

An fMRI study of motivated reasoning:
Partisan political reasoning
in the U.S. Presidential Election

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Note: DRAFT, not for citation except by permission

Abstract

Research on political decision making suggests the ubiquity of motivated reasoning, the tendency to draw conclusions consonant with motives and desired emotional responses. We used fMRI to study partisans during the U.S. Presidential election of 2004 while reasoning about threatening information regarding their own candidate, the opposing candidate, and neutral controls. Motivated reasoning was associated with activations of the ventromedial prefrontal cortex, anterior cingulate, posterior cingulate, and lateral orbitofrontal cortex. Motivated reasoning was not associated with increased neural activity in regions previously linked to "cold" reasoning. The findings provide the first neuroimaging evidence for motivated reasoning and implicit affect regulation or psychological defense.

In political science, cognitive science, economics, law, and business, the predominant models of judgment and decision making today might be called “*almost-rational man*” models. These models suggest that people are rational within limits imposed by cognitive shortcuts and heuristics that can bias reasoning (1-3). In political science, a long-standing body of research on “partisan” biases in political judgment (4) points to another set of limits to rational judgment imposed by motivated reasoning (i.e., reasoning biased to produce emotionally preferable conclusions, 5). Motivated reasoning can be viewed as a form of implicit affect regulation, in which the brain converges on solutions that minimize negative and maximize positive affect states (6-8). Freud described such processes decades ago, using the term “defense” to denote the processes by which people can adjust their cognitions to avoid aversive feelings such as anxiety and guilt.

Neural network models of motivated reasoning suggest that in affectively relevant situations, the brain equilibrates to solutions that simultaneously satisfy two sets of constraints: *cognitive constraints*, which maximize goodness of fit to the data, and *emotional constraints*, which maximize positive affect and minimize negative affect (8-10). Decision theorists have long argued that people gravitate toward decisions that maximize expected utility (or in emotional terms, that optimize current or anticipated affect; 11, 12). Contemporary views of motivation similarly emphasize approach and avoidance systems motivated by positive and negative affect (13). The same processes of approach and avoidance, motivated by affect or anticipated affect, may apply to motivated reasoning, such that people will implicitly approach and avoid judgments based on their emotional associations.

A series of studies involving political crises in the U.S. spanning the last 8 years (the impeachment of Bill Clinton, the disputed Presidential election of 2000, and the discovery of

torture by the U.S. at Abu Ghraib prison in Iraq) supports this model (10). These studies, along with simulations using a connectionist network designed to address “hot cognition” (9), suggest that political reasoning can be strongly influenced by the emotional consequences of drawing one conclusion or the other. Although research has begun to examine explicit (conscious) processes used to regulate emotion, notably suppression and distraction (14-16), no studies have yet examined the neural processes involved in motivated reasoning, implicit affect regulation, or psychological defense. Nor has any published study of which we are aware examined the neural basis of any form of political decision making.

In this study, conducted during the U.S. Presidential election of 2004, we observed the reasoning processes of committed partisans as they were presented with threatening information about their own candidate, the opposing candidate, and neutral control individuals. We hypothesized that reasoning about threatening information about one’s own candidate would activate regions likely to be involved in implicit emotion regulation, notably the ventromedial prefrontal cortex (VMPFC) and the anterior cingulate cortex (ACC), as well as regions reflecting elicitation of negative emotion (the insula, lateral orbitofrontal cortex, and amygdala).

We recruited subjects by placing flyers at local political party offices, public places, and cars and houses with political endorsements (e.g., bumper stickers); posting information on internet political discussion groups and local political and party listserves; and placing newspaper and radio advertisements. Recruitment materials requested right handed men ages 22-55 who were “committed Republicans or Democrats.” We conducted all screening and scanning from late August through early October of 2004. Subjects received \$50 compensation.¹

To simulate the constraint satisfaction processes that occur as citizens confront political information, we devised six sets of statements regarding each of the following targets: George

Bush, John Kerry, and neutral male targets without strong perceived ties to either party (e.g., Tom Hanks, Hank Aaron, William Styron). Although many of the statements and quotations were edited or fictionalized, we maximized their believability by embedding them in actual quotes or descriptions of actual events.

Each statement set consisted of seven slides presenting verbal material, designed to present a clear contradiction between the target person's words and actions and then to resolve that contradiction (Fig. 1). Slide 1 presented an *initial statement*, usually a quote from the target individual. Slide 2 presented a *contradictory statement* suggesting that the target's words and actions were inconsistent. Slide 3 asked subjects to consider whether the target's "statements and actions are inconsistent with each other," and Slide 4 asked them to rate the extent to which they agreed that the target's words and deeds were contradictory, from 1 (strongly disagree) to 4 (strongly agree) using a four-button pad. Slide 5 presented an *exculpatory statement* that explained away the inconsistency. Slide 6 then asked subjects to consider whether the target's "statements and actions are not quite as inconsistent as they first appeared." The final slide asked them once again to rate the extent to which they agreed with this statement, using the same 4-point scale.²³

We tested hypotheses using planned comparisons (contrast analyses). Because the focus of this report is on partisans' responses to threatening information about their candidate (rather than on differences in neural processing between Democrats and Republicans), and because Democrats' neural and behavioral responses to Kerry contradictions resembled Republicans' responses to Bush contradictions, we aggregated the data across parties.⁴ We tested three primary contrasts. The first compared neural responses in the *same-party* condition (i.e., Republicans evaluating Bush and Democrats evaluating Kerry) to responses in the neutral

condition (i.e., the neutral targets) during the *contradiction* slide (treated as a block), when subjects were confronted with a cognitive contradiction. By subtracting responses to the neutral targets from the same-party targets, we controlled for cognitive processes involved while reasoning about a contradiction relatively free of emotional entailments to isolate neural processes associated with emotional constraint satisfaction.

