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Belief in a just world is associated with activity in insula and somatosensory cortices as a response to the perception of norm violations

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Previous studies identified a network of brain regions involved in the perception of norm violations, including insula, anterior cingulate cortex (ACC), and right temporoparietal junction area (RTPJ). Activations in these regions are suggested to reflect the perception of norm violations and unfairness. The current study aimed to test this hypothesis by exploring whether a personal disposition to perceive the world as being just is related to neural responses to moral evaluations. The just-world-hypothesis describes a cognitive bias to believe in a just world in which everyone gets what he or she deserves and deserves what he or she gets. Since it has been demonstrated that ACC, RTPJ, and insula are involved in the perception of unfairness, we hypothesized that individual differences in the belief in a just world are reflected by different activations of these brain areas. Participants were confronted with scenarios describing norm-violating or -confirming behavior. FMRI results revealed an activation of dorsal ACC, RTPJ, and insula when perceiving norm violations, but only activity in insula/somatosensory cortex correlated with the belief in a just world. Thus, our results suggest a role for insula/somatosensory cortex for the belief in a just world.

Keywords: Social neuroscience; Fairness; Moral; Just-world-hypothesis; fmri.

The just-world-hypothesis claims that people have a strong need to believe that the world is an orderly, predictable, and just place, in which we all get what we deserve (Lerner, 1980). This belief is important because in order to plan our lives and accomplish our goals we need to assume that our actions have predictable consequences. Hence, it enables people to deal with their social environment as though it was stable and orderly and thus serves important adaptive functions. However, this belief is challenged by reality. Irrespective of if we look at the distribution of money, education, or access to health care—the world is full of injustices and inequalities. How do people cope with this? According to the just-world-hypothesis people are motivated to defend their belief, e.g., by compensating a victim. If injustice cannot be resolved in reality, people may try to restore justice cognitively by reevaluating the situation in line with their belief in a just world, e.g., by blaming the victim in order to justify the status quo (Dalbert & Umlauft, 2009).

In the past decades numerous studies demonstrated how the belief in a just world affects social behavior. For example, many studies examined victim derogation and devaluation linked with the belief in a just world (Furnham, 2003). Previous research examined the just world belief as a disposition and stressed

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individual differences in this attribution bias (Furnham & Procter, 1989). For example, studies have found sociopolitical and religious correlates of the belief in a just world (e.g., protestantic work ethic). Gender does not seem to have any systematic differences (Bègue, 2002; Furnham & Procter, 1989).

Recent advantages in neuroimaging now allow exploring neural correlates for the perception of fairness. Several studies demonstrated an involvement of the insula in response to unfair compared with fair offers during economic games. For example, Sanfey, Rilling, Aronson, Nystrom, and Cohen (2003) related responses to unfair offers in the ultimatum game to the insula (similar to Güroglu, van den Bos, Rombouts, and Crone (2010)). While those studies reported anterior insula activation in relation to responses to unfairness, Hsu, Anen, and Quartz (2008) demonstrated posterior insula engagement when subjects were being asked to choose between distribution of meals for African children that varied in inequality and amount. Posterior and mid-insula activation is also reported by Wright, Symmonds, Fleming, and Dolan (2011), which examined objective and contextual aspects of fairness perception.

Based on these results it has been suggested that insula activation might reflect the detection of social norm violations following unfair proposals. This is supported by the known role of the insula in generating subjective perceptions of negative affective states (Güroğlu, van den Bos, van Dijk, Rombouts, & Crone, 2011). But how does the insula link social norms with its ability to generate subjective perceptions of negative affective states? Corradi-Dell'Acqua, Civai, Rumiati, and Fink (2013) tried to disentangle the different functions of the insula. They used the ultimatum game to separate self- and fairness-related mechanisms in the brain. Results revealed that activation in the left insula was associated with rejections of unfair offers both for themselves and on behalf of another person. Thus, in contrast to the medial prefrontal cortex the insula seems to play a role when perceiving fair behavior for the own person as well as for third parties. This is also supported by Civai, Crescentini, Rustichini, and Rumiati (2012). The authors showed that the violation of social norms such as equal treatment is reflected in insula activation, whereas self-interest is linked to activity in the medial prefrontal cortex. In addition, Krüger, Hoffman, Walter, and Grafman (2013) demonstrated insula activation during aversive interoceptive-emotional processing of perceived norm violations.

