

Us versus them: Political attitudes and party affiliation influence neural response to faces of presidential candidates

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Abstract

We investigated how political party affiliation and political attitudes modulate neural activity while viewing faces of presidential candidates. Ten registered Democrats and 10 registered Republicans were scanned in an event-related functional MRI paradigm while viewing pictures of the faces of George Bush, John Kerry, and Ralph Nader during the 2004 United States presidential campaign. We found that compared with viewing one's own candidate, viewing the candidate from the opposing political party produced signal changes in cognitive control circuitry in the dorsolateral prefrontal cortex and anterior cingulate, as well as in emotional regions such as the insula and anterior temporal poles. BOLD signal in these regions correlated with subjects' self-reported ratings of how they felt emotionally about the candidates. These data suggest that brain activity when viewing a politician's face is affected by the political allegiance of the viewer and that people regulate their emotional reactions to opposing candidates by activating cognitive control networks.

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Much attention in the study of face processing has been focused on the neural processes that underlie the visual identification of a face. Viewing human faces has been shown to preferentially activate certain regions of extrastriate cortex, including the lateral fusiform gyrus (Kanwisher, McDermott, & Chun, 1997; Kanwisher, Stanley, & Harris, 1999; Puce, Allison, Asgari, Gore, & McCarthy, 1996). There is, of course, considerable controversy about the exact role of the fusiform gyrus and its specificity in face processing. Some studies have found expertise-related activations here with non-face stimuli, suggesting that this region may be more generally involved in visual expertise (Gauthier, Skudlarski, Gore, & Anderson, 2000; Gauthier, Tarr, Anderson, Skudlarski, & Gore, 1999; Tarr & Gauthier, 2000). There is little doubt, however, that the fusiform gyrus plays a central role in facial identification, and that it involves sophisticated visual analysis (Grill-Spector, Knouf, & Kanwisher, 2004; Haxby, Hoffman, & Gobbini, 2000; Hoffman

& Haxby, 2000). Strong evidence for this comes from studies showing that repeated presentations of the same person's face lead to decreases in fMRI signal in the fusiform gyrus but not in other face-sensitive regions, like the superior temporal sulcus (STS), which may be more sensitive to changeable aspects of a face such as expression and eye gaze (Andrews & Ewbank, 2004; Winston, Henson, Fine-Goulden, & Dolan, 2004).

A viewer's reaction to seeing a face, however, involves much more than simply recognizing identity. Other neural systems are involved with retrieving associated memories, assessing emotional content, and determining the social significance of the face and these are activated while perceiving a face (Haxby, Hoffman, & Gobbini, 2002; Ida Gobbini, Leibenluft, Santiago, & Haxby, 2004; Gobbini & Haxby, 2007; Todorov, Gobbini, Evans, & Haxby, 2007). For example, the amygdala and other associated limbic structures such as the insula have been implicated in the perception of facial emotions (Adolphs, Tranel, Damasio, & Damasio, 1995; Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Glascher, Tuscher, Weiller, & Buchel, 2004; Morris, deBonis, & Dolan, 2002;

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Phillips et al., 2004, 1998; Graham, Devinsky, & LaBar, 2007). The previous associations linked to a particular face appear to shape which neural structures are activated. For example, a familiar face tends to activate semantic processing regions in the temporal lobes (Leveroni et al., 2000; Nakamura et al., 2000; Sugiura et al., 2001), and one's own face activates the right prefrontal cortex (Keenan, Wheeler, Gallup, & Pascual-Leone, 2000; Platek, Keenan, Gallup, & Mohamed, 2004; Uddin, Kaplan, Molnar-Szakacs, Zaidel, & Iacoboni, 2005). Activity in emotional brain structures can be modulated by the specific relationship one has with the face, for example, if it is the face of one's own child (Leibenluft, Gobbin, Harrison, & Haxby, 2004) or loved one (Bartels & Zeki, 2004).

Recent work has investigated the impact of social attitudes and group membership on face processing. Processing of same-race faces has been found to relate to increased activity in the fusiform gyrus compared with other-race faces (Golby, Gabrieli, Chiao, & Eberhardt, 2001). Hart et al. (2000) found greater habituation of amygdala activity during the presentation of in-group faces, leading to greater amygdala activity over time in response to out-group faces. This change in amygdala activity may be a correlate of a perceived threat posed by out-group faces. Amygdala activity in response to out-group faces may correlate more with unconscious, automatic biases as compared with conscious, controlled processing. Phelps et al. (2000) demonstrated a correlation between implicit measures of race bias and amygdala activity in response to other-race faces. However, these implicit attitudes may invoke cognitive control mechanisms to suppress unwanted biases. There is evidence that such a mechanism is at play: racial bias correlates with increased activity in cognitive control regions such as the dorsolateral prefrontal cortex and anterior cingulate (Cunningham et al., 2004; Richeson et al., 2003). For example, Cunningham et al. (2004) found that with very short presentation times, White subjects showed increased amygdala activity in response to Black faces, but that with more time the increased amygdala activity was replaced by activity in dorsolateral prefrontal cortex and anterior cingulate cortex.