The second contrast made use of the structural similarity of the *contradiction* statement to the *exculpatory* statement. In both statements (each presented for 12 s), subjects were presented with information that seemingly contradicted prior information (i.e., imposing new cognitive constraints requiring resolution). What differs is that the contradictory but not the exculpatory statement generates a conflict between conclusions that would be reached by weighing the evidence (cognitive constraints) and desired conclusions (emotional constraints). Hence, the *contradiction* but not the *exculpatory* statement should activate neural circuits involved in motivated reasoning. Thus, the second contrast focused on the same-party condition only, subtracting activations related to the exculpatory statement (reasoning without emotional conflict) from those associated with the contradiction statement (reasoning plus emotional conflict).

The third planned contrast, which is conceptually the most complex, tested the interaction between target (same-party vs. neutral) and block (*contradiction* vs. *exculpatory*). In other words, this contrast describes activations that were significantly greater when subjects were processing negative vs. exculpatory information for their preferred candidate vs. a neutral target. The interaction subtracts neural activity for *neutral targets* from *same-party* targets (isolating conditions of emotional conflict, as in the first contrast) while processing information presenting during the *contradiction* block minus the *exculpatory* block.

Subjects' ratings during image acquisition of the extent to which targets' statements and actions were contradictory provided strong evidence of motivated reasoning (Fig.2). As can be seen from Fig.2, mean ratings on the 6 Bush *contradiction* blocks were 3.79 for Democrats vs. 2.16 for Republicans, $t(27) = 12.96$, $p < .0001$, with small SEs (indicated by the error bars). Mean ratings on the 6 Kerry contradictions were 2.60 (± 0.14) for Democrats vs. 3.55 (± 0.12) for Republicans, $t(27) = 5.21$, $p < .0001$. The patterns were similar (and statistically significant) for the post-exculpatory-block ratings (i.e., partisans were substantially more likely to accept the exculpatory statements for their own candidate vs. the opposing candidate). As predicted, Democrats and Republicans did not differ in their ratings of the neutral targets.

The first contrast subtracted neutral targets from same-party targets during the *contradiction* block (e.g., Republicans evaluating Bush contradictions vs. contradictions involving Hank Aaron). As can be seen in Fig. 3, processing emotionally threatening information about one's preferred candidate relative to a neutral target activated distributed sites in medial prefrontal cortex, including particularly the ventral ("affective") subdivision of the ACC but also the more rostral ("cognitive") subdivision (17). Also activated were a small superior medial prefrontal region and a larger ventromedial region of PFC associated with affective processing (18, 19). The other notable finding was a large area of activation in the posterior cingulate cortex (along with coextensive regions of the precuneus and inferior parietal cortex), associated in prior studies with neural information processing related to social emotions, moral evaluations, and judgments of forgivability (20-22).

To rule out the alternative hypothesis that these activations might simply reflect general emotion processing, we ran a secondary contrast subtracting responses to neutral targets from those to *other-party* target conditions (i.e., Democrats evaluating Bush, Republicans evaluating

Kerry) during the *contradiction* block. This contrast produced a single, large area of activation centered in the posterior cingulate and extending to the precuneus and posterior parietal cortex (Fig. 4). Thus, evaluating a contradiction with strong moral overtones led to activation of the posterior cingulate cortex and precuneus for both same-party and other-party candidates. However, only when the contradiction created conflict between data and bias (i.e., when unbiased reasoning would produce judgments with negative emotional consequences) did we observe a large activation of the anterior cingulate and medial prefrontal cortex.

Our second primary contrast subtracted processing during the *exculpatory* block from the *contradiction* block for *same-party* conditions only. This allowed us to examine two conditions in which subjects had to make judgments about new information that contradicted prior information, isolating processes involved when the emotionally desired conclusion did not coincide with the conclusion likely to be drawn based on unbiased assessment of the data (Fig. 5). The contrast analysis showed activations in the left lateral inferior frontal cortex and left insula (not shown: maximum at -36, -18, 18), both consistent with processing of negative affect. Also seen were activations in the inferior orbitofrontal cortex (gyrus rectus) bilaterally, indicative of emotion processing (23-25) as well as the precuneus (suggesting evaluative judgments, as above). The only other prominent activations were bilateral activations in the parahippocampal gyrus and extending to the hippocampus, perhaps indicative of efforts to generate solutions (rationalizations) based on memory retrieval. We again observed no differential activation of DLPFC, suggesting that motivated reasoning did not engage regions previously linked with conscious attempts to reason, suppress information, or regulate affect.

The third contrast (Fig. 6) tested the interaction between target (same-party vs. neutral) and block (contradiction vs. exculpatory). Consistent with the expectation that same-party

contradictions would elicit negative affect, the contrast yielded activations in the right lateral orbitofrontal cortex (not shown: maximum at 36, 52, -6). Also consistent with affect processing and regulation were multiple activations throughout the medial and orbital prefrontal cortex, including the left superior frontal gyrus (associated in previous studies with moral reasoning and evaluation of self-generated information; 20). The contrast also showed large activations in the posterior cingulate/precuneus.

