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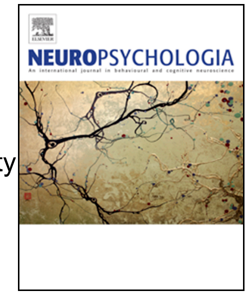

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Nudge for justice: An ERP investigation of default effects on trade-offs between equity and efficiency

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Abstract

Default options are an increasingly common tool used by organizations, managers, and policymakers to guide individuals' behavior. We wondered whether the known preference for default options could constitute a nudge to achieve more equitable or more efficient results. Combining with event-related potentials, we found that both the default option and distributive justice contributed significantly to decision-making. The N200s and P300s were extracted using the tensor decomposition, which showed superiority in terms of capturing multi-domain features. The results demonstrated that greater brain activity associated with conflict monitoring was elicited in the trade-off between equity and efficiency when the default could not represent a socially desirable action. Besides, participants attached more motivational/affective significance to equitable defaults than inequitable but maybe efficient default options. Further, individuals with larger neural response differences between equitable and inequitable defaults appeared to be more inequity aversion in behavior. These findings offer a novel perspective on the role of default effects on distributive justice, while contributing to both organizational policy and practice by using the default to improve social welfare.

Keywords: Nudge; default effect; equity; efficiency; distributive justice; tensor decomposition

1. Introduction

The big trade-off between equity and efficiency is inescapable. Just as Boulding (1962) put it, we face the dilemma that if everyone gets his deserts, some may be driven from the table; and if everyone comes to the table, some may not get their deserts. The trade-off between equity and efficiency is the central tension in theories of distributive justice (Hsu et al., 2008). If both equity and efficiency are valued, and neither takes absolute priority over the other, then, in places where they conflict, compromises ought to be struck (Okun, 1975). In such cases, some equity will be sacrificed for the sake of efficiency, and some efficiency for the sake of equity. When people fail to make good decisions under such conflict, is there any way to offer assists that are most likely to help and least likely to inflict harm?

A nudge is any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives (Thaler & Sunstein, 2003). In fact, individuals always make pretty bad decisions which can be attributed to their limited attention and cognitive ability, incomplete self-control, and the possession of incomplete information. Because of this, Thaler and Sunstein (2008) argued for self-conscious efforts by institutions in the private sector and also by government to steer people's choices in directions that will improve their lives. At the same time, the nudge has not lost its libertarian aspect, which is reflected in the fact that people are free to make choices, and all the choices are not blocked, fenced off, or significantly burdened.

One prominent nudge is to make an endorsed option the default choice. Policy makers or other practitioners make increasing use of defaults because the defaults offer successful and cost-effective ways of triggering behavior change. It has been shown that default options exert an influence in areas as varied as insurance choices, retirement program design, organ donation policy (Choi et al., 2002; Camerer et al., 2003; Madrian & Shea, 2001; Johnson & Goldstein, 2003). For example, the study on the impact of automatic enrollment on 401(k) savings behavior has found that participation is significantly higher under automatic enrollment, and the default contribution rate and default investment allocation chosen by the company for automatic enrollment has a strong influence on the savings behavior of 401(k) participants (Madrian & Shea, 2001). The preference for defaults can also be an effective tool in real-life social behavior. In the case of donation, a small donation as default results in lower donation amounts which is defined as a “scale-back” effect, along with a “lower-bar” effect that more people donating when the small amount is defaulted (Goswami & Urminsky). Similarly, Gartner et al. (2017) find that subjects are more prone to choose the selfish option when it is presented as the default.

1.1 Causes of default effects

Why might default effects occur? Several mechanisms with different ethical and practical implications are thought to drive default (Johnson & Goldstein, 2003; Dinner et al., 2011; Smith et al., 2013). The first is effort: choosing the default options requires no effort whereas changing the defaults does, and people do not want the bother of changing to the non-default options (Samuelson & Zeckhauser, 1988). Although effort plays a role in decisions, default effects are also found when no additional effort is required to switch from the default (Johnson & Goldstein, 2003), so effort does not completely explain default effects. Secondly, defaults may result from cognitive bias: people may view the default as the status quo, and giving it up will be perceived as a loss. Under loss aversion, the impact of a loss is greater than the impact of an equivalent gain achieved by changing to the non-default options (Kahneman & Tversky, 1984). The third is implied endorsement: evidence suggests that defaults are interpreted as being the recommended options, or as being implicitly endorsed (McKenzie et al., 2006). Everett et al. (2015) further propose that participants perceive a default option as being the option that is both recommended and the one that most people choose, and because individuals are motivated to follow social norms, they are subsequently more likely to follow the default option.

1.2 Neural perspective of default effects

Different forms of default bias can be explored by different paradigms. In the gambling paradigm, the study using functional magnetic resonance imaging (fMRI) identifies the neural mechanisms contributing to the default inertia, including an anticipatory somatic signal in the insula as a potential mechanism for loss aversion and a ventral striatal mechanism associated with default selection encompassing the same area as seen in winning, implying that selecting the default might be rewarding in itself (Yu et al., 2010). In the go/no-go paradigm to reject or accept the defaults, participants tend to favor the defaults when making difficult, but not easy, decisions, even if more errors will be made when accepting defaults. And specific prefrontal-basal ganglia dynamics are involved in rejecting the default, a mechanism that may be important in a range of difficult choice scenarios (Fleming et al., 2010).

While previous behavioral researches have demonstrated that default effects can be explained, at least in part, through an attempt to follow social norms, little is known about the neural process involved in the evaluation of defaults especially when the default options follow or violate social norms. Event-related potentials (ERPs), one of the most informative and dynamic methods of monitoring brain activity, are used here to explore the evaluation process of default options and equitable choices in a distribution task. In contrast to an ERP's conventional feature which exploits the ERP's information in one or more domains sequentially, the multi-domain feature of the ERP extracted by tensor decomposition can reveal the properties of the ERP in the time, frequency, and spatial domains simultaneously (Cong et al., 2012). Firstly, the major advantage of multi-domain feature of an ERP is that it reveals the strength of brain activity in terms of temporal, frequency, and spatial domain properties simultaneously, and therefore it is less affected by the heterogeneousness of datasets (Cong et al., 2012; Cong et al., 2015). Secondly, important effects might be lost through the inadvertent selection of the "wrong" time windows and/or electrodes in the time-domain analysis or time-frequency analysis, however, the statistical results of multi-domain feature are not affected by the chosen time window and electrodes. In addition, the tensor-based result was more discriminative than those derived from time-frequency analysis (Zhang et al., 2020a).

1.3 Hypothesis development

The preference for defaults has been increasingly used to promote "good" causes by influencing socially relevant decisions in desirable ways (Ghesla et al., 2019). For instance, a strong impact of default was found in the domain of charitable giving in a field experiment (Altmann et al., 2014) and in promoting altruistic behavior and pro-social behavior in laboratory experiments (Everett et al., 2015; Ghesla et al., 2019). Such default effects appear to have strong impacts on people's decision-making. It remains unknown, however, how the defaults modulate the trade-off between equity and efficiency, as well as the neural process involved in the evaluation of defaults. To address these questions directly, we conducted a binary distribution task to explore whether utilizing a simple psychological phenomenon, the preference for defaults, could constitute such a nudge to increase equitable or efficient behaviors. Subjects had to choose which side could get the donations, the side of two children or the side of one child. In each trial, one side was indicated by a pre-selected box, which was referred to as the default option. Our treatments varied whether the side of one child got more donations than the group of two children, whether the two children got equal distribution, and which side was set to the default option. We assumed that subjects would be more likely to choose the two-child side when the two children got equal distributions than unequal distributions. The advantageous efficiency of one-child side would increase its probability of being chosen. And the pre-selected side would be more likely to be chosen. Concretely, the equitable default would increase the equitable choice, and the efficient default would increase the efficiency consideration.

