Brain Activity in Fairness Consideration during Asset Distribution: Does the Initial Ownership Play a Role?

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Abstract

Previous behavioral studies have shown that initial ownership influences individuals' fairness consideration and other-regarding behavior. However, it is not entirely clear whether initial ownership influences the brain activity when a recipient evaluates the fairness of asset distribution. In this study, we randomly assigned the bargaining property (monetary reward) to either the allocator or the recipient in the ultimatum game and let participants of the study, acting as recipients, receive either disadvantageous unequal, equal, or advantageous unequal offers from allocators while the event-related potentials (ERPs) were recorded. Behavioral results showed that participants were more likely to reject disadvantageous unequal and equal offers when they initially owned the property as compared to when they did not. The two types of unequal offers evoked more negative going ERPs (the MFN) than the equal offers in an early time window and the differences were not modulated by the initial ownership. In a late time window, however, the P300 responses to division schemes were affected not only by the type of unequal offers but also by whom the property was initially assigned to. These findings suggest that while the MFN may function as a general mechanism that evaluates whether the offer is consistent or inconsistent with the

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This study was therefore conducted to investigate how initial ownership of a bargaining property modulates recipient's fairness consideration; this was measured through behavioral reactions (i.e., accepting vs. rejecting offers) and electrophysiological recordings. We randomly assigned the property (a certain amount of monetary reward) to either the allocator or the recipient before the presentation of the division scheme and measured the recipient's event-related potentials (ERPs) evoked by the division scheme. We manipulated the level of fairness in asset allocation by letting the recipient receive disadvantageous unequal offers (1, 2, or 3 out of 10 Chinese yuan), equal offers (5 out of 10 yuan) or advantageous unequal offers (7 or 8 out of 10 yuan). Behaviorally, we were interested in the acceptance rate for different offers. This rate should decrease as the level of fairness in the division scheme decreases. Importantly, this rate could be lower when the assets were initially owned by the recipient than by the allocator, especially when the offers were disadvantageously unequal. The feeling of entitlement might lead the recipient to demand a larger portion of the pie.

Electrophysiologically, we focused on MFN and P300, two ERP components that are sensitive to the evaluation of fairness in asset distribution. The medial frontal negativity (MFN) or the feedback-related negativity (FRN) was originally observed in studies on performance monitoring and the evaluation of decision outcome [10,11,12,13]. The FRN is a negative deflection peaking between 200 ms and 350 ms at frontocentral recording sites, and is more pronounced for negative feedback associated with unfavorable outcomes, such as incorrect responses or monetary loss, than for positive feedback. Later studies showed that these differential responses to decision outcome can be modulated by social factors, such as interpersonal relationship between the evaluator and the decision maker [14,15,16,17,18,19,20] and the extent of personal responsibility for the outcome [21,22ationii8i-615.3(ow1.3(w23.3(ies)3onses4tdef4c(demand)853tween)at2,7he)-(thi6975(offers)-418.outcom464(offerationl

paid according to their decisions in the task, although in the end all the participants were paid 20 yuan extra on top of the basic payment. Four graduate students (2 females), who were strangers to the EEG participants, were recruited as confederates. The purpose of using four confederates was to reduce reputation building in the repeated-trial game and to make the experimental setup more realistic since the EEG participant would play against different allocators in rounds of the game.

All the participants were right-handed and had normal or corrected-to-normal vision. They self-reported on a short questionnaire no history of neurological or psychiatric disorders. Informed consent was obtained from each participant before the test. The experiment was carried out in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Department of Psychology, Peking University.

Design and procedures

The experiment had a 3×2 within-participant factorial design, with the first factor referring to the offer type (disadvantageous unequal vs. equal vs. advantageous unequal offer) and the second factor referring to the initial ownership (self vs. other). Disadvantageous unequal offers could be 1, 2, or 3 yuan (out of 10 yuan), equal offers could be 5 yuan (out of 10 yuan), and advantageous unequal offers could be 7 or 8 yuan (out of 10 yuan). The bargaining property (10 yuan) was assigned ostensibly by the computer to either the recipient or the allocator in random order before the division scheme was presented to the recipient.

