

The impacts of racial group membership on people's distributive justice: an event-related potential study

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How individuals and societies distribute benefits has long been studied by psychologists and sociologists. Previous work has highlighted the importance of social identity on people's justice concerns. However, it is not entirely clear how racial in-group/out-group relationship affects the brain activity in distributive justice. In this study, event-related potentials were recorded while participants made their decisions about donation allocation. Behavioral results showed that racial in-group factor affected participants' decisions on justice consideration. Participants were more likely to make relatively equity decisions when racial in-group factor was congruent with equity compared with the corresponding incongruent condition. Moreover, this incongruent condition took longer response times than congruent condition. Meanwhile, less equity decisions were made when efficiency was larger in the opposite side to equity than it was equal between the two options. Scalp event-related potential analyses revealed that greater P300 and late positive

potential amplitudes were elicited by the incongruent condition compared with the congruent condition. These findings suggest that the decision-making of distributive justice could be modulated by racial group membership, and greater attentional resources or cognitive efforts are required when racial in-group factor and equity conflict with each other. *NeuroReport* 00:000–000 © 2013 Wolters Kluwer Health | Lippincott Williams & Wilkins.

NeuroReport 2013, 00:000–000

Keywords: distributive justice, efficiency, equity, event-related potentials, racial group membership

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Received 30 September 2013 accepted 29 October 2013

Introduction

Distributive justice is an important aspect in social psychology, and the central problem of distributive justice is the trade-off between equity and efficiency. Equity diverges from efficiency in some cases. From profit-maximizing perspective, people are not equal, although equity is important for altruistic behavior [1]. Utilitarian theories of distributive justice focus on favoring the aggregate welfare or maximizing efficiency, irrespective of equity, whereas deontological theories of distributive justice stand on intuitive principle and emphasize that equity is before efficiency [2]. Both views may be right in different circumstances, and each act may lead to different consequences. Efficiency and equity interact in a complex way, they may balance against each other or sacrifice for each other [3].

Empirical research indicates that social identity can impact people's justice concerns on behalf of one's group and lead to in-group-favoring behaviors [4]. According to the social identity theory, the group that one belongs to generally is an important source of pride and self-esteem, which provides a sense of social identity [5]. To achieve a positive self-image, people often enhance the status of the group to which they belong by perceiving one's own in-group more favorably than out-group, or preferring for one's in-group over the out-group [6]. In addition, as people's self-concept integrates with their group, people are inherently more concerned with the welfare of their in-group and tend to behave on behalf of their in-group's interests [4].

The social identity-based motivation probably leads to an in-group bias, which is called in-group favoritism (the tendency for people to evaluate their in-group positively) [7]. As race helps defining group membership [8], the in-group favoritism may influence people's distributive justice towards racial in-group/out-group.

Recently, a growing body of research has focused on the brain mechanisms underlying decision-making [9]. Event-related potentials (ERPs) with a high temporal resolution may help provide a method to evaluate the timing of cognitive processes. Previous ERP researches have demonstrated that the N170 (maximal around 170 ms) is related to activity of face-specific cortical areas, and this component has been suggested to reflect face processing [10,11]. In contrast to the N170, the later peaking P300 has been suggested to be recruited in decision-making [12], with its amplitudes being related to the amount of attentional resources used in the process of decision-making [13,14]. Other research suggested that the late positive potential (LPP) has many signature characteristics similar to that of the P300 [15], with larger positive amplitudes reflecting heightened processing related to motivated attention [14,16].

As outlined above, racial group membership seems to have a great impact on distributive justice, and we wonder to what extent the event-related neurophysiological response in equity–efficiency trade-off can be modulated by racial group membership. On the behavioral level, we hypothesize that people's distributive justice

might be affected by racial group membership, leading to bias in in-group decisions. Moreover, this effect might be further reflected in an ERP activation pattern, possibly indexed by P300 and LPP components, which are related to decision-making and the allocation of attentional resources [13,14,16]. This study may help us further understand the influence of racial in-group factor on distributive justice.

