Evaluating Political Questions:

Evidence from Functional Brain Imaging

Political scientists often say that political sophisticates think differently about politics than political novices. In this paper, I use functional brain imaging to test four hypotheses about the differences in the mental processes of political novices and sophisticates. I show that while political sophisticates can evaluate political questions using a type of implicit, automatic, and social cognition, political novices must use heterogeneous explicit and controlled cognitive processes. The implication is that while political sophisticates can readily apply values developed in a social context to political problems, political novices are unable to. I thus uncover the neural underpinnings for the behavioral differences observed by Phillip Converse (1964) and John Zaller (1992), but reject the "non-attitudes" and "information processing" theories they pose. Rather, my data support a theory that, for sophisticates, political cognition is social cognition. Novices lack knowledge about how to apply their values to questions of national politics, not the values themselves.

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Political novices and political sophisticates think differently about politics. That is the central claim motivating the research I will discuss in this paper. While this claim has been prominent in research on political behavior for the past forty years, this paper uses functional brain imaging to explore its validity and meaning. Functional brain imaging, in particular functional magnetic resonance imaging (fMRI), has ushered in a revolution in the way cognitive neuroscience understands the brain and mind. Changes in the magnetic field generated around a research subject are linearly correlated with changes in the blood flow within neural tissue in regions of the subject's brains, which are linearly correlated with changes in neural activity in that region of tissue. Thus, by observing changes in the fMRI signal, we can draw relationships between different mental operations and their neural correlates.

In this paper, I will use fMRI to investigate four hypotheses about the nature of political thought. First, behavioral differences between political sophisticates and novices have neural correlates. Second, political sophistication is like other kinds of sophistication. Third, political cognition is a kind of social cognition. And fourth, the differences in political cognition between political sophisticates and political novices involve distinct neural systems, described as the reflective and reflexive systems. Since much of the reasoning in cognitive neuroscience is done through reasoning by analogy to other, better known, mental operations, I would pose a simple question. Which subject in school is political thinking most like: language arts and reading, math, recess, social science, history, art, or science? I will return to this question at the end of the paper.

I will begin in the first section by exploring the motivation behind these four hypotheses. Then I will describe the fMRI experiment that is the center point of this paper. Because the analysis of function brain imaging data requires special considerations, I will explore some of the issues in analyzing fMRI data in the third section. The fourth section will examine the resulting data and the fifth section will consider the cognitive neuroscience interpretations of that data. In the sixth section, I will explore the political science implications for the results we obtain.

Motivating the Four Hypotheses

Phillip Converse's (1964) "The Nature of Belief Systems in Mass Publics" set off a controversy when he concluded that many responses to survey questions are "non-attitudes," the equivalent of mental coin flips. Many respondents to political surveys gave answers that were temporally or ideologically inconsistent. While a few subjects were able to conceptualize political questions in ideological terms, many appeared to have little sense of "what goes with what" and responded without apparent ideological constraint. His conclusion was that "large portions of an electorate do not have meaningful beliefs, even on issues that have formed the basis for intense political controversy among elites for substantial periods of time (Converse 1964, p. 245)." The level of political sophistication appeared to be the major difference between those who had ideologically coherent and stable political attitudes and those who did not. A variety of measures of political sophistication have been proposed, but they generally attempt to quantify a difference in political knowledge, experience, or commitment (Delli Carpini and Keeter 1996; Zaller 1992).

Chris Achen (1975) was disturbed by the implications of Converse's research and claimed that "democratic theory loses its starting point" if Converse is right. In a psychological study where subjects were asked to repeatedly identify their favorite shade of gray, the authors discovered two sources of ambiguity: subjects were uncertain about the choices available to them and about their own preferences (Coombs 1967). Achen contended that similar ambiguities faced the unstable respondents identified by Converse and that the weak correlation among responses for political novices was the result of "fuzziness of the questions and other errors of measurement."

John Zaller's (1992) book The Nature and Origins of Mass Opinion contended that the behavioral differences among political novices and sophisticates could be understood as the consequence of basic axioms regarding the probability of reception, acceptance, and sampling of political considerations. Political novices paid little attention to political considerations in the news or public sphere, were thus more likely to accept any new political information they received because they had lower amounts of prior information to motivate rejecting the new information. They were also more likely to report one of the new pieces of information when they sampled the small set of considerations that they held about an issue.

