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Research

Ascribing beliefs to ingroup and outgroup political candidates: neural correlates of perspective-taking, issue importance and days until the election

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We used the five weeks leading up to the 2008 presidential election as a backdrop to examine the ways that the brain processes attitudes and beliefs under different circumstances. We examined individual differences in personal issue importance and trait perspective-taking, as well as the temporal context in which attitude representation took place (i.e. number of days until the election). Finally, we examined the extent to which similar or dissimilar processes were recruited when considering the attitudes of political ingroup and outgroup candidates. Brain regions involved in social cognition and theory of mind, and to a lesser extent the limbic system, were modulated by these factors. Higher issue importance led to greater recruitment of neural regions involved in social cognition, across target perspectives. Higher trait perspective-taking was also associated with greater recruitment of several regions involved in social cognition, but differed depending on target perspective; greater activity was observed in prefrontal regions associated with social cognition when considering the perspective of one's own candidate compared with the opponent, and this effect was amplified closer to the election. Taken together, these results highlight ways in which ability and motivational relevance modulate socio-affective processing of the attitudes of others.

Keywords: functional magnetic resonance imaging; perspective-taking; political; attitudes; ingroup; outgroup

1. INTRODUCTION

> 'By using interactive Web 2.0 tools, Mr. Obama's campaign changed the way politicians organize supporters, advertise to voters, defend against attacks and communicate with constituents.'
>
> Claire Cain Miller [1]

While the emergence of social media as a campaign tool in the 2008 United States presidential election highlighted a new way for candidates to connect with voters, the idea that candidates must rally people behind particular ideas and forge positive emotional bonds with the populace is not new. Indeed, Aristotle's characterization of persuasion in terms of ethos and pathos reflect each of these ideas. Likewise, decades of social psychological research have demonstrated the importance of cognitive, emotional and social factors as moderators of attitudinal processes [2].

Recent research in social cognitive neuroscience has also begun to uncover the neural mechanisms that underlie our attitudes and beliefs. This work has examined the generation and the retrieval of personal attitudes, beliefs and evaluations [3,4] and generic ascription of beliefs to unknown others [5]. However, with some notable exceptions [6,7], much of the extant neuroimaging literature considers the ascription of beliefs in cases when participants have limited information about the likely beliefs of the other person, and/or when the beliefs in question are of low motivational relevance to participants.

In the present investigation, we took steps to address this gap by collecting data in the time leading up to the 2008 presidential election. Pre-election periods provide an optimal opportunity to study attitudes as well as the factors that moderate attitudinal processes for a number of reasons.

First, for most other people, most of the time, we only have access to information about a handful of their beliefs, and this may be especially true for

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One contribution of 12 to a Theme Issue 'The biology of cultural conflict'.

outgroup members. During elections, candidates actively express their beliefs in position statements, interviews and debates over a wide range of issues, allowing us to be as informed about their beliefs as we choose to be. Thus, individual differences in the tendency to take the perspective of others (i.e. trait perspective-taking) may be accentuated. In other words, individual differences in perspective-taking tendency may be more apparent when the target of judgement is a political candidate than when the target is a completely unknown individual (as in previous neuroimaging research).

Second, while we may be exposed to volumes of information about multiple candidates, we typically align ourselves more with the views of one candidate over others. In the United States, for those who consider themselves partisan Democrats or Republicans, one candidate represents the ingroup and the other major party candidate represents the outgroup—both literally and figuratively. These individuals are officially selected through the primary process to represent opposing parties, and they also come to symbolically represent the opposing ideologies. Thus, the conflict between one's ingroup and outgroup is very salient during election periods.

Third, some of the issues discussed in the period prior to an election may be near and dear to us, while others may be of little importance to us. Thus, elections provide an opportunity to study issue importance as a moderator of attitudinal processes, and to do so in a naturalistic context.

Finally, the dynamics involved in considering various issues may change as the election nears and media coverage intensifies. Although coverage is heavy in the months leading up to the election, in the final days before the election, there is an outright frenzy. As such, the motivational salience of the upcoming event may alter the process of considering each candidate's views as the election is just days, rather than weeks away.

Each of the factors listed above (trait perspective-taking, ingroup/outgroup status of the target individual, issue importance and temporal context) is likely to influence the ways that individuals generate, process and represent the attitudes of both self and other. These factors form the basis of the current investigation, which aims to address a series of related questions about these hypothesized moderators. For example: Do the neurocognitive processes involved in affirming that one's own candidate does (or does not) believe in a given issue (e.g. climate change and abortion) depend on our dispositional perspective-taking tendencies? Do the processes change when we consider the views of the opposing candidate, in contrast to considering our own candidate? Do they change as a function of whether we are making the assessment five weeks versus five days before the election? Do they differ as a function of how much we care personally about whether climate change is real or how much we care whether abortion is legal?

In considering the neural systems that are likely to be modulated by the factors described above, we turn to the literature examining attitude and belief processes more generally. Thinking about the beliefs of others is commonly associated with a network of brain regions referred to as the mentalizing, theory of mind or social cognition network and includes dorsomedial prefrontal cortex (DMPFC), medial prefrontal cortex (MPFC), temporoparietal junction (TPJ), contiguous regions of precuneus and posterior cingulate cortex (precuneus$_{PCC}$), posterior superior temporal sulcus (pSTS) and anterior temporal cortex [5]. Expressing one's own attitudes, beliefs and evaluations has been observed to recruit a subset of the same regions along with limbic areas including amygdala, ventral and dorsal striatum and insula [8]. Thus, these social cognitive and affective regions were the central focus of our investigation.

A number of studies have also looked at neural responses to perceptually observed ingroup and outgroup members in general. These have typically found greater amygdala responses to outgroup members [9,10], or greater amygdala response as a function of attitudes towards the outgroup [11]. Other research has also suggested that amygdala responses to outgroups may be a special case of the amygdala's function in signalling motivational relevance or cultural learning more broadly [12,13].

More recent studies have examined how empathy processes are modulated by the ingroup or outgroup status of the individual in pain or suffering. Some studies have demonstrated decreased limbic and mentalizing responses to the suffering of outgroup, relative to ingroup members [14–16] (cf. [17]). However, to our knowledge, only a single study has examined neural responses to beliefs held by ingroup and outgroup members. Bruneau & Saxe [7] presented Arab and Israeli participants with pro-Arab and pro-Israeli statements and observed greater precuneus activity when participants were processing outgroup sentiments, compared with ingroup sentiments (also see [6]). Thus, the studies of ingroup and outgroup processing also reinforce a focus on social cognition and affective regions.

(a) *The current study*

We scanned self-identified Democrats and Republicans in the month leading up to the 2008 presidential election (from 34 days to 1 day before) using functional magnetic resonance imaging (fMRI). Participants saw issue statements on each trial (e.g. 'abortion should be legally available in all states') and in different blocks of trials were asked to indicate the extent to which Barack Obama, John McCain or they themselves agreed with the statement. Given our interest in ingroup versus outgroup processes, we categorized blocks as taking the perspective of either *self*, *own candidate* and *opposing candidate*.