Furthermore, Yamada et al. (2012) provided further evidence for a role of the insula in reflecting social norm violations by showing that interindividual differences in the activation of this brain region predict the degree of mitigating criminal sentences.

In addition, numerous studies on witnessing moral or immoral behavior report an activation of the RTPJ. The RTPJ seems to be activated when considering others' intentions. Thus, it has been related to switching attention between different perspectives (Frith & Frith, 2003; Mitchell, 2008; van Overwalle, 2009) and in particular to be a specific brain region for thinking about thoughts (Young, Camprodon, Hauser, Pascual-Leone, & Saxe, 2010). Hence, this brain region is a core brain area for theory-of-mind approaches (Saxe & Kanwisher, 2003).

In addition to insula and RTPJ an involvement of ACC and prefrontal brain areas (medial and dorsolateral prefrontal cortex, MPFC and DLPFC) when responding to unfair offers or allocations has been reported (e.g., Forbes & Grafman, 2010; Güroglu et al., 2010; Güroğlu et al., 2011; Knoch, Pascual-Leone, Meyer, Treyer, & Fehr, 2006). For example, Güroğlu et al. (2011) discussed a network including insula and dorsal ACC (dACC) involved in detecting personal norm violations. The role of ACC in this network has been related to conflict and control in the context of moral judgment (Greene, Sommerville, Nystrom, Darley, & Cohen, 2001).

The current study aimed to investigate whether the personality disposition to believe the world as being just is related to neural responses to unfairness and moral evaluations. To test this we employed an fMRI approach to examine neural correlates for the perception of norm violations. We presented short scenarios to the participants describing norm-violation or norm-following behavior, followed by questions in which the participants were asked to judge the protagonist's behavior. We hypothesized that the belief in a fair world would interact with the neural network elicited by the perception of unfair and immoral behavior. More in detail, we assumed that in particular the insula as a brain region known to reflect social norm violations is linked with the belief in a just world.

MATERIAL AND METHODS

Participants

Seventeen right-handed subjects (eight females) with a mean age of 25 (standard deviation ± 3.54) years participated in the study. The participants gave informed written consent to the study, which adhered to the Declaration of Helsinki and was approved by the local human subjects' committee.

Procedure

Participants were instructed to read 48 short scenarios while lying in the scanner. Half of the scenarios showed a norm-violation behavior, whereas the other half described norm-confirming behavior. Each scenario was followed by a question about the appropriateness of the agent's behavior. For example, participants read the following scenario describing a norm violation: »Maria is very busy. Her boss asked her to build the new homepage, which means a lot of work. Maria is thinking that her colleague Alexander is not that busy. Unfortunately it is well known that Alexander never helps other people. But Maria knows something, that his girlfriend may be interested in. "Hi Alexander, did your girlfriend see the pictures of our last Christmas party? What would she think about those pictures? Well, she doesn't have to know everything, but perhaps you can help me with this work here?"«. For the scenario version of a norm confirmation participants read: »Maria is very busy. Her boss asked her to build the new homepage, which means a lot of work. Maria is thinking that her colleague Alexander is not that busy. Unfortunately it is well known that Alexander never helps other people. However, she still tries to ask him: "Hi Alexander, I am really busy. Our boss asked me to build the new homepage. This is really a lot of work. Could you please help me? Please!"«. Thus, each scenario had two different continuations. The scenarios were taken from a pre-study to ensure that they clearly present either norm-confirming or norm-violation behavior.

After each of the scenarios participants were prompted with the following question: »Do you think Maria's behavior was morally right? Yes = right button. No = left button. «. For the response participants used a custom-made two-button device placed in their right hand. The stimuli were presented on a visual display projected into the scanner. Prior to the beginning of the experiment we made the participants familiar with the task. The order in which the scenarios appeared was randomized.

Each screen describing the scenario lasted for 24 seconds, followed by a screen prompting the question to the participant. The participants could use a time window up to 24 sec to respond to the questions (not self-paced). The inter-trial interval lasted for 12 seconds. The experiment consisted of four runs, each lasting about 12 minutes. The experiment lasted for about 1 hour.

At the end of the fMRI experiment participants were asked to complete a German scale measuring the personal disposition for a belief in a just world. We used the GWAL (Allgemeine Gerechte Welt Skala, Dalbert, Montada, & Schmitt, 1987), which has been widely used in similar studies (Furnham, 1995). The questionnaire consisted of six questions (scale from 1 to 6, where 6 represents strong agreement to the belief in a just world), e.g., "I believe that in general people get what they deserve."

