The Neural Underpinnings of Intergroup Social Cognition: An fMRI Meta-Analysis

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Abstract

Roughly twenty years of functional magnetic resonance imaging (fMRI) studies have investigated the neural correlates underlying engagement in social cognition (e.g., empathy, emotion perception) about targets spanning various social categories (e.g., race, gender). Yet findings from individual studies remain mixed. In the present quantitative functional neuroimaging meta-analysis, we summarized across 50 fMRI studies of social cognition to identify consistent differences in neural activation as a function of whether the target of social cognition was an ingroup or outgroup member. We investigated if such differences varied according to social category (i.e., race) and social cognitive process (i.e., empathy, emotion perception). We found that social cognition about ingroup members was more reliably related to activity in brain regions associated with mentalizing (e.g., dmPFC), whereas social cognition about outgroup members was more reliably related to activity in regions associated with exogenous attention and salience (e.g., anterior insula). These findings replicated for studies specifically focused on the social category of race, and we further found intergroup differences in neural activation during empathy and emotion perception tasks. These results help shed light on the neural mechanisms underlying social cognition across group lines.

Keywords: intergroup bias, social cognition, fMRI, meta-analysis, race

Introduction

From an early age, humans tend to categorize ourselves and others as "us versus them" (Liberman, Woodward, & Kinzler, 2017; Mahajan & Wynn, 2012). These categorizations can lead individuals to enact disparate behaviors toward ingroup and outgroup members. For example, individuals tend to behave in ways that favor ingroup members (i.e., ingroup favoritism) and disfavor outgroup members (Balliet, Wu, & De Dreu, 2014; Tajfel, 1982; Tajfel & Turner, 1979). Such is the case when White individuals assign less harsh legal punishments to White (vs. Black) targets (Johnson et al., 2002) or grant more comprehensive medical care to White patients compared to patients of other races (Drwecki, Moore, Ward, & Prkachin, 2011; Kaseweter, Drwecki, & Prkachin, 2012). Further, perceptions of outgroups as more homogenous than one's ingroup (i.e., *outgroup homogeneity effect*) can also influence social behavior in intergroup interactions (Brauer, 2001; Hughes et al., 2019; Judd & Park, 1988; Ostrom & Sedikides, 1992). This can manifest in individuals' tendency be less discerning in their perception of emotional expressions of outgroup members (Richeson, Dovidio, Shelton, & Hebl, 2007), which may engender discriminatory behavior via stereotyping and prejudice (Hughes et al., 2019).

It is clear from this behavioral literature that social categorizations matter: the ways in which we think about one another vary depending on perceived ingroup versus outgroup status (Brewer, 2007). Further, these differences in ingroup versus outgroup social cognition can underlie biased social behaviors (Brewer, 1999; Major, Mendes, & Dovidio, 2013; Molenberghs & Louis, 2018). However, it is less clear *how* exactly an individual's group membership sets into action the neural processes that may ultimately mediate biased behavior.

Neuroscience of Intergroup Social Cognition

Neuroimaging approaches have been widely used over the past two decades to address this "how" by examining the neural mechanisms that underlie social cognitive processes directed toward ingroup versus outgroup members. For instance, consistent with the ingroup favoritism effect, fMRI data reveal greater activity in the ventral striatum for ingroup members (Telzer, Ichien, & Qu, 2015) and more amygdala activity for outgroup members (Cunningham et al., 2004; Hein, Silani, Preuschoff, Batson, & Singer, 2010), suggesting that ingroup members may be perceived as more valuable and/or rewarding, and outgroup members might be more uncertain, ambiguous, or aversive. Moreover, consistent with an outgroup homogeneity effect, greater activity in the dorsomedial prefrontal cortex (dmPFC) for ingroup members (Adams et al., 2010; Mathur, Harada, Lipke, & Chiao, 2010) and less activity in dmPFC for outgroup members (Harris & Fiske, 2006) further underscores that people may be more likely attribute unique and rich mental qualities to ingroup compared to outgroup members.

However, inconsistencies in the literature also abound, making it difficult to draw definitive conclusions about the neural mechanisms underlying intergroup social cognition. For instance, some neuroimaging studies reveal greater insula and dorsal anterior cingulate cortex (dACC) activation to *outgroup* members during emotion perception tasks (Liu, Lin, Xu, Zhang, & Luo, 2015; Watson & de Gelder, 2017), whereas others show greater activity in these regions during *ingroup* emotion perception (Azevedo et al., 2013; Cikara & Van Bavel, 2014; Lee et al., 2008; Xu, Zuo, Wang, & Han, 2009). Similarly, some studies in which group membership is based on race find greater amygdala activation in response to *outgroup* faces, which may reflect other-race negativity bias (Cunningham et al., 2004; Hart et al., 2000; Phelps et al., 2000). However, neuroimaging studies involving social categorization based on minimal groups (e.g., red team vs. blue team) have demonstrated greater amygdala activation in response to *ingroup* members (Van Bavel, Packer, & Cunningham, 2008). These results suggest that the specific type of social grouping under consideration (i.e., race vs. minimal group) may influence the neural regions engaged during social cognition across group lines (Cikara & Van Bavel, 2014; Van Bavel et al., 2008). These inconsistencies are further complicated by the fact that individual neuroimaging studies are more prone to Type I errors due to small sample sizes and insufficient statistical corrections (Wager, Lindquist, & Kaplan, 2007).

Since past studies in this area assess diverse social categories (e.g., race, minimal groups) and social cognitive processes (e.g., empathy, emotion perception), it is important to identify the core neural mechanisms underlying ingroup and outgroup social cognition across the literature. This is particularly important in light of the fact that it is not possible to make inferences about generalized intergroup neural processes from single studies that only investigate one type of social group (e.g., race). Further, while some studies offer evidence of the neural regions involved in generalized social categorization (Cikara, Van Bavel, Ingbretsen, & Lau, 2017; Lau & Cikara, 2017), still relatively little is known about how the brain distinguishes between "us" and "them" more broadly. Meta-analysis is useful in this context because it allows us to identify the most reliable patterns of activation across several studies, regardless of the social category of distinction in any individual study. Further, this analytic tool overcomes the limitations associated with sample size, power, and experimental design inherent in individual fMRI studies (Cremers, Wager, & Yarkoni, 2017; Turner, Paul, Miller, & Barbey, 2018) to help reveal the functional neuroanatomy or "neural reference space" consistently related to a process of interest (i.e., intergroup social cognition) (Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012).

Additionally, research needs to address how neural activity in intergroup contexts varies according to both the *social category* assessed and *social cognitive process* involved. Thus, we also aimed to use meta-analysis to identify how the neural mechanisms of intergroup social cognition may reliably vary as a function of a specific *social category* (i.e., race) and two particular *social cognitive processes* (i.e., empathy and emotion perception). We focused on *race* as a key social category given the importance of race-based bias in inter-race contexts (Han, 2018; Richeson et al., 2007) and the consequences of these behaviors on the health and well-being of marginalized racial group members (Major et al., 2013). Further, we focused on *empathy* and *emotion perception* given that these are two of the most studied processes in the intergroup social cognition fMRI literature (Molenberghs & Louis, 2018), and it is commonly argued that these social cognitive processes allow perceivers to represent the uniquely human experiences of group members that are important to intergroup relations (Richeson et al., 2007; Zaki & Cikara, 2015). Investigating these ingroup/outgroup differences in the neural underpinnings of social cognition according to racial grouping and among the specific social cognitive processes of empathy and emotion perception will provide a more nuanced understanding of how group membership may shape behavior in intergroup contexts, especially in the case of race-based biases in social behavior.

The Present Study

In sum, this meta-analysis addressed four primary questions: (1) Are a core set of brain regions reliably involved during social cognition across various *social categories* and *social cognitive processes*? (2) Do the neural correlates of ingroup/outgroup social cognition consistently differ when *race* is the category on which the target's group membership is based? (3) Does neural activation across ingroup vs. outgroup consistently differ when *empathy* and *emotion perception* are the specific social cognitive process engaged? Finally, (4) within the specific social category of race, does neural activation consistently differ according to the specific social cognitive process engaged (i.e., empathy, emotion perception)?

Our analysis expands upon a prior meta-analysis (Shkurko, 2013) of approximately 30 studies which found that the amygdala, ACC, fusiform gyrus, and right insula were reliably involved in distinguishing between ingroup and outgroup members generally. The current meta-analysis contains a total of 50 studies published through 2000-2018 and utilizes multilevel kernel density analysis (MKDA) as opposed to activation likelihood estimation (ALE) technique used in Shkurko (2013). Moreover, the present paper extends this prior work, which did not distinguish between a variety of social categories and types of social cognition, to examine the more specific neural correlates of intergroup social cognition for the social category of race and the specific social cognitive processes of empathy and emotion perception.