Materials and methods

Participants

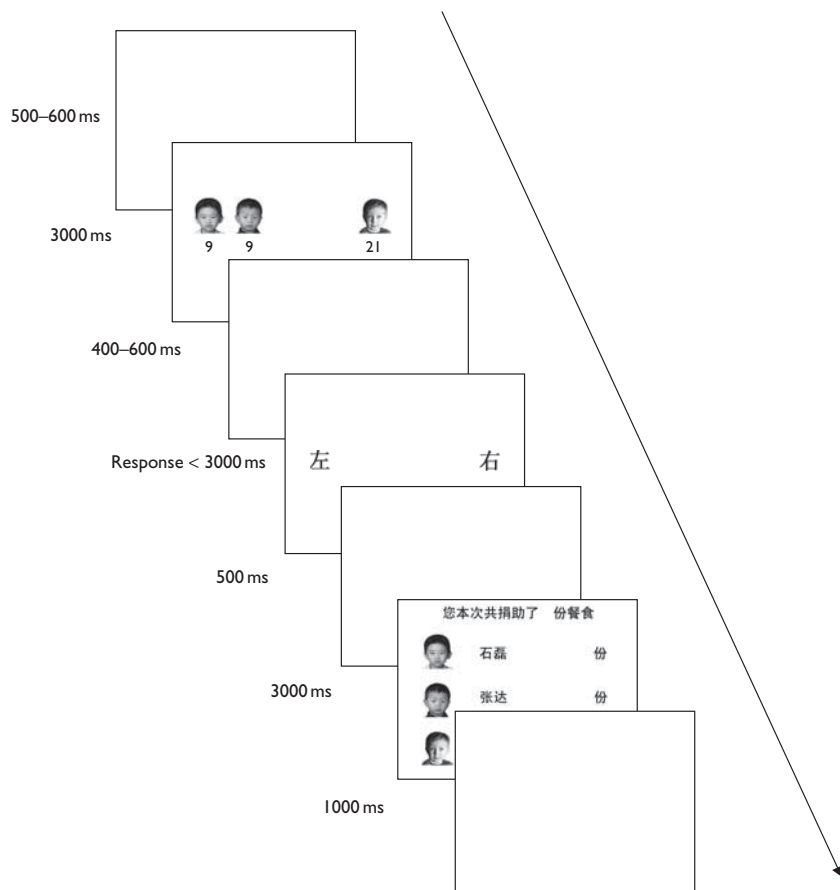
Twenty-one undergraduate and graduate students (10 female, aged 21 ± 2 years, range 18–25 years) were recruited from Dalian University of Technology. All participants were right-handed, and had normal vision or corrected to normal vision. The study was approved by the Institutional Review Board at Dalian University of Technology and informed consent was obtained from each participant.

Stimuli and procedure

The experiment had a 2×2 within-participant factorial design, with the first factor referring to distributive type (T1: distribution between two Chinese children and one

Western child vs. T2: distribution between two Western children and one Chinese child) and the second factor referring to efficiency between the two options ($\Delta M = 0$ vs. 3). Participants were required to make a decision about allocating meals to children in an international orphanage, and they had to choose between one of two options in each trial: a group of two children (belong to the same racial group) or only one child (belong to another racial group), with the positions of the two options counterbalanced on the left and right sides of the screen. The absolute difference in meals between the two sides (ΔM) could be 0 or 3 meals, which denoted the difference in efficiency between one child and two children allocation. Furthermore, meals of two children's side were always less than or equal to those of one child's side. A total number of 120 trials were presented, and each condition had 30 trials. Presentations of trials were generated and controlled using E-Prime software (Psychology Software Tools, Inc., version 1.1; Sharpsburg, Pennsylvania, USA). Each trial was presented on the computer monitor through a series of seven screens (Fig. 1). First, the blank screen was displayed for 500–600 ms (uniformly distributed), and then followed

Fig. 1



Sequence of events in a single trial.

by the distribution screen, which gave the children's head picture, a group of two children on one side and another one child on the other side. Face stimuli subtended approximate visual angles of 3.4° (vertically) and 8.0° (horizontally) from a viewing distance of 100 cm. Below the head picture of each child was the amount of meals that each kid might potentially receive. Participants were required to observe this screen without pressing any button at this stage. After 3 s, the distribution screen disappears, and the decision screen was presented after a blank screen of random duration (uniformly distributed on 400–600 ms), then participants were required to make their decision about which side to give. Participants had 3 s to make their decisions and respond by pressing a bimanual button ('left' or 'right'). After a response, another blank screen appeared for 500 ms, and then a feedback screen lasting for 3 s showed how many meals each kid received. After the feedback screen, a blank screen lasted for 1 s, and was followed by the next trial. When performing the task, participants were instructed to minimize eye movements to avoid excessive artifacts. Four practice trials were administered before the formal test to familiarize the participants with the task.

At the beginning of the experiment, participants read the brief description of the international orphanage, following an instruction on how to make their decisions. They were informed that the international orphanage would get a sum of financial aid (or changing into meals) from a social welfare organization, and meals would be donated according to their decisions. Participants were told that their choices would have a real impact on the gains for each child in the orphanage.