Political party membership and related political attitudes may involve a similar interplay between implicit emotional and explicit cognitive processing (Lieberman, Schreiber, & Ochsner, 2003; Way & Masters, 1996). Political attitudes can be powerful forces, motivating action and influencing perception, but there has been little to no investigation of their neural correlates. Here we use event-related fMRI to investigate how neural activity while viewing politicians' faces is affected by political attitudes and by party affiliation. We scanned registered Republican and Democratic voters as they viewed faces of George Bush, John Kerry, and Ralph Nader during the 2004 presidential campaign. These were stimuli with high emotional significance to American voters at the time, and so we expected subjects to react emotionally. Furthermore, we expected these reactions to depend upon their identification with a political party. Specifically, we predicted neural changes in emotional and cognitive control circuitry to be modulated by out-group compared with in-group faces.

1. Method

1.1. Subjects

Twenty registered voters from the Los Angeles area participated in the experiment, which was conducted between April and August 2004, during the campaign for the 2004 United States presidential election. Half (10) of the participants were registered Democrats who supported the Democratic candidate, the other half were registered Republicans who supported the Republican candidate. The two groups were matched for age and gender. Each group consisted of five males and five females. The mean age of Democrats was 35.7 ± 6.34 years, and mean age of Republicans was 35.6 ± 9.29 years. All participants were screened to rule out medication use, head trauma, and history of neurological or psychiatric disorders, substance abuse, or other serious medical conditions. Subjects gave informed consent according to the guidelines of the UCLA Institutional Review Board.

1.2. Stimuli and procedure

Subjects in the scanner viewed images and video through magnet-compatible goggles and headphones (Resonance Technology Inc.). After initial anatomical scans, subjects first completed one functional scan during which they were presented with pictures of three presidential candidates, George Bush, John Kerry, and Ralph Nader, for 5 min. Twenty-five digital pictures of each candidate were gathered from the news media and presented in color in central vision. Pictures showed the candidates in various angles, contexts, and backgrounds. After an initial rest period of 8 s, the pictures were presented for 2 s each, with at least 1 s between each picture. Stimuli were presented in an order to optimize the discrimination of differences in the fMRI signal to each of the three candidates. This ordering produced sufficient temporal jitter between stimuli of the same type. In between each picture a central fixation cross remained on the screen. The entire functional run with 75 pictures lasted for 5 min and 8 s. Subjects were instructed to simply look at the pictures, and were not required to make any overt response. These subjects were scanned watching the political faces as part of a larger study involving a variety of political stimuli including political advertisements, which were shown after the faces. Data from these other scans are not presented here.

After the experiments, subjects completed a questionnaire that asked them to rate various aspects of their experience. Subjects indicated on a scale from 1 to 10 how strongly they felt each of the following emotions while viewing each candidate: pride, relief, excitement, connection, delight, happiness, hope, understanding, respect, pleasure, fear, sadness, anger, shame, disgust, disappointment, contempt, despair, hopelessness, and anxiety.

1.3. Image acquisition

Images were acquired using a Siemens Allegra 3.0 T MRI scanner. During the functional scan, while subjects viewed the images of the candidates, we acquired 152 EPI volumes (gradient-echo, TR=2000, TE=25, flip angle=90°), each with 36 transverse slices, 3 mm thick, 1 mm gap, and a 64×64 matrix yielding an in-plane resolution of $3 \text{ mm} \times 3 \text{ mm}$. Two sets of high-resolution anatomical images were also acquired for registration purposes. We acquired an MP-RAGE structural volume (TR=2300, TE=2.93, flip angle=8°) with 160 sagittal slices, each 1 mm thick with .5 mm gap and $1.33 \text{ mm} \times 1.33 \text{ mm}$ in-plane resolution. We also acquired a T2-weighted co-planar volume (TR=5000, TE=33, flip angle=90°) with 36 transverse slices covering the whole brain, each 3 mm thick with 1 mm gap, a 128×128 matrix and an in-plane resolution of $1.5 \text{ mm} \times 1.5 \text{ mm}$.

1.4. Data processing and statistical analysis

Analysis was carried out using fMRI Expert Analysis Tool (FEAT) Version 5.1, part of FMRIB's Software Library (FSL, www.fmrib.ox.ac.uk/fsl). After motion correction, images were temporally high-pass filtered with a cut-off period of 75 s and smoothed using a 5 mm Gaussian FWHM algorithm in three dimensions.

We modeled the BOLD response using a separate explanatory variable (EV) for each of the three candidates. For each stimulus type, the presentation design

was convolved with a gamma function to produce an expected BOLD response. The temporal derivative of this timecourse was also included in the model for each EV. Functional data were then fitted to the model using FSL's implementation of the general linear model.

Each subject's statistical data were then warped into a standard space based on the MNI-152 atlas. We used FLIRT to register the functional data to the atlas space in three stages (Jenkinson et al., 2002; Jenkinson & Smith 2001). First, functional images were aligned with the high-resolution co-planar T2-weighted image using a 6 degrees of freedom rigid-body warping procedure. Next, the co-planar volume was registered to the T1-weighted MP-RAGE using a 6 degrees of freedom rigid-body warp. Finally, the MP-RAGE was registered to the standard MNI atlas with a 12 degrees of freedom affine transformation.