Methods

Study Selection and Search Strategy

Following PRISMA standards (Liberati et al., 2009), our search strategy first collected relevant papers from PubMed and PsycINFO. We searched for English-language publications of fMRI studies that examined processing of ingroup/outgroup human targets. The initial search terms used were: “fMRI+ingroup+outgroup”; “fMRI+group membership”. We also used these terms in conjunction with various social categories to capture as many different ingroup/outgroups as possible (see **Supplemental Materials/SM** for all search terms).

Titles and abstracts of papers from these searches were reviewed to eliminate any clearly irrelevant studies or duplicates. The initial searches also resulted in several narrative review papers, which we mined for additional papers but excluded from the database of studies. Next, we completed full-text screening to eliminate studies that did not meet the following criteria: (1) participants were healthy, non-medicated adults; (2) used fMRI to measure BOLD signal as an index of neural activity; (3) coordinates of activation for contrasts were reported in either MNI or Talairach space; (4) reported contrasts that directly compared processing of distinguishable ingroup versus outgroup (or vice versa) targets. We included both contrasts involving explicit processing of ingroup/outgroup distinctions (e.g., categorization of stimuli by group membership) and contrasts involving implicit processing of these distinctions (i.e., passive viewing of stimuli representing group membership). Coordinates for both region-of-interest (ROI) and whole-brain analyses were included, consistent with prior MKDA approaches (Kober & Wager, 2010; Lindquist, Satpute, Wager, Weber, & Barrett, 2016; Lindquist et al., 2012; MacCormack et al., 2020). These inclusion criteria resulted in a total of 50 papers in the final database, which together yielded 116 contrasts. See **Figure 1** for PRISMA diagram and **SM Table 2** for characteristics of the included studies.

Data Collection

Data extraction was completed by two coders (i.e., the first and third authors), with each coder reviewing all articles separately. Thus, all studies were double-coded and cross-checked to identify discrepancies. If discrepancies were noted, both coders reviewed the article again to determine the accurate data to report. Each article was coded for the following elements: sample size, social cognitive process, stimuli (e.g., still face images, videos), social group (e.g., race, culture, gender, minimal), relational status of the target and reference (i.e., ingroup or outgroup), and coordinates of peak activation.

Data Analysis

MKDA (see **SM** for more information) was implemented through the Matlab toolbox NeuroElf (http://neuroelf.net/). Consistent with MKDA and neuroimaging meta-analytic procedures (van Hoorn, Shablack, Lindquist, & Telzer, 2019; Lindquist et al., 2016; Wager et al., 2007), contrast coordinates in Talairach space were first converted to MNI space and then convolved using a smoothing kernel of 12mm, ultimately producing binary indicator contrast maps. Weights were placed on each study based on the square root of the sample size and whether the study used fixed or random effects. Fixed-effect studies were down-weighted by .75 to reduce the influence of those studies. By weighting studies in this manner, MKDA allows for higher-quality (i.e., higher powered, more generalizable) studies to have greater impact on the meta-analytic results (Kober & Wagner, 2010). The weighted averages of the kernels across individual study contrasts were used to produce contrast maps based on the proportion of activation near a given voxel from *N* contrasts. This proportion is thresholded by comparing it to a null distribution created through Monte Carlo simulations (5000 samples) that compute the likelihood of finding any activation in any voxel within gray matter (excluding white matter). For all analyses, we set this *a priori* threshold to a stringent height-based threshold of $p<.001$ (family-wise error-corrected for multiple comparisons) to determine whether voxels were significant. Results thus represent the neural regions displaying the most consistent activation for a given contrast (i.e., *ingroup>outgroup)* when averaged across all studies.

First, we investigated the neural reference space of brain regions consistently activated during *ingroup>outgroup* and *outgroup>ingroup* contrasts across all study-level contrasts. Identifying these neural reference spaces allowed us to determine the core set of brain regions consistently associated with ingroup vs. outgroup social cognition across the literature, regardless of the social cognitive process or group category studied. To supplement these primary contrasts, we also conducted meta-analytic contrasts in which we contrasted both of the aforementioned sets of contrasts against each other as follows: [(*ingroup>outgroup*)>(*outgroup>ingroup*)] and [(*outgroup>ingroup*)>(*ingroup>outgroup*)]. These meta-analytic contrasts allowed us to determine which clusters of activation were relatively more consistent for *ingroup>outgroup* contrasts relative to *outgroup>ingroup* contrasts, and vice versa.

Second, we examined the neural correlates of social cognition specifically for contrasts in which race was the social category of distinction. To do so, we investigated the neural reference space for each *racial ingroup>racial outgroup* and *racial outgroup>racial ingroup* contrast. Again, we supplemented these primary contrasts with meta-analytic contrasts, [(*racial ingroup>racial outgroup*)>(*racial outgroup>racial ingroup*)], to determine the relative specificity of activation for each contrast.

Third, we examined how consistent differences in neural activation might differ based on the specific social cognitive process engaged. Thus, we investigated the neural reference space for *ingroup>outgroup* and *outgroup>ingroup* by specific social cognitive process. We focus in the main text on empathy and emotion perception, given their prevalence in the literature and importance for predicting biases in behavior (Molenberghs & Louis, 2018; Richeson et al., 2007; Zaki & Cikara, 2015). Results for other social cognitive processes are presented in **SM Table 3**.

Finally, we examined the neural reference spaces for specific social cognitive processes (i.e., empathy, emotion perception) specifically within race-based contrasts. Results for other types of social cognition within race-specific contrasts are presented in **SM Table 4**.

Results

Overall differences in functional activation for ingroup vs. outgroup

We first identified the neural reference space of regions more consistently activated for *ingroup>outgroup*, irrespective of task or social group (515/520 points; 115/116 contrasts). This analysis revealed consistent activity in the bilateral anterior insula, including a left anterior insula cluster (-36, 15,10; *k*=260) that extended into the claustrum, and a right anterior insula cluster (43, 20, 8; *k*=260) that extended into the right inferior frontal gyrus (iFG) and right precentral gyrus. A third cluster was centered in the right dmPFC (8, 47, 27; *k*=260), extending into the superior frontal gyrus.

Next, we examined the neural reference space of regions more consistently activated for *outgroup>ingroup*, irrespective of task or social group (515/520 points; 115/116 contrasts). Here, we observed one significant cluster of activity, with its peak in the right anterior insula (33, 12, 13; *k*=3060), extending into the right iFG and precentral gyrus. Thus, both the *ingroup>outgroup* and *outgroup>ingroup* contrasts revealed similar, but distinct, peaks in the anterior insula (See **Table 1** and **Figure 2**).

Meta-analytic contrasts for ingroup vs. outgroup

We also conducted meta-analytic contrasts [(*ingroup>outgroup*)>(*outgroup>ingroup*)] and [(*outgroup>ingroup*)>(*ingroup>outgroup*)] to determine which regions, if any, were more consistently active for *ingroup>outgroup* relative to *outgroup>ingroup* and vice versa. The [(*ingroup>outgroup*)>(*outgroup>ingroup*)] contrast revealed a significant cluster in the left dmPFC (0, 51,36; *k*=100), while the [(*outgroup>ingroup*)>(*ingroup>outgroup*)] contrast revealed a significant cluster of activation in the right anterior insula (33, 12,13; *k*=130) extending into the right iFG and precentral gyrus. (See **Table 2** and **Figure 3**).

Overall differences in functional activation for racial ingroup vs. outgroup

We next assessed the neural correlates of race-specific ingroup versus outgroup social cognition. There were no clusters consistently activated across studies at the *p* <.001 threshold for *racial ingroup>racial outgroup*. However, *racial outgroup>racial ingroup* (358/520 points; 80/116 contrasts) revealed two significant clusters of activity: one in left middle frontal gyrus (mFG; 0, 9, 44; *k*=119), which extended into the mid-cingulate cortex (MCC), and one cluster in right anterior insula (40, 20, 13; *k*=123), which extended into the claustrum and iFG (See **Table 3** and **Figure 4**).