Our hypotheses focus on potential moderators of neural responses to these issue statements, considered from different perspectives. Specifically, we were interested in trait perspective-taking [18], days until the election and issue importance. None of these factors have previously been examined in the social cognitive neuroscience literatures on personal attitudes or attributing issue-based attitudes to ingroup or outgroup members; however, each is hypothesized to modulate

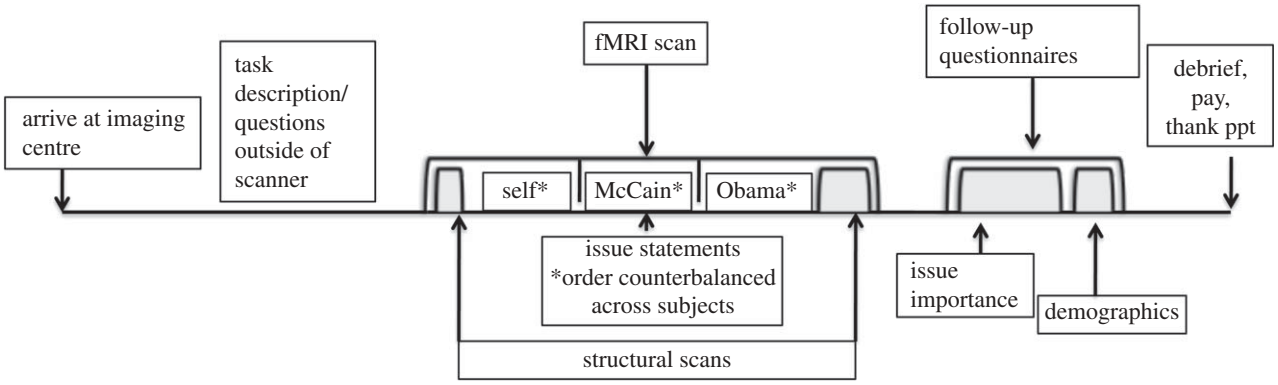

Figure 1. Election study overview. Participants were scanned in the five weeks leading up to the 2008 presidential election. While undergoing fMRI scanning, participants responded to a range of issues relevant to the 2008 election from their own perspective and from the perspective of each of the two major party presidential candidates. Upon exiting the scanner, participants also provided information about the importance of each issue to them personally.

social cognitive and/or affective processes. As this was a first study on the topic, we did not have strong directional hypotheses. We tentatively predicted that attitude importance and nearing the election might both intensify limbic responses. Additionally, the lion-share of prior studies on ingroup and outgroup processes have shown stronger social cognition-related activations to ingroup members than outgroup members [14,15]. Thus, we predicted that social cognition regions would show greater ingroup activity that was altered by each of the moderator variables.

2. METHODS

(a) *Participants*

Participants ($n = 28$) were recruited prior to the 2008 presidential election, through mass emails, posted fliers, from student organizations on campus and through the UCLA subject pool, and received either course credit or financial compensation for their participation. Participants were not told that the study was related to the election, though specific strategies (e.g. recruiting through campus partisan clubs) were employed to balance the number of participants in the sample who self-identified as Obama supporters ($n = 16$) and McCain supporters ($n = 12$). In performing data analysis, two participants were excluded owing to significant signal dropout, two participants were excluded for lack of attention to the task (not providing any variability in agree/disagree responses, despite the fact that all issues were presented separately with opposing frames), and one additional participant did not complete individual difference measures necessary to perform key analyses. Thus, our analyses focused on the remaining 23 participants (14 Obama supporters, 9 McCain supporters; 10 female, 13 male) scanned prior to the election. All participants were right-handed and met the following criteria related to fMRI safety: (i) were not claustrophobic; (ii) had no metal in their bodies (other than tooth fillings); and (iii) were not pregnant/breast-feeding. Potential participants were excluded if they were currently taking any psychoactive medication. Participants consisted primarily of younger adults (mean age = 24, s.d. = 5.65 years; range = 18–39), and were primarily white/Caucasian (65%), Asian (13%) and Middle Eastern (9%). All participants were American citizens who were eligible to vote, and spoke English fluently.

(b) *Materials*

A set of 76 issue statements were developed, reflecting issues of concern to most Americans in the 2008 presidential election. Issues of concern were adapted from CNN public opinion polls (http://www.cnn.com/ELECTION/2008/issues/), and from procon.org's issue tracker (http://2008election.procon.org/). Each issue was presented in two forms to balance positive and negative framing (e.g. 'invading Iraq was the right choice'; 'it was a mistake to invade Iraq'); however, statements about the same issue were never presented directly adjacent to one another. Statements were balanced such that half of the statements were framed in a way that is typically consistent with liberal ideology and half in a way that is typically consistent with conservative ideology.

(c) *Procedure*

Upon arrival, participants were given informed consent and familiarized with the scanner task. During task instructions, participants were told that they would be presented with a variety of issues that related to the presidential election. It was explained that the task would take place in three phases in which participants would be asked to rate whether they agreed, felt neutral or disagreed with the statement presented. They were also told that they would also be asked to perform the same task, but from the perspectives of Barack Obama and John McCain. The order of perspectives was counterbalanced across participants, such that there was an even balance between the order of Obama versus McCain, and between the order of one's own candidate versus the opponent (figures 1 and 2).

Next, while in the fMRI scanner, each of the 76 issues was presented visually and aurally (to control for participant reading speed) in three sections (figures 1 and 2). During the instructions, participants were told that during 'self' blocks, they should indicate whether they agreed, felt neutral or disagreed with the statement presented using one of three buttons,

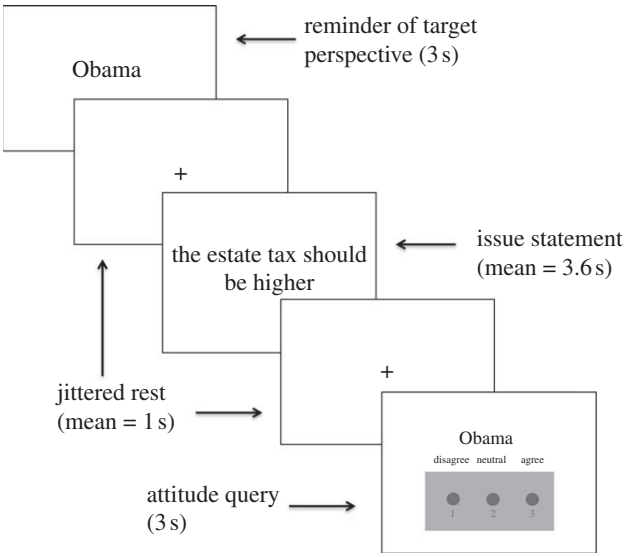

Figure 2. Example stimulus block. Each stimulus block began with a reminder of the target perspective that participants should take in considering the issue presented. This reminder was displayed for 3 s, followed by visual and auditory presentation of an issue relevant to the election. Following exposure to the issue, participants were queried as to the attitude of the target individual (self, Obama or McCain), and allowed 3 s to make a response. The order of targets was counterbalanced across subjects, both in terms of ordering of self/Obama/McCain, and also in terms of the order in which one's own candidate appeared relative to the opposing candidate. The number of liberal/conservative statements was also counterbalanced across sections, as was the distribution of issues for each candidate. Trials within blocks were jittered using values drawn from a random exponential function, with a mean of 1 s.

