Regional homogeneity of intrinsic brain activity correlates with justice sensitivity

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A B S T R A C T

Individuals differ systematically in their vulnerability to injustice. Previous studies have developed the efficient measurement of justice sensitivity from four perspectives (victim, observer, beneficiary, and perpetrator), and examined its effect on interpersonal interactions, but little is known about the neural correlates of justice sensitivity. The present study used regional homogeneity (ReHo) as an index in resting-state fMRI (rs-fMRI) to identify brain regions correlated with individual differences in justice sensitivity. Results showed that victim sensitivity was positively associated with ReHo of the paracentral lobule; observer sensitivity was positively associated with the temporal pole; beneficiary sensitivity was positively associated with bilateral dorsolateral prefrontal cortex (DLPFC) and negatively correlated with the amygdala; and perpetrator sensitivity was negatively associated with bilateral orbital frontal cortex (OFC), and positively correlated with the dorsal striatum. Our results revealed the associations between individual differences in justice sensitivity and intrinsic brain activity, and implicated the underlying differences among the four perspectives.

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1. Introduction

Justice is a central issue in people’s social lives. Previous studies evidence the existence of stable individual differences in reactions to unfair situations (Schmitt, Gollwitzer, Maes, & Arbach, 2005). The concept of justice sensitivity has been introduced as a personality trait that reflects the sensitivity (e.g. cognitive, emotional and behavioral reactions) to experiences of injustice and unfairness (Schmitt, 1996).

Individuals can experience injustice from four different perspectives: from a victim’s perspective in which a person is the victim of an unfair behavior by others (victim sensitivity), from an observer’s perspective in which a person observes unfair behavior by another person without being personally involved (observer sensitivity), from a beneficiary’s perspective in which a person passively takes advantage of the unfair behavior (beneficiary sensitivity), or from a perpetrator’s perspective in which a person actively exploits a victim (perpetrator sensitivity). These sensitivities can be measured reliably with valid self-report scales (Schmitt, Baumert, Gollwitzer, & Maes, 2010). Though reflecting a common concern for justice, the four justice-sensitivity perspectives correlate differently with other personality traits and behavioral outcomes.

Victim sensitivity captures individuals’ differences in how they react towards unfairness at their own expense. Victim sensitivity was significantly correlated with self-related concerns such as machiavellianism, paranoia, suspiciousness, vengeance, jealousy, interpersonal trust (Schmitt et al., 2005), hostile (Schmitt et al., 2010), provocation sensitivity, hostile attribute bias, trait anger, and aggression (Bondù & Krahé, 2015; Bondù & Richter, 2016a, 2016b). Moreover, victim-sensitive individuals are more likely to form expectancies of injustice in ambiguous situations (Maltese, Baumert, Schmitt, & MacLeod, 2016), more sensitive towards mean intentions (Gollwitzer & Rothmund, 2011), less likely to trust others and more likely to behave uncooperatively (Fetchenhauer & Huang, 2004; Maltese et al., 2016), and less forgiveness (Gerlach, Allemand, Agroskin, & Denissen, 2012). They underestimated others’ cooperativeness (Gollwitzer, Rothmund, Alt, & Jekel, 2012), showed more intergroup anger and intergroup angst (Sussenbach & Gollwitzer, 2015), and contributed less to the public good (Gollwitzer, Rothmund, Pfeiffer, & Ensenbach, 2009). In addition, high victim sensitivity groups displayed enhanced memory performance for both unjust and just information (Baumert, Otto, Thomas, Bobocel, & Schmitt, 2012). These results suggest that victim sensitivity was a self-oriented mixture of self-protective motives and moral concerns (Schmitt et al., 2005; Schmitt et al., 2010).

In contrast, observer sensitivity and beneficiary sensitivity correlate more highly with other-related concerns such as role taking, empathy, social responsibility, modesty, agreeableness (Schmitt et al., 2005; Schmitt et al., 2010), and real moral courage (Baumert, Halmurger, &
Schmitt, 2013). Furthermore, observer sensitivity and beneficiary sensitivity correlate positively with cooperative and prosocial behaviors (Lotz, Schlosser, Cain, & Fetchenhauer, 2013). For example, individuals high in observer sensitivity and beneficiary sensitivity offered more money in the dictator game (Edele, Dziobek, & Keller, 2013) and in the solidarity game (Stavrova & Schlosser, 2015), contributed more to the public good (Gollwitzer et al., 2009), and were more likely to follow norms of equality (Fetchenhauer & Huang, 2004). Individuals high in observer sensitivity had better memory for the cheating information (Bell & Buchner, 2010), attended more strongly to unjust stimuli and displayed a memory advantage for unjust information (Baumert, Gollwitzer, Staubach, & Schmitt, 2011). These findings suggest that observer sensitivity and beneficiary sensitivity represent a genuine moral concern for justice for others. Although observer sensitivity and beneficiary sensitivity have more psychological elements in common, each justice sensitivity component has unique links with personality traits. For example, while beneficiary sensitivity is more strongly linked with modesty, observer sensitivity is linked with assertiveness (Schmitt et al., 2010).

Individuals high in perpetrator sensitivity are in particular sensitive to injustice that she/he provides to others (e.g. she/he treats someone else unfairly). Perpetrator sensitivity can be regarded as a protective factor for behavioral problems such as aggressive behavior (Bondü & Krahé, 2015; Bondü & Richter, 2016b). Neural biological research has revealed that individuals high in perpetrator sensitivity demonstrated larger P3 differences between stimuli requiring deceptive responses and irrelevant stimuli (Leue & Beauducel, 2015), suggesting that perpetrator sensitive individuals attended more strongly to ethically-salient information.