Meta-analytic contrasts for racial ingroup vs. racial outgroup

The meta-analytic contrasts for [(*racial ingroup>racial outgroup*)>(*racial outgroup>racial ingroup*)] and [(*racial outgroup>racial ingroup*)>(*racial ingroup>racial outgroup*)] revealed a set of clusters similar to those identified in the primary neural reference space contrasts outlined above. There were no significant clusters of activation detected at *p*< .001 for [(*racial ingroup>racial outgroup*)>(*racial outgroup>racial ingroup*)] (358/520 points, 80/116 contrasts). The [(*racial outgroup>racial ingroup*)>(*racial ingroup>racial outgroup*)] (358/520 points, 80/116 contrasts) mirrored the same clusters of activation as the *racial outgroup>racial ingroup* contrast: one in the left medial frontal gyrus (0, 9, 48; *k*= 119), and one in the right anterior insula, extending into the claustrum and iFG (36, 24, 9; *k*= 123; see **Table 4)**.

Differences in functional activation for ingroup vs. outgroup by social cognitive process

Empathy. Next, we conducted analyses summarizing the neural reference spaces associated with *ingroup empathy>outgroup empathy* and *outgroup empathy>ingroup empathy* (64/520 points; 25/116 contrasts). The *ingroup*>*outgroup* analysis revealed a large swathe of activation in the superior frontal gyrus with its peak in the left dmPFC (0, 49, 32; *k*=100), bordering the left anterior medial PFC. The reverse contrast (i.e., *outgroup>ingroup empathy*; 64/520 points; 25/116 contrasts) showed three significant clusters of activation: one cluster in the left dorsolateral prefrontal cortex (dlPFC; -44, 38, 13; *k*=256), a second cluster in the left premotor cortex (-27, 7, 50; *k*=260), and a third cluster in the right precentral gyrus extending into the right supplementary motor area (SMA; 43, 22, 40; *k*=250; see **Table 5**).

Emotion Perception. There were no significant clusters of activation at $p<.001$ for *ingroup>outgroup emotion perception* or *outgroup>ingroup emotion perception* (140/520 points; 21/116 contrasts). These findings suggest that there were no core regions that consistently showed increased activity during ingroup v. outgroup (and vice versa) emotion perception across studies of social categories.

Differences in functional activation for racial ingroup vs. outgroup by social cognitive process

Empathy. Finally, we conducted analyses summarizing the neural reference spaces associated with empathy and emotion perception specifically within our subset of racial ingroup vs. outgroup contrasts. For *racial ingroup empathy>racial outgroup empathy* (43/520 points; 20/116 contrasts), we found three significant clusters: one in the right dmPFC (7,30,34; *k*=362), one in the right anterior insula (43,20,8; *k*=260), and one in the claustrum (-23,20,6; *k*=260). The reverse contrast (*racial outgroup empathy>racial ingroup empathy;* 43/520 points; 20/116 contrasts) revealed one significant cluster located in the left mFG (-27,7,50; *k*=260; see **Table 6** and **Figure 5**).

Emotion Perception. For *racial ingroup emotion perception>racial outgroup emotion perception* (112/520 points; 18/116 contrasts), there were significant clusters in the right amygdala (37, -8, -19; *k*=269) and right fusiform gyrus (50, -42, -8; *k*=239). For *racial outgroup* *emotion perception>racial ingroup emotion perception* (112/520 points; 18/116 contrasts), there was one significant cluster in the right anterior insula (39, 20, 5; *k*= 206; see **Table 6** and **Figure 5**). For written and tabular results for contrasts of other social cognitive processes, see **SM Results and SM Tables 3-4**.

Discussion

Overall differences in functional activation for ingroup vs. outgroup

In this meta-analysis, we examined the consistency and specificity of neural activation during intergroup social cognition. Results confirmed that there are consistent differences in neural activation during social cognition corresponding to whether the target of such cognition is an ingroup vs. outgroup member. Across studies that engaged a variety of social cognitive processes and defined group membership based on diverse social categories, we found more consistent activation in prefrontal cortical regions including the right iFG, precentral gyrus, and dmPFC when social cognition was directed at ingroup (vs. outgroup) members. Moreover, meta-analytic contrasts indicated that the dmPFC was more consistently activated across study contrasts of *ingroup>outgroup* compared to *outgroup>ingroup* social cognition. Interestingly, the anterior insula was part of the neural reference space for social cognition regardless of whether the target of social cognition was an ingroup or outgroup member. However, subsequent meta-analytic contrasts revealed that although the anterior insula was consistently active across both *ingroup>outgroup* and *outgroup>ingroup* contrasts, this region was *more consistently* activated for *outgroup>ingroup* social cognitive processing relative to *ingroup>outgroup* across studies.

Our overall ingroup vs. outgroup findings offer some insight into neurocognitive processes that may underlie intergroup social behavior. For example, more consistent dmPFC activation during ingroup (vs. outgroup) social cognition aligns with behavioral theories suggesting that individuals are more likely to assign mental states to and act prosocially toward ingroup compared to outgroup members (Balliet et al., 2014; Cikara, Bruneau, Van Bavel, & Saxe, 2014; Cikara & Van Bavel, 2014), as dmPFC activity has been consistently associated with the ability to infer mental states of others (Amodio & Frith, 2006; Frith & Frith, 2006; Saxe, 2006) and has been implicated in prosocial behavior (Telzer, Masten, Berkman, Lieberman, & Fuligni, 2011; Waytz, Zaki, & Mitchell, 2012). Further, research shows that the ability to simulate the minds of others tends to lead to greater prosocial behavior (Gaesser, Shimura, & Cikara, 2020). Notably, this consistent dmPFC activation for ingroup relative to outgroup members may seem surprising in light of existing literature suggesting a ventral-dorsal gradient in the mPFC, with the dmPFC implicated in social cognitive processing of dissimilar (e.g., outgroup) others, and the vmPFC implicated in processing of similar (e.g., ingroup) others (Lieberman, Straccia, Meyer, Du, & Tan, 2019; Mitchell, Macrae, & Banaji, 2006). However, other studies have offered evidence that such ventral-dorsal distinctions of the mPFC maybe be task-dependent (see Wagner, Haxby, & Heatherton, 2012 for a review). Though the present analyses were not specifically intended to test the presence of a ventral- dorsal gradient in the mPFC, our results raise further questions about whether this gradient observed for some tasks generalizes across social cognition more broadly. As such, future work should explore this question more directly. Nevertheless, findings of the present study appear consistent with the notion that individuals are more likely to engage in mentalizing for ingroup (vs. outgroup) members, and that doing so may promote greater prosocial behavior (Balliet et al., 2014; Telzer et al., 2015), thus offering a potential neural mechanism underlying ingroup favoritism.

Our finding of more consistent anterior insula activation during outgroup social cognition also offers insight into the neural mechanisms that may underly outgroup biases identified in the behavioral literature. Existing meta-analytic evidence suggests two major functional-anatomic subregions within the anterior insula: the ventral region, shown to be more active during visceral and affective experiences (especially subjective arousal), and the dorsal region, which is more associated with exogenous attention, including salience detection, attention orientation, and task performance monitoring (Menon & Uddin, 2010; Touroutoglou et al., 2016; Touroutoglou, Hollenbeck, Dickerson, & Feldman Barrett, 2012; Touroutoglou, Zhang, Andreano, Dickerson, & Barrett, 2018). Given these distinctions, one interpretation of the present findings is that outgroup social cognition demands more attentional resources relative to ingroup social cognition, perhaps because outgroup members are more unfamiliar, infrequent, or novel. This interpretation also corresponds with previous functional connectivity analyses that have shown evidence of anterior insula laterality during orientating/arousal and tasks requiring cognitive control. Specifically, right anterior insula has shown stronger connectivity with regions implicated in attentional orientation and arousal (e.g., postcentral gyrus, supramarginal gyrus), while left anterior insula shows stronger connectivity with regions implicated in perspective taking and cognitive motor control (e.g., dmPFC, superior frontal gyrus; Kann, Zhang, Manza, Leung, & Li, 2016). Along these lines, the right lateralization of anterior insula for outgroup>ingroup processing may reflect recruitment of attentional resources that results in focus on an individual's salient outgroup status, rather than individuating processes associated with greater medial prefrontal activation. On the other hand, the left lateralization of the anterior insula during ingroup>outgroup processing may facilitate communication with regions involved in perspective taking and mentalizing processes that allow for more individuated perceptions of ingroup members. However, such interpretations are made cautiously given evidence suggesting that functional lateralization of the anterior insula may vary with age, gender, and other individual differences, and we were unable to account for these differences in the current analyses (Duerden, Arsalidou, Lee, & Taylor, 2013; Kann et al., 2016).

