Biological Psychology 123 (2017) 235–240

Contents lists available at ScienceDirect

Biological Psychology

journal homepage: www.elsevier.com/locate/biopsycho

Group-focused morality is associated with limited conflict detection and resolution capacity: Neuroanatomical evidence

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ARTICLE INFO

Article history:
Received 3 June 2016
Received in revised form
16 December 2016
Accepted 30 December 2016
Available online 5 January 2017

Keywords:
Group-focused moral foundations
Group-focused morality
Neuroanatomy
Neural trait
Gray matter volume
Conflict detection/resolution

ABSTRACT

Group-focused moral foundations (GMFs) – moral values that help protect the group's welfare – sharply divide conservatives from liberals and religiously devout from non-believers. However, there is little evidence about what drives this divide. Moral foundations theory and the model of motivated social cognition both associate group-focused moral foundations with differences in conflict detection and resolution capacity, but in opposing directions. Individual differences in conflict detection and resolution implicate specific neuroanatomical differences. Examining neuroanatomy thus affords an objective and non-biased opportunity to contrast these influential theories. Here, we report that increased adherence to group-focused moral foundations was strongly associated (whole-brain corrected) with reduced gray matter volume in key regions of the conflict detection and resolution system (anterior cingulate cortex and lateral prefrontal cortex). Because reduced gray matter is reliably associated with reduced neural and cognitive capacity, these findings support the idea outlined in the model of motivated social cognition that belief in group-focused moral values is associated with reduced conflict detection and resolution capacity.

1. Introduction

Morality has historically been the subject of somewhat myopic study, according to recent claims (Haidt, 2007, 2008). Intellectuals and researchers alike have primarily equated morality with treatment of the individual. However, people regularly identify separate moral concerns that transcend the individual and pertain to the group's welfare. Moral foundations theory (MFT) recognizes this and distinguishes three separate, group-focused moral values: In-Group Loyalty (value loyalty to family, community, and nation), Authority (value leadership and respect authority and tradition), and Sanctity (value nobility and suppress carnality, Haidt, 2007; Haidt & Graham, 2007).

Group-focused moral foundations, despite receiving empirical scrutiny only recently, are far from inconsequential. In fact, these foundations sharply divide liberals from conservatives (Graham, Haidt, & Nosek, 2009; Graham et al., 2012; Nilsson & Erlandsson, 2015; Van Leeuwen & Park, 2009) and non-believers from the devout (Graham & Haidt, 2010; Simpson, Piazza, Rios, 2016). Liberals and non-believers adhere primarily to the individual-focused moral foundations of harm reduction (value caring and minimizing harm) and fairness (value reciprocity and justice). When asked about group-focused moral foundations, liberals and the non-believers view them as in conflict with their preferred foundations centered on the individual. And indeed they are. Individual freedoms are directly restricted by values of authority and sanctity, and harm is often visited upon those who deviate from the ingroup. Yet conservatives and the religious emphasize both individual- and group-focused foundations. Moral foundation theorists suggest that because all people value individual-focused foundations, those who adhere to group-focused moral foundations seem to hold a broader, more integrative view of the moral landscape (Haidt, 2012; Haidt & Graham, 2007). Conservatives and the devout appear to

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http://dx.doi.org/10.1016/j.biopsycho.2016.12.018
0301-0511/

resolve directly conflicting moral values. This implicates a cognitive advantage, as well. Harmonizing group- and individual-focused moral foundations should require a superior capacity to detect and resolve conflict.

Such reasoning contrasts sharply with a separate view on group-focused morality. The model of motivated social cognition (here, MSC) defines core right-wing beliefs as *resistance to change* and *support for inequality* (Jost, Glaser, Kruglanski, & Sulloway, 2003). Group-focused moral foundations are highly related to these core beliefs. Much like the Authority and Loyalty foundations, resistance to change and support for inequality promote group welfare above individual welfare via consistent and normative group views, practices, and power structures (i.e., hierarchies that are inherently unequal). Notably, the MSC view holds that these group-based beliefs compensate for a reduced conflict detection and resolution capacity by placing the person in a more 'black and white' belief system that restricts ambiguity, strengthens communal consensus, resists the risky prospect of social change, and prescribes simple and clear guides for action (Jost & Amodio, 2012; Jost et al., 2007; see also Inzlicht, McGregor, Hirsh, & Nash, 2009 on the psychological function of religious beliefs). Consistent with this view, conservative and religious beliefs have been related to reduced neural sensitivity to conflict (Amodio, Jost, Master, & Lee, 2007; Inzlicht et al., 2009; Weissflog, Chorma, Dywan, van Noordt, & Segalowitz, 2013). Further, conservative beliefs have been related to reduced gray matter in the anterior cingulate cortex (ACC), a key region in conflict detection processes (Kanai, Feilden, Firth, & Rees, 2011).

