy was greater with non-conflicting proposals than with conflicting proposals, it did not reach a significant level, suggesting that it is possible that high empathy weakened the motivation to converge on non-conflicting proposals or increased the motivation to avoid conflicting proposals, which needs to be further verified in future experiments.

This research used ERP techniques to focus on exploring the differences in performance and neural activity of individuals with different empathic abilities in different conflict types of situations, further enriching the relevant research and neurophysiological evidence in the field of empathy and conflict of interest.

But there also have several shortcomings: first, the number of subjects was small and previous studies have shown differences in empathy between males and females.[42,43] Therefore, future studies need to further expand the sample size and include gender as one of the independent variables to explore more closely whether gender plays a moderating role. Second, the present study did not directly manipulate empathy and thus could not obtain a causal relationship between empathy and conflict-of-interest processing, based on the empathy-altruism hypothesis that people have strong empathy for people in need and in distress,[44] so future studies can directly examine empathy by creating different situations[5,45] to elicit different levels of empathy from subjects the causal relationship between empathy and conflict-of-interest processing. Third, in daily life, people usually face conflicts of interest in more complex social contexts, and their own emotional state in the moment, the attitudes of others, and the degree of closeness of the other person to themselves all influence the final decision,[38,46] so these factors will be factors to be considered in future research.

Conclusion

High-empathy individuals showed more altruistic behaviors and fewer conflict tendencies compared to low-empathy individuals. Low-empathy individuals had greater negative evaluations of conflicting offers, while high-empathy individuals weakened their negative evaluations of conflicting proposals because of their relatively high empathy.

Compared to high-empathy individuals, low-empathy individuals showed stronger motivation to converge on non-conflicting proposals.

Data Sharing Statement

The data will be available from the corresponding author upon reasonable request.

Ethical Approval

The study is in accordance with the Declaration of Helsinki, and this research was approved by the Ethics Committee of Tianjin Normal University.

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Disclosure

The authors report no conflicts of interest in this study.

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