This literature on political sophistication has grown in importance and led some to claim that nearly every statement about the political behavior of citizens must be qualified by their level of political sophistication (Hamill and Lodge 1986). The main thrust of this literature is that political novices and political sophisticates "think differently" about politics. Political novices give responses that are less stable (Achen 1975; Converse 1964), less tied to their own values (Zaller 1991; Zaller 1992), are more susceptible to question wording effects (Kinder and Sanders 1990), and are less ideologically coherent (Converse 1964; Converse 2000). The widely held belief is that these behavioral differences reflect some difference in cognition, either in quality or quantity.

Shortly after the publication of The Nature and Origins of Mass Opinion, neuroscientist Marcus Raichle (1994) and his colleagues injected subjects with a radioactively labeled sugar and used a positron emission tomography (PET) scanner to image them while they performed a cognitive task for the first time. They then allow the subjects to practice the tasks repeatedly. Then they imaged the subjects again while they performed the practiced task. By contrasting the PET image taken while the subject was doing the task, with an image taken while the subject was at rest, they could identify the brain areas that had increased blood flow and thus were involved in processing the task. There were a number of brain areas that appeared to be working very hard to process the task when the subject had initially tried it. However, with practice, the image of the brain doing the task was very similar to the image of the brain at rest.

This result led me to conjecture that if political novices and sophisticates truly did "think differently" then this difference should be apparent using brain imaging. It also lead the to the conjecture that perhaps political sophistication is just like the other forms of sophistication studied by cognitive neuroscientists and psychologists. I formalize this as my first and second hypothesis:

1. Behavioral differences in political sophisticates and novices have neural correlates.
2. Political sophistication is like other kinds of sophistication.

The literature on quantifying the cognitive effects of sophistication goes back to F. C. Donders seminal research nearly a century and a half ago (1969 (original work 1868-1869)). Donders' believed that measuring the amount of time that it took a person to complete a mental task gave a rough measure of cognitive effort. He demonstrated that by subtracting the time required to do a simple mental task from the time required to perform a mental task that required one additional step to complete, one could estimate the amount of cognitive effort required for that additional step. While this method was strongest with tasks that were serial rather than parallel in nature (Luce 1986), it provided a simple, but crude measure of cognition still in use today (see e.g. Dovidio et al. 1997; Bassili and Scott 1996; Bassili and Bors 1997; Huckfeldt, Sprague, and Levine 2000). One of the chief results of this line of research was that subjects became faster and better at performing tasks with such regularity that it became known as the "power law of practice" (see e.g. Palmeri 1999).

As a simple initial test of the second hypothesis, the I estimated the effect of political sophistication on response times to political questions (Schreiber 2000). This test used response latency data from the 1996 Political Network Election Study dataset (see Huckfeldt et al. 1999). As one would predict from the psychology literature on response times, the political sophisticates were faster on average than the political novices across a range of political questions.

Another important component of the psychology literature on sophistication has been the development of the dual process models. While over three dozen dual process models have been described in the social psychology literature (Chaiken and Trope 1999), they generally predict that a person will shift from controlled, conscious, and explicit processing of a task to automatic, subconscious, and implicit processing, with the gain of expertise in the task. The "power law of practice" is thus understood as the result of the brain learning how to automate the task and relegate its performance away from the more limited controlled mental processes (Anderson 1999).

Matthew Lieberman (2002) and Kevin Ochsner have theorized that the dual processes described in the social psychology literature may arise from two distinct neural subsystems. I joined them in applying the dual processing models to political cognition in a recent piece for Political Psychology (2003) entitled "Is Political Sophistication Like Learning to Ride a Bicycle? How Cognitive Neuroscience Can Inform Research on Political Thinking." This work inspired the next two hypotheses of the current paper:

3. Political cognition is a kind of social cognition.
4. Behavioral differences in political cognition between political sophisticates and novices involve the reflective and reflexive systems.