Like the MFT view, then, the MSC view points to an association between adherence to group-focused moral foundations and individual differences in conflict detection and resolution capacity. In direct contrast to the MFT view, however, the MSC implies that adherence to group focused moral foundations might relate to *reduced* conflict detection and resolution capacity.

Because increased gray matter volume is reliably associated with better neural and cognitive capacity (Kanai & Rees, 2011; Kochunov et al., 2012; Madden, Bennett, & Song, 2009), these views on group focused moral foundations have divergent implications for gray matter volume in specific brain regions. Conflict detection and resolution are strongly associated with an ACC-lateral prefrontal cortex (LPFC) system (Botvinick, Cohen, & Carter, 2004; Kerns et al., 2004; Shackman et al., 2011). The MFT view suggests a relation between group focused moral foundations and superior conflict detection and resolution, which implies *increased* volume in the ACC and lateral PFC. The MSC view suggests an association between group focused moral foundations and inferior conflict detection and resolution, which implies *decreased* ACC and lateral PFC volume.

In sum, these views on group-focused moral foundations have opposing implications for underlying differences in conflict detection and resolution capacity. Do people that adhere to group-focused moral foundations possess an enhanced conflict detection and resolution capacity, as the MFT view suggests? Or do these people have a more limited conflict detection and resolution capacity, as the MSC view suggests? To probe these questions, we examined whether group-focused moral foundations would be associated with differences in brain anatomy. Such an examination can also address a major critique of MFT—the connection between these putatively innate moral foundations and functionally-relevant neurobiological systems is not well understood, particularly for the under-researched group-focused foundations (Suhler & Churchland, 2011). To clearly index dispositional brain differences, we assessed gray matter volume using Voxel Based Morphometry (VBM). Objective measurement of meaningful and stable neuroanatomical differences has been demonstrated as an effective tool in revealing sources of individual differences (Nash, Gianotti, & Knoch, 2014).

2. Method

2.1. Participants

Fifty-six healthy individuals participated (mean age ± S.D. = 22.3 ± 3.47 years, 26 females). We recruited for one academic year and collected as much data as possible during that time. Participants first gave informed written consent (which was approved by the local ethics committee) and completed a number of individual difference questionnaires as part of a larger research initiative, which included the Moral Foundations Questionnaire (see below). In a separate session, participants then completed the MRI scans. All participants reported no psychiatric illness or neurological disorder. Participants received 40 Swiss Francs (CHF 40; CHF 1 = about $1 U.S.) for study completion.

2.2. Moral foundations questionnaire

The 20 item Moral Foundations Questionnaire assesses the degree to which participants endorse the three group-focused foundations of in-group loyalty ("I am proud of my country's history"), authority deference ("Respect for authority is something all children need to learn"), and purity/sanctity ("People should not do things that are disgusting, even if no one is harmed") and the two individual-focused foundations of harm/care ("Compassion for those who are suffering is the most crucial virtue") and fairness/reciprocity ("Justice is the most important requirement for a society") (Graham et al., 2009, 2011). Consistent with prior research (Graham et al., 2011; Hirsh et al., 2010), in a factor analysis of the subscale totals, we found two factors. The two individual-focused subscales formed one factor (eigenvalue = 1.86, accounting for 37.17% of the variance) and the three group-focused subscales formed the second factor (eigenvalue = 1.60, accounting for 32.01% of the variance). This supports the idea that there are two distinct facets in this questionnaire. Based on this, we created two composite scores, a Group-Focused Morality score and an Individual-Focused Morality score. We focus our analyses on the Group-Focused Morality score, though we report findings on the Individual-Focused Morality score for comparison.

2.3. Scanning procedure

MRI data were collected using a 3 T whole body MR system (Magnetom Verio, Siemens Healthcare, Germany) equipped with a standard twelve-channel head coil. Anatomical images were acquired with a 3D magnetization prepared rapid gradient-echo (MPRAGE) sequence. The following acquisition parameters were used: TR (repetition time) = 2000 ms, TE (echo time) = 3.4 ms, TI (inversion time) = 1000 ms, flip angle = 8°, FOV (field of view) = 25.6 cm, acquisition matrix = 256 × 256 × 176, voxel size: 1 mm × 1 mm × 1 mm. A sagittal volume covering the entire brain was acquired in 7.5 min.