We performed a fourth, more exploratory analysis to isolate the neural information processing related to equilibrated, emotionally constrained solutions (i.e., solutions biased by emotional considerations). We hypothesized that neural processing indices of negative affect would be diminished or absent following motivated reasoning (because the function of motivated reasoning is hypothesized to be the elimination of the aversive affect states associated with threatening information). An inherent limitation of the study design was that we could not be sure precisely when subjects had reached conclusions over the course of exposure to the contradiction and instruction to consider it. However, given that the structure of the task was identical across all 18 statements sets, and subjects had 15 s to read the initial statement and 12 s to process the contradiction for each statement set, we expected that most would have equilibrated to solutions (including motivated solutions) by the time they reached the *consider* block (or at the latest during the *rating* block). We thus subtracted neural activity during the second *consider* block (after subjects had 12 s to consider the exculpatory information) from the first *consider* block (after having had 12 s to think about the contradiction) for same-party targets. This allowed us to isolate the neural responses associated with the cognitive *products* of emotional constraint satisfaction (i.e., the neural response to having generated a solution that resolved a cognitive-emotional conflict).

The contrast yielded a large activation in the ventral striatum (Fig. 7), suggesting processing of reward outcomes (26, 27) or of a reward prediction error. Given that subjects would be expected to experience some relief as a result of the exculpatory statement, this suggests a possible reinforcement mechanism for motivated judgments. Additional activations were observed in the ventral anterior cingulate cortex, suggesting continued neural processing related to affect regulation; as well as activation of left inferior parietal regions (not shown) indicative of effortful processing (perhaps reflecting efforts to bolster rationalizations in support of motivated reasoning (28)). The association of equilibrated decisions with reinforcement is further suggested by the absence of activations in lateral orbital frontal and insular cortex, sites related to negative affect that were active during the contradiction block.

We ran two secondary contrasts to clarify further the functional inferences from this fourth contrast. First, we compared the two *consider* blocks for the *neutral* targets. This contrast yielded few significant activations, all located outside of the regions implicated in motivated reasoning (e.g., small areas of visual cortex), suggesting the absence of the reinforcement mechanisms hypothesized to underlie the results obtained for same-party targets. Second, to test our conjecture that subjects had already equilibrated to a conclusion by the time they were asked to consider the contradiction, we contrasted neural activity during the second (post-exculpatory) *rating* block from the first (post-contradiction) *rating* block for the same-party condition. These blocks occurred immediately after the *consider* blocks for which we found substantial reinforcement effects. This contrast yielded spatially large activations in the left DLPFC (*ca.* –42, 4, 38) and small (<10 voxel) activations in the orbitofrontal cortex (maximum at –4, 44, –20). The DLPFC activations could reflect either the tendency toward effortful cognitive processing observed in behavioral studies of motivated cognition, which likely follows in rapid succession

an implicit judgment (i.e., to “shore up” the defensive cognition), or the fact that the post-exculpatory ratings required minimal processing because cognitive and affective constraints were congruent.

This is, we believe, the first study to describe the neural correlates of motivated reasoning and the closely related constructs of implicit affect regulation, and psychological defense (as well as forms of cognitive dissonance involving cognitive-evaluative discrepancies; see 6, 7). It is also, we believe, the first study describing the neural correlates of political judgment and decision making. Consistent with prior studies of partisan biases and motivated reasoning, when confronted with information about their candidate that would logically lead them to an emotionally aversive conclusion, partisans arrived at an alternative conclusion. This process was not associated with activation of DLPFC, as in studies of “cold” reasoning and conscious suppression. Rather, it was associated with activations in the lateral and medial orbital prefrontal cortex, ACC, insula, and the posterior cingulate and contiguous precuneus and parietal cortex. Neural information processing related to motivated reasoning appears to be qualitatively different from reasoning in the absence of a strong emotional stake in the conclusions reached.

These findings support the role in motivated reasoning of a network of functionally integrated brain areas. Activation of the left insula, lateral orbitofrontal cortex, and ventral medial prefrontal cortex (VMPFC) has been associated with experiences of punishment, pain, and negative affect (24, 29). The role of the VMPFC in cognitive-affective interactions is well established (30) and was hypothesized a priori in this study to be centrally involved in implicit appraisal and reappraisal of emotionally threatening information. Activation of the left ventral lateral frontal cortex may also be implicated in affect regulation. Previous studies of (explicit) emotion regulation (14-16) observed activation of the lateral ventral PFC when subjects were

cognitively suppressing responses to negative emotional stimuli; this in turn was associated with decreased amygdala response. Interestingly, we did not observe activation of the amygdala in this study. To what extent this reflects signal dropout in the anterior temporal lobe, rapid habituation of amygdala response (in comparison with more sustained activation of other regions), or other causes is unknown.