After analyzing the functional data for each subject, data were passed into a higher-level analysis which allowed comparisons between the groups and correlations with subjective ratings. Higher-level analysis was carried out using FMRIB's Local Analysis of Mixed Effects (FLAME) (Beckmann, Jenkinson, & Smith, 2003; Woolrich, Behrens, Beckmann, Jenkinson, & Smith, 2004). Z (Gaussianised T/F) statistical images were thresholded using clusters determined by $Z > 2.3$ and a (corrected) cluster significance threshold of $p = .05$ (Forman et al., 1995; Friston, Worsley, Frakowiak, Mazziotta, & Evans, 1994; Worsley, Evans, Marrett, & Neelin, 1992).

2. Results

2.1. Self-report measures

Mean responses on the questionnaire for the two groups are presented in Table 1. For each subject, we combined responses to individual questions to create two measures: pride, relief, excitement, connection, delight, happiness, hope, understanding, respect, and pleasure were averaged to obtain an overall positive rating for each candidate, while fear, sadness, anger, shame, disgust, disappointment, contempt, despair, hopelessness, and anxiety were averaged to obtain an overall negative rating for each candidate. The submeasures within each category showed high intercorrelations, as captured by Cronbach's alpha statistic (.95 for positive ratings and .96 for negative ratings).

To assess group differences in the ratings, we performed a t -test between two groups' ratings for each of the measures (positive and negative) for each candidate. Republicans gave significantly higher ratings of their positive emotion in response to George Bush's face (4.87) compared with Democrats (.67), $p < .005$. Conversely, Democrats gave significantly higher ratings of their negative emotion in response to George Bush (7.20) compared with Republicans (.37), $p < .00001$. Democrats reported significantly greater positive emotions in response to John Kerry (4.85) than did Republicans (.31), $p < .00001$. The

Table 1
Self-report data

	Democrats	Republicans	t -test (p)
Positive feelings about Bush	.67	4.87	<.0005
Negative feelings about Bush	7.20	.37	<.00001
Positive feelings about Kerry	4.85	.31	<.00001
Negative feelings about Kerry	1.48	3.78	<.06

Subjects rated on a scale of 1–10 how strongly they felt about the candidates and how much negative emotion they experienced. Presented here are group means, and two-tailed probability of group differences from t -tests between the two groups for each rating.

difference in the two groups' negative ratings of John Kerry did not reach statistical significance, though unsurprisingly they were greater in Republicans.

2.2. Group analyses

For each subject, we analyzed the data from the first run computing activity for viewing each candidate versus rest, as well as pair-wise comparisons between the candidates. Our higher-level analysis looked for differences between Democrats and Republicans in these lower level contrasts. In general, viewing the faces compared with rest produced widespread activations throughout the occipital lobe and inferior temporal lobe bilaterally, as well as the inferior frontal gyrus and precentral gyrus on the left side.

None of the pair-wise analyses between candidates yielded significant results when combined across subjects. However, when comparing data between Democrats and Republicans, we did find significant activations. A key analysis looked at differences between viewing one's own candidate and viewing the candidate from the opposing political party. This analysis took the Bush minus Kerry lower-level analysis for each subject and looked for group differences where Democrats showed a greater response than Republicans. Because of the double subtraction, this analysis is mathematically equivalent to Kerry minus Bush activity that was greater in Republicans than in Democrats, and thus represents BOLD response that was greater when subjects viewed the opposing candidate. This analysis showed significant signal changes throughout the prefrontal cortex bilaterally, the insula bilaterally, and the medial surface of the frontal and parietal lobes, and the temporal poles bilaterally. Local maxima are listed in Table 2 and pictured in Fig. 1. Percent signal changes in the dorsolateral prefrontal cortex, anterior cingulate, and insula are shown in Fig. 2. We did not find any significant signal changes in the opposite analysis, which looked for activity

Table 2
Significant signal changes: group differences

MNI coordinates			Anatomical location	Brodmann's area	Z score
X	Y	Z			
-60	8	20	L inferior frontal gyrus	44	3.68
44	36	10	R inferior frontal gyrus	44	3.12
-44	36	34	L middle frontal gyrus	46	3.18
46	36	26	R middle frontal gyrus	46	3.26
6	-2	62	Medial frontal gyrus	6.4	3.55
-2	14	32	Anterior cingulate	24	3.01
60	4	28	R precentral gyrus	6	3.40
-54	-32	48	L inferior parietal lobule	40	3.43
32	-56	42	R inferior parietal lobule	40	3.58
-60	8	-4	L superior temporal gyrus	22	3.26
64	4	0	R superior temporal gyrus	22	3.45
-4	-86	34	L cuneus	19	3.44
36	-4	-4	R posterior insula	13	2.96
-36	14	2	L anterior insula	13	2.92
-44	6	-4	L mid-insula	13	2.90
42	6	-2	R mid-insula	13	2.79
24	10	4	R putamen	n/a	2.94
-22	14	2	L putamen	n/a	2.66

Opposing candidate's face minus own candidate's face.