Hypothesis 1. Default effects occur in the distributional contexts. The equitable default would increase the equitable choice, and the efficient default would increase the efficiency consideration.

Further, the ERP results may provide new insights into the evaluation process of default options and the relationship between default and distributive justice. Two components of the ERP which bear special importance to stimulus evaluation, selective attention, response inhibition and conscious discrimination are the N200 negatively and the P300 positively, appearing about 200 ms and 300 ms post-stimulus, respectively (Patel & Azzam, 2005). N200 component is useful for understanding the nature and sequence of cognitive processes, covers strategic monitoring and control of motor response (Folstein & Petten, 2008). The inhibition of a prepotent response elicits larger N200s, which is critical to performance (Swainson et al., 2003; Correll et al., 2006). In addition, the P300, perhaps the most-studied ERP component, has also been observed in tasks involving decision making or outcome evaluation (Yeung & Sanfey, 2004; Yeung et al., 2005; Wu & Zhou, 2009). According to previous researches, the P300 is related to processes of attentional allocation and/or high-level motivational/affective evaluation, with more positive outcomes eliciting larger P300s (Nieuwenhuis et al., 2005; Yeung et al., 2005; Wu & Zhou, 2009; Wang et al., 2017). We hypothesized that larger N200s would be elicited by the default options that violating distributive justice, while the default options that fitting distributive justice would elicit larger P300s.

Hypothesis 2. Larger N200s would be elicited by the default options that violating distributive justice, while the default options that fitting distributive justice would elicit larger P300s.

2. Materials and methods

2.1 Subjects

Thirty-eight healthy Chinese volunteers (16 males, 22 females) were recruited from the university. The mean age was 20.7 years (SD = 1.9, range 18-24 years). All subjects were right-handed according to self-report, had normal or corrected normal vision with no history of psychiatric or neurological disorders, and were naïve to the study's intent. Each subject signed written informed consent forms prior to participation and received a payment of 60 Chinese yuan (CNY, roughly equal to US $8.6) for participation. All methods were carried out in accordance with the approved protocol.

2.2 Stimuli and task

The participants performed a binary donation distributive task. In each trial, participants decided which side could acquire the meals: the group of two children or a single child, with the positions of the two options counterbalanced on the left and right sides of the screen. Moreover, the total meals of two children were always less than or equal to those of one child. We used efficiency difference (ΔM) to represent the quantitative differences in meals between two sides. $\Delta M = 3$ denoted that the one-child side got three more meals than the two-child side, for example, each in the two-child side got 5 meals (10 totally), and one child on the other side got 13 meals. In this scenario, participants had to decide whether to allocate fewer meals to two children or more meals to just one child, which involved a dilemma between equity and efficiency. $\Delta M = 0$ denoted that two sides got equal meals, for example, each in the two-child side got 5 meals, and one child on the other side got 10 meals. There was no efficiency difference in this situation, and participants only needed to decide whether to allocate the certain amount of meals to two-child side or to one-child side. And the meals of each child in the two-child group might be divided equally or unequally. Unequally divided meant that one of the two children got about 70% of the total donations, for example, each one in the two-child side got 3 meals and 7 meals, respectively. The default option might be the group of two children or a single child, which meant that the default option might be an equitable option or an inequitable option. And the default options were counterbalanced on the left and right sides of the screen. The experiment had a 2×2×2 within-participant factorial design (Figure 1A). The first factor referred to the equality within the two-child side (equal vs. unequal). The second factor referred to the efficiency difference between two options ($\Delta M = 0$ vs. $\Delta M = 3$). The third factor referred to the default option (two-child side vs. one-child side as the default option). In other words, the absolute difference in meals between the two sides (ΔM) could be 0 or 3 meals, which denoted the difference in the allocation efficiency.

2.3 Procedure

The Electroencephalography (EEG) recording was performed in a small, sound-attenuated, and electrically shielded room. After the EEG electrodes were attached, the participants sat in a comfortable chair approximately 100 cm from the computer screen. Before the task began, participants were required to read a brief introduction of a Children Welfare Centre in China, followed by an instruction on how to make their decisions. They were informed that a charity planned to provide extra nutritious meals to children in this Children Welfare, and the quantity of meals for each child would be donated according to their decisions. Participants were highly emphasized that their choices would have a real impact on the gains of each child in the Children Welfare. Figure 1B showed the timeline of a single trial. Each trial began with a presentation of a single centrally located black fixation cross for 500 ms. Then the distribution screen followed, which showed children's photographs, two children on one side and one child on the other side and the amounts of meals for each child were below their photographs. Participants were required to make their decision by clicking the computer mouse ('left' or 'right') in 5000 ms or waiting for 5000 ms to let the default option be automatically chosen. The feedback screen with the amount of donated meals for each child would subsequently last for 1500 ms. Participants were instructed to minimize eye movements to avoid excessive artifacts while performing the task.

The entire experiment was comprised of 400 test trials and two practice trials. Only the test trials were used for EEG analysis. Due to the single occurrence of each child’s face, aggregately 1200

Chinese children's faces were used in test trials. In each trial, the presentation of three same-sex faces was matched for similar age, appearance, emotion, expression intensity, and lighting condition, to ensure that there were no confounds. The display of the stimuli and acquisition of behavioral data were conducted by E-prime software (Version 2.0, Psychology Software Tools, Inc.).

---Insert Figure 1 Here---

2.4 Inequity Aversion Model Estimation

To quantitatively characterize subjects' choice behavior, we used the inequity aversion model introduced by Hsu et al. (2008). In this model, subjects weighed between equity and efficiency linearly. Efficiency was measured by the total number of meals in the allocation. The Gini coefficient was used to measure equity, which calculated as the normalized mean differences between every possible pair of outcomes in the distribution. The Gini coefficient was defined as

$$\mathrm{G} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}|x_i - x_j|}{2n\sum_{i=1}^{n}x_i}, \qquad (1)$$

where n was the number of realizations. The utility function for subject i was

$$u_i(\mathrm{X}) = \sum_{x\in\mathrm{X}} x - \alpha_i \cdot G(\mathrm{X}), \qquad (2)$$

where X was a vector of allocations for the children, and the parameter α captured the weighting placed upon inequity. For example, under the scenario that each in the two-child side got 5 meals and the one-child side got 13 meals the vectors of allocations were denoted by X_1 = (5, 5, 0) and X_2 = (0, 0, 13). The number of realizations n of both X_1 and X_2 was 3. Then the utility function of subject i for allocation X_1 would be $u_i(X_1) = 10 – 0.33\alpha_i$, and for allocation X_2 would be $u_i(X_2) = 13 – 0.67\alpha_i$. The probability of the subject choosing an allocation was given by the logit or softmax formula,

$$\mathrm{P}(\mathrm{X}_1, \mathrm{X}_2; \alpha, \lambda) = \left\{1 + \exp\left(-\lambda\left(u(\mathrm{X}_1;\alpha) - u(\mathrm{X}_2;\alpha)\right)\right)\right\}^{-1}. \qquad (3)$$