The dorsomedial frontal cortex is associated with such processes as self-reference (31) and sympathy (32), which are congruent with the hypothesized processes by which partisans reason to emotionally biased conclusions about a candidate with whom they are presumably identified. Interestingly, the pattern of activity associated with implicit affect regulation in this study differs in an important respect from the pattern seen when subjects *consciously* attempt to regulate their affects by reappraising negative stimuli (15) in the increased rather than decreased activation observed in medial orbitofrontal circuits and in the absence of DLPFC activation as subjects are altering their cognitions. Of relevance, recent research (33) on the neural correlates of evaluation of information that is inconsistent with prior beliefs (but not emotionally threatening) yielded activations in the anterior cingulate and precuneus but in the DLPFC rather than the VMPFC, suggesting the difference between cognitive constraint satisfaction in the absence of strong emotional constraints and conflicts between cognitive and emotional constraints.

The activation of the ACC, particularly its ventral affective subdivision, is consistent with distress related to error detection (17) and motivational/emotional error detection, correction, and response (34). Activation of the ACC is associated more generally with modulation of activity in other brain regions (e.g., e.g., turning on cognitive activity, toning down affective activity; 35) and often predicts *subsequent* activation of the DLPFC, as the person corrects a mistaken

response (34). This may be relevant to our finding of an increase in activity of the DLPFC once subjects had apparently drawn motivated conclusions.

The activation in the posterior cingulate, precuneus, and adjacent parietal cortex in motivated reasoning fits well with studies showing activation in this region when people are judging forgivability of an action (20) and making emotionally laden moral judgments (21). These brain regions are also involved in emotion processing, emotional memory, and evaluative processing more generally (22, 36). The posterior cingulate also appears to be involved in judgments about one's own and others' feeling states (37) and has been reported in one study to be activated by threat words (36, 38). The posterior cingulate was activated in the present study while subjects were judging the culpability of both their own and the opposite party's candidate; however, the combination of a robust posterior cingulate activation and a large anterior cingulate activation distinguished processing of emotionally aversive information (i.e., threats to one's own candidate).

The large activation of the ventral striatum that followed subjects' processing of threatening information likely reflects reward or relief engendered by "successful" equilibration to an emotionally stable judgment. The combination of reduced negative affect (absence of activity in the insula and lateral orbital cortex) and increased positive affect or reward (ventral striatum activation) once subjects had ample time to reach biased conclusions suggests why motivated judgments may be so difficult to change (i.e., they are doubly reinforcing). These findings lend some support to a speculation made a number of years ago that the phenomenon described for a century in the clinical literature as psychological defense (e.g., denial, rationalization, motivated distortion) involves the operant conditioning of mental processes, such that people are reinforced for defensive responding by escape from negative (and perhaps elicitation of positive) affect (see

6). Of potential relevance, several researchers have found avoidance and escape conditioning to be associated with dopamine release in the nucleus accumbens and dorsal striatum in other animals (e.g., 39).

The study has several limitations. First, because this is the first study to examine the neural correlates of both motivated reasoning and political decision making, we chose to conduct whole-brain versus targeted ROI analyses. Second, because of data suggesting some differences in the processing of emotion in men and women (40), we only studied males, and hence cannot generalize to females without future investigation. Third, due to the complexity of the task and the fact that people are likely to recognize and respond to an emotionally significant contradiction of the sort presented here to partisans at different rates, we could not be certain precisely when subjects began to engage in motivated reasoning. Future research should attempt to parse the timeline for defensive responding more clearly and “window” data analyses accordingly to distinguish initial emotional reactions to threatening information, equilibration to motivated solutions, response to resolution of the conflict (e.g., reward), and subsequent cognitive activity (e.g., explicit rationalization). Fourth, because of limitations of time imposed by the U.S. presidential election cycle and the difficulty identifying people without any partisan leanings, particularly in the midst of a polarized election (cite), we examined only committed partisans and used neutral within- rather than between-subject controls. Future studies involving larger subject samples should examine the continuum of partisan feelings studied in research using NES data (i.e., from strong Democrat to strong Republican). Finally, we tested motivated reasoning in only one domain (politics). We chose this domain because of 50 years of research documenting emotionally biased decision making and because it allowed us to identify subjects

who would likely show defensive responses to the same stimuli. Nevertheless, future research should examine the neural correlates of motivated reasoning in other domains.

References

1. G. Gigerenzer, R. Selten, in *Bounded rationality: The adaptive toolbox* G. Gigerenzer, R. Selten, Eds. (MIT Press, Cambridge, 2001) pp. 13-36.
2. D. Kahneman, A. Tversky, Eds., *Choices, values, and frames* (Cambridge University Press., New York, NY, 2000), pp. xx, 840.
3. D. Westen, J. Weinberger, R. Bradley, in *Cambridge handbook of consciousness* M. Moscovitch, P. D. Zelazo, Eds. (Cambridge University, Cambridge, England, in press).
4. C. S. Taber, M. Lodge, J. Glathar, J. H. Kuklinski, Ed. (Cambridge University Press, New York, NY, 2001) pp. 198-226.
5. Z. Kunda, *Psychological Bulletin* **108**, 480 (1990).
6. D. Westen, *Self and society: Narcissism, collectivism, and the development of morals* (Cambridge University Press, N.Y., 1985), pp.
7. D. Westen, *Journal of Personality* **62**, 641 (1994).
8. D. Westen, *Psychological Bulletin* **124**, 333 (1998).
9. P. Thagard, *Cognition and Emotion* **17**, 361 (2003).
10. D. Westen, A. Feit, J. Arkowitz, P. S. Blagov. (Emory University, 2005).
11. D. Simon, D. C. Krawczyk, K. Holyoak, *Psychological Science* **15**, 331 (2004).
12. B. Mellers, *Psychological Bulletin* **126**, 910 (2000).
13. R. J. Davidson, D. C. Jackson, N. H. Kalin, *Psychological Bulletin* **126**, 890 (2000).
14. M. C. Anderson *et al.*, *Science* **303**, 232 (2004).
15. K. N. Ochsner, S. A. Bunge, J. J. Gross, J. D. E. Gabrieli, *Journal of Cognitive Neuroscience* **14**, 1215 (2002).