When the EEG participant came to the laboratory, he/she and the four confederates were told that they would sit in separate rooms to finish a task together through the computer network. The EEG participant was ostensibly selected through lottery to undergo the EEG test. This participant was then told that he/she would play as a recipient in UG and the others would be allocators. He/she was also informed about the rules of UG and the manipulation of ownership. That is, at the beginning of each round the computer would randomly assign 10 yuan to either the allocator or himself/herself, and the allocator would then offer a scheme on how to divide the amount. The EEG participant was asked to press a button with the index finger of his/her left or right hand, without elaborative thinking, to indicate whether he/she would accept or reject the offer. He/she was reminded that the allocators made their division schemes individually and independently, and his/her response would not be sent back to the allocator immediately and therefore could not affect the allocators' offers in following rounds.

Each trial began with the presentation of a fixation sign (a white dot subtended 0.3? of visual angle) for 500 ms against a black background (see Fig. 1). The sentence "The computer is randomly pairing" in Chinese (white and Song font, size 32) was presented for either 800, 850, 900, 950, or 1000 ms, indicating to the EEG participant that one of the other four persons was randomly selected to play as an allocator in the current round of game. Then the EEG participant's own head portrait and a silhouette (each subtended $1.5 \times 1.6^{\circ}$, separated for 2.3° between the centers of the two figures) were presented at the left side of the screen for either 800, 900, 1000, 1100 or 1200 ms, along with Chinese words "please wait" (white and Song font, size 32) at the left. This was to suggest to the participant that the computer was assigning the initial ownership of the 10 yuan. The positions of these two figures were counterbalanced over trials. After this frame, the assignment of initial ownership, with a photo of a 10 yuan bill ($2.6^{\circ} \times 1.3^{\circ}$) aligned with either of the figures, was presented for 1500 ms. It was explained to the participant that the computer had endowed the money initially to the person involved. After the presentation of a blank screen for a jittered time between 500 and 800 ms, the allocator's division scheme, in two lines of words (e.g., "he 8, you 2", white and Song font, size 32) was revealed at the center of screen for 1200 ms. The screen turned blank again for 500 ms, followed by the presentation of two options, "accept" and "reject", on the left and right side of the screen, with the positions of the two options counterbalanced over participants. The EEG participant was asked to make the "accept" or "reject" decision as quickly as possible and the next trial began after 1000 ms after the button press.

The participant was seated comfortably about 1.5 m in front of a computer screen in a dimly lit room. The experiment was administered on a computer with a Del 22-in. CRT display, using Presentation software (Neurobehavioral System Inc.) to control the presentation and timing of the stimuli. The experiment consisted of 4 blocks of 75 trials each. Under each of the two types of initial ownership, the disadvantageous unequal condition consisted of 20 trials of 1/9 offer, 20 trials of 2/8 offer and 10 trials of 3/7 offer; the equal condition consisted of 40 trials of 5/5 offer; and the advantageous unequal condition consisted of 20 trials of 7/3 offer and 20 trials of 8/2 offer. In addition, 10 trials of 4/6 offer and another 10 trials of 6/4 offer were used as fillers. The number before the slash indicated the offered amount to the recipient and the number after the slash indicated the amount left to the allocator. Without the participant's knowledge, all the offers were predetermined by a computer program. The 300 trials were pseudo-randomized with the restriction that no more than 3 consecutive trials were of the same offer type and no more than 3 consecutive trials were of the same initial ownership.

A practice block of 20 trials was administered before the formal test. To check the manipulation of initial ownership, we presented the participants, after the experiment, with the fourth frame of Fig. 1. and asked them to indicate on a 7-point Likert Scale to what extent they felt that the property should be in their own possession (1 = absolutely not in their own possession, 7 = absolutely in their own possession) and to what extent they felt that the property should be in the allocator's possession (1 = absolutely not in the allocator's possession, 7 = absolutely in the allocator's possession) in each initial ownership condition. We also presented the participants with the fourth frame of Fig. 1 and asked the participants to indicate the minimal amount (out of 10 yuan) they wanted from the pie and the fairest division they perceived when the property was assigned to themselves or to the allocator. The participants were debriefed, paid and thanked at the end of the experiment.