The parameter λ was the sensitivity of choice probability to the utility difference or the amount of randomness in the subject's choices. Because of a lack of data to accurately estimate λ individually, we set the parameter λ constrained to unity (the standard logit case). The boundary of the estimable parameter space was set to [0, 30] due to our experimental settings. Denoted the choice of the subject in trial i by y_i, where $y_i = 1$ if subject chose the allocation X_1, and 0 otherwise. We performed maximum likelihood estimation at the individual level, with the log-likelihood function

$$\sum_{i=1}^{N} y_i \log\big(P(X_1, X_2; \alpha, \lambda)\big) + (1 - y_i)\log(1 - \big(P(X_1, X_2; \alpha, \lambda)\big). \quad (4)$$

The Nelder-Mead simplex algorithm was used to find the maximum. Ten random starting positions were used and the iteration with the highest likelihood value was chosen. The behavioral data from the distribution task was used to estimate the value of α_i which captured the degree of inequity aversion. Individuals with higher α were considered more inequity averse.

2.5 Electroencephalography Acquisition and Data Analysis

The EEG signals were recorded using a 64-channel amplifier ANT Neuro EEGO mounted in a cap using 10/20 montage. The GND electrode served as the ground electrode and CPz served as the on-line reference. Electrode impedances were kept below 10 kΩ with a sampling rate at 500 Hz for off-line analysis.

Preprocessing of EEG data was performed with the EEGLAB 14.1.1 tool (Delorme and Makeig, 2004), implemented in MATLAB 2016a. In addition, a 50 Hz notch infinite impulse response (IIR) filter and a 0.1/30 Hz high-/low-pass IIR filter were applied respectively after the reference of EEG signals were reset to the average of the bilateral mastoids (average signals of M1 and M2). Independent component analysis (ICA) (Makeig et al., 1996) was performed to remove eye movement and blink artifacts, and the related ICA components were manually selected. Epochs were segmented from -200 to 1,000 ms around the presentation of distribution screen. Ocular and other artifacts were rejected if their amplitudes exceeded ±100 μV. This resulted in a rejection of 2.93% of the trials. In order to form a fourth-order tensor including time, frequency, channels/space, and subjects-stimuli/conditions, cleaned ERP data was converted into the time-frequency domain using complex Morlet Continuous Wavelet Transform (CMCWT) in a 1-30 Hz frequency window (Zhang et al., 2020b). Center frequency (f_c) and bandwidth (f_b) were both optimally set to 1 to define the mother wavelet (Zhang et al. 2017; 2020a). The elements of the high-order tensor were nonnegative. Nonnegative Canonical Polyadic decomposition (NCPD; Hitchcock, 1927; Cong et al., 2015) was then applied to extract R components from the high-order tensor which revealed the properties of the *rth* multi-domain feature. R, the number of extracted components for each mode, could be determined by the difference of fit (DIFFIT, Cong et al., 2015), and here we used R = 60. The component was selected when its temporal, spectral, and spatial components were consistent with these characteristics of the components of interest, and then its multi-domain feature mode was applied to statistical analysis (Zhang et al., 2020a).

Three-way repeated measures ANOVA (rmANOVA) was conducted both for behavioral data and feature mode, with equality in the two-child side (equality: equal vs. unequal), efficiency difference between two sides (efficiency: $\Delta M = 0$ vs. $\Delta M = 3$) and the default option (default: two-child side vs. one-child side) as within-subject factors. For all analyses, the values of *p* were corrected using the Greenhouse-Geisser correction when the sphericity assumption was violated. The level of significance was set at $p = 0.05$. The significant interaction was further analyzed using post-hoc tests. Partial eta-squared was reported to demonstrate the effect size of the statistical results. Statistical analyses were performed using IBM SPSS statistics 22 software.

3. Results

3.1 Behavioral Data

Assignment to the side of two children was considered a relatively equitable choice. Figure 2A showed the behavioral results of the percentage of making relatively equitable choices both actively (by clicking the mouse) and passively (by letting the timer run down). The three-way rmANOVA on the percentage of making relatively equitable choice was used to explore the default effects in distributive behavior in more detail. Hypothesis 1 stated that default effects occur in the distributional contexts, and the relatively equitable default would increase the equitable choice, while the efficient default would increase the efficiency consideration. A significant main effect of default was found ($F(1,37) = 10.369$, $p = 0.003$, $\eta_p^2 = 0.219$), with the percentage of making relatively equitable choice for two-child side as the default type (69.1%, SE = 2.9%) being larger than percentage for one-child side as the default option (62.2%, SE = 3.5%). The main effect of efficiency was also significant ($F(1,37) = 20.113$, $p < 0.001$, $\eta_p^2 = 0.352$). Under non-efficiency-difference condition ($\Delta M = 0$), the mean percentage of making relatively equitable choice was 77.5% (SE = 2.7%), which was significantly larger than that under efficiency difference condition ($\Delta M = 3$) (53.7%, SE = 5.0%). Besides, the significant main effect of equality was also found ($F(1,37) = 14.980$, $p < 0.001$, $\eta_p^2 = 0.288$). The mean proportion of choosing the side of two children with equal meals (74.1%, SE = 3.0%) was significantly larger than that when the two children got uneven distribution (57.1%, SE = 4.3%). However, all the interactions were not significant (all $p > 0.1$). The percentage of making relatively equitable choice actively was also analyzed using rmANOVA, which showed similar results of the main effects for efficiency ($F(1,37) = 19.973$, $p < 0.001$, $\eta_p^2 = 0.351$), equality ($F(1,37) = 14.966$, $p < 0.001$, $\eta_p^2 = 0.288$) and default ($F(1,37) = 8.627$, $p = 0.006$, $\eta_p^2 = 0.189$).

Besides, in order to see whether inactions varied across allocation trade-offs with different properties, we calculated the passively selected part (by letting the timer run down). In total, participants failed to make an active choice in 0.60% of all choice occasions (91 out of 15,200 choices). The three-way rmANOVA on the percentage of making inactive choice revealed a significant interaction between equality and efficiency ($F(1,37) =4.439$, $p = 0.042$, $\eta_p^2 = 0.107$). For $\Delta M = 3$, the percentage of making inactive choice under the condition of two children got equal meals was slightly larger than under the condition of two children got unequal meals (0.7% vs. 0.5%, $p = 0.071$). No other significant main effects or interactions were found.