16. A. R. Hariri, V. S. Mattay, A. Tessitore, F. Fera, D. R. Weinberger, *Biological Psychiatry* **53**, 494 (2003).
17. G. Bush, P. Luu, M. I. Posner, *Trends in cognitive science* **4**, 215 (2000).
18. S. Hamann, H. Mao, *Neuroreport* **13**, 15 (2002).
19. S. Hamann, T. D. Ely, J. M. Hoffman, C. D. Kilts, *Psychological Science* **13**, 135 (2002).
20. T. F. D. Farrow *et al.*, *Neuroreport* **12**, 2433 (2001).
21. J. D. Greene, R. B. Sommerville, L. E. Nystrom, J. M. Darley, J. D. Cohen, *Science* **293**, 2105 (2001).
22. W. A. Cunningham, C. L. Raye, M. K. Johnson, *Journal of Cognitive Neuroscience* **16**, 1717 (2004).
23. C. D. Kilts, G. Egan, D. A. Glideon, T. D. Ely, J. M. Hoffman, *Neuroimage* **18**, 156 (2002).
24. J. O'Doherty, M. L. Kringelbach, E. T. Rolls, J. Hornak, C. Andrews, *Nature Neuroscience* **4**, 95 (2001).
25. A. Bechara, H. Damasio, A. R. Damasio, *Cerebral Cortex* **10**, 295 (2000).
26. J. M. Bjork *et al.*, *Journal of Neuroscience* **24**, 1793 (2004).
27. B. Knutson, G. W. Fong, S. M. Bennett, C. M. Adams, D. Hommer, *Neuroimage* **18**, 263 (2002).
28. P. H. Ditto, G. D. Munro, A. M. Apanovitch, J. A. Scepansky, L. K. Lockhart, *Personality & Social Psychology Bulletin* **29**, 1120 (Sep, 2003).
29. S. Hamann, *Nature Neuroscience* **6**, 106 (2003).
30. A. R. Damasio, *Descartes' error: Emotion, reason, and the human brain* (Grosset/Putnam, New York, 1994), pp.

31. A. D'Argembeau *et al.*, *Neuroimage* **25**, 616 (2005).
32. J. Decety, T. Chaminade, *Neuropsychologia* **41**, 127 (2003).
33. K. N. Dunbar, J. A. Fugelsang, in *Scientific and technological thinking* M. E. Gorman, R. D. Tweney, D. C. Gooding, A. P. Kincannon, Eds. (Lawrence Erlbaum, Mahwah, NJ, 2005) pp. 57-79.
34. K. R. Ridderinkhof, M. Ullsperger, E. A. Crone, S. Nieuwenhuis, *Science* **306**, 443 (2004).
35. G. Bush, in *Cognitive neuroscience of attention* M. I. Posner, Ed. (Guilford, New York, NY, 2004) pp. 207-218.
36. R. J. Maddock, A. S. Garrett, M. H. Buonocore, *Human Brain Mapping* **18**, 30 (2003).
37. K. N. Ochsner *et al.*, *Journal of Cognitive Neuroscience* **16**, 1746 (2004).
38. R. J. Maddock, M. H. Buonocore, *Psychiatric Research: Neuroimaging* **75**, 1 (1997).
39. P. Rada, G. P. Mark, B. G. Hoebel, *Brain Research* **798**, 1 (1998).
40. T. Canli, J. E. Desmond, Z. Zhao, J. D. E. Gabrieli, *Proceedings of the National Academy of Science* **99**, 10789 (2002).

Table 1

Two Examples of Statement Sets

Sample Statement Set – George W. Bush

Initial	"First of all, Ken Lay is a supporter of mine. I love the man. I got to know Ken Lay years ago, and he has given generously to my campaign. When I'm President, I plan to run the government like a CEO runs a country. Ken Lay and Enron are a model of how I'll do that." - Candidate George Bush, 2000.
Contradictory	Mr. Bush now avoids any mention of Ken Lay and is critical of Enron when asked.
Exculpatory	People who know the President report that he feels betrayed by Ken Lay, and was genuinely shocked to find that Enron's leadership had been corrupt.

Sample Statement Set– John Kerry

Initial	During the 1996 campaign, Kerry told a Boston Globe reporter that the Social Security system should be overhauled. He said Congress should consider raising the retirement age and means-testing benefits. "I know it's going to be unpopular," he said. "But we have a generational responsibility to fix this problem."
Contradictory	This year, on <i>Meet the Press</i> , Kerry pledged that he will never tax or cut benefits to seniors or raise the age for eligibility for Social Security.
Exculpatory	Economic experts now suggest that, in fact, the Social Security system will not run out of money until 2049, not 2020, as they had thought in 1996.