EEG Recording and Analysis

EEGs were recorded from 64 scalp sites using tin electrodes mounted in an elastic cap (Brain Products, Munich, Germany) according to the international 10–20 system. The vertical electrooculogram (VEOGs) was recorded supra-orbitally from the right eye. The horizontal EOG (HEOG) was recorded from electrodes placed at the outer canthus of the left eye. All EEGs and EOGs were referenced online to an external electrode which was placed on the tip of nose and were re-referenced offline to the mean of the left and right mastoids. Electrode impedance was kept below 5 kΩ for EOG channels and for all other electrodes. The bio-signals were amplified with a band-pass from 0.016 to 100 Hz and digitized on-line with a sampling frequency of 500 Hz.

Separate EEG epochs of 1000 ms (with a 200-ms pre-stimulus baseline) were extracted offline, time-locked to the onset of each division scheme. Ocular artifacts were corrected with an eye-movement correction algorithm which employs a regression analysis in combination with artifact averaging [42]. Epochs were

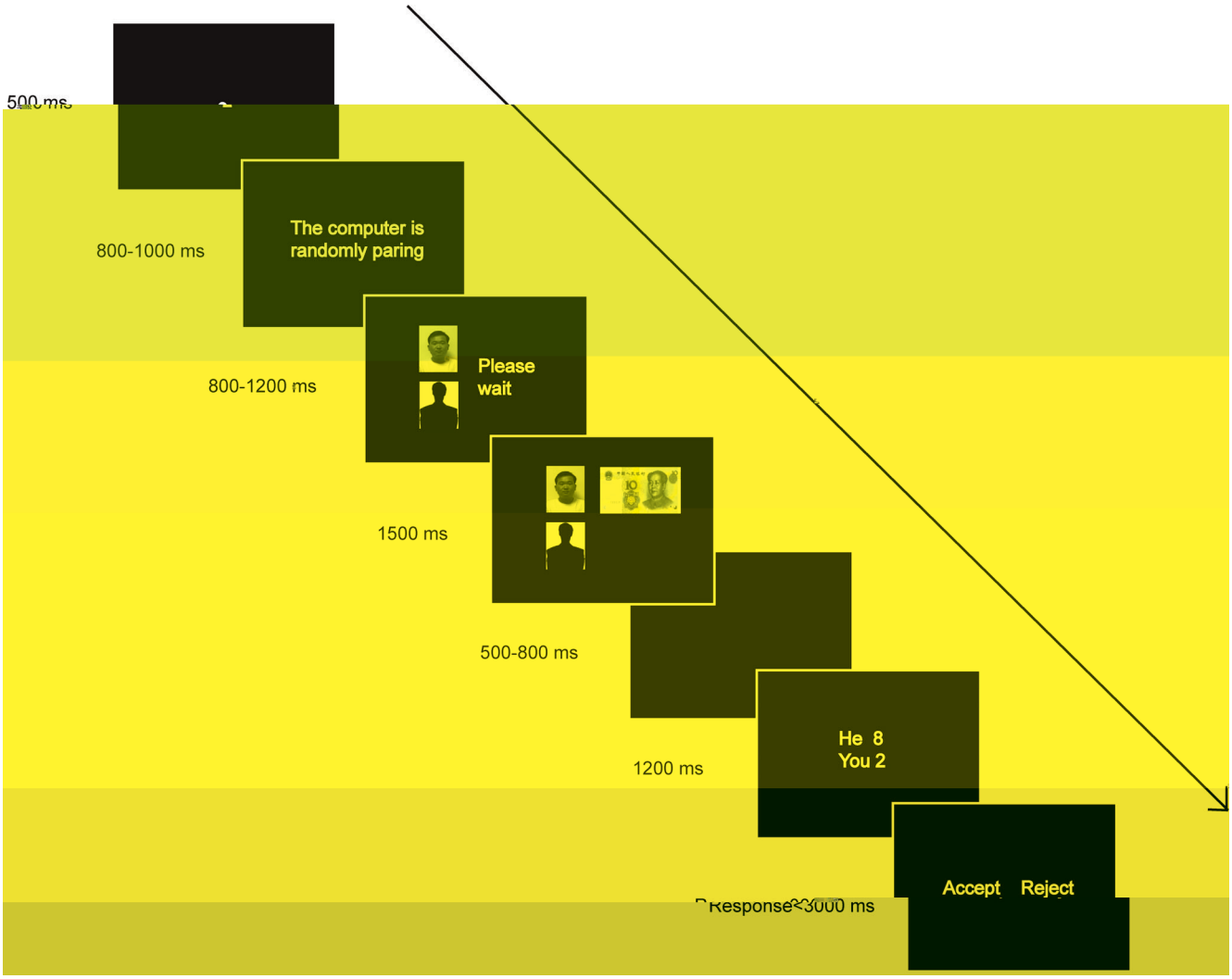

Figure 1. Sequence of events in a single trial.
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baseline-corrected by subtracting from each sample the average activity of that channel during the baseline period. All trails in which EEG voltages exceeded a threshold of ±80 μV during recording were excluded from further analysis. The EEG data were filtered with a band-pass from 0.016 to 30 Hz.

We focused on 10 frontocentral electrodes, FC3, FC1, FCz, FC2, FC4, C3, C1, Cz, C2 and C4 for the MFN responses and 10 centro-posterior electrodes, CP3, CP1, CPz, CP2, CP4, P3, P1, Pz, P2 and P4, for the P300 responses since the MFN and the P300 effects tended to be the strongest on these electrodes. Based on the visual inspection of ERP waveforms, we used the mean amplitudes in the 280–380 ms time window for the MFN measurement and the mean amplitudes in the 400–600 ms time window for the P300 measurement (see also [28] for similar treatment). Average amplitudes over frontocentral and centro-posterior electrodes were used in the following analysis. Analyses of variance (ANOVAs) were conducted with two within-participant factors: initial ownership (self vs. other) and offer type (disadvantageous unequal vs. equal vs. advantageous unequal offer). The Greenhouse-Geisser correction for violation of the assumption of sphericity was applied where appropriate. The Bonferroni correction was used for multiple comparisons.