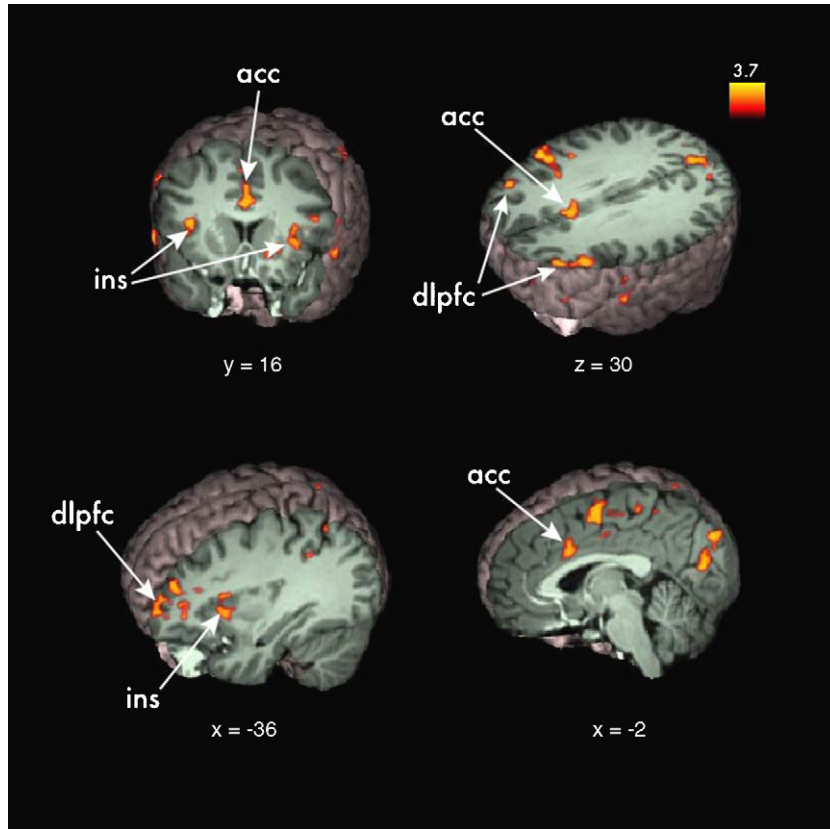


Fig. 1. Brain regions significantly more activated viewing the face of the candidate from the opposing political party compared to the candidate of subjects' own party. Activations include dorsolateral prefrontal cortex (DLPFC), insula (ins), anterior cingulate cortex (ACC), as well as the supplementary motor area, cuneus, and precentral gyrus.

that was greater viewing the candidate from one's own political party compared to the opponent.

The only other pair-wise comparisons between candidates to yield significant results involved Ralph Nader. In Republicans only, Nader produced widespread signal changes compared with Bush including foci in the right inferior parietal lobule, the

superior temporal gyrus bilaterally, the right middle and superior frontal gyri, the left precentral gyrus, the precuneus, the posterior cingulate, the right putamen, and the right insula (see Fig. 3). In Democrats only, John Kerry produced significant signal changes compared with Ralph Nader in the medial prefrontal cortex (see Fig. 3).

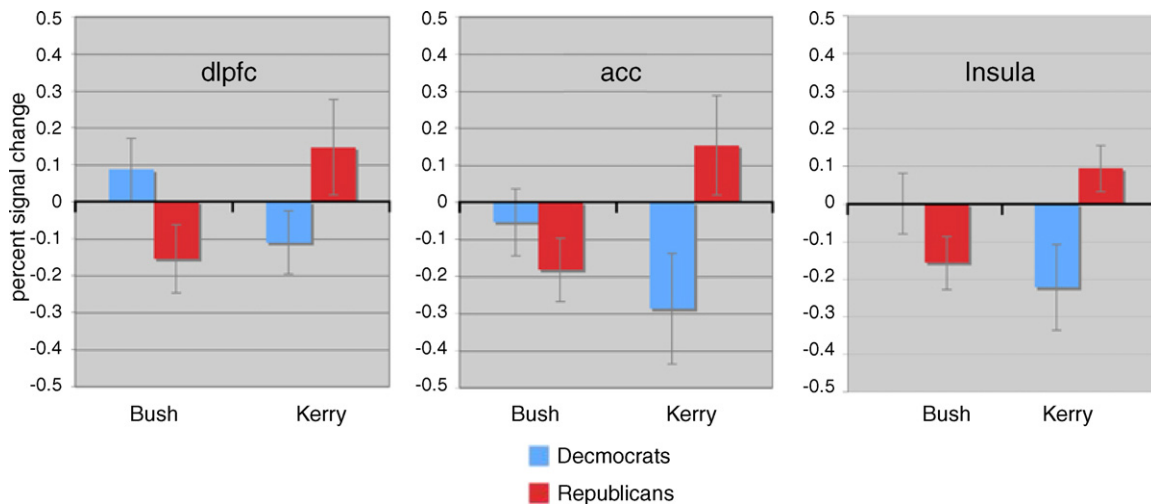


Fig. 2. Percent signal change for Democrats and Republicans in three key areas which showed significantly greater activation viewing the opposing candidate compared with one's own candidate: dorsolateral prefrontal cortex (DLPFC), anterior cingulate (ACC), and insula.