directly following the presentation of the issue. In the 'McCain' section, participants made equivalent responses taking the perspective of John McCain, and in the 'Obama' section, participants made equivalent responses taking the perspective of Barack Obama. Prior to each block, participants were reminded of the condition with a screen that either said 'self', 'Obama' or 'McCain', for 3 s. They were then presented with the issue in question (mean phrase duration = 3.6 s, s.d. = 1.1 s). Finally, they were prompted to register the target person's attitude (on the response screen, they were reminded of the mapping between disagree/neutral/agree and the button box, and also reminded of the target perspective; figure 2). In order to minimize effort switching between perspectives, the self, McCain and Obama blocks were kept together in larger sections which began with a more general reminder ('What do YOU think?'; 'What does OBAMA think?' and 'What does McCAIN think?'). The order of sections was counterbalanced across subjects, both in terms of the individual candidate (order of Obama versus McCain) and in terms of affiliation (order of one's own candidate versus the opponent). The number of liberal/conservative statements was also counterbalanced across sections, as was the distribution of issues for each candidate. Each candidate section contained 21 issues, while the self section contained 34 issues. Participants were given 3 s following each issue to indicate their response (agree, neutral and disagree). Trials were jittered using values drawn from a random exponential function, with a mean of 1 s (figure 2).

Upon exiting the scanner, participants again viewed each issue that they evaluated in the scanner and using 5 point Likert scales rated how important the issue was to them personally ('How important is this issue to you personally?').

(d) *Functional magnetic resonance imaging acquisition and analysis*

(i) *Functional magnetic resonance imaging data acquisition*

Imaging data were acquired using a Trio 3 T head-only MRI scanner at the UCLA Ahmanson-Lovelace Brain-mapping Centre. Head motion was minimized using foam padding and surgical tape; goggles were also fixed in place using surgical tape connecting to the head coil and scanner bed. A set of high-resolution structural T2-weighted echo-planar images were acquired coplanar with the functional scans (spin-echo; TR = 5000 ms; TE = 34 ms; matrix size = 128 × 128; 33 interleaved slices; FOVread = 220 mm; FOVphase = 100 mm; slice thickness = 4 mm; voxel size = 1.7 × 1.7 × 4.0 mm; flip angle = 90°). One functional run lasting 600 s was recorded for each participant (echo-planar T2-weighted gradient-echo, TR = 2000 ms, TE = 30 ms, flip angle = 75°, matrix size = 64 × 64, 33 axial slices, FOV = 220 mm, 4 mm thick; voxel size = 3.4 × 3.4 × 4.0 mm). Behavioural responses (i.e. agreement ratings) were collected using a scanner compatible button box.

(ii) *Functional magnetic resonance imaging data analysis*

The data were analysed using statistical parametric mapping (SPM5, Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK). Functional images were realigned to correct for motion, normalized into standard stereotactic space (Montreal Neurological Institute, MNI), and smoothed with an 8 mm Gaussian kernel, full width at half maximum. Following preprocessing, we conducted fixed-effect analyses for each subject. In all analyses described, 'self' refers to conditions in which the participant answered from his or her own perspective. 'Own candidate' refers to conditions in which the participant answered from the perspective of the candidate that they reported supporting (e.g. for participants planning to vote for Obama, 'own candidate' would refer to instances when answering from Obama's perspective). 'Opposing candidate' refers to conditions in which the participant answered from the perspective of the candidate that they reported opposing (e.g. for participants planning to vote for Obama, 'opposing candidate' would refer to instances when answering from McCains's perspective). Participants were excluded from specific analyses if they provided no variability in their answers in a given condition (e.g. answered 'agree' to all questions from Obama's perspective, given that all issues were presented with both liberal and conservative, mutually exclusive and framings), or if they did not have any responses that

fitted into a category of interest (e.g. never answered 'agree' to questions from Obama's perspective).

We intentionally included the same issue framed from both a liberal and conservative perspective in order to create a balanced number of agree and disagree responses. This was done in order to keep participants engaged in the task and unable to create a response set. Nevertheless, our interest and analyses focus on just the items for which participants selected 'agree' as their answer. Answering in the affirmative invokes a simpler, more streamlined set of cognitive processes than negation. For instance, psychologists have suggested that negation always involves an initial affirmation followed by additional negation-specific processes [19]. Additionally, numerous neurolinguistic studies highlight the neurocognitive differences between affirmation and negation [20–22]. Thus, we followed our procedure from a previous study [23] in which behavioural affirmations and negations were induced by the paradigm, but analyses focused on affirmations only (i.e. agree trials).

At the first level, we computed main effects of the task collapsing across targets and for each target person separately during issue exposure (all targets combined; self versus baseline; own candidate versus baseline; opposing candidate versus baseline; own candidate versus opposing candidate). We also computed the main effect of issue importance (collapsing across targets) for each subject individually, as well as the effect of issue importance on each target person condition, using each subject's individual importance ratings, collected after the scan for each issue, as a parametric modulator of the effect of issue agreement. Finally, at the single-subject level, we also examined the interaction between target candidates and personal issue importance (e.g. own candidate versus opposing candidate, with importance entered as a parametric regressor). The task was modelled as event related, focusing on the time during which participants were exposed to each issue (modelled as a boxcar from the onset of the voiced reading of the issue until offset, mean phrase duration = 3.6 s, s.d. = 1.1 s). Other task components (target reminder period and attitude query period) were included in the model as covariates of no interest. Jittered rest periods served as an implicit baseline.

In order to assess the effect of perspective-taking, we regressed individual difference scores from the interpersonal reactivity index (IRI) perspective-taking subscale [18] onto task-related activity during conditions of interest. We focused on this subscale of the IRI because we were interested in the cognitive ability to imagine others' perspectives, rather than the more emotional tendency to feel what others feel. We believed this was most appropriate, given the task of ascribing beliefs to candidates. This subscale includes items such as 'I try to look at everybody's side of a disagreement before I make a decision' and 'I sometimes find it difficult to see things from the 'other guy's' point of view' (reverse coded). We ran this type of analysis examining all targets together, and for each target perspective on its own. In order to assess the effect of temporal context, we similarly regressed proximity to the election (in days) onto task-related neural activity, with increasing values representing times closer to the election. More specifically, we coded days to the election using negative values, such that days farther from the election were more negative, and increased as election day approached (e.g. 10 days from the election was coded as −10). This coding means that positive correlations are interpreted as increasing as the election approached.