2.4. Gray matter volume: voxel-based morphometry

Anatomical brain images were analyzed using voxel-based morphometry version 8 (VBM 8) implemented in statistical parametrical mapping version 8 (SPM 8). VBM 8 is documented and freely available online (http://dbm.neuro.uni-jena.de/vbm/). It is a whole-brain technique capable of revealing subtle, regionally specific changes in gray matter by averaging across subjects. This method is based on high-resolution structural three-dimensional magnetic resonance images, registered in standard space, and designed to find significant regional differences throughout the brain by applying voxelwise statistics within the context of Gaussian random fields (Ashburner & Friston, 2000). Preprocessing of

the data involved spatial normalization, segmentation into gray matter (GM), white matter (WM), and cerebrospinal fluid (CSF), modulation, and spatial smoothing with a Gaussian kernel (full width at half maximum = 8 mm) (Ashburner & Friston, 2000, 2005). The segmentation approach is based on an adaptive Maximum a Posterior (MAP) technique without the need for a priori information of tissue probabilities and uses a Partial Volume Estimation (PVE) with a simplified mixed model of at most two tissue types. This segmentation approach also applies a classical Markov Random Field (MRF) analyses, which incorporates spatial prior information of adjacent voxels into the segmentation estimation. Finally, the modulation option we used during preprocessing multiplies the voxel values by the non-linear component derived from the spatial normalization, producing tissue volumes that are corrected for individual brain size (obviating the need for a brain size covariate).

2.5. Statistical analysis

To examine whether gray matter differences can explain differences in group-focused moral foundations (or in individual-focused moral foundations), linear regression analyses were performed on the smoothed gray matter volume images in SPM 8 that are already corrected for individual brain size (see above). Because age is also known to affect brain anatomy (Im et al., 2008; Silk & Wood, 2011), we further controlled for this variable in all analyses (as a covariate), in line with previous research (e.g. Bickart, Wright, Dautoff, Dickerson, & Barrett, 2011). Ersche et al., 2012). We used a primary cluster-forming threshold of $p < 0.001$ for the whole brain volume as the criterion to detect voxels with a significant correlation with the Group-Focused Morality and Individual-Focused Morality scores. Clusters with a significant Family-Wise-Error (FWE) correction ($p < 0.05$) on a cluster level are reported.

3. Results

Linear regression analyses were conducted with gray matter volume as the dependent variable and Group-Focused Morality score as the predictor, controlling for age and brain volume (see methods section for details, Bickart et al., 2011; Ersche et al., 2012). Findings revealed (at $p < 0.05$, family-wise-error (FWE) corrected for the whole brain) that volume in four separate clusters in the PFC were correlated with the Group-Focused Morality score. These included clusters in 1) the right ACC ($x = 9$, $y = 29$, $z = 19$; cluster r-value = −0.491, explained variance = 24.1%, $p < 0.01$, corrected); 2) the right VLPFC ($x = 42$, $y = 60$, $z = 3$; cluster r-value = −0.610, explained variance = 37.2%, $p < 0.001$, corrected); 3) the right DLPFC ($x = 21$, $y = 42$, $z = 31$, cluster r-value = −0.548, explained variance = 30.0%, $p < 0.05$, corrected) and 4) the left VLPFC ($x = -29$, $y = 56$, $z = 4$, cluster r-value = −0.530, explained variance = 28.0%, $p < 0.05$, corrected). Each of these regions was negatively correlated with the Group-Focused Morality score, i.e., reduced gray matter volume in the ACC and in the lateral PFC is associated with stronger adherence to group-focused moral foundations (see Fig. 1). Because the ACC and the lateral PFC regions are implicated in conflict detection and resolution respectively (Botvinick et al., 2004; Carter & Van Veen, 2007; Kerns et al., 2004; Macdonald, Cohen, Stenger, & Carter, 2000; Miller & Cohen, 2001), these results support the idea that group-focused morality is associated with a less elaborate conflict detection and resolution network.

For comparison, we also examined whether the same analyses using the Individual-Focused Morality score would reveal neuroanatomical differences in the same or other brain regions. Whole-brain corrected analyses revealed no significant clusters and as depicted in Fig. 1C, the Individual-Focused Morality score was not associated with any of the same clusters that were associated with the Group-Focused Morality score.