For the purpose of response time analyses, we excluded trials when subjects failed to make active choices. Figure 2B showed the results of the mean response time. The three-way rmANOVA on response time revealed a significant main effect on equality ($F(1,37) =17.112$, $p < 0.001$, $\eta_p^2 = 0.316$), with the mean response time for each in two-child side getting equal distribution (1,346.2 ms, SE = 103.1) significantly shorter than getting uneven distribution (1,486.435 ms, SE = 118.105). Besides, the interaction between equality and efficiency was significant ($F(1,37) =8.247$, $p = 0.007$, $\eta_p^2 = 0.182$). The mean response time for equal distribution in two-child side was significantly shorter than unequal distribution under both conditions of $\Delta M = 0$ and $\Delta M = 3$ (1,304.7 vs. 1495.1 ms; 1,387.7 vs. 1477.7 ms; both $p < 0.01$). When each in two-child side getting equal distribution, the response time of $\Delta M = 3$ was slightly longer than $\Delta M = 0$ (1,387.7 vs. 1,304.7 ms, $p = 0.052$). Besides, the interaction between efficiency and default was also found to be significant ($F(1,37) =4.897$, $p = 0.033$, $\eta_p^2 = 0.117$). Post-hoc test revealed that for $\Delta M = 0$, the mean response time of two-child group as default option was slightly shorter than one-child side as default option (1,367.9 vs. 1,432.0 ms, p = 0.063). No other significant main effects or interactions were found.

---Insert Figure 2 Here---

3.2 Electrophysiological Data

Hypothesis 2 stated that larger N200s would be elicited by the default options that violating distributive justice, while the default options that fitting distributive justice would elicit larger P300s. The determination of N200 and P300 from the extracted multi-domain features was based on the following criteria. Regarding the multi-domain features of N200, firstly, the desired one for N200 may look like the waveform with a sole peak, typically evoked 180 to 325 ms following the presentation of a specific visual stimulus. And the desired waveform for P300 may appear approximately 300 to 400 ms following stimulus presentation (Patel & Azzam, 2005). Secondly, the desired spatial component should reveal the difference topography in fronto-central region for the N200 or in parietal region for the P300. Last, the desired spectral structure of an ERP may possess its largest energy between 1 and 8 Hz (Karakas et al., 2000).

The 7th component was chosen (Figure 3) due to its temporal, spectral and spatial properties consistent with N200. The three-way rmANOVA revealed a significant interaction between equality and efficiency (F(1,37) = 4.656, p = 0.038, η_p^2 = 0.112). The post-hoc test revealed that for ΔM = 3, the magnitude of multi-domain feature was larger for unequal distribution than equal distribution in the two-child side (p = 0.018). And for unequal distribution in two-child side, ΔM = 3 was larger than ΔM = 0 (p = 0.035). A significant interaction between equality, efficiency and default (F(1,37) = 5.995, p = 0.019, η_p^2 = 0.139) was also found. Post-hoc test revealed that for the two-child side with fewer donations as default option, the magnitude of feature was larger for equal distribution than unequal distribution (p = 0.012). And for two children getting unequal distribution as default option, the magnitude of feature for ΔM = 3 was larger than ΔM = 0 (p = 0.014). For unequal distribution in two children with fewer donations than one-child side, the magnitude of feature was larger for the two-child side as default than the one-child side as default (p = 0.015). No other significant main effects or interactions were found.

--Insert Figure 3 Here--

Likewise, the 22nd component was selected for the next step, which was consistent with the properties of P300, see Figure 4. The three-way rmANOVA revealed a significant main effect for default ($F(1,37) = 7.208$, $p = 0.011$, $\eta_p^2 = 0.163$). The magnitude of the multi-domain feature was larger for the two-child side as default than the one-child side as default. No other significant main effects or interactions were found.

--Insert Figure 4 Here--

3.3 Relationships between behavior and Electrophysiological Data

Behaviorally, the group inequity-aversion parameter estimate was $\alpha = 12.13 \pm 1.28$. Individual inequity-aversion estimates showed substantial variation, which further allowed us to use the estimated individual inequity-aversion attitude as a between-participant measure in the electrophysiological data. This analysis revealed a reliable correlation (two-sided Spearman rank correlation test, $\rho = 0.526$, $p = 0.001$) between inequity-aversion parameter estimates and the difference magnitude of the 22nd multi-domain feature between two default settings (Figure 5A). That is, individuals with greater differences in neural response between two default settings would in favor of one that was more equitable.

In addition, we assessed how the inequity aversion parameter reflected in behavior on the default options. The correlation between inequity aversion and the percentage of choosing default options (Figure 5B) revealed that subjects with higher inequity aversion were more likely to choose the two-child side when the two-child side was as the default ($\rho = 0.862$, $p < 0.000$) and were less likely to choose the one-child side when the one-child side was as the default ($\rho = -0.906$, $p < 0.000$).

--Insert Figure 5 Here--

4. Discussion

How can the preference for defaults in choices be used as a nudge to achieve equity or efficiency? In this study, we examined the default effects in distributive decisions and investigated the neural dynamics underlying the evaluation process of default using the ERP technique. Through behavioral analysis, we found that participants were reluctant to switch from a default option, which could constitute a nudge in the distributional context. We further confirmed this via the tensor decomposition results that the distributive justice involving equity and efficiency made significant contributions to the evaluation process of defaults, which reflected in the multi-domain features of N200 and P300. Besides, the between-subject measure indicated that individuals with greater differences in neural response between equitable defaults and inequitable defaults would in favor of more equitable choices. These findings may have important implications for understanding the default effects in distributive decisions.

Concerning the behavioral data, which side could get the donation was determined by three factors in our design, the default side, the equality within the two-child side, and the efficiency differences. The result that the default options were chosen more often was consistent with the previous finding (Jachimowicz et al., 2019). The percentage of choosing the two-child side was 69.1% when it was the default option; whereas it dropped to 62.2% when the other side (one-child side) was the default option. Besides, the distributive justice involving equality within the two-child side and the efficiency differences between two competitive sides also had significant effects on distributive results. Previous research had also found that although subjects exhibited equity preferences, efficiency concerns were also important in distributional experiments (Engelmann & Strobel, 2004). The mean percentage of the two-child side being chosen was 74.1% when the two children got equal distributions, while it dropped to 57.1% when the two children got unequal distributions. The one-child side with more donations significantly decreased the mean percentage of relatively equitable choices to 53.7%, compared to the condition of no efficiency differences between two sides.

In most cases, subjects had a clear conception of their ideal choice. However, under the condition that the one-child side got more meals, subjects tended to make more inactive choices when the distribution was equal than unequal in the two-child side. Prior research demonstrated if the advantages of both sides seemed to be equivalent and people found themselves in a dilemma, the status quo would typically dominate (Lu & Xie, 2014). Subjects faced the sharp conflict between equity and efficiency: one choice which could help two children was more equitable, and the other choice which the one child could get more donation amount was more efficient. It is hard for subjects to make decisions under such conflict, and thus they were more willing to implement the default allocations passively.

Complexity is an important factor affecting response time, along with strength-of-preference, stake size, and trial number (Moffatt, 2005; Krajbich et al., 2015). The situation of each in the two-child side getting unequal distribution might be harder than each getting equal distribution. Besides, under the condition of equal distribution in the two-child side, the efficiency difference between the two sides increased the difficulty of choice because participants might face the dilemma between equity and efficiency. In addition, when two sides had no efficiency difference, the equitable choices as default options would be more consistent with participant's preference than the inequitable choices as defaults because there wasn't a conflict between default and equity, and thus the decision might be easier to make.