FMRI data acquisition and analysis

The functional imaging was done using a 1.5 T scanner (General Electrics Signa LX, Fairfield, Connecticut, USA) to conduct functional imaging (gradient echo T2-weighted echo-planar images; TR = 2 sec, TE = 35 ms, flip angle = 80 degrees, FOV = 20 mm). Data were acquired in four functional imaging sessions. In each session, 363 volumes were acquired including four "dummy" volumes, which are acquired at the start of each session and subsequently discarded to allow for T1 equilibration effects. Functional volumes consisted of 23 slices. Each volume comprised 5 mm slices (1 mm gap, in-plane voxel size 3.125 × 3.125 mm). Functional slices were acquired interleaved in an ascending order. For anatomical reference a high-resolution T1-weighted structural image was collected (3D-SPGR, TR = 24 ms, TE = 8 ms).

Visual images were back-projected to a screen at the end of the scanner bed close to the subject's feet. Subjects viewed the images through a mirror mounted on the birdcage of the receiving coil. Foam cushions were placed tightly around the side of the subject's head to minimize head motion.

The fMRI data were analyzed using the Statistical Parametric Mapping Software (SPM5, Wellcome Department of Imaging Neuroscience, University College London, London, UK). The images were realigned to correct for head movements using sinc interpolation, co-registered with the individual MRI, and subsequently normalized into a standard anatomical space (MNI, Montreal Neurological Institute template) resulting in isotropic 3 mm voxels. Data were then smoothed with a Gaussian kernel of 6 mm full-width half maximum.

Statistical parametric maps were calculated using multiple regressions with the hemodynamic response function modeled in SPM5. Data analyses were performed at two levels. We examined data on the individual subject level using a fixed effects model. For each subject we calculated the contrast perception of norm violations relative to perception of norm-confirming behavior (block-wise) (*t*-test). The time windows covered the time of the presentation of the scenarios until the question screen appeared. In addition, we modeled the responses of the participants as events. Since we focused on brain responses during the perception of moral and immoral scenarios and had no hypotheses on brain activity associated with subsequent responses we modeled those events as effects of no interest. Then, the resulting parameter estimates for each regressor at each voxel were entered into a second-level analysis with the random effects model. Statistical contrasts (*t* tests) were performed to examine cortical activation associated with the experimental condition (perception of norm violations) relative to the control condition (perception of norm confirmation behavior). Furthermore, we used the individual GWAL scores as a regressor in this second-level analysis in order to reveal brain activations correlating with the individual differences in the belief in a just world.

The resulting images were thresholded at $p < .05$ corrected for multiple comparisons (FWE). Correction was achieved by imposing a threshold for the volume of clusters comprising contiguous voxels that passed a voxel-wise threshold of $p < .005$ (analogue to previous studies, e.g., Wright et al., 2011).

In addition, we report regions of interest that survived a small volume correction (SVC) of $p < .05$ (FWE corrected) for which we had an a priori hypothesis. Thus, an SVC was applied to activations within a sphere of 10 mm radius in the mid/posterior insula based on the study by Yamada et al. (2012, MNI coordinates: −34 −8 12), which reported interindividual differences (in the insula) when rating immoral deeds. In addition, we examined an SVC including the anterior insula based on the study by Corradi-Dell'Acqua et al. (2013, MNI coordinates −34 16 0), since this study showed the involvement for the anterior insula in perceiving unfairness in third-party conditions. Furthermore, we applied an SVC for the ACC (MNI coordinates −3 42 12) and for RTPJ (MNI coordinates 63 −48 33), based on Güroglu et al. (2010). Güroglu et al. (2010) reported involvement of those brain regions when considering context effects during the rejection of unfair offers. Anatomical interpretation of the functional imaging results was performed using the SPM anatomy toolbox (Eickhoff et al., 2005).

RESULTS

Behavioral results

The result scores of the questionnaire to measure the personal disposition for a belief in a just world (GWAL) revealed a mean value of 3.57 (±0.67; scale from 1 to 6, where 6 represents strong agreement to the belief in a just world). There were no significant differences between male and female participants. The GWAL questionnaire showed a good reliability (Cronbach's Alpha = .71).