Event-related potential recording and data analyses

Electroencephalographic recordings (EEGs) were recorded continuously from 64 scalp sites using Ag/AgCl electrodes mounted on an elastic cap (Brain Products GmbH, Munich, Germany) according to the international 10–20 system nomenclature. The signals were recorded at 500 Hz, and a reference electrode was placed at the center between Fz and Cz. The vertical electro-oculogram was recorded from right supraorbital electrode. The horizontal electro-oculogram was recorded from electrode placed at the outer canthus of the left eye. All EEGs and electro-oculograms were rereferenced offline to the mean of left and right mastoids (average signals of Tp9 and Tp10). Electrode impedance was kept below 8 k Ω .

Offline EEG data analyses were performed on the Brain Vision Analyzer (Munich, Germany). The continuously recorded data were segmented into epochs of 1000 ms length starting 100 ms before the onset of the distribution screen. Band pass and notch filtering (0.016–30 Hz, 50 Hz) were applied. Epochs were baseline-corrected against the mean voltage in the -100 to 0 ms time windows before distribution screen. Ocular and other artifacts were rejected from averaging if amplitudes

exceeded $\pm 80 \mu\text{V}$. Grand-averaged ERPs were obtained over participants. On the basis of the literature and observing from the grand-averaged ERP waveforms, the N170 component was measured from electrode site Pz in accordance with other research [11]. We focused on 10 centroposterior electrodes, CP3, CP1, CPz, CP2, CP4, P3, P1, Pz, P2, and P4 for the P300 and LPP responses, as the P300 and LPP effects tended to be the strongest on these electrodes [14,17]. The N170 and P300 components were defined as the peak amplitudes in time windows of 150–200 and 250–500 ms, respectively, following the onset of the distribution screen. The LPP component was then defined as the average amplitudes in time windows of 500–800 ms. Analyses of variance (ANOVAs) for the N170 component were conducted with two within-participant factors: distributive type (T1 vs. T2) and efficiency ($\Delta M = 0$ vs. 3). For the P300 and LPP components, the electrode factor (10 levels) was also included. For all analyses, *P*-values were corrected using the Greenhouse–Geisser method.

With regard to the behavioral data, both mean percentage of selecting two recipients' (relative equity decisions) and mean response time were computed separately by each participant. The two variables were performed separately by repeated-measures ANOVA, with distributive type (T1, T2) and efficiency ($\Delta M = 0$ or 3) as two within-participant factors.

Results

Behavioral results

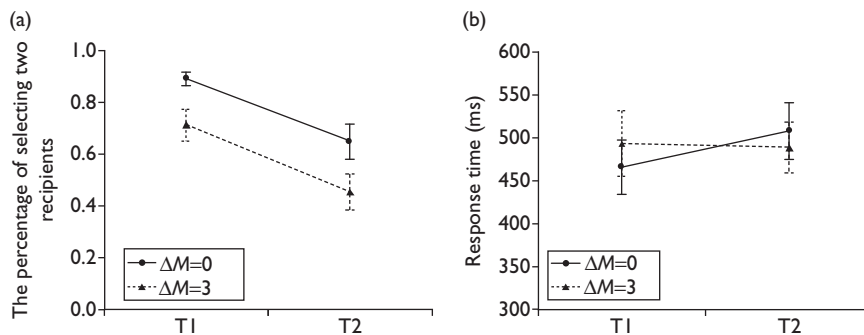
As shown in Fig. 2a, the percentage of making relative equity decisions demonstrated a significant effect on distributive type [$F(1,20) = 22.690$, $P < 0.001$]. The chance of making relative equity decisions in T2 distributive type ($M = 0.552$) was significantly smaller than in T1 distributive type ($M = 0.802$). The main effect of efficiency was also significant [$F(1,20) = 10.339$, $P = 0.004$], with smaller percentage of making relative equity decisions for ΔM of 3 compared with the condition for ΔM of 0 ($M = 0.584$ vs. 0.770). The interaction between distributive type and efficiency did not reach a significant level.

Repeated-measures ANOVA on response time showed a significant effect on distributive type [$F(1,20) = 5.869$, $P = 0.025$] (Fig. 2b). Response time of T2 distribution type was longer than those of T1 distribution type (498.513 vs. 479.945 ms). The main effect of efficiency was not significant [$F(1,20) = 0.115$, $P = 0.738$]. The interaction between distributive type and efficiency did not reach a significant level [$F(1,20) = 1.577$, $P = 0.224$].