Interestingly, the *outgroup>ingroup* anterior insula findings also align with recent neuroimaging work showing that the right anterior insula is involved in integrating information about how others relate to one another in the service of making social group inferences (Lau, Gershman, & Cikara, 2020). For instance, in Lau et al. (2020), (Lau et al., 2020)predictions about allyship among group members based on latent structure learning of social group coalitions was related to greater activation of the right anterior insula, compared to when predictions of allyship were based solely on similarity between targets). As such, the consistent anterior insula activation observed in our *outgroup > ingroup* contrasts may suggest that, when considering outgroup members, people engage in an additional layer of processing that incorporates how members of that outgroup relate to other groups, but do not engage in this same degree of processing when thinking about ingroup members.

Differences in functional activation for racial ingroup vs. racial outgroup

We also investigated whether there are consistent neural differences in intergroup social cognition specifically within the social category of race. Interestingly, we did not find any regions consistently activated during racial ingroup (vs. outgroup) social cognition. However, racial outgroup (vs. ingroup) social cognitive processing was associated with more frequent activation of the mFG. We also found consistent anterior insula activation during racial outgroup (vs. ingroup) social cognitive processing, mirroring the pattern of activation observed in the overall contrasts (i.e., *outgroup>ingroup*). A subsequent meta-analytic contrast comparing [(*racial outgroup>racial ingroup*) > (*racial ingroup>racial outgroup*)] revealed a significant cluster of activation in the right anterior insula that also closely mirrored the findings of the overall [(*outgroup ingroup*) > (*ingroup>outgroup*)] meta-analytic contrast, suggesting that the swathe of activation in this region may be associated with outgroup processing in general, rather than being specific to racial outgroup processing. Alternatively, this finding could be attributable to race being the most-frequently investigated social category in the current literature, thus causing race-specific findings to drive an overall meta-analytic effect.

Our failure to identify consistent activation during racial ingroup social cognition is interesting and suggests that there is heterogeneity in the brain areas underlying social cognition for racial ingroup members across the literature. There were 80 contrasts in our database that addressed this particular question, so our failure to find consistent activation is not likely due to a lack of power. Indeed, a review of the individual contrasts maps that contributed to these results revealed that the clusters of activation from individual studies were spatially heterogeneous, suggesting that the null results of these contrasts are driven by true variability in the data rather than due to lack of power. As such, one interpretation of these results is that social cognition for racial ingroup members may be so routine that it does not preferentially activate brain regions above and beyond those activated for racial outgroup members. In contrast, we did find that social cognitive processing directed at racial outgroup individuals consistently elicits increased activity in regions implicated in exogenous attention and salience (e.g., anterior insula, mFG, iFG), mirroring findings for outgroup members more generally and suggesting some consistency in regions involved in racial outgroup social cognition across the literature.

Differences in functional activation for overall ingroup vs. outgroup and racial ingroup vs. outgroup by social cognitive process

Finally, we explored how functional activation during intergroup processing may vary depending on the social cognitive process engaged, focusing specifically on empathy and emotion perception. We found empathy directed at ingroup members was associated with more consistent activation in the dmPFC, even when focused specifically on racial ingroup (vs. outgroup) empathy. Among racial ingroup (vs. outgroup) empathy contrasts, we also observed a significant cluster of activation centered on the anterior insula. This cluster was more dorsal, which, in following with the ventral-dorsal distinctions of anterior insula functionality (Menon & Uddin, 2010; Touroutoglou et al., 2012), suggests that empathy for ingroup members may be more salient or elicit stronger attentional control (compared to outgroup). However, these findings are difficult to interpret considering that our earlier results indicated that the anterior insula was more consistently activated in response to outgroup members when we collapsed contrasts across all social cognition tasks. Still, this empathy-specific finding might suggest that ingroup/outgroup differences in activation of the dorsal anterior insula depend on the particular social cognitive process engaged. Conversely, empathy directed at outgroup members was consistently associated with activity in motor (e.g., premotor cortex, precentral gyrus) and executive function areas (e.g., dlPFC and mFG) of the prefrontal cortex, perhaps suggesting that more effortful cognitive control is necessary to engage in empathy for outgroup members.

We also observed differences in neural activation in response to racial ingroup vs. outgroup members (though not to ingroup vs. outgroup members in general) during emotion perception tasks. Specifically, perceiving emotions of racial ingroup members was associated with activation in the amygdala and fusiform, regions that have been well-established in visual emotion perception (Dolcos, Iordan, & Dolcos, 2011; Lindquist et al., 2016; Pujol et al., 2009), while emotion perception directed at racial outgroup members was related to consistent anterior insula activation. Interestingly, this cluster was relatively more ventral than those observed in other outgroup>ingroup contrasts. One interpretation of this finding is that it may reflect greater aversive affective responding on the part of perceivers (Lindquist et al., 2016, 2012), as perceivers may find emotional racial outgroup members to be aversive. Again, these findings related to the activation of the anterior insula in these empathy and emotion perception contrasts remain difficult to interpret and warrant future studies to better understand how the ventral-dorsal anterior insula is operating in ingroup vs. outgroup empathy and emotion perception. Nonetheless, these task-specific findings ultimately indicate that the neural correlates of intergroup social cognition do indeed vary depending on the specific social cognitive process engaged. This variation appears to be especially true for affective tasks like empathy and emotion perception, which would explain the inconsistencies noted in literature regarding insula and dACC activity during ingroup vs. outgroup social cognitive processing (Azevedo et al., 2013; Cikara & Van Bavel, 2014; Lee et al., 2008; Liu et al., 2015; Watson & de Gelder, 2017; Xu et al., 2009).

Limitations and Future Directions

This work has some limitations. Data were constrained to published fMRI studies; therefore, it is unclear how the present results may be affected by publication bias. Moreover, the race-specific contrasts do not address how neural responding may vary depending on the specific racial groups involved (e.g., Black vs. White, Asian vs. Black). Distinguishing among various types of cross-race dyads is an important future direction, as different dynamics (e.g., cultural stereotypes, intergroup histories) exist for different racial/ethnic group pairings. Furthermore, due to a limited number of eligible studies, we were unable to assess ingroup versus outgroup differences in neural activation across all types of social cognition and social categories, thus leaving unanswered questions about other notable social cognitive processes such as theory of mind and perceptions of trustworthiness.

Finally, while our results may offer insight into neural mechanisms underlying intergroup social behavior, they are subject to important caveats inherent to any neuroimaging meta-analysis. First, coordinate-based neuroimaging meta-analyses are the gold-standard when aggregating across neuroimaging literature, yet these techniques rely on functional coordinates derived from contrast analyses, but do not incorporate coordinates derived from correlational or functional connectivity analyses, thus limiting the kinds of studies that can be included in the database. Nonetheless, this meta-analysis helps reveal which regions are most consistently active for different social cognitive processes and targets, which may in turn prove useful for future studies using more advanced techniques such as functional connectivity. Second, interpretation of meta-analytic neuroimaging data is subject to reverse inference—inferring cognitive processes from the presence of neural activation (Poldrack, 2011). Future studies should follow up on these interpretations using experimental designs that pinpoint brain-behavior links. Finally, our findings do not provide evidence of a causal link between neural activation and subsequent behavior in intergroup contexts. Future research might explore how inducing neural activity in the regions identified here may impact individuals' behavior when directed at ingroup versus outgroup members.

Conclusion

We conducted the largest meta-analysis to date of the fMRI literature examining the neural correlates of social cognition across group lines. Our findings align with existing behavioral data and theories on intergroup social phenomena (e.g., ingroup favoritism, outgroup degradation) and help clarify how the brain gives rise to diverse social cognitive processes, which in turn may manifest as biased social behaviors in intergroup contexts. We hope this work can help guide future research and interventions that address intergroup behavioral dynamics.