The multi-domain features extracted by NCPD from the fourth-order tensor could reveal the properties of the ERP in the time, frequency, and spatial domains simultaneously, which denoted the strength of brain activity (Cong et al., 2014; Cong et al., 2015). The 7th component was selected for further analysis, whose properties in the temporal, spectral, and spatial were consistent with those of N200. In this study, the desired multi-domain features of N200 revealed the interaction effect between equality, efficiency, and default. Greater brain activity was found for more violent conflict between default option and social preference. Previous studies showed that N200 amplitude was associated with response inhibition during tasks that elicited conflict, with increased amplitude reflecting greater conflict monitoring (Torbeyns et al., 2016; Yeung et al., 2004), including canceling a prepared response (Folstein et al., 2008). Although subjects were generally fond of helping two children because of equity preference, they increased the proportion of choosing the one-child side when facing the unequal distribution inside two-child and advantageous efficiency for the one-child side. The equitable default option, setting to two-child side, clashed with their preference for efficient option. Therefore, the conflict elicited higher brain activity, compared with changing one of the three factors in our experimental design, equal distribution in the two-child side, no efficiency difference, or one-child side as default.

The 22nd component was also selected, whose properties in the temporal, spectral, and spatial were consistent with those of P300. The P300, one of the most frequently studied components of ERPs, was typically regarded as a measure to investigate various cognitive processes, processing capacity, and mental workload (Polich, 2007). Stimulus meaning was one of the three categories or dimensions that influenced P300 amplitude (Johnson, 1986). In this study, our results found that the magnitude of the multi-feature of P300 for the two-child side as the default option was significantly larger than the one-child side as the default option. The present result was compatible with the previous findings that the P300 reflected the processes of attention allocation and the motivational/emotional salience of outcomes, for instance, the P300 was stronger in response to equal than unequal offers (Wu et al., 2012). The prior fMRI study demonstrated that high emotional system activity was associated with passing over the inequitable allocation and choosing the equitable allocation (Hsu et al., 2008). The equitable default option, setting to the two-child side, might represent that the default option was in accordance with the desirable equitable choice, which was regarded as a more positive outcome that elicited larger brain activity than the inequitable default option.

Besides, the motivational/affective significance difference between equitable default options and inequitable default options was consistent with their individual equity preference. Individuals with larger neural response differences to two default settings appeared to be more inequity aversion. Inequity aversion meant that people resisted inequitable outcomes; sometimes, they were willing to give up some payoffs to move in the direction of more equitable outcomes (Fehr & Schmidt, 1999). Behaviorally they were more likely to accept the equitable default allocation and reject the inequitable but maybe efficient default allocation. Therefore, the motivational significance difference measured by the multi-feature of P300 offered a valuable neurophysiological predictor of one’s distributive decisions in avoiding inequity.

Moreover, our behavioral and ERP results permit some informed speculations about the possible mechanisms in the distributional context. The explanation broadly in line with our findings was that participants perceived the default option as a recommended action (McKenzie et al., 2006) or a socially normative option (Everett et al., 2015). In the trade-off between equity and efficiency, greater brain activity associated with conflict monitoring was elicited, when the default option could not represent a desirable action. And participants attached more motivational/affective significance to equitable than inequitable default options, which was consistent with inequity aversion. Therefore, participants might follow the default options because they were uncertain about which was better or they did not want to deviate from a social norm that defaults might convey. The default option and distributive justice both contributed significantly to decision-making.

Our work suggested that the default effects made significant contributions to distributive justice involving equity and efficiency. The default option can be an effective tool to achieve a more equitable result by using equitable options as default, or to achieve a more efficient result by using efficient defaults. Besides, distributive justice influenced the neural comparison process of default and alternative options, which was indicated by the multi-domain features of N200s and P300s. And our work may provide behavioral and electrophysiological evidences that the default option was perceived as a recommended action or a socially normative option. Of course, our study was just a first step in the analysis of whether and how behavioral interventions such as choice defaults affected distributions, and the precise mechanisms of default effects and other nudges should be investigated further in future research. In addition, the extent to which the defaults affect equitable or efficient decisions is another important topic to explore. Future research could measure the impact of defaults by influencing default settings, choice frameworks such as opt-in and opt-out and the cost of opting out. More broadly, something more productive to shift from creating nudges to reducing sludge, eliminating the barriers that make otherwise good decisions difficult, should be further considered (Thaler, 2020). Practically, the results suggested that default could constitute a nudge to increase equitable choices or efficiency consideration. However, the processes and institutions that form interventions should be cautious and methodical, replete with redundant checks and balances. In order to improve social welfare, policymakers should make trade-offs between giving everyone a decent share of the pie at the expense of efficiency and increasing the size of the pie at the expense of equity, and choice architecture like defaults can be used when necessary.

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References

Altmann, S., Armin, F., Heidhues, P., & Jayaraman, R. (2014). Defaults and Donations: Evidence from a Field Experiment. *SSRN Electronic Journal*.

Boulding, K. E. (1962). Social justice in social dynamics. In Brandt R. B. (Ed.), Social justice (pp. 73-92). Englewood Cliffs, NJ: Prentice Hall.

Camerer, C., Issacharoff, S., Loewenstein, G., O'donoghue, T., & Rabin, M. (2003). Regulation for conservatives: Behavioral economics and the case for 'asymmetric paternalism'. *University of Pennsylvania Law Review*, 151, 1211–1254.

Choi, J., Laibson, D., Madrian, B. C., & Metrick, A. (2002). Defined contribution pensions: Plan rules, participant decisions, and the path of least resistance. In J. M. Poterba (Ed.), Tax policy and the economy (Vol. 16. pp. 67–114). Cambridge, MA: MIT Press.

Cong, F., Phan, A. H., Zhao, Q., Wu, Q., Ristaniemi, T., & Cichocki, A. (2012). Feature extraction by nonnegative tucker decomposition from EEG data including testing and training observations. In: International conference on neural information processing. Springer, pp 166–173.

Cong, F., Zhou, G., Astikainen, P., Zhao, Q., Wu, Q., Nandi, A.K., Hietanen, J. K., Ristaniemi, T., & Cichocki, A. (2014). Low-rank approximation based non-negative multi-way array decomposition on event-related potentials. *International Journal of Neural Systems*, 24(08):1440005.

Cong, F., Lin, Q. H, Kuang, L. D, Gong, X.F., Astikainen, P., & Ristaniemi, T. (2015). Tensor decomposition of EEG signals: a brief review. *Journal of Neuroscience Methods*, 248, 59–69

Correll, J., Urland, G. R., & Ito, T. A. (2006). Event-related potentials and the decision to shoot: The role of threat perception and cognitive control. *Journal of Experimental Social Psychology*, 42(1), 120-128.

Delorme, A., & Makeig, S. (2004). EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *Journal of Neuroscience Methods*, 134(1), 9-21.

Dinner, I., Johnson, E. J., Goldstein, D. G., & Liu, K. (2011). Partitioning default effects: why people choose not to choose. *Journal of Experimental Psychology: Applied*, 17(4), 332-341.

Engelmann, D., & Strobel, M. (2004). Inequality Aversion, Efficiency, and Maximin Preferences in Simple Distribution Experiments. *American Economic Review*, 94(4), 857-869.

Everett, J. A. C., Caviola, L., Kahane, G., Savulescu, J., & Faber, N. S. (2015). Doing good by doing nothing? The role of social norms in explaining default effects in altruistic contexts. *European Journal of Social Psychology*, 45.

Fehr, E. & Schmidt, K. (1999). A Theory of Fairness, Competition and Cooperation. *Quarterly Journal of Economics*, 114, 817–868.