To test for the impact of gender (consistent with practices in previous related research, e.g. Kanai et al., 2011), we conducted the same analysis with gender as an additional covariate. The results again revealed the same significant negative correlations between Group-Focused Morality and gray matter volume of the right ACC (cluster r-value = − 0.528, $p < 0.05$, corrected), the right VLPFC (cluster r-value = −0.650, $p < 0.001$, corrected), the right DLPFC (cluster r-value = −0.549, $p < 0.05$, corrected) and the left VLPFC (cluster r-value = −0.543, $p < 0.05$, corrected). No other brain region showed a significant correlation with Group-Focused Morality that survived the applied correction procedure. Finally, controlling for gender did not reveal any significant, whole-brain corrected association with Individual-Focused Morality. This indicates the validity of our findings irrespective of subjects' gender.

4. Discussion

Group-focused moral foundations represent a moral divide between both conservatives and liberals and religiously devout and non-believers. This moral split has resisted scrutiny given the somewhat myopic focus on individual-focused moral foundations (Haidt, 2007, 2008). Moral foundations theory recognizes the importance of group-focused moral foundations but has been criticized for the lack of connection between these putatively innate moral foundations and neurobiological systems (Suhler & Churchland, 2011). Here we found that increased adherence to group-focused moral foundations was associated with reduced gray matter in the ACC and the lateral PFC.

Conflict detection and resolution involve an ACC—lateral PFC network (Botvinick et al., 2004; Miller & Cohen, 2001; Mansouri, Tanaka, & Buckley, 2009). The ACC is sensitive to conflicting or aversive stimuli that challenge or frustrate an ongoing goal (Carter & Van Veen, 2007; Shackman et al., 2011). The ACC then signals the lateral PFC to resolve the conflict or implement cognitive control (Badre & Wagner, 2004; Kerns et al., 2004; MacDonald et al., 2000, Mansouri et al., 2009). Increased volume in the ACC and the lateral PFC is also reliably associated with better conflict-related processing (Abutalebi et al., 2012; Dolk, Liepelt, Villringer, Prinz, & Ragert, 2012; Ruscheweyh et al., 2013; Takeuchi et al., 2012; for a recent review see Yuan & Raz, 2014). Because we found that increased adherence to group-focused moral foundations was associated with reduced ACC and lateral PFC gray matter, people who adhere more strongly to group-focused moral foundations may be less able to detect and resolve conflict. Consistent with this, past research has found that conservatives have reduced ACC volume and muted error-related negativity (ERN; Amodio et al., 2007; Kanai et al., 2011; Weissflog et al., 2013)—an event-related potential source localized to the ACC that is broadly recognized to reflect conflict detection (Bartholow et al., 2005). A muted ERN has similarly been associated with increased religious conviction (Inzlicht et al., 2009).

The current findings thus map onto the neuroanatomical differences implied by the MSC view of group-focused moral foundations (Jost et al., 2003; see also Kanai et al., 2011). People adhering to ideologies that emphasize resistance to change and social inequality may be less able to detect conflicts and discrepancies, consistent with reduced ACC volume. When confronted with unavoidable conflicts, they may be less able to resolve it, consistent with reduced lateral PFC volume. Group-focused moral foundations might place people in a moral system that limits exposure to and pre-emptively resolves conflicts (Jost et al., 2003).

We note that although our conclusions involve reverse inference, they are based on a reliably demonstrated empirical