Participants rated the behavior in nearly all norm-confirming scenarios as morally right and in the norm-violating scenes as morally not right (94%). Furthermore, none of the participants claimed to have any difficulties when performing the task. Thus, we concluded that all participants understood the task properly. Mean reaction time of the responses was 7.18 (±1.06) seconds for moral scenarios and 6.94 (±1.02) seconds for immoral scenarios. Statistical test of the response times revealed no significant differences ($p > .10$). Reaction times were not correlated with GWAL scores ($p > .10$).

FMRI results

FMRI analysis for the contrast immoral relative to moral scenarios revealed activation in RTPJ, left mid/posterior insula (based on ROI analysis), and dACC (based on ROI analysis) (FWE corrected, see Table 1 and Figure 1). There were no other significant activations. Contrasting moral relative to immoral scenarios failed to show significant voxels, even when lowering the threshold to $p < .01$ (uncorrected).

TABLE 1
Results of random effects analysis for immoral scenarios relative to moral scenarios

Contrast	*Brain region*	*Peak MNI location (x, y, z)*	*Peak z-value*	*Number of voxels*
Immoral > moral	L insula	−40 −6 2	3.88	14
	RTPJ	66 −50 28	6.06	65
	L dACC	−8 50 10	3.65	20
Moral > immoral	–	–	–	–

Notes: $p < .05$, FWE corrected, L = left hemisphere, R = right hemisphere.

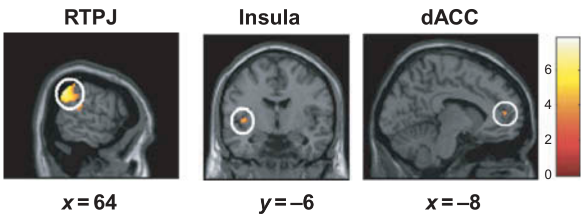

Figure 1. Statistical map showing brain activations (random-effects analysis, $p < .05$, FWE corrected) when participants perceived scenarios describing norm-violating behavior relative to scenarios describing norm-confirming behavior. Areas of significant fMRI signal change are shown as color overlays on the T1-MNI reference brain.

Combination of behavioral and FMRI data

We then correlated individual's differential brain activations for the contrast immoral relative to moral scenarios with individual GWAL scores. Results demonstrated a significant positive correlation of brain responses with the belief in a just world in left mid/posterior insula (peak MNI coordinates: −38 −12 16, $z = 3.99$, $r = 0.56$, $p = .01$). This cluster extended to posterior and included parts of the primary (SI) and secondary somatosensory cortex (SII) (MNI coordinates for maximum in SI: −42 −24 36, $z = 3.35$, $r = 0.41$, $p = .05$) (see Table 2 and Figure 2).

Brain responses in RTPJ correlated with individual GWAL scores, but failed to show significant results after FWE correction (see Table 2 and Figure 2). No other areas revealed significant correlations, even when lowering the threshold to $p < .01$.

BOLD responses in insula or somatosensory cortices were not correlated with reaction times ($p > .10$).

DISCUSSION

The current study aimed to investigate neural correlates of individual differences in believing in a just world when perceiving norm violations. The just world hypothesis claims that people have a strong need to believe that the world is an orderly, predictable, and just place, in which we all get what we deserve. Results demonstrated a network of brain regions associated with the perception of unfair behavior, including dACC, insula, and RTPJ. Only activity in the insula/somatosensory cortex was significantly associated with individual's beliefs in a just world.

Faced with scenarios describing norm-violating behavior, brain responses of our participants demonstrated activation of a network including dACC, insula, and RTPJ. This is in accordance with numerous previous studies on norm-violating behavior or responding to unfair offers. For example, numerous studies suggested a role for ACC in moral judging, fairness-related social decision-making, and empathy (e.g., Güroğlu et al., 2011; Singer, Critchley, & Preuschoff, 2009). Allman, Hakeem, Erwin, Nimchinsky, and Hof (2006) proposed that ACC may function as an interface between emotion and cognition. The dorsal part of the ACC seems to be involved in regulating cognitive control over goal-directed behavior (Sheth et al., 2012). Similarly, activation of the RTPJ brain region is consistently reported when participants are faced with norm-violating behavior and moral evaluations (e.g., Young et al., 2010). Furthermore, a role of the insula when responding to unfair offers or perceiving norm violations has been reported by numerous studies (e.g., Sanfey et al., 2003).