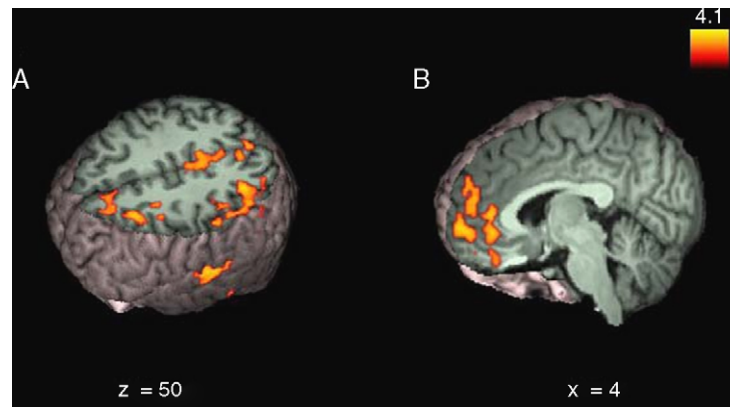


Fig. 3. The Nader Effect. Republicans showed greater activity for Ralph Nader compared with George Bush in the right inferior parietal lobule, the superior temporal gyrus bilaterally, the right middle and superior frontal gyri, the left precentral gyrus, the precuneus, the posterior cingulate, the right putamen and the right insula (A). In Democrats, there was greater activity in the medial prefrontal cortex looking at John Kerry compared with Ralph Nader (B).

2.3. Correlations with self-report measures

To further understand the relationship between subject's emotional responses to the candidates and their brain activity, we looked at how their subjective ratings of the candidates correlated with their brain activity while looking at the faces. The

Table 3
Significant signal changes: correlations with self-report

MNI coordinates			Anatomical location	Brodmann's area	Z score
X	Y	Z			
Negative Bush ratings correlate with Bush minus Kerry activity					
-44	-16	32	L precentral gyrus	6	3.65
58	-4	22	R precentral gyrus	6	3.53
-60	8	20	L inferior frontal gyrus	44	3.61
-44	36	32	L middle frontal gyrus	46	3.20
6	-2	34	R medial frontal gyrus	6	3.45
-44	-50	42	L inferior parietal lobe	39	3.14
-60	-4	4	L superior temporal gyrus	22	3.35
6	-76	24	Precuneus	31	3.39
38	-6	-6	R insula	13	3.08
26	2	10	R putamen	n/a	2.69
Positive Bush ratings correlate with Kerry minus Bush activity					
54	-14	44	R precentral gyrus	6	3.78
-18	-28	64	L precentral gyrus	6	3.51
-62	8	18	L inferior frontal gyrus	44	3.74
62	12	24	R inferior frontal gyrus	44	3.36
-38	60	10	L middle frontal gyrus	46	3.50
-36	48	24	L middle frontal gyrus	46	3.23
6	-4	62	R medial frontal gyrus	6	3.26
56	36	34	R inferior parietal lobule	40	3.80
-42	48	44	L inferior parietal lobule	40	3.46
64	4	0	R superior temporal gyrus	22	3.50
-58	4	0	L superior temporal gyrus	22	3.23
12	-58	46	R precuneus	31	3.20
44	-14	-2	R insula	13	3.14
38	8	6	R insula	13	2.77
26	-2	8	R putamen	n/a	2.90
Positive Kerry ratings correlate with Bush minus Kerry activity					
-44	26	26	L middle frontal gyrus	46	3.23
-44	36	34	L middle frontal gyrus	46	3.20
-40	48	26	L superior frontal gyrus	10	2.93
-60	8	20	L inferior frontal gyrus	44	3.18

positive and negative composite ratings were included in a higher-level analysis as covariates to find fMRI signal that correlated with subject's subjective reports. This yielded statistical Z maps that represent the extent to which each voxel's lower level statistics covary with the subjective ratings. These maps were then thresholded according to the same procedures as the rest of the data. These results are presented in Table 3 and Fig. 4.

Negative ratings of George Bush correlated with activity in the Bush minus Kerry contrast for several brain regions. Significant correlations were found in the precentral gyrus bilaterally, the inferior parietal lobule bilaterally, the left inferior frontal gyrus, the middle frontal gyrus bilaterally, the left superior temporal pole, the precuneus, the right insula, and the right putamen (see Table 3). The negative ratings of Bush did not significantly correlate with activity in any other contrast.

Positive ratings of George Bush correlated with activity in the Kerry minus Bush contrast. Significant correlations were found in the precentral gyrus bilaterally, the inferior frontal gyrus bilaterally, the middle frontal gyrus bilaterally, on the medial surface of the frontal and parietal lobes, in the inferior parietal lobule bilaterally, the superior temporal poles bilaterally, the right insula, and the right putamen (see Table 3). Positive ratings of Bush did not correlate significantly with any other contrasts.

Negative ratings of John Kerry did not significantly correlate with activity in any lower-level contrast. Positive ratings of John Kerry, however, correlated with activity in the Bush minus Kerry contrast. Significant correlations were found in the left frontal lobe, including the inferior frontal gyrus, middle frontal gyrus, and superior frontal gyrus. These signal changes are depicted in Fig. 4.