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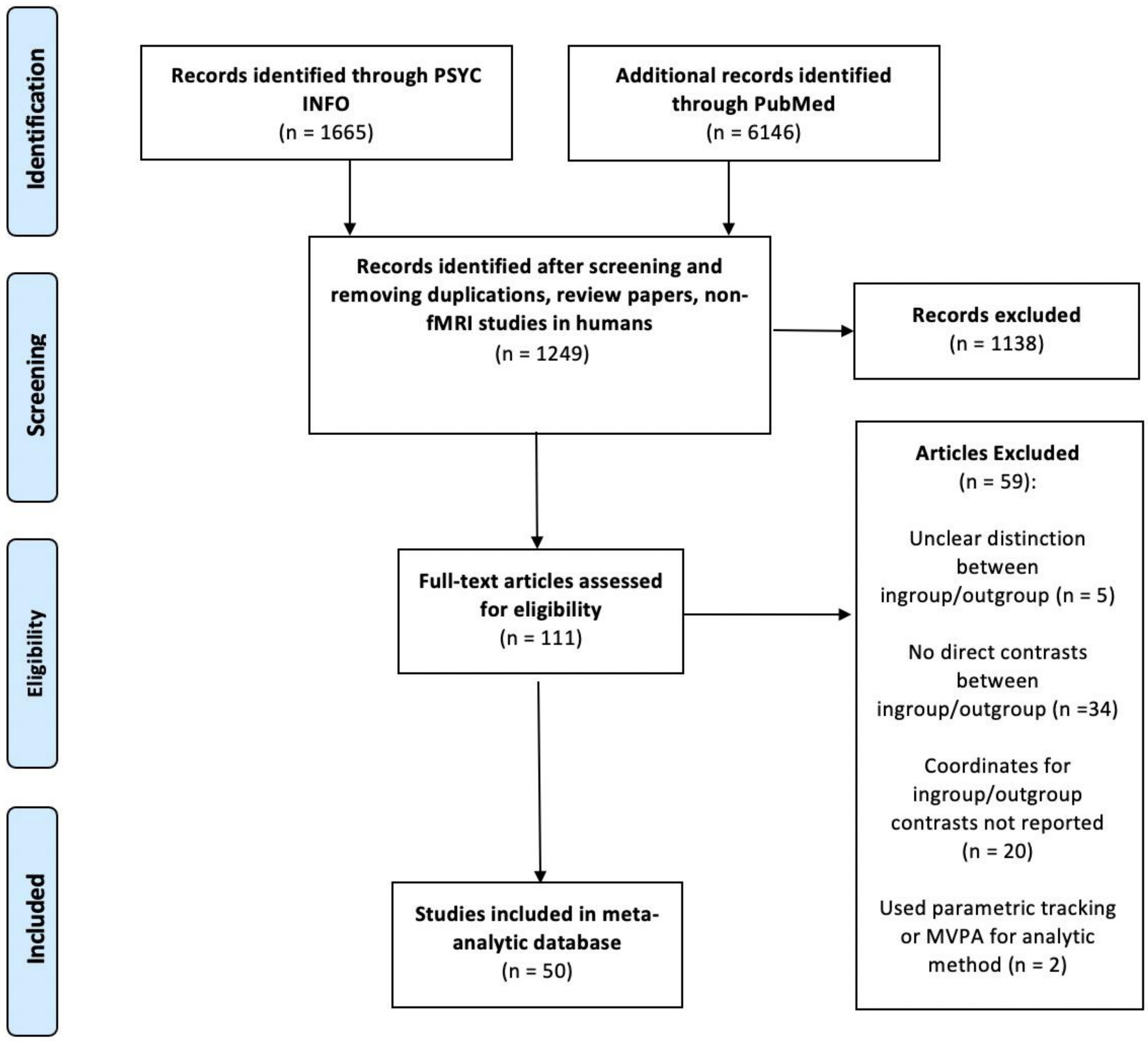

Figure 1. PRISMA diagram summarizing the literature search and study screening, eligibility, and inclusion process.

Table 1. Coordinates for overall differences in functional activation for ingroup vs. outgroup

Region	*Brodmann*	*x*	*y*	*z*	*k*	*max*	*mean*
Overall Ingroup > Outgroup							
LH Anterior Insula (cluster)	**13**	**-36**	**15**	**10**	**260**	**.33**	**.25**
LH Anterior Insula	13	-36	15	10	[a]	.33	.27
LH Claustrum	n/a	-23	20	6	[a]	.25	.22
RH Anterior Insula (cluster)	**13**	**43**	**20**	**8**	**260**	**.26**	**.21**
RH Inferior Frontal Gyrus	13	43	20	8	[c]	.26	.21
RH Precentral Gyrus	44	51	19	8	[c]	.21	.21
RH Dorsomedial PFC (cluster)	**9**	**8**	**47**	**27**	**260**	**.28**	**.18**
RH Dorsomedial PFC	9	8	47	27	[b]	.28	.17
RH Dorsomedial PFC	9	4	57	26	[b]	.20	.18
Overall Outgroup > Ingroup							
RH Anterior Insula (cluster)	**13**	**33**	**12**	**13**	**306**	**.21**	**.10**
RH Anterior Insula	13	33	12	13	[d]	.21	.11
RH Inferior Frontal Gyrus	13	40	26	10	[d]	.17	.10
RH Anterior Insula	13	35	2	11	[d]	.14	.10
RH Precentral Gyrus	44	47	4	11	[d]	.12	.09

Notes. *Brodmann* = Brodmann area; *x, y, z* = coordinates in Montreal Neurological Institute (MNI) space; *k* = cluster size in mm^3; *max* = maximum value within cluster; *mean* = average value within cluster. L = left, R = right. [a] = associated subclusters of LH Anterior Insula, [b] = associated subclusters of RH Dorsomedial PFC, [c] = associated subclusters of RH Inferior Frontal Gyrus. [d] = associated subclusters of RH Anterior Insula. All analyses were k-threshold corrected at p<.001.

Table 2. Coordinates for meta-analytics contrasts for overall ingroup v. outgroup

Region	*Brodmann*	*x*	*y*	*z*	*k*	*max*	*mean*
(In > Out) > (Out > In)							
LH Dorsomedial PFC	**9**	**0**	**49**	**32**	**100**	**.11**	**.09**
LH Dorsomedial PFC	9	0	49	32	[a]	.11	.09
LH Dorsomedial PFC	10	0	60	28	[a]	.10	.09
(Out > In) > (In > Out)							
RH Anterior Insula (cluster)	**13**	**33**	**12**	**13**	**130**	**.21**	**.10**
RH Anterior Insula	13	33	12	13	[b]	.21	.10
RH Anterior Insula	13	35	2	11	[b]	.14	.10
RH Inferior Frontal Gyrus	13	40	26	10	[b]	.17	.10
RH Precentral Gyrus	44	47	4	11	[b]	.11	.09

Notes. *In* = Ingroup, *Out* = Outgroup. Brodmann = Brodmann area; *x, y, z* = coordinates in Montreal Neurological Institute (MNI) space; *k* = cluster size in mm^3; *max* = maximum value within cluster; *mean* = average value within cluster. L = left, R = right. [a] = associated subclusters of LH Dorsomedial PFC, [b] = associated subclusters of RH Anterior Insula. All analyses were k-threshold corrected at $p<.001$.

Table 3. Coordinates for overall differences in functional activation for racial ingroup vs. outgroup

Region	*Brodmann*	*x*	*y*	*z*	*k*	*max*	*mean*
Overall Racial Ingroup > Outgroup							
No Significant Clusters	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Overall Racial Outgroup > Ingroup							
LH Middle Frontal Gyrus (cluster)	**32**	**0**	**9**	**44**	**119**	**.20**	**.15**
LH Middle Frontal Gyrus	32	0	9	44	[a]	.20	.15
RH Superior Frontal Gyrus	6	3	5	8	[a]	.18	.15
RH Anterior Insula (cluster)	**45**	**40**	**20**	**13**	**123**	**.20**	**.15**
RH Anterior Insula	45	40	20	13	[b]	.20	.15
RH Anterior Insula	13	39	20	5	[b]	.18	.15
RH Claustrum		32	11	8	[b]	.19	.16

Notes. *Brodmann* = Brodmann area; *x, y, z* = coordinates in Montreal Neurological Institute (MNI) space; *k* = cluster size in mm^3; *max* = maximum value within cluster; *mean* = average value within cluster. L = left, R = right. [a] = associated subclusters of LH Middle Frontal Gyrus, [b] = associated subclusters of RH Inferior Frontal Gyrus. There were no significant Ingroup > Outgroup clusters. All analyses were k-threshold corrected at $p<.001$.