The reflective neural system is composed anatomically of the prefrontal lobe, the anterior cingulate, and the medial temporal lobe. The prefrontal lobe is located in the front of the brain and is usually involved in tasks of mental deliberation (Lieberman et al. 2002; Goldberg 2001). The anterior cingulate acts as an alarm system alerting the prefrontal lobe that some information needs to be consciously attended to (Kerns et al. 2004; Fan et al. 2003). The medial temporal lobe, in particular, the hippocampus, encodes long-term explicit memories (Optiz et al. 1999; Tulving et al. 1996; Cohen et al. 1999; Dolan and Fletcher 1999). Together, these regions work to support intentional decision-making. The mental processes of the reflective system are conscious, explicit, and deliberate and are believed to be serial and symbolic.

In contrast, the reflexive system is characterized by unconscious, implicit, and automatic processing that relies on a sub-symbolic neural network that associates and processes information in parallel. The lateral temporal lobes, amygdala, and basal ganglia compose the reflective system. The lateral temporal lobes perform pattern recognition and aid in semantic memory (Garrard and Hodges 1999). The amygala is best known for its role in threat detection (LeDoux 1996; Phan et al. 2002) and the basal ganglia appear involved in learning rewards (Bartels and Zeki 2000; Knutson et al. 2001; Breiter et al. 1997).

We predicted that political novices would tend to rely on their reflective system in answering political questions. Since they did not have the experience, the stored memories, or the learned procedures for answering political questions, they would need to invoke explicit mental processes in order to generate a response. For political sophisticates, answering political questions would be a familiar task and we expected that they should be able to rely primarily upon automatic mechanisms for responding.

In addition to following the pattern of dual-process models in social psychology, we expected that political cognition would follow other patterns of social cognition. Social attitudes are known to be mediated by social context, mood, and prior habitual thought patterns (Anderson, Silver, and Abramson 1988; Chaiken, Liberman, and Eagly 1989; Forgas 1995; Petty and Cacioppo 1986). Each of these factors reflects the complexity of the problems which social cognition is required to solve.

In a seminal paper on social cognition, Nicholas Humphrey (1976) argued that while Robinson Crusoe's task of survival on the desert island was technically challenging, the really hard problems come from the arrival of Man Friday. This line of reasoning, sometimes called the Machiavellian Intelligence hypotheses (Byrne and Whiten 1988; Whiten and Byrne 1997), contends that managing the problems of the social world requires a far greater level of intellect because contexts change rapidly (see

Waal 1998). While the evolution of affective states is thought to have facilitated cooperation and thus complex social structures (Lewis, Amini, and Lannon 2000), monitoring the emotional and mental states of others requires a constant vigilance (Chance and Mead 1953). It is believed that the demands of increasingly complex social environments drove a cognitive arms race with competitive pressures leading to larger neo-cortices capable of navigating the politics of larger tribal groupings (Barton and Dunbar 1997; Dunbar 1993). One theory arising from this literature is that Robinson Crusoe's mental capacity for solving the technical problems of his mere survival evolved as an incidental benefit to the mental capacity for solving the more complex social problems (Humphrey 1976; Whiten and Byrne 1988; but see Oakley 1964).

Because there are so many different problems that manifest from social living, it has been argued that social intelligence is not a monolithic phenomenon, but rather a collection of intelligences that evolved to solve particular problems in the social environment (Gigerenzer 1997; Cosmides and Tooby 2002). Andrew Whiten and Richard Bryne (1997) note that the social intelligence exhibited by primates reflects a delicate subtlety requiring at least a basic ability to manipulate the behavioral, emotional, and even mental states of others and label this intelligence Machiavellian, not because it is callous, but because it is subtle. Thus, for animals in a complex social environment, theorizing about the intentional states of others is one particularly important task of social cognition (Premack and Woodruff 1978; Dennett 1987).

While imitation (Rizzolatti et al. 1999; Rizzolatti and Craighero 2004), symbolic thinking (Deacon 1997), language (Pinker 1994; Pinker 1999), normative judgment (Brosnan and De Waal 2003; c.f. Wynne 2004), and culture (Byrne et al. 2004) have all been described as kinds of social cognition emerging in primates, the argument made in the Machiavellian Intelligence theories is that these capacities evolved in response to the need for a kind of political cognition. However, this conceptualization of political cognition involves intimate relationships with those we encounter daily, not thinking about candidates in national elections. While I predicted that the neural correlates underlying political cognition would overlap with those of social cognition, it was not obviously so. Furthermore, it was not obvious what kind of social cognition thinking about politics would be like.