Results

Among the thirty EEG participants, three participants stated that they completely disbelieved the setup of the experiment in the interview after the EEG test, four participants displayed excessive artifacts in EEG recording, one participant misunderstood the game rule, and one participant accepted all the offer types. These participants were excluded from data analysis, leaving twenty-one participants (8 females) for the following analysis.

Manipulation Checks of Initial Ownership

The post-experiment questionnaire indicated that the incidental assignment of the 10 yuan bill in line with either the participant's head portrait or the other's silhouette strongly affected the participants' perception of potential ownership. A 2 (location of the 10 yuan bill: the recipient's head portrait vs. the other's silhouette) × 2 (benefactor of allocation: allocator vs. recipient) repeated measures ANOVA on the perceived ownership showed a significant interaction between the two factors, $F(1, 20) = 56.88$, $p<0.001$. Simple-effect tests revealed that when the 10 yuan bill was temporarily located in line with the participant's own portrait, participants thought that the property should be more in their own

possession (mean ± SE, 5.24±0.28) than in the allocator's possession (2.90±0.25), $p<0.001$. On the other hand, the participant perceived the property to be more in the allocator's possession (5.14±0.29) than in their own (3.14±0.32), $p<0.01$, when the 10 yuan bill was located in line with the other's silhouette.

The manipulation of initial ownership also influenced the participants' self-reported minimal acceptance amount out of 10 yuan. The minimal acceptance amount was significantly higher when the property was initially endowed to the participant (4.86±0.33) than when the bill was initially endowed to the allocator (2.86±0.33), $p<0.001$. Moreover, the participants indicated that the fairest offer for themselves was 6.48±0.25 yuan (out of 10 yuan) when the property was initially endowed to the participant, which was significantly higher than the amount when the bill was initially endowed to the allocator (4.67±0.26), $p<0.001$. These results indicate that the perceived fairness in asset allocation changes according to the initial ownership or the feeling of entitlement.