However, none of these brain regions is related to the personal trait of believing in a just world except one: the insula. So why is activity in the insula closely related to interindividual differences in the belief of a just world? It has been suggested that the insula reflects the detection of social norm violations due to its known role in generating subjective perceptions of negative affective states (Güroğlu et al., 2011; Yamada et al., 2012). Hsu et al. (2008) argued that individual differences in the engagement of the insula arise from different sensitivity to inequity norms. Hence, people who receive strong negative affective signals may be more sensitive when fairness norms

TABLE 2
Significant correlations between individual GWAL scores and individual brain activations in the contrast immoral scenarios relative to moral scenarios. Displayed are activations surviving cluster-level correction

Contrast	*Brain region*	*Peak MNI location* (x, y, z)	*Peak z-value*	*Number of voxels*
Immoral > moral	L insula/SII	−38 −12 16	3.99	1026
	L SI	−42 −24 36	3.35	
	(R SI/SII)	52 −6 22	3.61	51
	(RTPJ)	66 −50 28	3.87	27
	(L supplementary motor area (SMA))	−12 −14 62	3.71	19
	(R hippocampus)	28 −24 −26	3.75	24
Moral > immoral	–	–	–	–

Notes: $p < .05$, FWE corrected, threshold of $p < .005$ used to define the clusters, L = left hemisphere, R = right hemisphere; in brackets: uncorrected results.

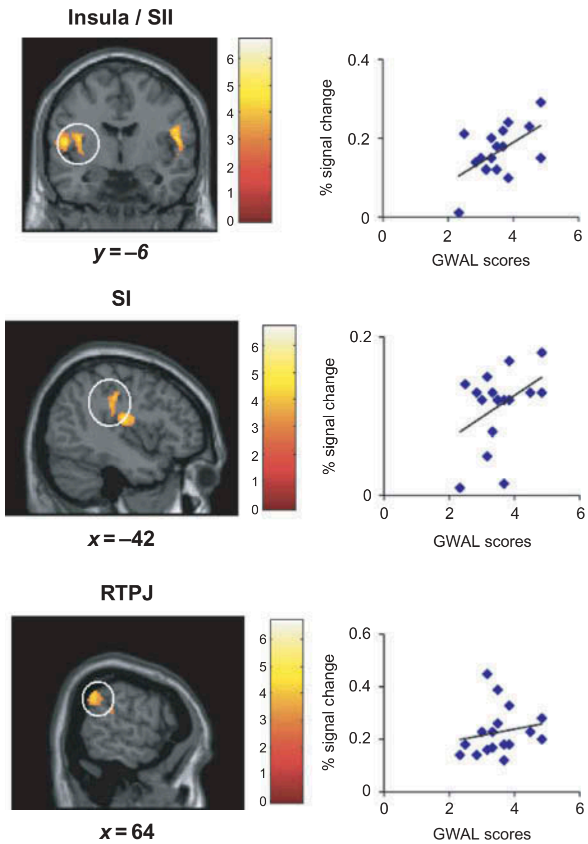

Figure 2. Statistical map showing brain activations for norm-violating relative to norm-confirming behavior with GWAL scores as regressors ($p < .005$). On the right scatterplots of insula/SII (at MNI coordinates −38, −12, 16, $r = 0.56$, $p = .01$), SI (MNI coordinates −42 −24 36, $r = 0.41$, $p = .05$), and RTPJ (66–50 28, $r = 0.14$, $p =$ n.s.) are depicted. Only activities in insula/SII and SI were significantly associated with the strength of the belief in a just-world disposition. See text for further details.

are violated (Hsu et al., 2008). Consequently, Hsu et al. (2008) suggest an affective basis to norm-following behavior, hypothesizing that participants with higher insula activity (who receive strong negative affective signals) are more prone to "deontological norm following". The results of the current study are in line with these considerations and extend the results by demonstrating that interindividual differences in insula activation can be linked to the personal trait of the belief in a fair world. We conclude that our results suggest that the insula plays a central role as an underlying neural structure for this belief.

According to Taylor, Seminowicz, and Davis (2009) insula activation in our study can be described as mid/posterior insula. Hsu et al. (2008) and Wright et al. (2011) demonstrated similar activations of the mid/posterior insula associated with unfairness and inequity. Yamada et al. (2012) reported that interindividual differences in the activation of this brain region predicted the degree of mitigating criminal sentences. In addition, Mazzola et al. (2010) showed interindividual differences (due to different affective-cognitive styles) in the activation of a very similar brain region in the insula when observing partners' painful facial expressions. The authors explain this result with the known role of the insula in connecting emotional experience with interoceptive states. Furthermore, Schaefer, Rotte, Heinze, and Denke (2013) report interindividual differences in left mid/posterior insula when observing someone being touched non-painfully on the hand. The current study confirms these results of interindividual differences in mid/posterior insula activation by reporting that insula activity is linked to the personal disposition of the belief in a fair world.