Figure Captions:

Fig. 1: The structure of the experiment. The top part of the figure describes the sequence of statement sets (and length of each statement set), alternating among Bush, Kerry, and neutral targets. The bottom describes the sequence of blocks within each set: initial statement block, contradiction block, first *consider* block (asking subjects to think about the possible contradiction), initial rating of contradiction block, exculpatory statement block, second *consider* block (asking subjects to reconsider the contradiction), and, in the final block, second rating of the contradiction in light of the exculpatory information.

Fig. 2: Behavioral ratings of the extent to which subjects perceived contradictions in statements by Bush, Kerry, and neutral figures. Democrats and Republicans reasoned to distinctly different conclusions about their preferred candidates, with mirror-image responses: Democrats readily identified the contradictions in Bush's statements but not Kerry's, whereas Republicans readily identified the contradictions in Kerry's statements but not Bush's. As can be seen from the standard error bars, the distributions of responses were essentially non-overlapping, demonstrating powerful effects of motivated reasoning. In contrast, Democrats and Republicans reasoned similarly about the contradictions of neutral figures.

Fig. 3: The figure presents three orthogonal views (axial, sagittal, coronal; at $x = 0$, $y = 50$, $z = 6$) of the areas of activation that differed when subjects were confronted with contradictory (threatening) information regarding their own party's candidate vs. a neutral target person.

mPFC: medial prefrontal cortex; ACC: anterior cingulate; vmPFC: ventromedial prefrontal cortex; pCING: posterior cingulate; PCU: precuneus.

Fig. 4: Three orthogonal views (axial, sagittal, coronal; at $x = 0$, $y = 50$, $z = 6$) of the areas of activation that differed when subjects were confronted with contradictory (threatening) information regarding the opposing party's candidate vs. a neutral target person. pCING: posterior cingulate; PCU: precuneus; PPC: posterior parietal cortex.

Fig. 5: Partisans' neural responses to the contradiction vs. exculpatory statements regarding their party's candidate. It presents three orthogonal views (axial, sagittal, coronal; axial, sagittal, coronal; at $x = 0$, $y = 34$, $z = -22$) of the neural regions showing greater activation while partisans were reading emotionally threatening information (contradiction block) relative to nonthreatening (exculpatory) information. LOFC: lateral orbitofrontal cortex; mOFC: medial orbitofrontal cortex; PHG: parahippocampal gyrus; PCU: precuneus.

Fig. 6: This figure shows three orthogonal views (axial, sagittal, coronal; at $x = 0$, $y = 44$, $z = 6$) of the neural regions that were significantly more active when subjects were processing threatening vs. exculpatory information for their party's candidate vs. a neutral target person. mPFC: medial prefrontal cortex; ACC: anterior cingulate; pCING: posterior cingulate; PCU: precuneus; supPFC: superior prefrontal cortex.

Fig. 7: The figure shows three orthogonal views (axial, sagittal, coronal; at $x = 12$, $y = 0$, $z = 0$) of brain regions that were significantly more active when partisans were asked to consider the

initial contradiction regarding their party's candidate than when they were asked to consider the contradiction again with the exculpatory information in mind. We presumed that most subjects had already equilibrated to solutions by this point. The neural regions previously active indicating negative affect processing are no longer active. However, the ventral striatum shows a large region of activation, suggesting reward or reinforcement. vSTR: ventral striatum; ACC: anterior cingulate.