Behavioral Results

The acceptance rates for different division schemes are presented in Fig. 2. A 2 (initial ownership: self vs. other) × 3 (offer type: disadvantageous unequal vs. equal vs. advantageous unequal offer) repeated measures ANOVA revealed a significant main effect of offer type, $F(2, 40) = 108.31$, $p<0.001$, indicating that the acceptance rate for disadvantageous unequal offers (0.24±0.05) was lower than for either equal (0.91±0.03) or advantageous unequal offers (0.94±0.03), as confirmed by the post-hoc tests ($p<0.001$). The differences between the equal and the advantageous unequal offer conditions were not significant ($p>0.1$). The main effect of initial ownership was also significant, $F(1, 20) = 12.24$, $p<0.01$, suggesting that the acceptance rate was higher when the 10 yuan bill was initially aligned with the other's silhouette (0.76±0.02) than when bill was presented with the participant's own portrait (0.63±0.03). Importantly, the interaction between initial ownership and offer type was significant, $F(2, 40) = 7.25$, $p<0.01$. Simple-effect tests showed that the acceptance rate to disadvantageous unequal offers was significantly higher in the "other" condition (0.36±0.07) than in the "self" condition (0.11±0.04), $t(20) = 3.81$, $p<0.01$. A similar pattern was observed for equal offers (0.99±0.003 vs. 0.83±0.06), $t(20) = 2.59$, $p<0.05$. However, this effect was absent for advantageous unequal offers, $t(20) = -0.70$, $p>0.1$.

ERP Responses to the Presentation of Division Schemes

For the mean amplitudes in the 280–380 ms (MFN) time window (Fig. 3A and 3B), a 2 (initial ownership: self vs. other) × 3 (offer type: disadvantageous unequal vs. equal vs. advantageous unequal offer) repeated-measures ANOVA showed a significant main effect of offer type, $F(2, 40) = 8.66$, $p<0.01$, indicating that ERP responses were more negative-going for disadvantageous (−2.06 μV) and advantageous unequal offers (−2.72 μV) than for equal offers (−1.19 μV), $p = 0.06$ and $p<0.01$, respectively. The ERP responses to the two types of unequal offers did not differ, $p>0.1$. However, we found no significant main effect of initial ownership, $F(1, 20) = 0.18$, $p>0.1$, nor the interaction between initial ownership and offer type, $F(2, 40) = 1.13$, $p>0.1$.

Similarly, for the mean amplitudes in the 400–600 ms (P300) time window (Fig. 3A and 3C), the 2 × 3 ANOVA showed also a main effect of offer type, $F(2, 40) = 32.98$, $p<0.001$, indicating that the mean amplitudes were more positive for equal offers (4.36 μV) than for disadvantageous unequal offers (0.94 μV) or advantageous unequal offers (0.12 μV). The differences between conditions were all significant after Bonferroni correction, $p<0.001$ or $p<0.01$. The main effect of initial ownership was also significant, $F(1, 20) = 8.28$, $p<0.01$, suggesting that the ERP responses were more positive for the "other" (2.12 μV) than for the "self" condition (1.49 μV). The interaction between offer type and initial ownership did not reach significance, $F(2,40) = 0.54$, $p>0.1$, indicating that the initial ownership effect on the P300 was essentially the same across the three types of offers.

Discussion

This study demonstrated that initial ownership influenced recipients' brain responses to unfair asset allocation schemes and their behavioral decisions to accept offers. Participants were more reluctant to accept disadvantageous unequal and equal offers when the bargaining property was initially in their own possession than when it was in the other's possession, and this distinction disappeared for advantageous unequal offers. Electrophysiologically, both disadvantageous and advantageous unequal offers elicited more negative going ERP responses compared to equal offers in an earlier, MFN time window (280–380 ms), with no obvious differences between the two types of unequal offers. These earlier effects were not affected by the initial ownership. In a later time window (400–600 ms), however, the P300 was more positive for equal offers than for disadvantageous unequal or advantageous unequal offers and were more positive when the bargaining property was initially owned by the allocator than by the recipient. In the following paragraphs, we explore the implications of our behavioral and electrophysiological findings, focusing on the effects of fairness in asset allocation and the effects of initial ownership.

Previous studies have shown that noncausal forms of association between an individual and an object (e.g., the numbers corresponding to an individual's birthday, prior touch or use of the object) can significantly increase the individual's preference or valuation of the object [43,44,45,46]. In this study, the initial random assignment of the 10 yuan bill strongly affected the participants' perception of ownership and the feeling of entitlement in subsequent asset distribution, as demonstrated by their post-experiment self-report. Although the participants had been explicitly told that the initial assignment was randomly conducted by computer and it did not imply that they would eventually have the money, this perception of ownership and feeling of entitlement had nevertheless affected the participants' subsequent acceptance or rejection of disadvantageously unfair and even fair (equal) offers.