Table 4. Coordinates for meta-analytic contrasts for overall racial ingroup v. outgroup

Region	*Brodmann*	*x*	*y*	*z*	*k*	*max*	*mean*
Racial (In > Out)) > Racial (Out > In)							
No Significant Clusters	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Racial (Out> In) > Racial (In > Out)							
LH Medial Frontal Gyrus (cluster)	**32**	**0**	**9**	**44**	**119**	**.20**	**.15**
LH Medial Frontal Gyrus	32	0	9	44	[a]	.20	.15
RH Superior Frontal Gyrus	6	3	5	58	[a]	.18	.15
RH Anterior Insula (cluster)	**45**	**36**	**24**	**9**	**123**	**.20**	**.15**
RH Anterior Insula	45	36	24	9	[b]	**.20**	**.15**
RH Anterior Insula	13	36	24	0	[b]	.18	.15
RH Claustrum		30	15	3	[b]	.19	.16

Notes. *In* = Ingroup, *Out* = Outgroup. *Brodmann* = Brodmann area; *x, y, z* = coordinates in Montreal Neurological Institute (MNI) space; *k* = cluster size in mm^3; *max* = maximum value within cluster; *mean* = average value within cluster. L = left, R = right. [a] = associated subclusters of LH Middle Frontal Gyrus, [b] = associated subclusters of RH Anterior Insula. There were no significant Ingroup > Outgroup clusters. All analyses were k-threshold corrected at $p<.001$.

Table 5. Coordinates for differences in functional activation for ingroup vs. outgroup by social cognitive process

Region	*Brodmann*	*x*	*y*	*z*	*k*	*max*	*mean*
Empathy							
Ingroup > Outgroup							
LH Dorsomedial PFC (cluster)	**9**	**0**	**49**	**32**	**100**	**.11**	**.09**
LH Dorsomedial PFC	9	0	49	32	[a]	.11	.09
LH Dorsomedial PFC	10	0	60	28	[a]	.10	.09
Outgroup > Ingroup							
LH Dorsolateral PFC (cluster)	**46**	**-44**	**38**	**13**	**256**	**.53**	**.28**
LH Premotor Cortex (cluster)	**6**	**-27**	**7**	**50**	**260**	**.52**	**.52**
Emotion Perception							
Ingroup > Outgroup							
No Significant Clusters	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Outgroup > Ingroup							
No Significant Clusters	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Notes. *Brodmann* = Brodmann area; *x, y, z* = coordinates in Montreal Neurological Institute (MNI) space; *k* = cluster size in mm^3; *max* = maximum value within cluster; *mean* = average value within cluster. L = left, R = right. [a] = associated subclusters of LH Superior Frontal Gyrus. All analyses were k-threshold corrected at $p<.001$.

Table 6. Coordinates for differences in functional activation for racial ingroup vs. outgroup by social cognitive process

Region	*Brodmann*	*x*	*y*	*z*	*k*	*max*	*mean*
Empathy							
Racial Ingroup > Outgroup							
RH Dorsomedial PFC (cluster)	**9**	**7**	**30**	**34**	**362**	**.40**	**.20**
RH Dorsomedial PFC	9	7	30	34	[a]	.40	.20
RH Dorsomedial PFC	8	15	34	42	[a]	.22	.18
RH Anterior Insula (cluster)	**13**	**43**	**20**	**8**	**260**	**.25**	**.21**
RH Anterior Insula	13	43	20	8	[b]	.25	.21
RH Precentral Gyrus	44	51	19	8	[b]	.18	.18
LH Claustrum (cluster)		**-23**	**20**	**6**	**260**	**.35**	**.31**
Racial Outgroup > Ingroup							
LH Middle Frontal Gyrus (cluster)	**6**	**-27**	**7**	**50**	**260**	**.52**	**.52**
Emotion Perception							
Racial Ingroup > Outgroup							
RH Amygdala (cluster)	**20**	**37**	**-8**	**-19**	**269**	**.34**	**.30**
RH Fusiform (cluster)	**37**	**50**	**-42**	**-8**	**239**	**.23**	**.23**
Racial Outgroup > Ingroup							
RH Anterior Insula (cluster)	**13**	**39**	**20**	**5**	**206**	**.46**	**.33**
RH Anterior Insula	13	39	20	5	[c]	.46	.33
RH Inferior Frontal Gyrus	13	40	26	12	[c]	.33	.33

Notes. *Brodmann* = Brodmann area; *x, y, z* = coordinates in Montreal Neurological Institute (MNI) space; *k* = cluster size in mm^3; *max* = maximum value within cluster; *mean* = average value within cluster. L = left, R = right. [a] = associated subclusters of R Dorsomedial PFC, [b] = associated subclusters of RH Anterior Insula, [c] = associated subclusters of RH Anterior Insula. All analyses were k-threshold corrected at $p<.001$.

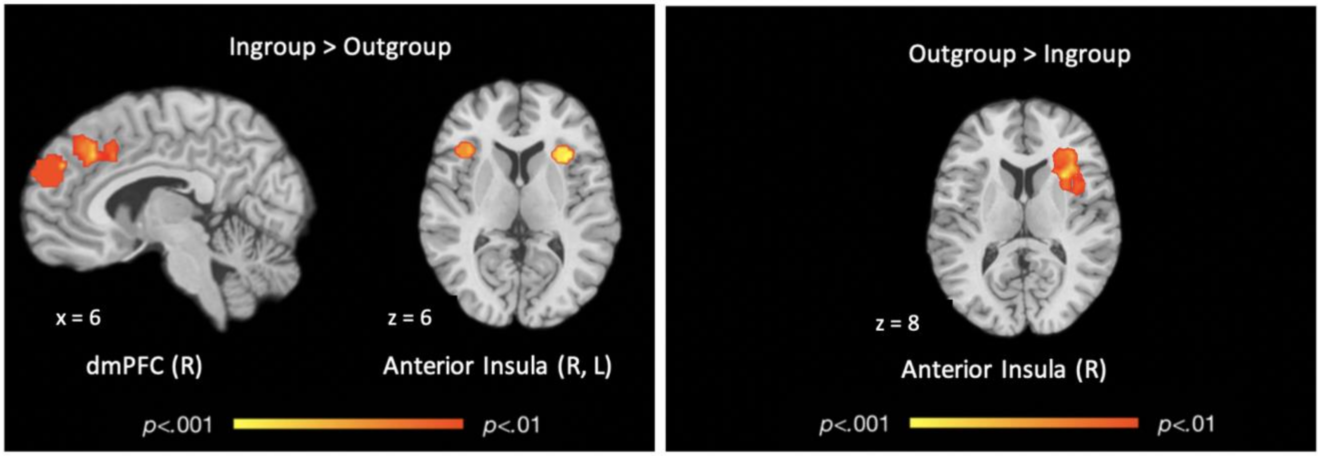

Figure 2. Regions of significant, consistent functional activation for overall ingroup v. outgroup social cognitive processing.

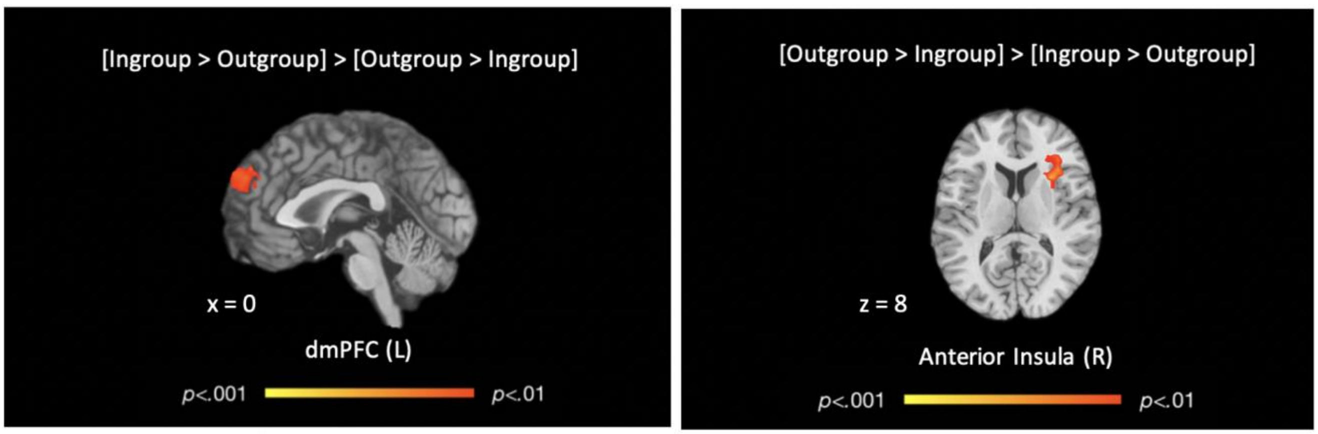

Figure 3. Regions of significant, consistent functional activation for meta-analytic contrasts of ingroup v. outgroup social cognitive processing.