Describing the Experiment

To explore these hypotheses, I recruited eighteen healthy, normal, and consenting college students with email solicitations to participate in an experiment using functional magnetic resonance imaging (fMRI). The twelve political sophisticates (5 female, mean age 21.1±2.1) were recruited from the UCLA Republican Club and the UCLA Democratic Club with six subjects from each group. The six political novices (5 female, mean age 20.2±1.5) were recruited from a list of UCLA students who had volunteered to participate in functional brain imaging experiments. All the subjects were screened to rule out medication use, a history of neurological or psychiatric disorders, head trauma, substance abuse, or other serious medical conditions.

I also used a sixteen item questionnaire of factual political knowledge to screen subjects (Delli Carpini and Keeter 1993). I had a total of eighty-nine respondents to the email solicitations with a mean political knowledge score of 12.0±2.9. The mean political knowledge score of the twelve political club member participants was 15.2±0.9. The political novices were chosen from lowest scores of the broader email solicitation and had a mean political knowledge score of 7.9±1.9. In order to reasonably control age and education, I exclusively used UCLA undergraduates.

Due to the exploratory nature of this experiment, I decided to conflate ideological commitment and political sophistication by selecting political club members. The goal in the experimental design was to maximize the variance in the political knowledge and involvement of the subject population while controlling for demographic factors such as age and education. Although there were substantial differences in other indicators political participation, the novice and sophisticate groups did not appear substantially different in their recognition of movie stars (a crude measure of media attentiveness) or their grade point averages (a crude measure of general intelligence).

Prior to the scanning, subjects were given a description of the experimental procedures and practiced responding to some non-political stimuli. In the fMRI scanner, subjects wore scanner-compatible video goggles and headphones so that they could receive audiovisual stimuli. They also held a response box so that they could indicate whether they agreed or disagreed with the statements they heard. The subjects' heads were cushioned on both sides and secured with a strap to reduce motion.

Before the experimental stimuli began, a high-resolution structural MRI image was acquired as an anatomical reference for the subject's brain. The experiment itself had three functional imaging sessions in which subjects heard digitally recorded statements that were either political or non-political in nature. The statements were each six seconds long and were designed to be very similar in format and with the salient piece of information at the end of the question so that subjects would need to hear the entire statement before deciding upon a response. After they heard each statement, visually presented numbers counted down three seconds for the subject to press either the "agree" or "disagree" button. Then, the subject was given three seconds of a blank screen to rest before the next question. During each of the three functional imaging sessions, the subject heard a different set of twenty-eight randomly ordered statements. A functional MRI image was acquired every four seconds and each session lasted a total of six minutes.

Analyzing fMRI Data

Scanning eighteen subjects every four seconds during three, six minute imaging sessions generates over four thousand whole brain images, each of which contains around 50,000 cubic millimeter voxels (the 3 dimensional equivalent of pixels) and thus yields a total of over two hundred million data points. Fortunately, recent advances in statistics and computing make analyzing this volume of data possible. However, fMRI analysis also poses particular problems involving data cleaning and preparation.

To analyze the data from this experiment, I utilized the FMRIB's Software Library (FSL)(www.fmrib.ox.ac.uk/fsl). Since the entire head of the subject is scanned, FSL provides an advanced set of tools for such tasks as extracting the brain from the surrounding skull and tissue (Smith 2002) and correcting for any movement of the subject's head (e.g. from breathing)(Jenkinson et al. 2002). FSL also contains tools for registering each subject's functional imaging data onto the anatomy of the subject's structural MRI scan. And, it contains tools for warping the data from each individual subject onto a common reference brain. The reference brain I used is an average of the high resolution scans of 152 healthy individuals created by the Montreal Neurological Institute. This warping allows the data from a number of subjects to be meaningfully compared despite differences in anatomy for each individual subject. The subjects were healthy, young, and had no brain lesions or neurological disorders so they had less difficulty with holding still throughout the experiment. As a result, the brain extraction, motion correction, and registration to the reference brain worked well.

FSL contains a functional analysis toolkit that supports hierarchical modeling and uses the Markov Chain Monte Carlo method (MCMC) to estimate a general linear model (Beckmann, Jenkinson, and Smith 2003; Woolrich et al. 2004). The hierarchical model here works in three stages. First, I estimate a statistical model for each of the three functional scanning sessions for each subject. Second, I generate a mean of the three session models for the subject. And third, I group the subjects into the Democratic Club members, the Republican Club members, and the political novices and create a contrast of the political sophisticates and novices. For the functional data analysis, FSL brings the data from each prior level of analysis to the higher-level analysis, improving the accuracy of the estimate and accounting for session and subject variance.