Event-related potential results

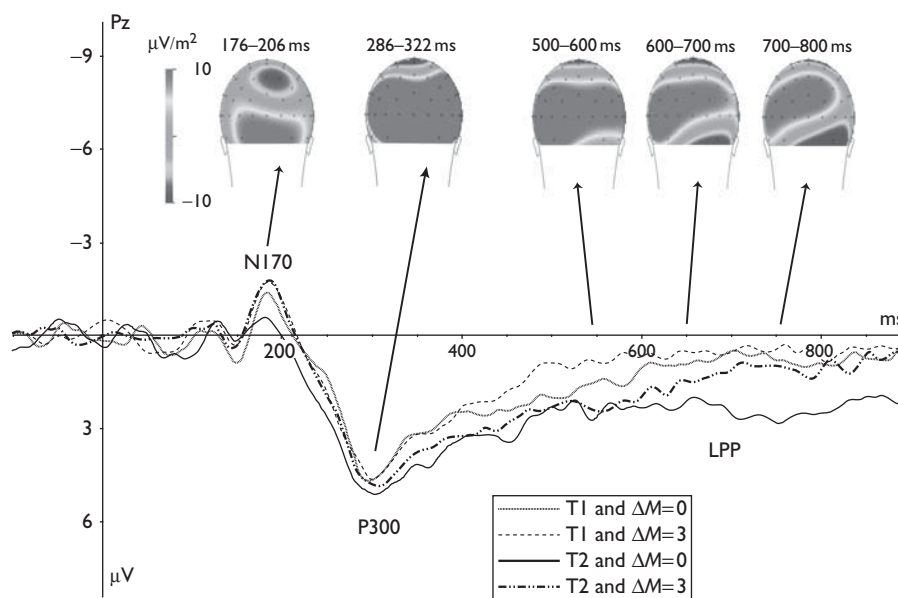
The ERPs elicited by the four experimental conditions were displayed at Pz electrode site in Fig. 3. Moreover, the current source densities showed the scalp distribution of the N170, the P300, and the LPP components.

Fig. 2



(a) The percentage of selecting two recipients' as a function of distributive type and efficiency. Error bars indicate SEMs. (b) Response time as a function of distributive type and efficiency. Error bars indicate SEMs.

Fig. 3



Grand average waveforms at Pz. The current source densities illustrate the scalp distribution of each event-related potential component. LPP, late positive potential.

N170

The results of the ANOVAs for N170 peak amplitudes showed that the main effect of distributive type was not significant [$F(1,20) = 0.444, P > 0.1$]. There was neither significant main effect of efficiency [$F(1,20) = 2.383, P > 0.1$], nor interaction between distributive type and efficiency [$F(1,20) = 0.101, P > 0.1$].

P300

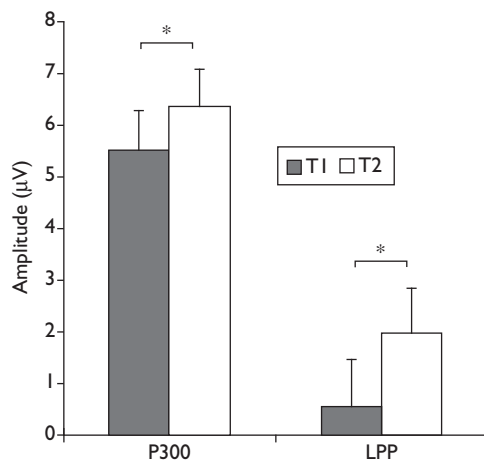
Repeated-measures ANOVA on P300 peak amplitudes revealed that the main effect of distributive type was significant [$F(1,20) = 4.759, P = 0.041$], with a more positive P300 value for T2 distributive type ($M = 6.359 \mu V$) than T1 distributive type ($M = 5.520 \mu V$) (Fig. 4, left). No significant

main effect of efficiency [$F(1,20) = 1.104, P > 0.1$] or interaction of distributive type \times efficiency [$F(1,20) = 0.140, P > 0.1$] was found for P300 amplitudes.

Late positive potential

Repeated-measures ANOVA on LPP mean amplitudes yielded a significant main effect of distributive type [$F(1,20) = 4.839, P = 0.040$]. The LPP amplitudes were also more positive for T2 distributive type ($M = 1.980 \mu V$) than T1 distributive type ($M = 0.561 \mu V$) (Fig. 4, right). The main effect of efficiency [$F(1,20) = 2.042, P > 0.1$] and the interaction between distributive type and efficiency [$F(1,20) = 0.097, P > 0.1$] were not significant.