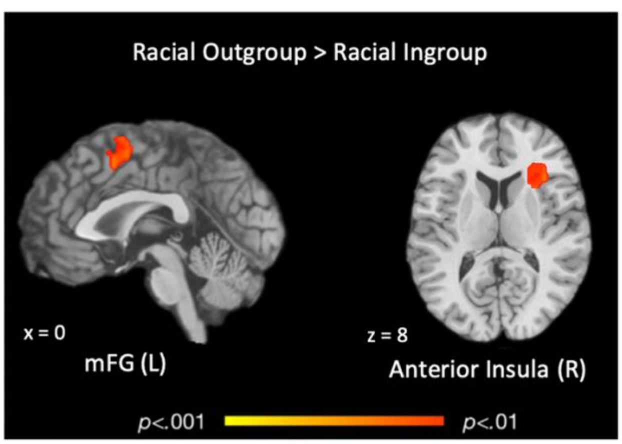

Figure 4. Regions of significant, consistent functional activation for overall racial ingroup v. racial outgroup social cognitive processing. These regions also reflect the meta-analytic contrasts of racial ingroup v. racial outgroup social cognitive processing: [(Racial Outgroup> Ingroup) > (Racial Ingroup > Outgroup)].

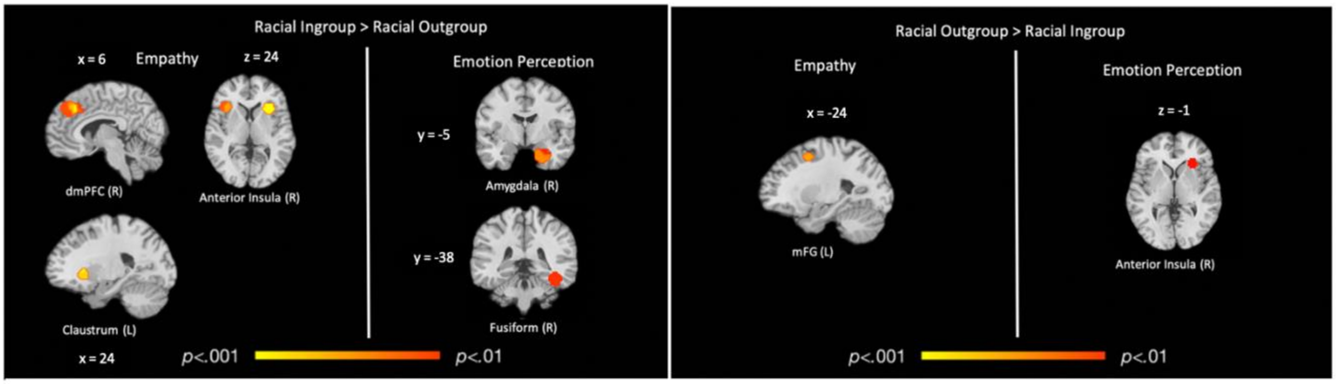

Figure 5. Regions of significant, consistent functional activation for racial ingroup v. racial outgroup empathy and emotion perception.

Supplementary Materials

Methods

Search Terms

Search terms for identifying articles: “fMRI + ingroup + outgroup + political (politics)”; “fMRI + ingroup + outgroup + religion”; “fMRI + ingroup + outgroup + gender”; “fMRI + ingroup + outgroup + social status”; “fMRI + ingroup + outgroup + race”. Hyphenated versions of ingroup (i.e., in-group) and outgroup (i.e., out-group) were included in searches. We also ran searches excluding the “ingroup + outgroup”/ “group membership” terms and using only “fMRI + [social category]”, “fMRI + [social category], + bias” or fMRI + [social category] + affiliation”. This ensured that we captured all possible studies examining different social categories.

Data Analysis: Overview and Rationale

To address the aims of this study, we used Multilevel Kernel Density Analysis (Kober et al., 2008; Kober & Wager, 2010; Wager, Lindquist, & Kaplan, 2007), which is a coordinate-based fMRI meta-analysis technique that computes meta-analytic summary contrasts of brain regions that are more reliably active above beyond what would be expected by chance during one condition versus another (e.g. *ingroup* > *outgroup*) across the included studies. The MKDA procedure nests reported peak coordinates within contrast maps, thus making the contrast maps the unit of analysis and treating them as random effects. This method is advantageous over other methods in which the peak coordinates are the unit of analysis because it prevents a single study from biasing the results if the study reports several nearby peaks (Kober et al., 2008). Additionally, the MKDA method accounts for both study quality and sample by weighting studies based on their sample size and their use of fixed vs. random effects analysis. Specifically, MKDA down-weights study contrasts models that used fixed effects modeling in their analyses, as fixed effects are unable to generalize to the population. By weighting studies in this manner, MKDA allows for higher-quality (i.e. higher powered, more generalizable) studies to have greater impact on the meta-analytic results, as random effects analysis allows (Kober & Wagner, 2010).

A general rule of thumb is that a MKDA with <10 contrasts is unreliable (van Hoorn et al., 2019; Lindquist et al., 2016), so we only ran supplemental analyses for individual social cognitive processes when there were more than 10 contrasts. Processes that met this criterion were: Social Perception, Social Categorization, and Impression Formation (see **SM Table 1** for how these processes/task types were defined).

Results

Differences in functional activation for ingroup vs. outgroup by social cognitive process

We conducted supplemental analyses examining differences in functional activation during additional social cognitive processes identified in the literature, including social perception, social categorization, and impression formation tasks (see **SM Table 3**). Of note, findings reported here should be interpreted with caution given the limited number of contrasts contributing to the results.

Social perception tasks. Among studies in which participants passively viewed ingroup and outgroup members or completed an unrelated task not involving categorization according to group membership (e.g., "viewing Black/White faces and indicating on which side of the screen the face appeared"), the *ingroup > outgroup* comparison (122/520 points; 22/116 contrasts) revealed one cluster of activation with its peak in the right inferior occipitotemporal gyrus (53, -68, 2; k=199, p<.001) that extended into the right fusiform gyrus. The contrast of *outgroup > ingroup social perception* (122/520 points; 22/116 contrasts) showed one cluster of activation centered in the right dorsal anterior cingulate cortex (dACC; 3, 21, 31; k=146, p<.001). No other significant clusters were observed.

Social categorization tasks. Among studies that explicitly instructed participants to categorize stimuli based on their group membership, an analysis of *ingroup* > *outgroup* (29/520 points; 12/116 contrasts) revealed one cluster of activation with its peak in the right iFG (50, 6, 33; k=179, p<.001). There were no significant regions of activation at p<.001 for *outgroup* > *ingroup social categorization.*

Impression formation tasks. Among studies in which participants were explicitly instructed to generate impressions of ingroup and outgroup others, there were no significant cluster of activation at p < .001 for *ingroup* > *outgroup impression formation*. However, the *outgroup* > *ingroup impression formation* comparison (28/520 points; 11/116 contrasts) revealed three significant clusters of activation: one in the right anterior medial prefrontal cortex (amPFC; 22, 57, 7; k= 256, p <.001), one in the right middle temporal gyrus (45, -55,11; k= 257, p <.001), and one in the right middle occipital gyrus extending into the fusiform gyrus (48, -98, 0; k=257, p <.001).

Differences in functional activation for racial ingroup vs. racial outgroup by social cognitive process

For our race-specific contrasts, there were no significant *racial ingroup* > *outgroup* or *racial outgroup* > *ingroup* clusters for social categorization and impression formation tasks. However, we did find significant differences in activation for social perception tasks. The contrast of *racial ingroup* > *outgroup social perception* (77/520 points, 20/116 contrasts) revealed two significant clusters: one in the right dorsal anterior cingulate cortex (dACC; 7, 37,-11; k=266, p <.001) and one in the cerebellum (-7, -79, -25; k=262, p <.001). The *racial outgroup* > *ingroup* *social perception* contrast (77/520 points, 20/116 contrasts) again revealed significant activation in the right dACC, which extended into the mid-cingulate cortex (3, 21, 31; k=146, p <.001). (see **SM Table 4**).