Although justice sensitivity has been established as a stable personality trait, and has been shown to be powerful predictors of reactions to perceived injustice, the precise neural correlates of dispositional justice sensitivity remain unclear. Therefore, in this study, we explored the neural correlates underlying individual differences in four justice sensitivity traits. Behavioral studies suggest that the four justice sensitivity traits can be clearly discriminated from each other. We therefore aimed to locate the brain regions that each justice sensitivity trait was associated with.

Several researchers have explored the neural correlates of justice decision making via task-based fMRI. For example, a meta-analysis of 11 fMRI studies using the ultimatum game (UG, a widely studied social decision-making task, which models responses to unfairness) showed that injustice treatments were consistently associated with increased activations in the anterior insula, the anterior cingulate cortex (ACC) and cerebellum (Gabay, Radua, Kempton, & Mehta, 2014). Using fMRI, a recent study examined how dispositional justice sensitivity could modulate the neural response when participants evaluate good and bad everyday situations in the anterior insula, the anterior cingulate cortex (ACC) and cerebellum (Gabay, Radua, Kempton, & Mehta, 2014). These findings suggest that perpetrator sensitive individuals attended more strongly to ethically-salient information.

To directly test the correlations between the four justice sensitivity traits and the brain, we recorded baseline brain activity using resting state fMRI. Regional homogeneity (ReHo) measures the temporal synchronization of the time series of an area’s nearest neighbors (Zang, Jiang, Lu, He, & Tian, 2004). As an index of baseline brain activity, ReHo has been widely used in the resting-state literature. In healthy subjects, ReHo measures have been proven to be an effective tool for investigating the neural basis of individual differences in behavior (Tian, Ren, & Zang, 2012), and personality traits (Xiang, Kong, Wen, Wu, & Mo, 2016). In the present study, we used the ReHo-justice sensitivity correlations to explore how the individual variability in the local connectivity in the baseline brain activity associated with the four justice sensitivity traits. Significant ReHo-justice sensitivity correlations demonstrated that a higher (positive correlation) or lower (negative correlation) regional synchronization of certain areas correlates with higher sensitivity scores. Because of the lack of existing literature, the present study was exploratory, and no specific hypothesis could be made.

2. Method

2.1. Participants

Seventy-four right-handed healthy adults (35 men and 39 women, mean age 22.26 ± 2.55 years) participated. All participants had no history of mental or neurological illness and gave written informed consent for participation in the study. This study was approved by the Imaging Center Institutional Review Board.

2.2. Measures

2.2.1. Trait justice sensitivity

Four justice sensitivity traits were assessed through a Chinese translation of the 40-item, 6-point Justice Sensitivity Inventory developed by Schmitt et al. (2010). Examples of statements include, “It makes me angry when others are undeservingly better off than me” (victim sensitivity), “I am upset when someone is undeservingly worse off than others” (observer sensitivity), “I feel guilty when I am better off than others for no reason” (beneficiary sensitivity), and “I feel guilty when I enrich myself at the cost of others” (perpetrator sensitivity). Each item was scored on a 6-point Likert-type scale, in which 0 = not at all, 5 = Exactly. The Chinese version showed adequate internal consistency reliability (Chronbach’s alpha ranged from 0.85 to 0.90) (Wu et al., 2014), and had acceptable reliability with the present sample (Chronbach’s alpha ranged from 0.805 to 0.872).

2.3. Data acquisition

The rs-fMRI scan was collected on a 3.0 GE Discovery MRI-750 scanner. Rs-fMRI sequences lasted about 6 min (corresponding to 180 brain volumes). The scanning parameters were as follows: TR = 2000 ms; TE = 30 ms; flip angle = 90°; 43 slices; matrix = 64 × 64; FOV = 220 × 220 mm; slice thickness = 3.2 mm; acquisition voxel size = 3.4 × 3.4 × 3.2 mm. A high-resolution T1-weighted anatomical image was also acquired using a magnetization prepared gradient echo sequence (3D MPRAE, 176 sagittal slices; TR = 8100 ms; TE = 3.1 ms; TI = 450; flip angle = 8°; FOV = 250 × 250 mm; slice thickness = 1 mm). During resting state scanning, participants were instructed to just lie quietly in the scanner, keep their eyes closed, and stay awake.

2.4. Image preprocessing

fMRI data were preprocessed by DPARSF (Data Processing Assistant for Resting-State fMRI software; http://www.restfmri.net/forum/DPARSF) using functions of SPM 8 (www.fil.ion.ucl.ac.uk/spm/software/spm8) on the MATLAB platform (The MathWorks, Natick, MA, USA), comprising the following steps: 1) discarding the first 10 volumes to ameliorate the possible effects of scanner instability, 2) slice timing correction, 3) realignment, 4) co-registering the T1-weighted image to the corresponding mean functional image after realignment, 5) segmentation, 6) spatial normalization, 7) detrending, 8) regressing out the variance of nuisance covariates, and 9) filtering (0.01 < f < 0.1 Hz).

2.5. ReHo analysis

ReHo valuates the synchronization within the time series of a given voxel and its nearest neighbors (Zang et al., 2004). ReHo was performed on a voxel-by-voxel basis by calculating the Kendall’s coefficient of the
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