In order to assess the effect of attitude importance across participants, we conducted a random effect analysis, averaging across the parametric modulation analysis conducted at the individual subject level. In order to assess the effect of the interaction between issue importance and perspective-taking, we entered IRI perspective-taking scores as a between-subject regressor in a group-level analysis, averaging across first-level maps of the parametric modulation of task by issue importance. We assessed the interaction between days and perspective-taking by first mean centring each variable and calculating a product of the two centred variables. We then entered this score as a regressor in a group-level analysis averaging across task-related activity at the single-subject level. Finally, we assessed the interaction between representations of ingroup and outgroup with each of the effects described above, in a group-level analysis.

All results are reported at a voxel-wise threshold of $p < 0.005$, $k = 45$, corresponding to false discovery rate (FDR)-corrected $p < 0.05$ based on a Monte Carlo simulation implemented using AlphaSim in the software package AFNI (http://afni.nimh.gov/afni/doc/manual/AlphaSim). Additional results are also presented that are significant at a less conservative threshold ($p < 0.005$, $k = 20$), reflecting a reasonable balance between type I and type II error concerns [24]. All coordinates are reported in MNI space.

3. RESULTS

(a) *Behavioural ratings*

(i) *Issue importance*

For each issue viewed in the scanner, participants provided a personal rating of issue importance (scale 1–5) upon exiting the scanner. On average, participants rated the issues assessed as being somewhat important to them ($M = 3.32$, s.d. = 0.44, range = 2.31–4.23). Average issue importance ratings did not differ statistically by candidate supported ($M_{\text{obama\_supporters}} = 3.32$, s.d. = 0.37, $M_{\text{mccain\_supporters}} = 3.33$, s.d. = 0.44, $F_{1,22} = 0.005$, $p = 0.95$).

(ii) *Perspective-taking*

Each participant's perspective-taking tendency was measured using the perspective-taking subscale of the IRI (items coded 0–4; total possible points = 28). On average, participants' scores were within the normal range ($M = 19.09$, s.d. = 3.07; range = 13–24), and no difference was observed between Obama supporters ($M = 18.92$, s.d. = 2.97) and McCain supporters ($M = 19.33$, s.d. = 3.39), $F_{1,22} = 0.091$, $p = 0.77$.

(iii) *Days until the election*

Participants were scanned between 34 and 1 day prior to the election ($M = 14$ days, s.d. = 11 days). Days prior to the election were coded as negative values (e.g. 14 days prior was coded as −14) to allow

Table 1. Reaction time differences between Obama supporters and McCain supporters. No reaction time differences were found between Obama supporters ($n = 14$) and McCain supporters ($n = 9$) for any of the target perspectives.

target	group	mean RT (seconds)	s.d.	*p*-val (support Obama versus McCain)
all (self + McCain + Obama)	supports McCain	0.86	0.10	0.31
	supports Obama	0.80	0.12	
	all	0.82	0.12	
self	supports McCain	0.76	0.14	0.60
	supports Obama	0.72	0.18	
	all	0.74	0.16	
McCain	supports McCain	0.94	0.21	0.42
	supports Obama	0.86	0.24	
	all	0.89	0.23	
Obama	supports McCain	0.87	0.19	0.69
	supports Obama	0.83	0.22	
	all	0.85	0.21	

interpretation of positive correlations with this metric as increasing as election day approached. While not statistically significant, Obama supporters were scanned marginally earlier than McCain supporters on average (mean days prior, Obama supporters = 17, s.d. = 12; mean days prior, McCain supporters = 10, s.d. = 8, $F_{1,22} = 2.77$, $p = 0.11$).

(iv) *Reaction times*

There were no reaction time differences by partisan group overall, or by partisan group for any of the targets assessed (table 1).

(b) *Neuroimaging results*

(i) *Ingroup and outgroup perspectives*

We first compared the main effect of taking the perspective of one's own candidate compared with the opposing candidate. Taking these two different perspectives were associated with differential activity in specific regions associated with theory of mind. Taking the perspective of one's own candidate resulted in increased activity in posterior cingulate (PCC), whereas taking the opponent's perspective was associated with greater activity in bilateral TPJ, and insula (table 2).

Table 2. Neural regions associated with differences between taking the perspective of one's own candidate versus the opponent. All analyses thresholded at voxel-wise threshold of $p < 0.005$; results starred (*) survive cluster threshold of $k = 45$, corresponding to FDR-corrected $p < 0.05$; results not starred survive $k = 20$, uncorrected. All results are reported in MNI space. Note: no. voxels = number of voxels in independent clusters (note: rows where cluster size is not specified imply subregions of the same cluster; rows where region is not listed imply separate clusters within the same region). TPJ, temporoparietal junction.

region	*x*,*y*,*z* (mm)	no. voxels	*t*-val
my candidate > opponent			
posterior cingulate*	6, −24,30	71	3.98
	−3, −24,36		3.04
brainstem	−3, −30, −27	20	4.00
opponent > my candidate			
TPJ	63, −51,36	36	3.95
	−63, −36,36	20	3.36
inferior frontal gyrus	60,6,12	25	4.11
insula*	39,12,12	49	3.59
	42,6,0		3.35

(ii) *Issue importance*

For this analysis, we used self-reported issue importance as a parametric modulator in our first-level models, such that each participant's idiosyncratic ratings of issue importance were used to scale the predicted BOLD response on each trial. When the parametric regressor was applied to all agree trials, collapsing across target perspective (self, own candidate and opposing candidate), regions commonly associated with social cognition ($\text{precuneus}_{\text{PCC}}$ and bilateral TPJ) were more active in response to attitude statements rated as more important (table 3 and figure 3*a*). Although these regions appeared sporadically in parametric regression analyses for individual target perspectives, there was no robust pattern present: from the self-perspective, activity in right TPJ and PCC was associated positively and negatively, respectively, with issue importance; for the own candidate perspective (i.e. taking my preferred candidate's perspective) MPFC and left TPJ activity was positively associated with issue importance, and for the opposing perspective (i.e. taking my non-preferred candidate's perspective) $\text{precuneus}_{\text{PCC}}$ activity was positively associated with issue importance, similar to the effect observed by Bruneau & Saxe [7]. Thus, issue importance seems to modulate social cognition regions across attitude assessments in general, but only weakly for any particular target perspective. None of these regions was modulated for issue importance differentially for own and opposing candidate perspectives (electronic supplementary material, table S1).