For each of the fifty-four individual sessions, I specify in FSL the order of the stimuli presented to the subject. Functional MRI works because we know that by measuring the changes in the MRI signal we can make reliable inferences about the changes in the underlying neural tissue. As a region of the brain works harder at a task, blood flow is increased to that region. Because more hemoglobin is brought to the region than is consumed, the excess is detectable as a change in the blood oxygen level dependent (BOLD) MRI signal. In this event-related experimental design, FSL models a hemodynamic response function (how blood flow changes in response to the event of the question answering) for each question. The fit of this model is estimated for each of the voxels in the brain. Finally, I specify a contrast between the responses to political and to non-political questions. And thus, FSL estimates the difference in the MRI signal that occurs from responding to political questions having subtracted out the effect of responding to questions in general.

In the individual level analysis, FSL creates an image that is the mean of each of the three session level contrasts so that we can see on average how the regions of the brain in that particular subject responded to the political questions compared to the non-political questions. The contrast method used with FSL for estimating the effect of the political questions compared to the non-political questions is similar to the subtraction method that F.C. Donders used in his response time studies and has the same logic. By specifying a control task that is similar to the task of interest, one can make inferences about the difference in neural activity caused by the additional work required in the task of interest. As in its application to response times, this subtraction method limits the kinds of inferences that can be made from the data (Horowitz 1998). However, new methods are emerging that will improve our ability to understand the functional connectivity of particular regions and overcome some of the main limitations in the subtractive method (see e.g. Friston, Harrison, and Penny 2003).

The third level of statistical analysis is the group level. The mean data from each individual subject is assigned to one of the three groups (Democratic Club members, Republican Club members, and political novices). Then, I specified a contrast between the sophisticates and the novices. Because FSL is using MCMC to estimate the general linear model (rather than just performing a standard ANOVA for instance), the software can easily accommodate the different number of subjects in two sides of the contrast and still generate a good estimate of the model fit.

Results from the fMRI Experiment

The end product of the three levels of analysis is a single three-dimensional brain image. Each of the voxels in the resulting image contains a value that corresponds with the z-score for that voxel; essentially, indicating how well the statistical model estimated fits the data in that particular voxel. The convention in the social sciences is often to provide a series of asterisks to indicate how statistically significant a particular result is. The brain images typically produced in journal articles or featured in newspaper and magazine stories about brain imaging are thus equivalent to maps of statistical significance or asterisks, with more intense colors representing the better fit of the estimated model for the data in that particular voxel.

To assist in understanding this visualization of the data, I generated **Figure 1**. This is an axial slice of the brain imaging data, which cuts from an area in the forehead horizontally to the back of the head. The colored functional imaging data is overlaid upon a gray-scaled structural image for easy reference. The structural image used for these pictures is of a particular individual who imaged his brain twenty-seven times in order to generate an extremely high resolution image that is now a common standard for fMRI data visualization. In the underlying image, one can easily observe the white oval of skull tissue surrounding the brain, the connective white matter branching out from the midline of the brain, and the gray matter that folds in and out around the surface of the white matter.

This image (**Figure 1**) is an average of the activation for all of the subjects while responding to all of the questions (the resting period and statement listening periods are used as contrasts). The colored functional data indicates areas where the fMRI signal was different in a statistically significant manner. The yellow to orange spectrum colors indicate areas of increased neural activity and the blue spectrum colors indicate areas of decreased neural activity. What we can observe from this image is the tendency of the brain to be left lateralized for language processing. The large orange blob in the upper left quarter of the image is located in Broca's area, a region well known for language processing. The orange blobs on the bottom show activations in the occipital lobe, which processes visual information. The two smaller blue regions located on either side of the brain are in the lateral temporal lobes in an area often associated with semantic memory. This image also illustrates the need for contrasts between more similar stimuli. Because the whole brain is constantly active, dissimilar tasks (such as resting and listening to a question versus answering a question) generate brain images that appear to activate the majority of neural tissue. Thus, the central result for this paper shows an image that is a much tighter contrast comparing the process of answering political questions and non-political questions and comparing the differences between political sophisticates and political novices. Such a contrast allows for far more interpretable and meaningful imaging data.