Fig. 4



Amplitudes of P300 and late positive potential (LPP) components for T1 and T2 distributive types. Error bars indicate SEMs. * $P < 0.05$.

Correlational analyses

Significant negative correlation was obtained between the percentage of making relative equity decisions and overall P300 amplitude scores (across all four experimental conditions) ($r = -0.489$, $P = 0.024$), indicating that the larger the P300 amplitudes, the smaller the percentage of equity decisions that was made in the donation allocation task. No other significant correlations were observed between behavioral performances and electrophysiological measures.

Discussion

This study provided new insights into the temporal dynamics of racial group membership effect on distributive justice. During the decision-making of asset distribution, choosing two children was a relatively equity decision, whereas the efficiency of choosing one child was always equal to or larger than that of choosing two children. The trade-off between equity and efficiency was investigated when participants made their donation decisions. Participants showed a typical trend of preference for their in-group members, making more in-group-biased decisions. Electrophysiologically, both P300 and LPP components were sensitive to the manipulation of racial group factor, with larger amplitudes for the incongruent condition in which racial in-group factor conflicted with equity.

In-group favoritism or in-group–out-group bias has been widely studied in social psychology [6]. The racial in-group–out-group differences might automatically activate people's social identity and consequently influence the allocation decisions [18]. It is not surprising that people are more likely to help their own in-group members compared with out-group ones, and the psychological distance between the perceiver and the recipient is shorter

when the recipient is categorized as one's in-group member than out-group one [19]. Previous researches employing economic games (the dictator game) have also indicated that people tend to distribute more money to the recipient as social distance decreases [20,21]. In an fMRI study, Xu *et al.* [22] have also demonstrated that for both Caucasian and Chinese, the racial in-group faces induce increased empathic neural response in anterior cingulate cortex.

On an electrophysiology level, obvious P300 activities were elicited time-locked to the onset of distributive options. Moreover, it was found that the T2 distributive type elicited more positive P300 than the T1 distributive type. The amplitudes of P300 have been suggested to be proportional to the allocation of attentional resources [13,17] or the amount of cognitive efforts [23]. Therefore, the P300 differences might reflect the different amount of attentional resources or cognitive efforts required for the two distributive types. For the T2 distributive type, participants might be in a dilemma as the racial in-group factor conflicted with equity, the concern about one's own racial in-group members seemed to refrain from making equity decisions, and this competitive condition might demand more attentional resources or cognitive efforts as suggested by the pattern of the P300 effect. In addition, a significant negative correlation between the percentage of equity decisions and P300 amplitudes was obtained, thus supporting the foregoing interpretation. In T1 distributive type it might not be difficult to make a decision as racial in-group factor was congruent with equity. Accordingly, the behavioral results were in favor of the above hypothesis, as demonstrated by smaller percentage of selecting two recipients' and longer response times in T2 than T1 distributive type.

LPP waveforms also showed similar results as P300 component, with T2 distributive type evoking greater LPP amplitudes than T1 distributive type. Although the LPP may differ from the P300 in temporal dynamics, the LPP appears to share similar functions as P300 in terms of a phasic increase in attention toward [24]. Moreover, the LPP has been suggested to be sensitive to stimulus valence, with enhanced positive amplitudes in response to unpleasant stimuli [25]. Therefore, the more positive LPP could also be interpreted as increased attentional resources required in the incongruent condition, as participants might feel that their racial in-group members were under unfavorable condition when racial in-group factor conflicted with equity.

It was noteworthy that the efficiency factor indeed influenced participants' decision in food distribution, as demonstrated by smaller percentage of relative equity decisions when the efficiency was larger for opposite side. However, the efficiency effect was not significant in either face-specific N170 component or P300/LPP components. Lack of main effect of efficiency in these components might suggest that the efficiency factor might be not processed during these stages. In addition,

the N170 was also not significant for the main effect of distributive type. In the current study, each condition has both Western and Eastern faces, and the N170 might be insensitive to the information derived from each condition, as the N170 has been typically shown to discriminate between face and nonface stimulus [11].

Conclusion

The current study was performed with the aim to investigate the impacts of racial in-group membership on distributive justice through electrophysiological indicators. The results suggested that the racial in-group factor had great influence on the justice decisions in asset distribution. As indicated by P300 and LPP components, more attentional resources or cognitive efforts were required when racial in-group factor was incongruent with equity compared with the corresponding congruent condition. Our findings provide direct electrophysiological evidence for further understanding real-life social behavior.

Acknowledgements

This work was supported by 973 Program 2012CB518200.

Conflicts of interest

There are no conflicts of interest.

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