(iii) *Perspective-taking*

Trait perspective-taking was measured using the perspective-taking subscale of the IRI [18] and entered as a regressor between participants. Collapsing across target perspectives those higher in trait perspective-taking showed greater activity in a number of posterior regions associated with social cognition including left

Table 3. Neural regions associated with self-rated personal issue importance, across targets. All analyses thresholded at voxel-wise threshold of $p < 0.005$; results starred (*) survive cluster threshold of $k = 45$, corresponding to FDR-corrected $p < 0.05$; results not starred survive $k = 20$, uncorrected. All results are reported in MNI space. Note: no. voxels = number of voxels in independent clusters (note: rows where cluster size is not specified imply subregions of the same cluster; rows where region is not listed imply separate clusters within the same region). MPFC, medial prefrontal cortex; rACC, rostral anterior cingulate cortex; VLPFC, ventrolateral prefrontal cortex.

region	*x*,*y*,*z* (mm)	no. voxels	*t*-val
precuneus$_{PCC}$*	12, −57,42	1478	5.87
precuneus$_{PCC}$*	12, −60,57		5.21
TPJ/inferior parietal lobe*	54, −33,39		5.43
posterior cingulate	15, −36,30	27	4.25
precuneus	−15, −60,54	21	3.96
inferior parietal lobe*	−51, −48,57	320	4.67
TPJ*	−51, −45,45		3.45
insula*	−33,0,12	100	4.63
rACC/MPFC	−12,48, −3	20	3.21
middle temporal gyrus*	−57, −63,3	37	4.50
	45, −69,15	36	4.43
	54, −66,0	114	4.33
middle cingulate*	9, −9,33	51	4.34
middle frontal gyrus	33,36,3	20	4.06
VLPFC	39,42,0		3.45
middle frontal gyrus*	−24,42,6	25	4.04
	−36,39,33	60	3.90
	30,36,18	40	3.83
calcarine	−12, −48,15	28	3.80
insula*	42,3, −3	51	3.77
mid-cingulate	−18, −15,48	33	3.75
	−3, −6,42		3.56
cerebellum	−9, −72, −45	27	3.66
cuneus	−15, −75,36	39	3.33
lingual gyrus	21, −90, −3	24	−3.71
inferior occipital	−21, −87, −6	22	3.46

TPJ, pSTS and precuneus$_{PCC}$ (table 4). None of these effects was observed for the self perspective, as would be expected given that expressing one's own attitude may not involve perspective-taking. However, when considering one's own candidate's perspective, those higher in perspective-taking produced greater activity in a number of regions involved in social cognition, including DMPFC, MPFC, precuneus$_{PCC}$ and right pSTS, along with amygdala. Thinking about the opposing candidate's perspective recruited some posterior social cognitive regions (left TPJ and bilateral pSTS) in those higher in perspective-taking. The interaction of perspective-taking and target perspective (own versus opposing candidate) yielded effects in both DMPFC and MPFC, such that these regions were more active when considering one's own candidate to the extent that one was higher in trait perspective-taking (figure 4 and electronic supplementary material, table S2).

(iv) *Days until the election*

Participants were scanned between 1 and 34 days prior to the 2008 presidential election. Values corresponding to days from election were entered as a

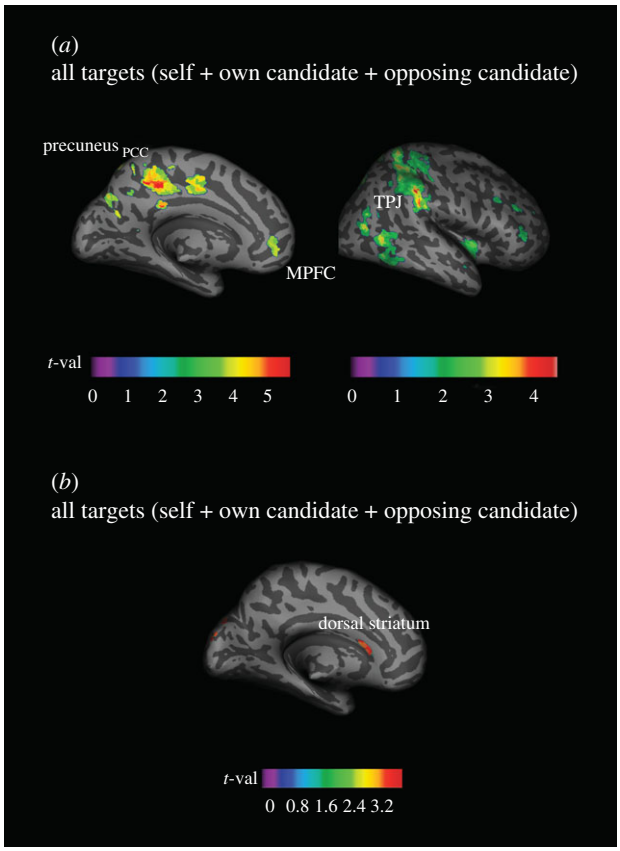

Figure 3. Main effects of issue importance and temporal context. (*a*) Main effect of issue importance. Increased personal issue importance was associated with activity in regions involved in social cognition, including temporoparietal junction (TPJ), precuneus$_{PCC}$ and medial prefrontal cortex (MPFC). Results displayed at $p < 0.005$, $k = 20$. (*b*) Main effect of temporal context. As election day drew nearer, increased activity was observed in dorsal striatum. Results displayed at $p < 0.005$, $k = 20$.

Table 4. Neural regions associated with trait perspective-taking across targets. All analyses thresholded at voxel-wise threshold of $p < 0.005$; results starred (*) survive cluster threshold of $k = 45$, corresponding to FDR-corrected $p < 0.05$; results not starred survive $k = 20$, uncorrected. All results are reported in MNI space. Note: no. voxels = number of voxels in independent clusters (note: rows where cluster size is not specified imply subregions of the same cluster; rows where region is not listed imply separate clusters within the same region). Perspective-taking was measured using the IRI perspective-taking subscale [18]. HCMP, hippocampus; MTL, medial temporal lobe; OFC, orbitofrontal cortex; pSTS, posterior superior temporal sulcus.

region	*x*,*y*,*z* (mm)	no. voxels	*t*-val
precuneus	9, −51,66	30	3.81
TPJ	−48, −36,27	25	3.61
VLPFC/OFC*	−27,30, −6	86	5.50
MTL/HCMP*	45, −18, −15	173	4.60
MTL/parahippocampal	21, −24, −21	29	3.83
middle frontal gyrus	48,9,51	27	4.23
postcentral gyrus*	−57, −12,18	94	4.12
pSTS*	−48, −33,6		3.42
VLPFC*	−48,39,0	52	4.08
middle temporal gyrus	45, −81,21	21	4.01
middle occipital gyrus	−39, −87,12	36	3.86
fusiform	−36, −60, −3	23	3.29