One of the prominent motivations for individuals rejecting disadvantageous unequal offers in asset distribution is to preserve self-image/self-esteem and/or to punish unfair behavior [47,48]. The assignment of initial ownership to a participant may increase his feeling of entitlement, and disadvantageous unequal divisions and even equal divisions would be perceived as challenges to his/her self-image or self-esteem. These challenges would then meet strong reactions, resulting in lower acceptance rates. Thus, the perceived fairness or equity in asset distribution can be highly context-dependent [33,34].

On the other hand, the high acceptance rate and the absence of initial ownership effect for advantageous unequal offers can also be taken as evidence for the context-dependent nature of fairness consideration. Although individuals care for fairness in asset distribution, particularly when they are in a disadvantageous position [30,31], they are nevertheless self-interested. This care for self-interests may be strategic and is shown when their self-interests are not likely to be negated. In this situation, effects of other social

factors (including the initial ownership) are dwarfed or overshadowed.

The finding of an MFN effect, with more negative going responses to disadvantageous unequal offers than to equal offers, replicated previous studies [24,25,26,27,28]. This effect may reflect the detection of social expectancy violation as egalitarian distribution of assets is an expected social norm in our life [49,50,51]. The human brain might have developed specific mechanisms to detect ongoing deviation from social norms [52] and these mechanisms might be based on similar neural substrates as those engaged in detecting errors during non-social reinforcement leaning [53]. For instance, a recent fMRI study on social conformity in facial attractiveness judgment showed that conflict with group opinions, regardless of whether the opinions were given by human peers or by computers, triggered activation of brain regions implicated in reinforcement learning, i.e., rostral cingulate zone and the ventral striatum, and these neural signals can predict whether the participants would subsequently change their initial judgment [54].

Importantly, we found that the advantageous unequal offers also elicited more negative-going MFN responses than equal offers, and this effect appeared to be of equal magnitude as for disadvantageous unequal offers. This finding is novel and important because it allows us to differentiate theoretical proposals concerning the nature of MFN or FRN (assuming they are essential the same, as we argued in the Introduction). One proposal is that the FRN reflects the impact of midbrain dopamine signals on the anterior cingulate cortex (ACC) [11,55]. The phasic decreases in dopamine inputs elicited by negative prediction errors (i.e., "the result is worse than expected") give rise to the increased ACC (anterior cingulate cortex) activity that is reflected as larger MFN amplitude, whereas the phasic increases in dopamine signals elicited by positive prediction errors (i.e., "the result is better than expected") give rise to decreased ACC activity that is reflected as smaller MFN amplitudes. By this account, we should expect to observe *less negative* (or *more positive*) *going* MFN responses to advantageous unequal offers than to equal offers. Another more viable conception is that the FRN (the associated ACC) serves as a general performance monitoring system which detects violation of (social and non-social) expectancy, irrespective of whether the violated expectancy is positive or negative [29,39,56]. By this account, although the advantageous unequal offers could benefit the recipients (i.e., better than expected), they nevertheless violated the equity rule in asset distribution [57,58], just as the disadvantageous unequal offers. Thus any division schemes in violation of the equity rule would be detected by the monitoring system, resulting in more negative-going MFN responses (see also [29,39,56]). Indeed, recent studies suggest that the short-latency phasic responses in the dopamine system are related to a general process of switching attention to unexpected, behaviorally relevant stimuli [59]. The feedback, whether positive or negative, elicits a phasic increase in the activity of mesencephalic dopamine neurons which, in turn, induces increased excitability in the ACC, thereby giving rise to the FRN/MFN effect.