Fig. 1

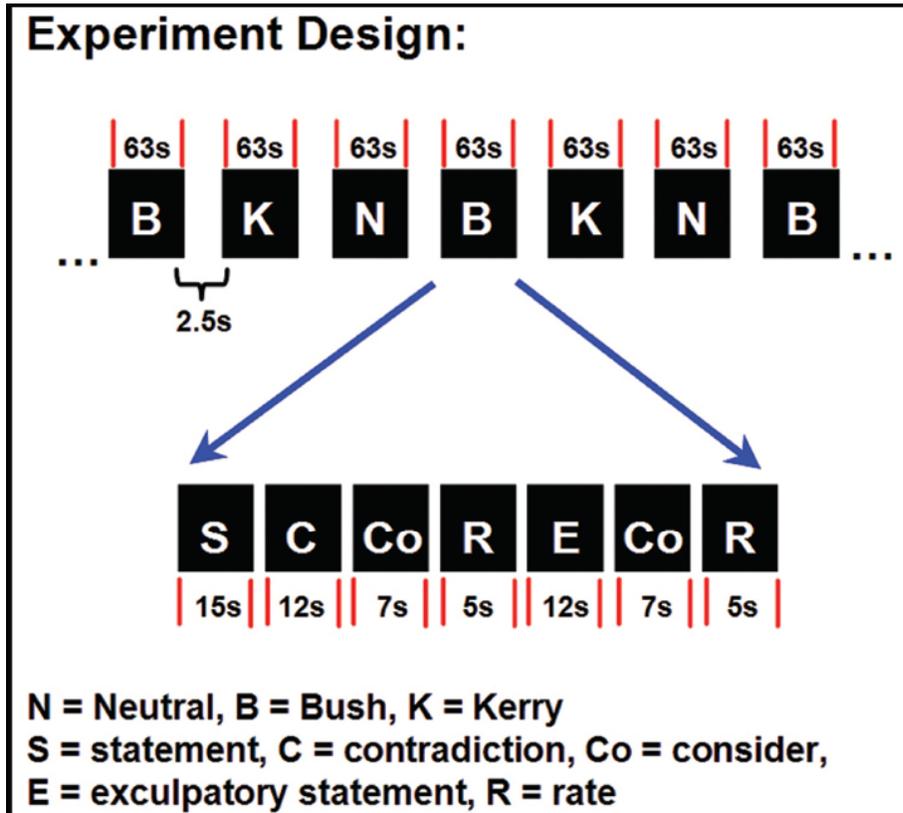


Fig. 2

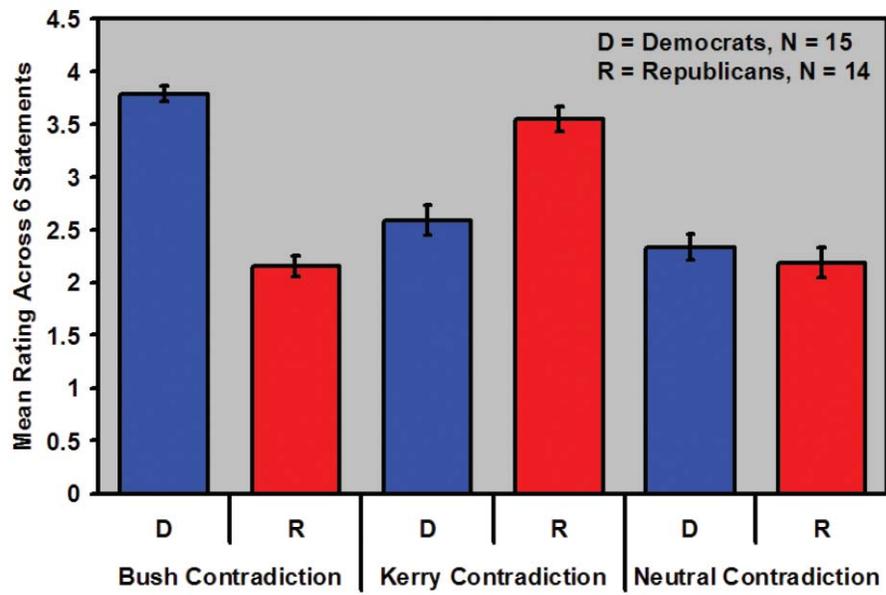


Fig. 3

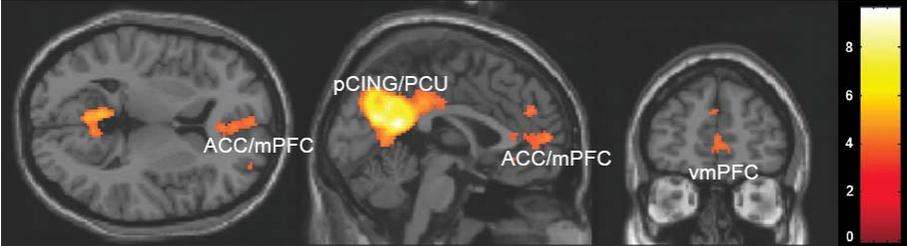


Fig. 4

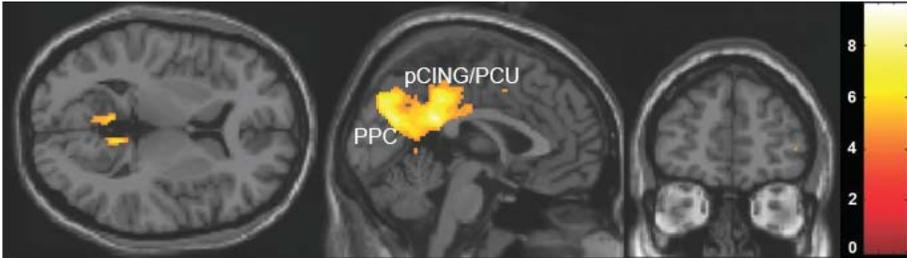


Fig. 5

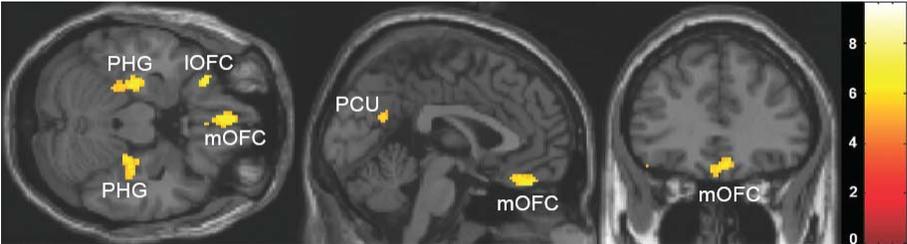


Fig. 6

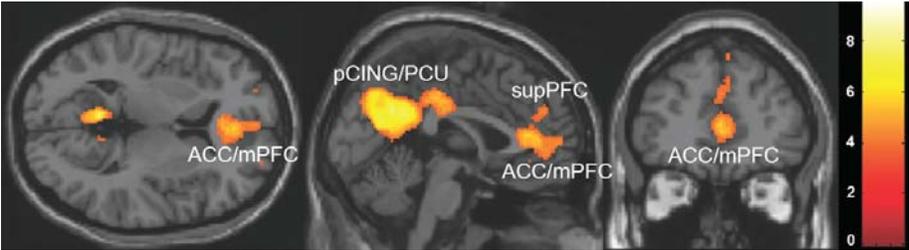
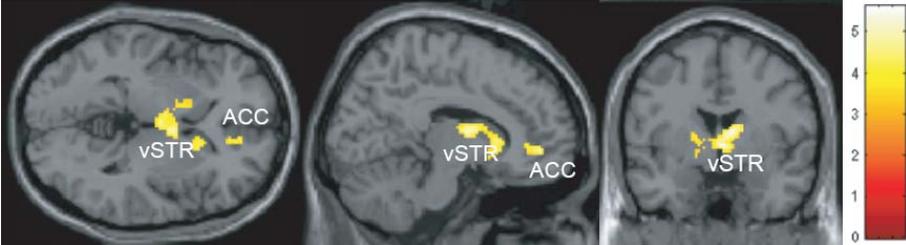


Fig. 7



Footnotes

¹ Potential subjects were screened by phone using an MRI screener (to rule out safety risks, neurological conditions, etc.) and a political attitudes questionnaire, using items from the National Election Studies (NES, <http://www.umich.edu/~nes>) to measure partisanship. Using NES item wording, we asked about nature and strength of *party affiliation*; obtained ratings on their feelings toward *George Bush, John Kerry, Bill Clinton, Dick Cheney*, the *Democratic Party*, and the *Republican party* using a 0-100 “feeling thermometer” (from cold to warm); obtained 4-point ratings of how often Bush and Kerry made them feel *angry, hopeful, afraid, proud*, and *disgusted*; and obtained 4-point ratings of the extent to which they saw the two candidates as *moral, intelligent, dishonest*, and *out of touch with ordinary people*. To be included subjects had to rate themselves as a *strong* Democrat or Republican and to endorse a difference between the two parties or the two candidates ≥ 30 points on the feeling thermometer.

² The progression of statements provides a reasoning task, in which subjects have to judge twice whether the information represents a contradiction. For example, for the practice statement set, Walter Cronkite was the target:

Initial statement: “I think my days in journalism are over. I’ve had a wonderful, full life, but when it’s time to retire, it’s time to retire. And it’s my time to retire” - Walter Cronkite, 1981.

Contradictory statement: Twenty-one years later, Mr. Cronkite hosted a series on CBS.

Exculpatory statement: Mr. Cronkite had no intention of hosting any further shows, but a longtime friend at CBS asked him as a special favor to do a retrospective on TV journalism.

Statement sets regarding the two candidates had the same structure, except that the contradiction would be threatening to partisans on one side or the other (Table 1). We

counterbalanced order of presentation of targets, such that half of subjects (stratified by party) were presented with a Bush vignette first and the other half with a Kerry vignette.