Fleming, S. M., Thomas, C. L., & Dolan, R. J. (2010). Overcoming status quo bias in the human brain. *Proceedings of the National Academy of Sciences of the United States of America*, 107(13), 6005-6009.

Folstein, J. R., & Van Petten, C. (2008). Influence of cognitive control and mismatch on the N2 component of the ERP: a review. *Psychophysiology*, 45(1), 152-170.

Gartner, M., & Sandberg, A. (2017). Is there an omission effect in prosocial behavior? A laboratory experiment on passive vs. active generosity. *PLoS One*, 12(3), e0172496.

Ghesla, C., Grieder, M., & Schmitz, J. (2019). Nudge for Good? Choice Defaults and Spillover Effects. *Frontiers of Psychology*, 10, 178.

Goswami, I., & Urminsky, O. (2016). When should the Ask be a Nudge? The Effect of Default Amounts on Charitable Donations. *Journal of Marketing Research*, 53(5), 829-846.

Hitchcock, FL. (1927). The expression of a tensor or a polyadic as a sum of products. *Journal of Mathematical Physics*. 6(1), 164–189.

Hsu, M., Anen, C., & Quartz, S. R. (2008). The right and the good: distributive justice and neural encoding of equity and efficiency. *Science*, 320(5879), 1092-1095.

Jachimowicz, J. M., Duncan, S., Weber, E. U., & Johnson, E. J. (2019). When and why defaults influence decisions: a meta-analysis of default effects. *Behavioural Public Policy*, 3(02), 159-186.

Johnson, R. J. (1986). A Triarchic Model of P300 Ampliude. *Psychophysiology*, 23(4), 367-384.

Johnson, E. J., & Goldstein, D. (2003). Medicine. Do defaults save lives? *Science*, 302(5649), 1338-1339.

Kahneman, D. and Tversky A. (1984), Choices, Values, and Frames. *American Psychologist*, 39 (4), 341-50.

Karakas, S., Erzengin O.U., & Basar, E. (2000). The genesis of human event-related responses explained through the theory of oscillatory neural assemblies. *Neuroscience letters*, 285, 45-48.

Krajbich, I., Hare, T., Bartling, B., Morishima, Y., & Fehr, E. (2015). A Common Mechanism

Underlying Food Choice and Social Decisions. *PLoS Computational Biology*, 11(10), e1004371.

Lu, J., & Xie, X. (2014). To change or not to change: A matter of decision maker's role. *Organizational Behavior and Human Decision Processes*, 124(1), 47-55.

Madrian, B., & Shea, D. (2001). The power of suggestion: inertia in 401(k) participation and saving behavior. *Quarterly journal of economics*, 116 (4), 1149-1187.

Makeig S, Bell AJ, Jung TP, Sejnowski TJ. (1996). Independent component analysis of electroencephalographic data. In: Touretzky D, Mozer M, Hasselmo M, editors. *Advances in Neural Information Processing System*, 8, 145–51.

McKenzie, C. R. M., Liersch, M. J., & Finkelstein, S. R. (2006). Recommendations implicit in policy defaults. *Psychological Science*, 17, 414–420.

Moffatt, P. G. (2005). Stochastic Choice and the Allocation of Cognitive Effort. *Experimental Economics*, 8(4), 369-388.

Nieuwenhuis, S., Aston-Jones, G., & Cohen, J. D. (2005). Decision making, the P3, and the locus coeruleus-norepinephrine system. *Psychological Bulletin*, 131(4), 510-532.

Okun, A. M. (1975). Equality and efficiency: The big tradeoff. The Brooking Institution, Washington, D.C.

Patel, S. H., & Azzam, P. N. (2005). Characterization of N200 and P300: selected studies of the Event-Related Potential. *International Journal of Medical Sciences*, 2(4), 147-154.

Polich, J. (2007). Updating P300: an integrative theory of P3a and P3b. *Clinical Neurophysiology*, 118(10), 2128-2148.

Samuelson, W. & Zeckhauser R. (1988). Status Quo Bias in Decision Making. *Journal of Risk and Uncertainty*, 1, 7-59.

Smith, N. C., Goldstein, D. G., & Johnson, E. J. (2013). Choice without Awareness: Ethical and Policy Implications of Defaults. *Journal of Public Policy & Marketing*, 32(2), 159-172.

Swainson, R., Cunnington, R., Jackson, G. M., Rorden, C., Peters, A. M., Morris, P. G., et al. (2003). Cognitive control mechanisms revealed by ERP and fMRI: Evidence from repeated task-switching. *Journal of Cognitive Neuroscience*, 15, 785–799.

Thaler, R. H., & Sunstein C. R. (2003). Libertarian Paternalism, *American Economic Review*, 93, 175-179.

Thaler, R. H., & Sunstein C. R. (2008). Nudge: Improving Decisions about Health, Wealth, and

Happiness. Yale University Press, New Haven.

Thaler, R. (2020). What's next for nudging and choice architecture? *Organizational Behavior and Human Decision Processes*. In Press. doi:10.1016/j.obhdp.2020.04.003

Torbeyns, T., de Geus, B., Bailey, S., De Pauw, K., Decroix, L., Van Cutsem, J., & Meeusen, R. (2016). Cycling on a Bike Desk Positively Influences Cognitive Performance. *PLoS One*, 11, e0165510.

Wang, Y., Kuhlman, D. M., Roberts, K., Yuan, B., Zhang, Z., Zhang, W., & Simons, R. F. (2017). Social value orientation modulates the FRN and P300 in the chicken game. *Biological Psychology*, 127, 89-98.

Wu, Y., & Zhou, X. (2009). The P300 and reward valence, magnitude, and expectancy in outcome evaluation. *Brain Research*, 1286, 114-122.

Wu, Y., Hu, J., van Dijk, E., Leliveld, M. C., & Zhou, X. (2012). Brain activity in fairness consideration during asset distribution: does the initial ownership play a role? *PLoS One*, *7*(6), e39627.

Yeung, N., Sanfey, A.G., (2004). Independent coding of reward magnitude and valence in the human brain. *Journal of Neuroscience*. 24, 6258–6264.

Yeung, N., Holroyd, C.B., Cohen, J.D. (2005). ERP correlates of feedback and reward processing in the presence and absence of response choice. *Cerebral Cortex*, 15, 535–544.

Yu, R., Mobbs, D., Seymour, B., & Calder, A. J. (2010). Insula and striatum mediate the default bias. *Jounal of Neuroscience*, 30(44), 14702-14707.

Zhang G, Tian L, Chen H, Li P, Ristaniemi T, Wang H, Li H, Chen H, Cong F. (2017). Effect of parametric variation of center frequency and bandwidth of morlet wavelet transform on time-frequency analysis of event-related potentials. In: Chinese intelligent systems conference. Springer, pp 693–702.

Zhang, G., Zhang, C., Cao, S., Xia, X., Tan, X., Si, L., & Cong, F. (2020a). Multi-domain Features of the Non-phase-locked Component of Interest Extracted from ERP Data by Tensor Decomposition. *Brain Topography*, 33(1), 37-47.

Zhang G., Ristaniemi T., Cong F. (2020b). Objective Extraction of Evoked Event-related Oscillations from Time-frequency Representation of Event-related Potentials. bioRxiv preprint the version posted May 17, 2020. doi: https://doi.org/10.1101/2020.05.17.100511.