3. Discussion

The self-report measures clearly show that our Democratic and Republican subjects differed in their emotional responses to the candidates, expressing negative feelings towards the opponent and positive feelings towards their own candidate. The only group difference which did not reach statistically significance was the ratings of negative feelings about John Kerry. Neither group expressed very negative feelings towards

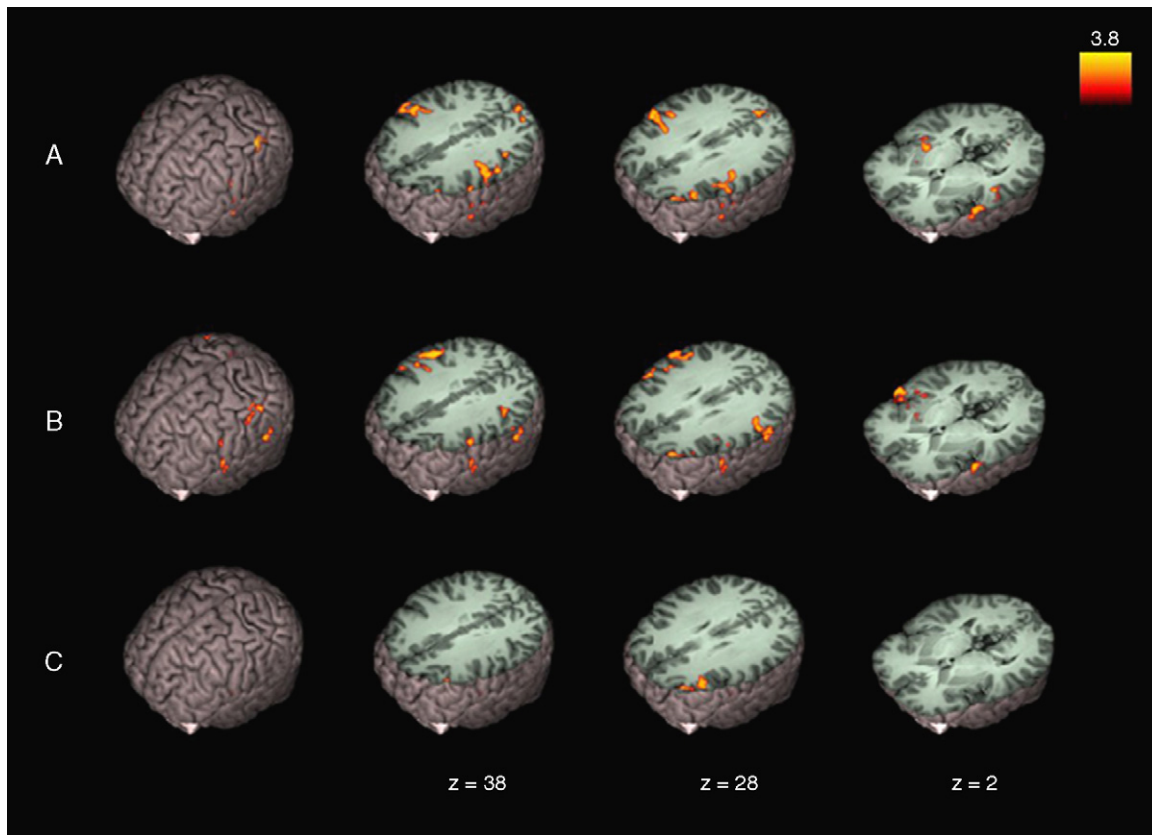


Fig. 4. Subjective ratings correlated with increased fMRI signal while viewing the opponent candidate. (A) Negative ratings of Bush correlated with Bush minus Kerry activity, (B) positive ratings of Bush correlated with Kerry minus Bush activity, and (C) positive ratings of Kerry correlated with Bush minus Kerry activity.

Kerry, while Democrats felt quite negatively about George Bush.

We found that brain activity while viewing the presidential candidate's faces was modulated by subjects' political attitudes. Most notably, activity while viewing the opposing candidate compared to one's own candidate activated the dorsolateral prefrontal cortex (DLPFC) and anterior cingulate cortex (ACC). The ACC may be divided into "emotional" and "cognitive" subregions; the more anterior "emotional" sector shares connections with other limbic structures such as the amygdala, nucleus accumbens, and hypothalamus, while the posterior "cognitive" sector is strongly interconnected with the lateral prefrontal cortex, premotor and supplementary motor cortex, and parietal cortex (Bush, Luu, & Posner, 2000). The activation in our study is centered at -2 , 14 , and 32 , falling well within the "cognitive" subregion of the ACC. This subregion of the ACC is involved in attentional control and self-monitoring, and together with the DLPFC forms a network that monitors response conflict and recruits cognitive control when necessary (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Cohen, Botvinick, & Carter, 2000; Gehring & Fencsik, 2001; Gehring & Knight, 2000; Kerns et al., 2004). In our study, activity in this network tended to correlate with subjects' ratings of their emotional reaction to the candidates. The more negatively they felt about the opponent, and the more positively they felt about their own candidate, the greater the DLPFC activity discriminated between the two candidates' faces. This effect was most obvious for ratings of

George Bush, which tended to differ more between Democrats and Republicans than did ratings of John Kerry. That activity in the DLPFC/ACC network varied with the emotional response of the subjects suggests that the pictures of the candidates were eliciting cognitive control mechanisms for the purposes of emotional self-regulation.