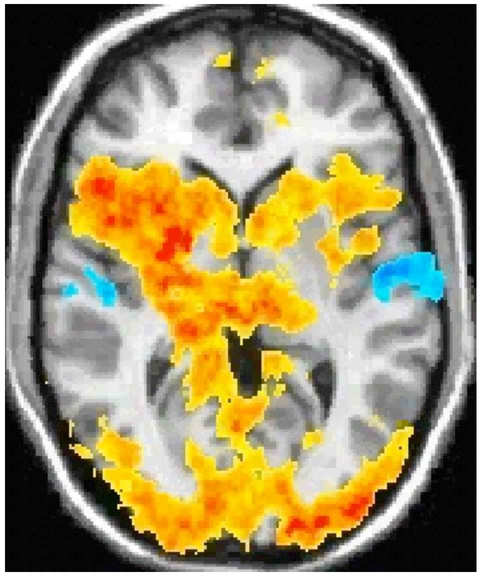

Figure 1. Mean BOLD fMRI signal in all subjects while responding to questions.

In **Figure 2**, we see the main result of this experiment. This is a volume rendering of the entire head, with a quarter portion of skull and brain removed to highlight the brain region of interest. In the bottom right of the image, we can see the right eye of the reference head. In the bottom left of the image, we can see a portion of the right ear. The quarter removed runs axially from the occipital region of the brain to the middle of the forehead and sagitally through the midline of the brain. We can again note the white matter exposed in the axial slice and the folds of the grey matter highlighted in the sagittal slice. The white colored corpus callosum is located in the center of the image and is the main connective tissue through which the left and right hemispheres of the brain communicate.

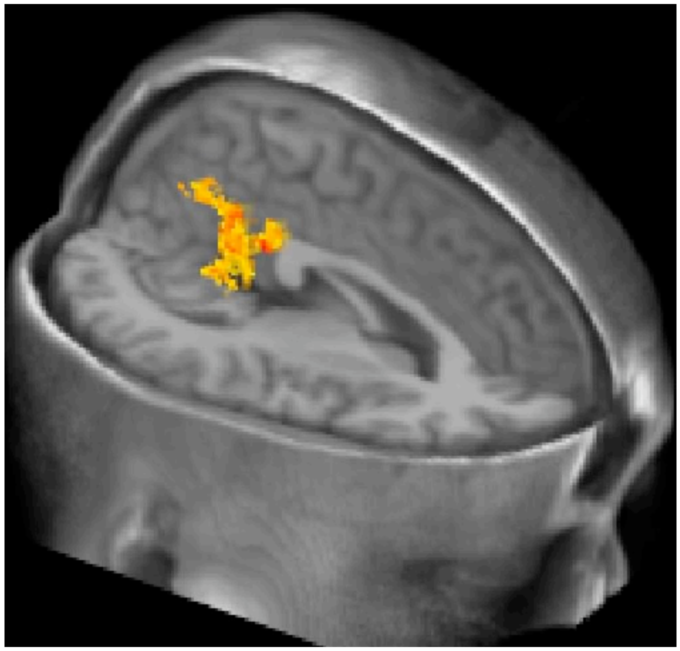

Figure 2. BOLD fMRI Signal increases in medial posterior cortical areas in political club members answering political questions, compared to political novices. The cluster is composed by 520 voxels, with a peak Z score of 4.68 located at (-4, -51, 24) in Talairach coordinates.

Because we are essentially running a statistical model over 50,000 voxels simultaneously, using a p value of 0.05 would lead to many false positives. One way that cognitive neuroscientists have coped with this in the past is with the Bonferroni correction, which adjusts the z-score voxel threshold for number of simultaneous tests. However, the tests we are running are not truly independent and our knowledge of the brain leads us to expect that the co-activation of a cluster of voxels is more likely to be of substantive significance than the same number of active voxels randomly distributed through space. Thus, FSL uses Gaussian random field theory to partially account for this knowledge (Worsley et al. 1992; Friston et al. 1994; Forman et al. 1995). I first set a voxel level threshold of $Z>2.3$ and then set a cluster level threshold of $p<0.05$. This is still a conservative statistical thresholding method, but more reasonable in its assumptions than the Bonferroni correction.