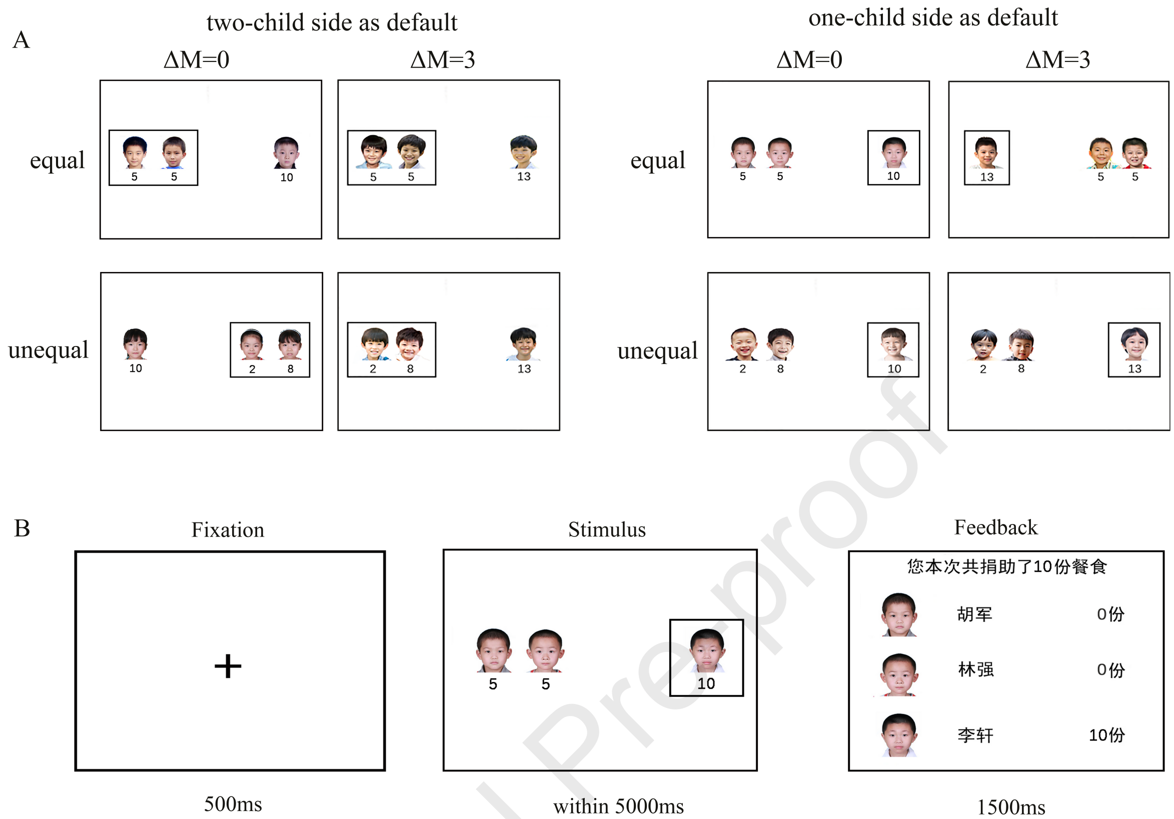
Figure 1. Experimental Paradigm. (A) The experiment had a 2×2×2 within-participant factorial design. The first factor referred to the equality within two-child side (equal vs. unequal). The second factor referred to efficiency difference between two options ($\Delta M = 0$ vs. $\Delta M = 3$). The third factor referred to the default option (two-child side vs. one-child side as default option). (B) Time course of a single trial. Each trial began with a 500 ms fixation point. A distribution screen displaying the stimulus was then shown. Participants were required to make their decision by clicking the computer mouse ('left' or 'right') in 5000 ms or waiting for 5000 ms let the default option be automatically chosen. The feedback screen with the amount of donated meals for each child would subsequently last for 1500 ms. The Chinese characters in the figure represented the results of the donation (您本次共捐助了十份餐食: You've donated 10 meals in this trial) and the names of each child (胡军：Jun Hu; 林强：Qiang Lin; 李轩：Xuan Li).

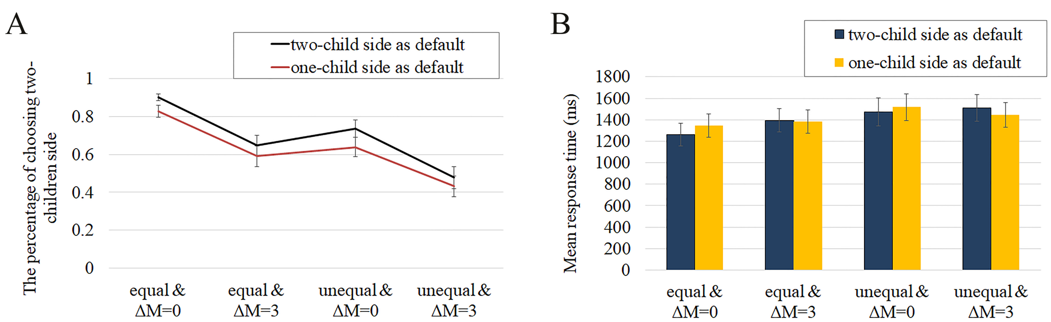
Figure 2. (A) Behavioral result of the percentage of choosing the two-child side. Error bars denoted standard error of the mean. (B) Behavioral result of the mean response time. Error bars denoted standard error of the mean.

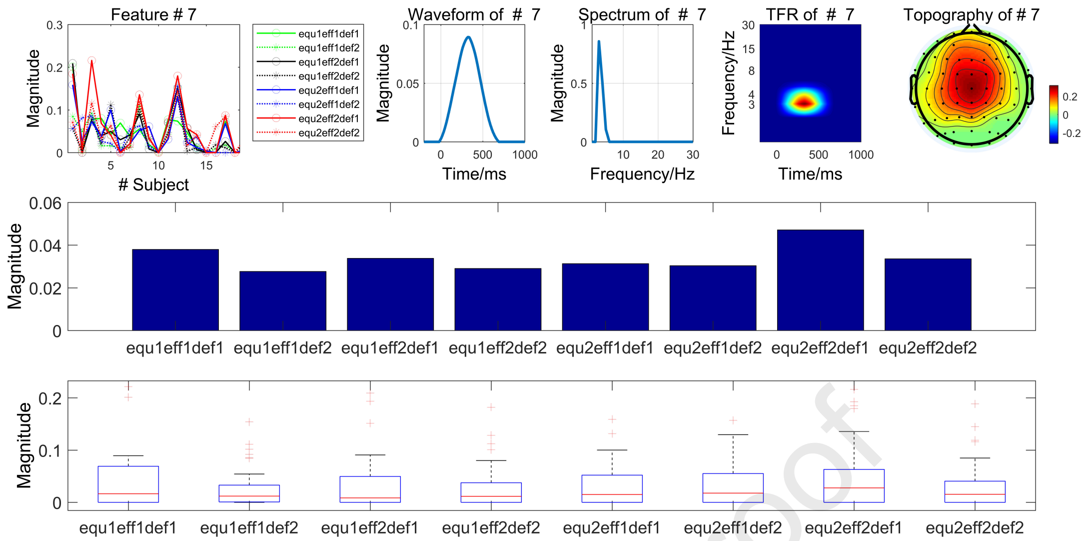
Figure 3. The multi-domain features of N200 component as well as the corresponding temporal, spectral, and spatial components extracted from all brain activity. The mean magnitude of every condition. The scatter plots with boxplots of the mean magnitude of all conditions. (equ1: equal, equ2: unequal; eff1: $\Delta M = 0$, eff2: $\Delta M = 3$; def1: two-child side as default, def2: one-child side as default).