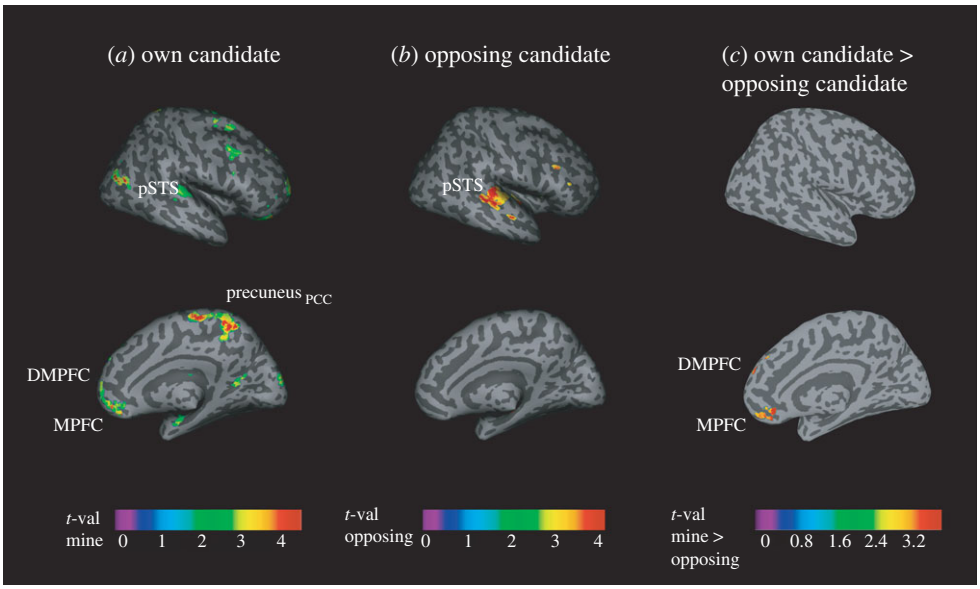

Figure 4. Effect of trait perspective-taking by target group. Several regions associated with social cognition were observed for those higher in trait perspective-taking (measured using the perspective-taking subscale of the IRI [18]) when taking the perspective of both (*a*) ingroup and (*b*) outgroup candidates. However, more regions of the network were observed when taking the perspective of one's own candidate than the opponent, and specifically, activity in both medial prefrontal cortex (MPFC) and dorsomedial prefrontal cortex (DMPFC) were higher for ingroup than outgroup targets (*c*). Results displayed at $p < 0.005$, $k = 20$.

between-participant regressor in an analysis averaging across contrasts of issue statement trials versus rest, such that positive correlations are associated with greater activity as election day approaches. In an analysis that ignored target perspective, dorsal striatum was the only region associated with affective or social cognitive processing that was more active in participants scanned closer to election day. No regions of interest showed the opposite pattern (table 5 and figure 3*b*). This dorsal striatum effect appears to be driven largely by trials from the self perspective as this was the only target perspective to display this pattern. The self perspective was also associated with greater anterior temporal cortex and insula activity farther from election day. Paralleling the self perspective, the own candidate perspective was associated with greater anterior temporal cortex and left pSTS activity farther from election day, whereas trials when the opposing candidate's perspective was taken produced greater left pSTS and precuneus$_{PCC}$ activity closer to the election. Finally, MPFC and bilateral pSTS were both associated with the interaction between target perspective (own versus opposing candidate) and days until the election, such that both regions were more active when considering one's own candidate's perspective, the further away the election was (electronic supplementary material, table S3).

(v) *Interaction between issue importance and perspective-taking*

This analysis was conducted by adding a between-participant regressor for trait perspective-taking to the parametric modulation analyses of issue importance that was conducted at the single-subject level. Relatively few activations were observed in these analyses. Collapsing across target perspectives, precuneus$_{PCC}$ and right TPJ were negatively associated with the interaction, suggesting that for lower importance issues, these regions were engaged more by those high in trait perspective-taking (table 6). The precuneus$_{PCC}$ effect was observed when considering one's own candidate's perspective; however, this activity did not statistically differ between target perspectives. The reverse effect was observed for amygdala when considering the opposing candidate, suggesting that for high importance issues, those lower in dispositional perspective-taking recruited more amygdala when considering the views of the opposing candidate, and this activity significantly differed between target perspectives (electronic supplementary material, table S4).

Table 5. Neural regions associated with proximity to the election measured in days, across targets; positive correlations imply increased activity closer to the election. All analyses thresholded at voxel-wise threshold of $p < 0.005$; results starred (*) survive cluster threshold of $k = 45$, corresponding to FDR-corrected $p < 0.05$; results not starred survive $k = 20$, uncorrected. All results are reported in MNI space. Note: no. voxels = number of voxels in independent clusters (note: rows where cluster size is not specified imply subregions of the same cluster; rows where region is not listed imply separate clusters within the same region).

region	*x*,*y*,*z* (mm)	no. voxels	*t*-val
dorsal striatum	−6,21,9	35	3.58
	−9,21,6		2.88
cuneus	0,−99,21	28	4.06

(vi) *Interaction between days to election and perspective-taking*

The most robust and widespread effects were observed in the interaction between days to election and perspective-taking. When collapsing across target perspective,

Table 6. Neural regions associated with the interaction between personal issue importance and trait perspective-taking across targets. All analyses thresholded at voxel-wise threshold of $p < 0.005$; results starred (*) survive cluster threshold of $k = 45$, corresponding to FDR-corrected $p < 0.05$; results not starred survive $k = 20$, uncorrected. All results are reported in MNI space. Note: no. voxels = number of voxels in independent clusters (note: rows where cluster size is not specified imply subregions of the same cluster; rows where region is not listed imply separate clusters within the same region).

region	*x*,*y*,*z* (mm)	no. voxels	*t*-val
TPJ	45,−36,33	22	4.58
precuneus*	6,−45,69	55	4.45
superior parietal lobe	24,−48,57	34	3.53
cerebellum*	−39,−81,−27	55	3.91
	−30,−48,−51	51	5.63
	18,−69,−48	20	4.68

Table 7. Neural regions associated with the interaction between trait perspective-taking and temporal proximity to the election. All analyses thresholded at voxel-wise threshold of $p < 0.005$; results starred (*) survive cluster threshold of $k = 45$, corresponding to FDR-corrected $p < 0.05$; results not starred survive $k = 20$, uncorrected. All results are reported in MNI space. Note: no. voxels = number of voxels in independent clusters (note: rows where cluster size is not specified imply subregions of the same cluster; rows where region is not listed imply separate clusters within the same region). DMPFC, dorsomedial prefronal cortex.