SM Table 1. List and Description of Task Types

Construct Name	Description of Tasks	Example Task	Number of Contrasts
Empathy	Participants view ingroup/outgroup members in pain	Viewing individuals of same/other race being touched by needle	25
Emotion Perception	Participants view emotional ingroup/outgroup stimuli	Viewing faces of same/ other race individuals with angry/happy/neutral expressions	22
Social Perception	Participants passively view ingroup/outgroup members or complete an unrelated task while viewing ingroup/outgroup members	Viewing images of individuals in same/opposing political parties	12
Social Categorization	Participants explicitly categorize stimuli according to ingroup/outgroup membership	Viewing faces of same/other team members and categorizing faces according to team membership	21
Impression Formation	Participants generating impressions of ingroup/outgroup members	Forming a quick impression of same/other race individuals based on face images	12
Individuation	Participants receive individuating information about ingroup/outgroup member or engage with stimuli in a way that leads to individuation of ingroup/outgroup other	Judging same/other race individuals on “friendliness” based on an image and brief descriptive of the individual	2
Imitation	Participants imitate ingroup/outgroup members’ gestures	Imitating same/other gender actors performing hand gestures and	7
Imitation Regulation	Participants suppress (as opposed to follow) tendency to imitate ingroup/outgroup members’ gestures	Refraining from imitating same/other race actors’ facial expressions and hand gestures	2
Theory of Mind	Participants perform mentalizing or perspective-taking tasks for ingroup/outgroup members	Reading the Mind in the Eyes Task with same/other race eyes	3
Prosociality	Participants decide whether to act prosocially toward ingroup/outgroup other	Modified Dictator Game with same/other culture confederate	3
Resource Allocation	Participants make decisions about allocating resources among a group of ingroup/outgroup members	Distributing money to same/other team members	1
Delivering Reward	Participants deliver reward to ingroup/outgroup member	Administering a monetary reward or electric shock punishment to a student from same/other university	1
Perception of Harm	Participants perceive ingroup/outgroup members perpetrating harm against others	Viewing images of student from same/other university	

		harming another student from same/other university	1
Social Exclusion	Participants are socially excluded by ingroup/outgroup members	Cyberball with same/other race confederates	1
Trust	Participants play a trust game within group/outgroup members	Deciding whether to “trust” an individual from same/other political party to carry out risky investment or keep investment to self	1
Memory Recall	Participants subsequent memory recall (versus forgetting) of ingroup/outgroup member stimuli	Viewing images of same/other race faces and recalling those faces 24 hours later	1

Notes. Only bolded task types were included in analyses as other tasks had too few contrasts to provide reliable meta-analytic estimates.

SM Table 2. List of references included in the meta-analysis and their corresponding social category and social cognition process engaged

Author	Social Category	Task Type
Adams et al. (2010)	Race	Theory of Mind
Azevedo et al. (2013)	Race	Social Perception, Empathy
Berlingeri et al. (2016)	Race	Empathy
Bestelmeyer et al. (2015)	Culture	Social Categorization
Brown et al. (2017)	Race	Memory Recall
Cao et al. (2015)	Race	Empathy
Cheon et al. (2013)	Culture	Empathy
Chiao et al. (2008)	Culture	Emotion Perception
Contreras et al. (2013)	Race	Empathy
Cunningham et al. (2004)	Race	Social Perception
Earls et al. (2013)	Race	Imitation, Social Perception
Falk et al. (2012)	Political	Theory of Mind
Feng et al. (2011)	Race	Social Categorization
Freeman et al. (2010)	Race	Individuation
Hart et al. (2000)	Race	Social Perception
Hein et al. (2010)	Minimal	Empathy
Junger et al. (2013)	Gender	Social Categorization
Kaplan et al. (2007)	Political	Social Perception
Krautheim et al. (2018)	Minimal	Emotion Perception
Krill et al. (2009)	Race	Social Exclusion
Lee et al. (2008)	Race	Social Perception
Li et al. (2015)	Race	Emotion Perception

Li et al. (2016)	Race	Impression Formation
Liu et al. (2015)	Race	Emotion Perception
Losin et al. (2014)	Race	Imitation
Losin et al. (2012)	Race	Imitation
Losin et al. (2012)	Gender	Imitation
Luo et al. (2015)	Race	Empathy
Mathur et al. (2010)	Race	Social Perception
Mattan et al. (2018)	Race	Impression Formation
Molenberghs et al. (2017)	Political	Impression Formation
Molenberghs et al. (2016)	Minimal	Perception of Harm
Molenberghs et al. (2014)	Minimal	Delivering Reward
Molenberghs et al. (2014)	Minimal	Social Categorization
Morrison et al. (2012)	Minimal	Social Categorization
Rauchbauer et al. (2015)	Race	Imitation Regulation
Richeson et al. (2008)	Race	Social Perception
Richeson et al. (2003)	Race	Social Perception
Richins et al. (2019)	Minimal	Social Perception, Empathy
Ronquillo et al. (2007)	Race	Social Perception
Ruckmann et al. (2015)	Minimal	Empathy
Rule et al. (2010)	Culture, Political	Impression Formation
Sheng et al. (2014)	Race	Emotion Perception
Telzer et al. (2015)	Race	Prosociality
Van Bavel et al. (2008)	Race, Minimal	Social Categorization

Volz et al. (2009)	Minimal	Resource Allocation
Watson et al. (2017)	Race	Emotion Perception
Wheeler et al. (2005)	Race	Individuation
Wu et al. (2018)	Political	Trust
Xu et al. (2009)	Race	Empathy

SM Table 3. Coordinates for differences in functional activation for ingroup vs. outgroup by social cognitive process

Region	*Brodmann*	*x*	*y*	*z*	*k*	*max*	*mean*
Social Perception							
Ingroup > Outgroup							
RH Occipitotemporal Gyrus (cluster)	n/a	**53**	**-68**	**2**	**199**	**.52**	**.43**
Outgroup > Ingroup							
RH Dorsal ACC (cluster)	**32**	**3**	**21**	**31**	**146**	**.44**	**.31**
RH Dorsal ACC	32	3	21	31	[a]	.44	.32
RH Dorsal ACC	32	14	20	37	[a]	.23	.23
Social Categorization							
Ingroup > Outgroup							
RH Inferior Frontal Gyrus (cluster)	**9**	**50**	**6**	**33**	**179**	**.27**	**.26**
Outgroup > Ingroup							
No Significant Clusters	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Impression Formation							
Ingroup > Outgroup							
No Significant Clusters	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Outgroup > Ingroup							
RH Anterior Medial PFC (cluster)	**10**	**22**	**57**	**7**	**256**	**.22**	**.22**
RH Middle Temporal Gyrus (cluster)	**39**	**45**	**-55**	**11**	**257**	**.22**	**.22**
RH Middle Occipital Gyrus (cluster)	**19**	**48**	**-98**	**0**	**257**	**.22**	**.22**

Notes. *Brodmann* = Brodmann area; *x, y, z* = coordinates in Montreal Neurological Institute (MNI) space; *k* = cluster size in mm^3; *max* = maximum value within cluster; *mean* = average value within cluster. L = left, R = right. [a] = associated subclusters of RH Dorsal ACC. There were no significant Ingroup > Outgroup or Outgroup > Ingroup clusters for Emotion Perception. There were no significant Outgroup > Ingroup clusters for Social Categorization. There were no significant Ingroup > Outgroup clusters for Impression Formation tasks. All analyses were k-threshold corrected at $p<.001$.

SM Table 4. Coordinates for differences in functional activation for racial ingroup vs. outgroup by social cognitive process

Region	*Brodmann*	*x*	*y*	*z*	*k*	*max*	*mean*
Social Perception							
Racial Ingroup > Outgroup							
RH Dorsal ACC (cluster)	**32**	**7**	**37**	**-11**	**266**	**.20**	**.20**
Cerebellum (cluster)		**-7**	**-79**	**-25**	**262**	**.20**	**.20**
Racial Outgroup > Ingroup							
RH Dorsal ACC (cluster)	**32**	**3**	**21**	**31**	**146**	**.44**	**.31**
RH Dorsal ACC	32	3	21	31	[a]	.44	.32
RH Dorsal ACC	32	14	20	37	[a]	.23	.23
Social Categorization							
Racial Ingroup > Outgroup							
No Significant Clusters	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Racial Outgroup > Ingroup							
No Significant Clusters	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Impression Formation							
Racial Ingroup > Outgroup							
No Significant Clusters	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Racial Outgroup > Ingroup							
No Significant Clusters	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Notes. *Brodmann* = Brodmann area; *x, y, z* = coordinates in Montreal Neurological Institute (MNI) space; *k* = cluster size in mm^3; *max* = maximum value within cluster; *mean* = average value within cluster. L = left, R = right. [a] = associated subclusters of RH Dorsal ACC. There were no significant Racial Ingroup > Outgroup or Racial Outgroup > Ingroup clusters for Social Categorization and Impression Formation tasks. All analyses were k-threshold corrected at $p<.001$.