Figure 4. The multi-domain features of P300 component as well as the corresponding temporal, spectral, and spatial components extracted from all brain activity. The mean magnitude of every condition. The scatter plots with boxplots of the mean magnitude of all conditions. (equ1: equal, equ2: unequal; eff1: $\Delta M = 0$, eff2: $\Delta M = 3$; def1: two-child side as default, def2: one-child side as default)

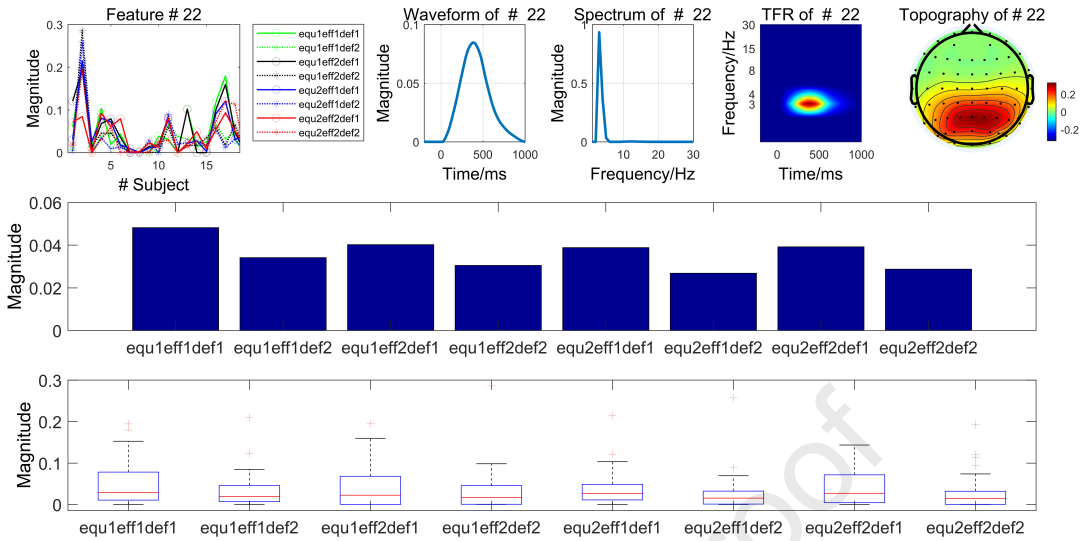
Figure 5. (A) Correlations between the default difference of brain activity (22nd feature) and inequality aversion parameter. (B) Correlations between inequity aversion parameter and behavior.


A
two-child side as default
one-child side as default
ΔM=0
ΔM=3
ΔM=0
ΔM=3
equal
unequal
equal
unequal
B
Fixation
Stimulus
Feedback
+
500ms
within 5000ms
1500ms
您本次共捐助了10份餐食
胡军 0份
林强 0份
李轩 10份

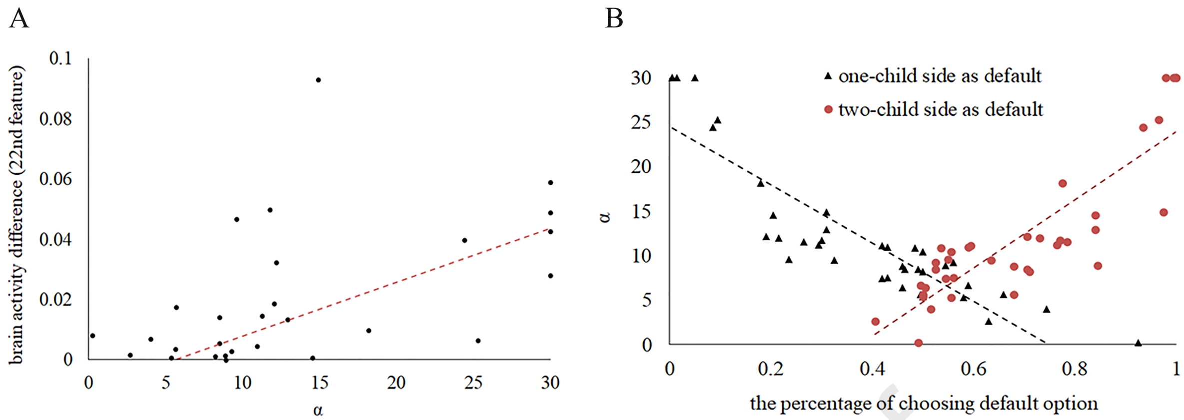

A
two-child side as default
one-child side as default
The percentage of choosing two-children side
1
0.8
0.6
0.4
0.2
0
equal & ΔM=0
equal & ΔM=3
unequal & ΔM=0
unequal & ΔM=3
B
two-child side as default
one-child side as default
Mean response time (ms)
1800
1600
1400
1200
1000
800
600
400
200
0
equal & ΔM=0
equal & ΔM=3
unequal & ΔM=0
unequal & ΔM=3



Feature # 7
Magnitude
Subject
equ1eff1def1
equ1eff1def2
equ1eff2def1
equ1eff2def2
equ2eff1def1
equ2eff1def2
equ2eff2def1
equ2eff2def2
Waveform of # 7
Time/ms
Spectrum of # 7
Frequency/Hz
TFR of # 7
Frequency/Hz
Time/ms
Topography of # 7
Magnitude
equ1eff1def1
equ1eff1def2
equ1eff2def1
equ1eff2def2
equ2eff1def1
equ2eff1def2
equ2eff2def1
equ2eff2def2



Feature # 22
Magnitude
Subject
equ1eff1def1
equ1eff1def2
equ1eff2def1
equ1eff2def2
equ2eff1def1
equ2eff1def2
equ2eff2def1
equ2eff2def2
Waveform of # 22
Time/ms
Spectrum of # 22
Frequency/Hz
TFR of # 22
Frequency/Hz
Time/ms
Topography of # 22
Magnitude
equ1eff1def1 equ1eff1def2 equ1eff2def1 equ1eff2def2 equ2eff1def1 equ2eff1def2 equ2eff2def1 equ2eff2def2
Magnitude
equ1eff1def1 equ1eff1def2 equ1eff2def1 equ1eff2def2 equ2eff1def1 equ2eff1def2 equ2eff2def1 equ2eff2def2


A
brain activity difference (22nd feature)
0.1
0.08
0.06
0.04
0.02
0
0
5
10
15
20
25
30
α
B
one-child side as default
two-child side as default
30
25
20
15
10
5
0
α
0
0.2
0.4
0.6
0.8
1
the percentage of choosing default option

Highlights

Default options can constitute a nudge to achieve more equitable or more efficient results in distributional contexts.

Greater brain activity associated with conflict monitoring was elicited when the default could not represent a socially desirable action.

More motivational/affective significance was attached to equitable default options than inequitable but maybe efficient default options.

Individuals with larger neural response differences between equitable and inequitable defaults appeared to be more inequity aversion in behavior.