The response of prefrontal and cingulate cortices to other-party candidates is consistent with research showing activity in these areas to faces of racial out-groups (Cunningham et al., 2004; Richeson et al., 2003). However, in that context, activation of cognitive control networks is usually interpreted to reflect the active suppression of unwanted racial biases. In the case of political attitudes, it is not clear that voters are motivated to mitigate their negative feelings towards the opposing candidate. Participants in this experiment were instructed simply to view the pictures; we did not attempt to explicitly manipulate their reactions to the faces, allowing for their natural, unconstrained reactions. We propose three possible non-mutually exclusive explanations for these activations and consider them in turn: (1) DLPFC/ACC activity reflects the suppression of negative emotions which are unpleasant and unwanted in general, (2) DLPFC/ACC activity reflects the suppression of positive feelings voters have towards the opponent candidate, or (3) DLPFC/ACC activity reflects the up-regulation of negative feelings about the opposing candidate.

There is clear evidence that the DLPFC/ACC network is involved in the suppression of negative emotions. For example, Levesque, Eugene et al. (2003) found increased DLPFC

and ACC activity when subjects were asked to explicitly control their reaction to sad films. Johanson et al. (1998) found that spider phobics who were able to successfully control their panic reactions to the sight of spiders showed increased DLPFC activity, while those who panicked did not. It is possible that the sight of the opponent candidate's face, like the face of a member of a different race, elicits emotions associated with threat and that these emotions are unpleasant to experience and need to be suppressed. We did not find amygdala activity in response to the opponent candidate, which may be due to a successful suppression of negative emotion.

However, DLPFC activity has also been shown to relate to the suppression of positive emotions. Beauregard, Levesque, and Bourgouin (2001) showed erotic films to young men and found DLPFC activity when they attempted to control their arousal. If voters have some positive reactions to the opposing candidate, these may need to be suppressed in order to maintain internal consistency with their conscious political attitudes. Voters may feel positively towards the opponent simply because of a natural tendency towards empathy, or they may agree with some of the opponent candidate's positions.

Finally, we suggest that since the DLPFC seems to be involved in regulating emotional responses in general, the activity in these subjects may relate to attempts to increase negative emotions concerning the opposing candidate. Recently, Ochsner et al. (2004) have shown that the ACC/DLPFC network is activated by both the down-regulation and up-regulation of negative emotions. This interpretation is supported by the additional activations we found in brain structures associated with negative emotion. Viewing the opposing candidate compared to one's own candidate led to differentially greater activity in the insula, putamen, anterior temporal cortex, and in the inferior frontal gyrus. Both the insula and the putamen have been associated with the perception of disgust in the faces (Anderson et al., 2003; Phillips et al., 2004, 1998, 1997; Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998). Schienle et al. (2002) found that the insula was activated not only by pictures of disgusting objects, but also by threatening pictures. In our study, greater activity in the insula in response to the other-party candidate compared with the own-party candidate correlated with subjects' ratings of their negative emotions about the opponent. Looking at signal changes within the insula (see Fig. 2) this effect seems mostly to be driven by the Republican subjects. The anterior temporal poles, also activated here by the opponent candidate, have also been associated with negative emotions, including sadness (Levesque, Eugene et al., 2003; Levesque, Joanne et al., 2003) and anger (Dougherty et al., 1999; Kimbrell et al., 1999). The anterior temporal poles are strongly interconnected with the insula (Chabardes, Kahane, Minotti, Hoffmann, & Benabid, 2002; Mesulam & Mufson, 1982; Mufson & Mesulam, 1982) and may be part of a paralimbic circuitry supporting negative emotions. In summary, the concurrent activation of both cognitive control mechanisms and negative emotion circuitry leads us to favor this final hypothesis, that subjects may be up-regulating their negative affect in response to the opponent candidate. This raises the question of why we see up-regulation of negative emotion in response to the opponent candidate, but not up-regulation of positive emo-

tion in response to one's own candidate. We suggest that this pattern may reflect the prevalence of "negative" campaigning. In a campaign focused on the negative attributes of the candidates, regulating negative emotion may be the primary concern of voters.

The process we are describing may be the physiologic manifestation of a well-demonstrated pattern of human response to emotion-evoking stimuli. Beck (1963) noticed that people would report strong negative emotional reactions to events, and would be unaware that they were inducing these reactions through automatic and nearly instantaneous negative thoughts. For example, if a friend shows up late for a planned appointment, the subject might induce feelings of anger and humiliation in themselves by interpreting the lateness as proof the friend did not care about them or respect them. Beck's finding is the basis for what is by the best proven form of talk therapy, cognitive-behavioral therapy, which focuses on helping patients recognize and change these automatic thoughts (Butler, Chapman, Forman, & Beck, 2006). The process we propose here, in which the DLPFC and the ACC actively induce increased feelings of anger, fear, and disgust in the insula, putamen, anterior temporal cortex, and inferior frontal gyrus, may be the physiologic basis of negative thoughts inducing negative emotions. Although we are the first group of which we are aware of that is interpreting their findings as an immediate view of cognition-inducing negative emotions, there are previous neuroimaging studies that have demonstrated reductions in activity in areas associated with negative emotions following treatment with cognitive-type therapies (Baxter et al., 1992; Goldapple et al., 2004; Paquette et al., 2003).