³ The study was conducted on a 3 Tesla Siemens Magnetom Trio whole body MRI scanner in the Biomedical Imaging Technology Center at Emory Hospital. Brain imaging involved the acquisition of 30 axial slices of 3 mm thickness, acquired parallel to the AC-PC line with a matrix size of 64 x 64 over a field of view of 22 x 22 cm. Blood oxygenation level dependent (BOLD) contrast images were acquired (TE of 30 msec) using T2*-weighted gradient echo, echo-planar pulse sequences with a TR of 2.5 seconds for a total of 477 scans. In addition, a 3-D MP-RAGE sequence was collected at an isotropic resolution of 1 x 1 x 1 mm for 3-D anatomic analysis and visualization of task-related activations. Head movement was limited by padding and restraint. Subsequent to reformatting the data into the ANALYZE image format, the images were resliced and corrected for motion by registration to the first functional image acquired for each subject using a 6 parameter transformation. Images were then spatially normalized to the Montreal Neurological Institute (MNI) template by applying a 12 parameter affine transformation followed by nonlinear warping using basic functions. Images were smoothed using a Gaussian kernel of 8 mm full width at half maximum to enhance signal to noise ratios and facilitate group comparisons. Differences in global BOLD signal were controlled by proportional scaling. Low frequency noise was removed using a high-pass filter, and an autoregressive model (SPM2) was used to account for serial correlations in the data.

The data were analyzed using a two-stage, random effects procedure. In the first stage, the BOLD response for each vignette condition for each subject was modeled with the standard canonical hemodynamic response function (cHRF). Parameter estimates of the cHRF were created via within-subject contrasts collapsed across conditions. The resulting summary statistic

images were then entered into a second stage analysis that treated each subject as a random variable. Image analysis was conducted using MATLAB and Statistical Parametric Mapping software (SPM2; Wellcome Department of Cognitive Neurology, <http://www.fil.ion.ucl.ac.uk/spm>). The data were analyzed in a block design format, with the input model designed to reflect the durations of each condition. Subjects were given detailed instructions prior to scanning and a practice run to familiarize them with procedure and insure responding within blocks. While making 4-point ratings, subjects were instructed to press a button on a 4-button MRI-compatible response pad. Unless otherwise indicated, all activations were assessed at a significance level of $p < 0.001$ (uncorrected) and an extent threshold of 5 contiguous voxels.

⁴ Elsewhere we will address any neural differences between Democrats and Republicans as they responded to these statements or to photographs of political, nonpolitical social, and emotional stimuli presented after the tasks described here.