A perhaps surprising finding in this study was that the initial ownership of the distributed asset had no obvious effect on the MFN responses to division schemes. This absence of an initial ownership effect appears to be at odds with Wu et al. [27] in which the social distance between the recipient and the allocator (being a friend or a stranger) modulated the MFN responses to fair and disadvantageous unfair offers. We believe that the discrepancy

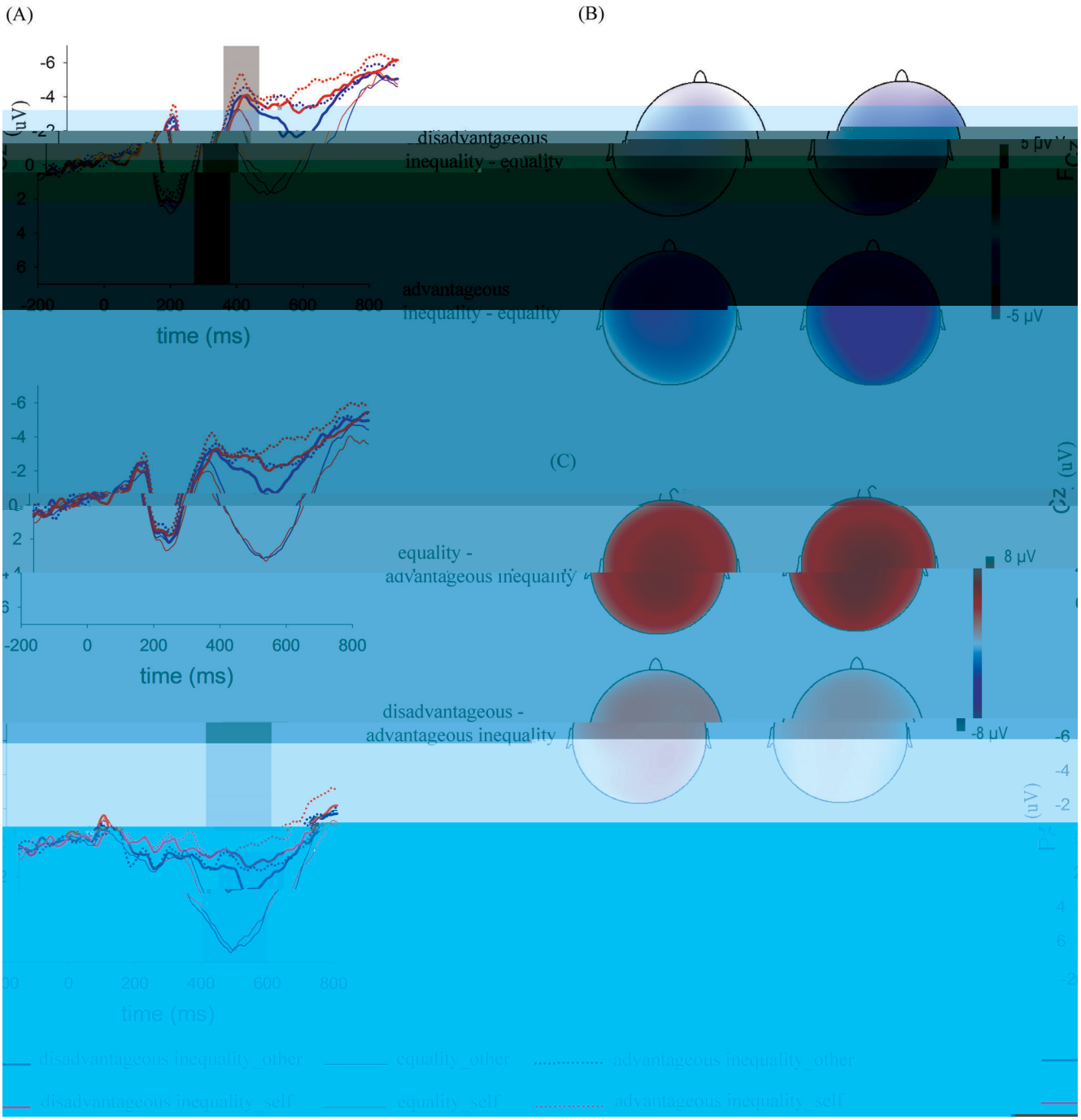

Figure 3. ERP responses and topographic maps. (**A**) ERP responses time-locked to the onset of different offers at the midline FCz, Cz and Pz. The shaded 280–380 ms time window was for the calculation of the mean amplitudes of the MFN. The shaded 400–600 ms time window was for the calculation of the mean amplitudes of the P300. (**B**) Topographic maps for the MFN effects in the 280–380 ms time window. (**C**) Topographic maps for the P300 effects in the 400–600 ms time window.
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processes [18,19,60,61], rendering a P300 effect for the initial ownership (see later discussion).