region	*x*,*y*,*z* (mm)	no. voxels	*t*-val
TPJ/pSTS*	−51,−48,27	663	7.40
insula*	−27,15,15	2540	6.87
amygdala*	−21,−3,−18		3.97
	24,0,−21		3.96
ventral striatum*	12,15,0		3.38
middle frontal gyrus*	45,30,21		5.96
hippocampus*	30,−12,−18		5.37
	−21,−6,−18		4.14
MPFC*	0,60,12	1646	6.56
DMPFC*	0,51,33		4.72
$\text{precuneus}_{\text{PCC}}$*	15,−51,27	856	5.88
	3,−66,33		5.33
TPJ/pSTS*	54,−60,36	448	5.24
	48,−63,21		4.98
	54,−66,42		4.90
anterior temporal cortex*	−54,0,−12	131	4.86
inferior temporal gyrus	45,−15,−33	28	5.73
inferior occipital lobe*	33,−90,−9	276	4.43
middle frontal gyrus*	−33,51,6	125	4.24
VLPFC	−45,45,−15		3.36
middle cingulate	9,−6,33	30	4.13
	24,−3,39		3.58
lingual gyrus	−27,−57,0	34	3.85
cerebellum*	−15,−63,−27	102	3.47
	0,−72,−45	44	4.01
	45,−66,−39	50	5.12
	15,−27,−30	27	4.35

as the election drew closer, those higher in trait perspective-taking produced greater activity in various regions associated with social cognition (DMPFC, MPFC, $\text{precuneus}_{\text{PCC}}$, bilateral TPJ and bilateral pSTS) and affect (ventral striatum, amygdala, insula; table 7 and figure 5*a*). Both the self and own candidate perspectives showed effects in multiple regions associated with social cognition and affect. In the self-perspective, DMPFC, $\text{precuneus}_{\text{PCC}}$, bilateral pSTS, anterior temporal cortex, ventral and dorsal striatum, amygdala and insula all followed this pattern. In the own candidate perspective, left TPJ, bilateral pSTS, ventral and dorsal striatum, and insula showed this pattern. In contrast, when considering the opposing candidate's perspective, only insula showed this effect. The difference between effects for own and opposing candidate's perspective was quantified in a three-way interaction between days to the election, trait perspective-taking and target perspective (own versus opposing candidate) in which DMPFC, $\text{precuneus}_{\text{PCC}}$, left TPJ and ventral striatum were more active when considering one's own candidate as the election neared to the extent that one was high in trait perspective-taking (figure 5*b*). In other words, as people thought about their own candidate, those high in trait perspective-taking recruited regions involved in perspective-taking more as the election approached, but this same pattern was not present when thinking about the opposing candidate's perspective. Of note, in this analysis (IRIpt × days), very few regions that are not associated with social cognition showed greater activity when taking the perspective of one's own candidate, compared with the opponent, and no regions involved in social cognition showed greater activity when taking the perspective of the opponent compared with one's own candidate (electronic supplementary material, table S5).

4. DISCUSSION

In the current investigation, we used the five weeks leading up to the 2008 presidential election as a backdrop to examine the ways that attitudes and beliefs are processed in the brain under different circumstances. In particular, we were interested in how contextual and individual difference factors change the ways that our brains process our own attitudes, and those of ingroup and outgroup members. We examined both individual differences in personal issue importance and trait perspective-taking, as well as the temporal context in which attitude representation took place (i.e. number of days until the election). Finally, we examined the extent to which similar or dissimilar processes were recruited when considering the attitudes of ingroup and outgroup members.

(a) *Perspective-taking*

The basic comparison between perspective-taking targets (taking the perspective of the ingroup candidate versus the outgroup candidate) was not very revealing. One region commonly associated with social cognition was more active when considering one's own candidate (PCC) and another region associated with social cognition was more active when considering the opposing candidate (TPJ). The presence of activity in regions within the social cognition network to both ingroup and outgroup targets is consistent with other work examining responses to motivationally relevant outgroups [7]. However, the specific regions observed

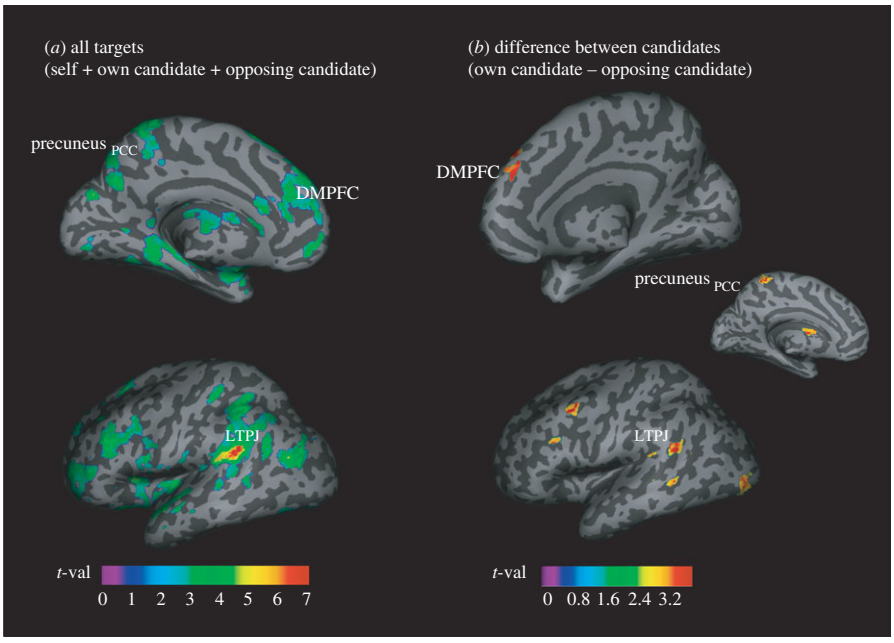

Figure 5. Interaction between trait perspective-taking and temporal context. (*a*) Widespread activity in the mentalizing network and in affective processing regions was observed for those higher in perspective-taking (measured using the perspective-taking subscale of the IRI [18]), as election day approached. However, neural activity in these regions was not equally recruited when considering the attitudes of one's own candidate compared with the opponent (*b*). Several regions associated with perspective-taking (dorsomedial prefrontal cortex, DMPFC; temporoparietal junction, TPJ; precuneus$_{PCC}$) were more strongly associated with this interaction when taking the perspective of one's own candidate, compared with taking the perspective of the opponent. Results displayed at $p < 0.005$, $k = 20$.

are inconsistent with this prior work (in which increased precuneus was observed when considering outgroup targets). Thus, this does not suggest a clear general inference about the role of the social cognition network in attitudinal processing, but might instead lead to speculation about the distinct contributions of TPJ and precuneus to social cognition.

A clearer picture is present once trait level of perspective-taking is considered (in the form of an interaction between trait perspective-taking and whose perspective was being taken). Taking the perspective of both ingroup and outgroup targets recruited posterior regions, which tend to be associated with thinking about the states and traits of other's minds. However, taking the perspective of the ingroup candidate preferentially recruited prefrontal regions (MPFC, DMPFC), in comparison with taking the perspective of the outgroup candidate.

This effect of perspective-taking for ingroup versus outgroup targets is striking and at the same time somewhat disheartening. Various theories of negotiating peace between opposing sides, whether in the context of a financial negotiation or between heads of state, suggest that a fundamental roadblock is a lack of perspective-taking [25,26]. Interventions often involve attempting to encourage each party to appreciate the alternative perspective and to consider that both perspectives are valid and reasonable. We might have expected, therefore, that individuals who are higher in dispositional tendency to take the perspective of others would be a boon to such negotiations. However, the current data suggest that those high in trait perspective-taking, left to their own devices, apply this ability selectively. They show greater activity in prefrontal regions involved in social cognition when considering their own candidate, relative to the opposing candidate. In other words, unless properly channelled, inherent perspective-taking skill may serve motivated ends rather than facilitating greater consideration of all views equally [6].