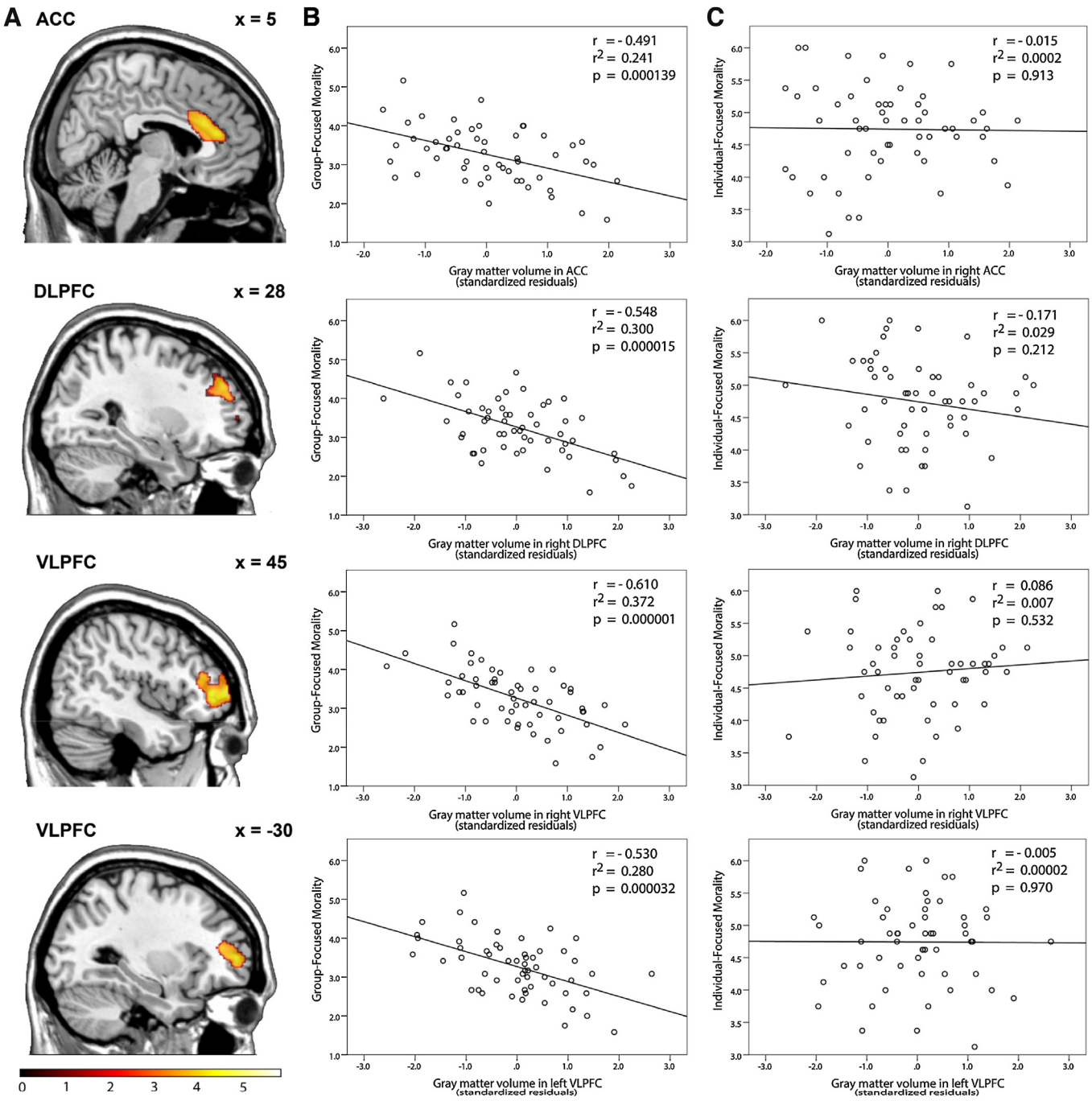

Fig. 1. Gray matter volume in prefrontal brain areas relates to group-focused morality. Depicted in (A) are the regions of the prefrontal cortex, including right ACC (x = 9, y = 29, z = 19), right DLPFC (x = 21, y = 42, z = 31), right VLPFC (x = 42, y = 60, z = 3), left VLPFC (x = −29, y = 56, z = 4), demonstrating a strong negative correlation with the group-focused morality scale of the moral foundation questionnaire. All depicted regions survive whole brain family-wise error corrections at the cluster-level (right ACC at $p < 0.01$, corrected; right VLPFC at $p < 0.001$, corrected; right DLPFC and left VLPFC at $p < 0.05$, corrected). Depicted in (B) are the scatter plots of the group-focused morality scale against the gray matter volume of the four significant clusters shown in (A). Depicted in (C) are the scatter plots of the individual-focused morality scale against the gray matter volume of the four significant clusters shown in (A). Note that the gray matter volume measures depicted in the scatter plots are adjusted for covariates (age and brain size) and standardized (z-transformed). Moreover, lines of best fit are displayed for the entire sample of 56 individuals together with r coefficients, r-squared values and uncorrected p-values. Please note that these scatterplots are made for visualizations of the findings and should not be used for drawing additional statistical inferences (Kriegeskorte, Simmons, Bellgowan, & Baker, 2009).

relationship between the ACC and LPFC and conflict detection and resolution processes (see discussion above). However, future research could address the current limitations associated with inference and use separate measures of conflict detection and resolution processes for convergent evidence.