Note that the assignment of bargaining property to the participant may enhance their demand for a larger portion of the pie, evidenced by the reduced acceptance rate for the equal division in the "self" condition than in the "other" condition. One might view this enhanced demand for the pie in self-ownership as a kind of social norm. Consequently if the MFN reflects the violation of social norm, we should expect to observe more negative-going MFN responses to the disadvantageous offers in the "self" condition than in the "other" condition. Although we did obtained numerically larger MFN responses for the former (-2.21 μV) than for the latter (-1.92 μV), the difference between the two conditions did not reach statistical significance. It is possible that when different social norms are involved in evaluating schemes of asset division, the equity rule, which is

ubiquitous in the society, might dominate over other rules, including the rule for a larger portion of pie in self-ownership, in determining the MFN responses. Further studies are needed to investigate how different social norms or rules might interact to modulate the brain activity in outcome evaluation or interpersonal interaction.

In contrast to the MFN, we found that the P300 was modulated by both the offer type and the initial ownership, although these modulations were independent from each other. Previous studies on outcome evaluation have indicated that the P300 is related to processes of attentional allocation [62,63] and/or high-level motivational/affective evaluation [13,64]. According to the equity theory [57,58], individuals who are facing inequity would feel distressed and are less satisfied with asset distribution than individuals who are facing equity. The stronger P300 responses to equal offers than to unequal offers may suggest that participants (recipients of asset distribution) in this study attached more motivational/affective significance to the equal divisions than to unequal divisions, consistent with the social fairness norms cultured in individuals.

In addition, we found that disadvantageous unequal offers elicited more positive P300 than advantageous unequal offers. Although both types of offers violate the equity rule of social norms, it is possible that different amount of attentional resources are used to process the two types of offers. For disadvantageous unequal offers, participants might be in a difficult position to assess the pros and cons of accepting or rejecting offers; for advantageous unequal offers, participants might not have such dilemma and they can assess the implications of offers, as demonstrated by their 94% acceptance rate.

On the other hand, we observed a small, but significant initial ownership effect on the P300, with the offers from the bargaining property initially owned by allocator eliciting more positive P300 responses than the offers from the property initially owned by the recipient himself/herself. A number of studies on outcome evaluation have shown that the P300 is sensitive to reward valence in gambling tasks, with positive outcomes eliciting more positive P300 than negative outcomes [18,37,38,39,40]. In the present study, any amount proposed by the allocator in the "other" condition might be considered, implicitly, as a kind of extra "gain", even though the recipient may eventually decide to reject the offer and lose it. Conversely, any amount proposed by the allocator in the "self" condition might be considered as a kind of "loss" as the bargaining property was initially assigned to the recipient and he/she might implicitly declare the ownership of the whole lot (see also [65]).

An important finding here was that the modulations of the P300 by offer type and initial ownership appeared to be independent from each other, consistent with the absence of an interaction between fairness of offers and social distance between the allocator and recipient in DG [27]. We would like to suggest that there are two top-down processes associated with the P300. One process cares for fairness of different offers, with different levels of attentional resources being devoted to the elaborative processing of the social/affective significance of offers. Another process cares more for self-interests and is sensitive to gain/loss. Either of two processes can modulate the P300 magnitude, although it needs further investigation to elucidate under what circumstances the two processes work independently when they are manipulated concurrently.

In summary, by assigning a bargaining property to either the allocator or the recipient and presenting the recipient with offers of different fairness levels, we found that the participant, acting as the recipient, were more likely to reject disadvantageous unequal and equal offers when they initially owned the property than when they did not. The two types of unequal offers evoked more negative-going MFN than the equal offers in an early time window (280–380 ms) and these differential effects were not modulated by the initial ownership. In a late time window (400–600 ms), however, the P300 responses to division schemes were affected not only by offer types but also by whom the property was initially assigned to. These findings suggest that while the MFN may function as a general mechanism that evaluates whether the offer is consistent or inconsistent with the equity rule, the P300 is sensitive to later, top-down controlled processes, into which factors related to the allocation of attentional resources, including initial ownership and personal interests, come to play.

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Author Contributions

Conceived and designed the experiments: YW JH ML XZ. Performed the experiments: YW JH. Analyzed the data: YW JH. Wrote the paper: YW JH EVD ML XZ.

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