Unlike previous research on the neural correlates of reactions to racial out-group faces (Cunningham et al., 2004; Hart et al., 2000; Phelps et al., 2000), we did not find activation in the amygdala to respond to opponent candidates' faces. Cunningham et al. (2004) found that amygdala activity was greatly reduced when the presentation time of out-group faces was increased from 30 ms to 525 ms, presumably due to cognitive suppression. Our stimulus presentation was 2 s, so the lack of amygdala response could be explained within this framework. However, we have interpreted our data as indicating the up-regulation of negative emotions in response to opponent candidates' faces. An alternative explanation for the lack of amygdala activity is that an opponent candidate invokes a different kind of emotional response from a member of a racial out-group. Rather than invoking a visceral, threatening emotion, an opponent candidate may generate a more subtle feeling of "distaste" involving the insula more than the amygdala.

Also modulated by group membership and self-report measures in this analysis were the inferior frontal gyrus (IFG), particularly on the left side, and the precentral gyrus and the inferior parietal lobule on both sides. While activation in the left IFG suggests a verbal strategy may be part of voters' response to opponent candidates, along with the precentral gyrus and inferior parietal lobule the IFG forms part of an action planning and execution system (Grezes & Decety, 2001). It may be that viewing the opponent candidate stimulates the planning of a behavioral response to the perceived challenge posed by the opponent. However, this circuitry is not only activated by exe-

cution of action, but also by action observation (Buccino et al., 2001; Grezes, Armony, Rowe, & Passingham, 2003; Iacoboni et al., 1999; Molnar-Szakacs, Iacoboni, Koski, & Mazziotta, 2005), forming what has been referred to as the human mirror neuron system (Rizzolatti & Craighero, 2004). The mapping of perceived actions onto one's own motor system seems to be a mechanism for understanding others, and activity in this network has been linked to empathy and theory of mind (Bodini, Iacoboni, & Lenzi, 2004; Gallese, 2003a, 2003b). Unexpectedly, we find the mirror neuron system to be activated more by the opponent candidate than by the preferred candidate with whom they identify more closely. It is likely that the mirror neuron system is not only activated when we resonate empathically with others, but also when we try to understand and possibly when we strategize about their intentions (Iacoboni et al., 2005).

In addition to Bush/Kerry differences in the Democrats and Republicans, we found some significant results related to viewing the face of Ralph Nader. Republicans showed widespread signal changes looking at Nader compared with Bush. Many of these regions are the same ones activated in Republicans for the Kerry minus Bush analysis: DLPFC, insula, and frontal and parietal motor regions. We did not collect subjective reports of the subjects' feelings about Ralph Nader, but these activations suggest that Nader and Kerry elicited a similar reaction in Republicans. These signal changes were not seen in the Democratic subjects, perhaps because they feel they share more with Ralph Nader than Republicans do. However, Democrats showed significantly more signal in the medial prefrontal cortex (MPFC) viewing Kerry's face compared with Nader's. The MPFC signal changes may relate to feelings of positive emotion and empathy. MPFC activity has been associated with theory of mind (Gallagher & Frith, 2003), cooperation (McCabe, Houser, Ryan, Smith, & Trouard, 2001), and reward (Knutson, Fong, Adams, Varner, & Hommer, 2001). This could be a neural correlate of Democrats' identification and feeling of identification with John Kerry. This raises the question of why we did not find this activity in a Kerry minus Bush analysis. We speculate that even though Democrats feel negatively about Bush, they do identify with him as their president. Way and Masters (1996) found that inducing a negative mood before showing Republican subjects videos of President Clinton actually made their attitude towards Clinton more favorable. This may be a form of the so-called "rally-round-the-flag" effect, where public anxiety actually increases favorable ratings of a president. In other words, the negative emotion that Democrats feel towards Bush may not be inconsistent with a feeling of identification.

An alternative explanation is that the MPFC activity does not indicate positive emotion, but rather is activated when any affect-laden decision is considered. Since both Kerry and Bush have emotional significance to the participants and are the objects of a decision, they both elicit MPFC activity and a direct comparison of these two faces does not show any difference. However, since Nader was not viewed as a significant factor in the election, he may not be emotionally significant to our subjects, and therefore does not elicit an MPFC response.

In conclusion, we have found that activity in neural networks involved in cognitive control and emotion is modulated when

subjects view faces of presidential candidates, and that these systems are activated differentially depending upon the political orientation of the subject. There is much to be learned about the neural basis of political decision making and the formation of political attitudes, but our research shows that those attitudes can have clear neural correlates. Specifically, political attitudes can guide the activation of emotional systems in the brain and influence how people regulate those emotional responses. Politics is a ubiquitous form of human social interaction, and may be an effective way to understanding the neural basis of social behavior.

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