We also note that although we focused on conflict detection and regulation (i.e., key processes implied by these divergent views on group-focused moral foundations), each view might have unique implications for other underlying individual differences in brain anatomy. For example, the MFT view could suggest that the ability to simultaneously value and consider both the welfare of individuals and groups might also involve a superior social cognition capacity, perhaps evidenced by a more elaborate temporal parietal junction or dorsomedial PFC (Van Overwalle, 2009). Or the MSC

could suggest that group-focused moral foundations are also associated with increased threat sensitivity, perhaps evidenced by a more elaborate amygdala and insula (Craig, 2009; Davis, 2006). Our analyses were whole-brain, and in contrast to these other potential differences, our results were specific to the ACC and the lateral PFC. Moreover, even if we strongly lower the significance threshold to $p < 0.01$ (uncorrected), we do not find any significant correlations in these other brain areas.

Additionally, although our primary interest was on group focused moral foundations and the divergent implications for brain structure associated with the MFT and MSC views, one might also expect that differences in individual focused moral foundations would be associated with brain structure differences. Here, we found no such associations. Though it is prudent to treat negative results with caution, we note that such results may be partly due to our relatively strict statistical threshold. Future research could perhaps use a more liberal threshold and also an increased sample size (see Mar, Spreng, & De Young, 2013) to better determine whether adherence to individual focused moral foundations is associated with brain structure.

The current results may also help shed light on an existing empirical discrepancy. Part of the same research group that reported a link between *decreased* ACC volume and conservative belief (Kanai et al., 2011) also reported a link between *increased* subcallosal gyrus volume and group-focused moral foundations (there termed 'binding' foundations, Lewis, Kanai, Bates, & Rees, 2012). The authors concluded "the association of subcallosal gyrus volume with binding does not obviously reflect findings from previous work in the social and moral neuroscience literature. . ." It is unclear why their results diverge from the current results, but one possibility may be that Lewis and colleagues did not conduct whole-brain corrected analyses and thus used more liberal statistical thresholding that carried increased chance of false-positive results. Given the clear link between conservative belief and group-focused moral foundations (Graham et al., 2009), our findings appear to provide the theory-grounded extension from findings on conservative beliefs and neuroanatomy (Kanai et al., 2011). However, we hold that these findings do not reflect a simple conceptual replication. Moral foundations are primarily viewed as innate constructs whereas political views are typically not viewed at the same basic level (Haidt & Graham, 2007). Rather, political beliefs appear to be driven by moral foundations (Graham et al., 2009). Thus, moral foundations may be closer than political beliefs to basic psychological processes and/capacities and, ultimately, to brain structure and function.

Do the current findings necessarily contradict the interpretation of a kind of moral or cognitive advantage suggested by the MFT theory, however? Perhaps not. A less elaborate conflict detection and resolution system might be understood as simply different, or better suited to different tasks. For example, cognitive control is generally thought to promote goal-directed behavior, particularly in unpredictable or confusing environments. However, cognitive control can undermine goal-directed behavior in highly structured and predictable environments (Bocanegra & Hommel, 2014). Perhaps those who promote group-focused moralities are less suited to navigate conflict and confusion but better suited towards efficient action in structured environments. Rather than a moral advantage, the group-focused, the conservatives, and the devout may have different skills than their individual-focused, liberal, and non-believer counterparts.

The current research invites compelling questions. The most obvious: what is the causal relationship? Does a less elaborate conflict detection and resolution system lead to group-focused morality, or vice versa? The fact that people specifically bolster conservative and religious convictions following experimental manipulations of conflict and uncertainty suggests that such beliefs are part of a defensive coping strategy (Jost & Amodio, 2012; McGregor, Nash, & Prentice, 2010). If this is the case, the ACC and lateral PFC may become less elaborate after people shift towards group-focused moral foundations. Future research should examine whether people also bolster group-focused moral convictions after experiences of conflict. Research could also track brain structure and moral foundations over time to examine the relationship between changes in group-focused morality and ACC-PFC structure.

Author contributions

K. Nash, T. Baumgartner, and D. Knoch developed the study concept. T. Baumgartner and D. Knoch contributed to the study design. T. Baumgartner collected and analyzed the data. T. Baumgartner and K. Nash interpreted the data. K. Nash and T. Baumgartner drafted the manuscript. D. Knoch revised the manuscript. All authors approved the final version of the manuscript for submission.

Acknowledgement

This project was supported by a grant to DK by the Swiss National Science Foundation (PP00P1_146317).

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