However, several studies also report a relationship of activity in anterior insula with norm violations, in particular when rejecting unfair offers in the ultimatum game (e.g., Sanfey et al., 2003). Whereas some studies confirmed these findings (Halko, Hlushchuk, Hari, & Schürmann, 2009), others found only little activation for the same contrast in the anterior part of the insula (Tabibnia, Satpute, & Lieberman, 2008; Wright et al., 2011). A recent study by Güroglu et al. (2010) may help understand these divergent findings by demonstrating that anterior insula activity depends on proposer intentionality in the ultimatum game (Güroglu et al., 2010). However, similar to Wright et al. (2011) we argue that distinct fairness-related processes seem to be expressed in segregated portions of the insula. Thus, more abstract and contextual aspects of fairness may map to mid/posterior regions of the insula, whereas anterior parts of the insula may reflect interospective awareness of emotion and bodily state (e.g., Craig, 2009).

Interestingly, the cluster in insula that was associated with a strong belief in a fair world extended to somatosensory cortices (SI and SII). Why are SI and SII linked to the belief in a fair world? Numerous recent studies suggest that the somatosensory cortices are engaged in social perceptions, in particular to empathy. For example, Ruby and Decety (2004) reported that empathy in complex social events is associated with activation in SI. Similarly Hooker, Verosky, Germine, Knight, and D'Esposito (2010) presented social scenes in an fMRI experiment and showed a correlation of somatosensory areas on the left postcentral gyrus with empathy. Furthermore, an increasing body of evidence demonstrates mirror-like activations in somatosensory cortices when observing others being touched, suggesting a mechanism that provides a somatic dimension to our perception of other people's experiences (Keysers, Kaas, & Gazzola, 2010). These mirror-like activations in the somatosensory cortices have been shown to be linked with the empathic abilities of the observer (e.g., Schaefer, Heinze, & Rotte, 2012). The present results extend these findings by showing that the belief in a fair world is associated with activity in somatosensory cortices. Thus, the belief in a fair world may be linked to empathic processes in SI and SII. This novel finding should be further examined by future studies.

Numerous studies revealed a role for the RTPJ in moral cognitions. In particular, the RTPJ brain area has been linked to thinking about thoughts (Saxe & Kanwisher, 2003; Young et al., 2010). Our results demonstrate a relationship between the RTPJ and GWAL scores, but this correlation failed to reach the level of significance after correction. Nevertheless, given that the present study included only a limited number of participants (N = 17), future studies are needed to determine the role of the RTPJ in the network of underlying brain areas to the belief in the fair world.

The present study suggests that individual variations in the belief in a just world are associated with neural responses of the insula and somatosensory cortices when witnessing unfairness or norm-violating behavior. However, other explanations should also be taken into account. Thus, one could argue that a strong belief in a fair world may be associated with a generally increased cortical activation level. Nevertheless, since the GWAL scores correlated significantly with the insula/somatosensory cortex only, this explanation seems to be unlikely.

Future studies may include variables such as emotional valence of the scenarios (or arousal) in order to distinguish between the roles of the insula in negative affective states generation relative to social norm-violation detection. Furthermore, future studies may also include additional questionnaires in order to cross-validate the GWAL questionnaire. However, previous research on the GWAL questionnaire demonstrated good construct validity. For example, previous research has demonstrated that the belief in a fair world measured with the GWAL is different from concepts such as authoritarism (Dalbert, 1992) and optimism (Dalbert, 1996; Dalbert, Lipkus, Sallay, & Goch, 2001).

In sum, the results of our study report a relationship between brain responses in insula/somatosensory cortex when witnessing unfair behavior with interindividual differences in the belief in a just world, suggesting important roles for the insula and the somatosensory cortices as underlying neural structures for the just-world-hypothesis. We think that the results are encouraging to conduct further neuroimaging research in order to help us to better understand the intriguing theory of the belief in a fair world.

Supplemental data

Supplemental data for this article can be accessed here. http://dx.doi.org/10.1080/17470919.2014.922493

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