(b) *Days until the election and trait perspective-taking*

Building on this idea, contextual factors, such as the political climate, may also influence the manifestation of trait perspective-taking. In examining the main effect of temporal context on our processes of interest, dorsal striatum was one of only two regions of the brain whose activity was associated with how close the scanning session was to election day; the closer to the election, the greater was the dorsal striatum activity when considering the issue statements. Although both dorsal and ventral striatum have been associated with reward processes, dorsal striatum has more commonly been associated with action-based rewards in which some behaviour must be enacted in order to obtain the reward [27,28]. Days until the election may take on particular relevance, then, because the election itself consists of people voting not just for the candidate, but symbolically voting to endorse a wide spectrum of beliefs shared between oneself and the candidate heading one's party. Dorsal striatum activity may have increased in anticipation of being able to perform an issue-supporting behaviour (i.e. voting) that could help to bring about desired outcomes.

The most dramatic effects in our study were observed for the interaction of trait perspective-taking and time until the election. There was widespread

activity in the social cognition network that was greater as the election approached to the extent that one was higher in trait perspective-taking. Put in a different way, those who view themselves as possessing greater perspective-taking skills showed greater activity in the social cognition network as the run-up to the election intensified. It is possible that individuals who tend to consider the perspectives of others more, in general, were more sensitive to the social environment as the election approached (e.g. media attention to the campaign, discussion among friends, co-workers and strangers), whereas those lower in dispositional perspective-taking may have been less influenced by the social environment around the campaigns. Furthermore, in considering the views of the different candidates, the effect of trait perspective-taking on ingroup versus outgroup candidates intensified as the election approached (those high in trait perspective-taking produced greater and more widespread activity in social cognition regions when considering their own candidate when compared with the opposing candidate in the days right before the election). If those higher in dispositional perspective-taking were more susceptible to changes in the social environment as suggested above, and were disproportionately surrounded by likeminded individuals, we might expect the type of interaction between perspective-taking, election proximity and ingroup/outgroup perspective-taking that was observed. An additional possible explanation of the ingroup–outgroup divergences in social cognition activity observed may be linked to motivational processes. In the interaction between days to the election and trait perspective-taking, ventral striatum activity was observed—an effect not present in the trait perspective-taking analyses that ignored days to the election. It is possible that the striatum mediates an increasing motivational salience of one's own candidate, promoting greater attention to this candidate and more engagement in considering their viewpoint, relative to the opponent [29]. Given that these mediational accounts were not tested in the current study, however, these should be understood as among multiple possible explanations for these effects.

(c) *Issue importance*

Unlike the effects of perspective-taking or its interaction with days until the election, self-rated issue importance produced effects when collapsing across target perspectives and not when one's own and opposing candidate perspectives were compared. MPFC, precuneus$_{PCC}$ and TPJ were all recruited to a greater degree when thinking about self-rated important issues than less important issues. Thus, to the extent that an issue is important to oneself, this enhances activity in regions of the social cognition system and does so in a way that is not different for one's own versus opposing candidates.

Consistent with dual process theories of persuasion [30,31] suggesting that both ability and motivation play a role in how deeply attitudinal concepts are processed, activity in regions associated with social cognition (TPJ, precuneus) was negatively associated with the interaction between issue importance (a motivational factor) and trait perspective-taking (an ability factor). In other words, at lower levels of trait perspective-taking, we observed greater activity in neural regions associated with social cognition for higher importance issues (or, at lower levels of issue importance, we observed higher levels of social cognition activity for those highest in tendency to take the perspective of others). These results, in combination with the results described above, may suggest that issue importance and trait perspective-taking each promote activity in regions implicated in social cognition. However, issue importance may affect the consideration of attitudes across targets and in situations when other factors (such as trait perspective-taking) do not promote consideration of other views. This idea is consistent with data suggesting that information about issues that are more personally important is given more weight [32], and may suggest that by increasing perceived personal relevance, differences in tendency to take the perspective of others would be diminished.

5. CONCLUSION AND LIMITATIONS

Only one other study has examined neural responses during exposure to issue statements associated with ingroup or outgroup members. Bruneau & Saxe [7] observed a single region, precuneus, associated with the social cognition network that differentiated between the ingroup and outgroup statements. Similarly, we observed one social cognition region, PCC, that was more active when thinking about the ingroup candidate's views and one social cognition region, TPJ, that was more active when thinking about the outgroup candidate's views.

However, when we considered various moderator variables of these effects, a more clear and consistent picture emerged: consistent with dual process models of persuasion [30,31], the ability and the motivation to think about issues, and the relevance of the candidates to those issues, led to stronger recruitment of the social cognition system for one's own candidate, but not for the opposing candidate. In this case, motivation was inferred from self-rated issue importance (personal motivational relevance) along with days until the election (temporal motivational significance). Increased ability/tendency to engage in perspective-taking unprompted was inferred from trait perspective-taking. Both motivational factors (issue importance and days to the election) interacted with trait perspective-taking. However, whereas the temporal motivational significance (as election day neared) served to accentuate the effects of trait perspective-taking, personal motivational relevance (issue importance) exerted a compensatory effect (issue importance served to increase activity in regions associated with social cognition most for those who were not already high in tendency to take the perspective of others).

Finally, it is noteworthy that, consistent with our other work on attitudes and persuasion [33–35], very few activations were observed in regions associated with working memory and central executive processes. Although one might expect logical cognitive processes to be involved in this task [30,31], the most consistent activations were associated with social cognitive and affective processes.

Given that this was a preliminary study, more research is needed to replicate, extend and clarify the results observed here. For instance, many of our findings relate to activity in brain regions implicated in social cognition, however, additional research is needed to pinpoint the function of subregions within these broader areas (e.g. precuneus$_{PCC}$ covers a large amount of cortex, as do TPJ, MPFC, DMPFC and other regions discussed), and to further clarify the role of different subsets of activity within the social cognition 'network'. Furthermore, our hypotheses and discussion focus on the role of social cognition in attitudinal processes. However, this is one of several possible explanations for these effects, given the one-to-many mapping between brain regions and psychological processes [36].

Despite these limitations, taken together, our results contribute to the burgeoning literature examining the biology of cultural conflict [37]. Our results suggest that ability and motivation to take the perspective of others are reflected in neural responses to considering the attitudes of ingroup and outgroup members, and that neural systems implicated in social cognition and affective responding play a significant role in processing these attitudinal concepts. As the nation faces challenges moving forward, it may benefit our democracy to bring our perspective-taking abilities to bear similarly when considering outgroup perspectives to those of our own, and to recognize the biases that arise in our thinking as a function of the contexts in which we find ourselves. The 2008 presidential election was the first to begin to harness the power of social media to interactively engage citizens. However, within our brains, we may yet still have untapped potential for social connection across the aisle.

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