The cluster shown activated in **Figure 2** contains 520 voxels that have a Z score greater than 2.3 and the entire cluster has a p value of less than 0.0001. The Talairach (1988) brain atlas has been used a standard reference for locating phenomena in the brain. The Talairach coordinates are specified in millimeters, are centered on the anterior commisure (a small connection between the hemispheres located near the center of the brain), and are usually used to specify locations in the brain. The highest Z-score in this cluster is 4. 68 and it is located at the Talairach coordinates (-4, -54, 24).

Considering the Neuroscience Interpretations

Anatomically, this cluster of activation is located in an area that can be generally described as the medial posterior cortices. More particularly, it is centered in the posterior cingulate and extends into the precuneus. This area has also been described as the retrosplenial cortex. To begin to understand meaning of this activation pattern, I will first review a simple theory of neuroanatomical organization.

Paul MacLean (1990) has argued that neuroanatomy can be considered in three roughly evolutionary units. He describes the brainstem as the “reptilian brain”, which regulates basic survival phenomena like respiration, digestion, sleep, and movement. When a person is called “brain dead” it means that the rest of the brain has ceased function, but the “reptilian brain” is still alive. In contrast, if a person suffers damage to the brainstem, it is likely the whole body will die (Firsching et al. 2002). The limbic system wraps around the “reptilian brain” and was described by MacLean as the “mammalian brain.” One theory is that the limbic system in mammals allows them to synchronize emotional states, evolutionarily supporting the larger investment mammals make in their partners and in their young (Lewis, Amini, and Lannon 2000).

The “primate brain” in MacLean’s theory is the neo-cortex. While cats have a neo-cortex, it is a very small portion of their total brain mass. For higher primates however, the neo-cortex has so much surface area that it must be complexly folded to fit into the tight space it occupied. For humans, the neo-cortex represents nearly eighty percent of the total brain mass.

The cingulate gyrus arcs over the brainstem through the middle of the brain and is a key component of the limbic system. The posterior cingulate (where the bulk of the activated cluster lies) is the portion of the cingulate gyrus that lies near the back of the head. The posterior cingulate contains neurons that monitor eye movements and respond to sensory stimuli. It also performs an evaluative function, monitoring sensory inputs and the organism’s own behavior. This evaluative role of the posterior function contrasts with the executive role of the anterior cingulate described above (Vogt, Finch, and Olson 1992).

Richard Maddock (1999) conducted a meta-analysis of brain imaging studies of emotion and found that the posterior cingulate was one of the areas most frequently implicated. He has followed this up with other studies that indicate a role for the posterior cingulate in emotion (e.g. Maddock, Garrett, and Buonocore 2003). The involvement of the posterior cingulate in emotional processing would be consistent with its location in the limbic system.

Aside from Maddock’s findings, however, the posterior cingulate is an area that is rarely activated in brain imaging studies. Roberto Cabeza and Lars Nyberg (2000) conducted a meta-study of 275 functional brain imaging studies of cognition. Only a few of those studies implicated the posterior cingulate, for tasks involving the successful retrieval of episodic memories.

An intriguing explanation for the rare activation of the posterior cingulate was posed by Marcus Raichle and his colleagues (2001). As described above, the vast majority of brain imaging studies use a "subtractive" paradigm, contrasting the activation in the brain during a mental task with the brain doing a simpler version of the task or the brain at rest. Raichle had an insight similar to John Cage's (1961) 4'33" of silence, and decided to instead focus on the rests. He and his colleagues used a meta-analysis to look at the changes in cerebral blood flow as the brain went from rest to a variety of different cognitive tasks.

Raichle theorized that the areas that consistently deactivated during the transition from rest to task constitute a "default state network" in the brain. The two most important parts of this default state network are the medial prefrontal cortex and the posterior medial cortices (including of the posterior cingulate, precuneus, and retrosplenial cortex). Although only 2% of body mass, the brain consumes over 20% of the calories (Raichle and Gusnard 2002). Within the brain, the posterior medial cortices have the highest level of glucose consumption (Gusnard and Raichle 2001). The body is allocating very large portions of its caloric budget to this area of the brain and yet, it is rarely activated during cognitive tasks. From an evolutionary perspective, this seems odd. The explanation proffered by Raichle is that the posterior cingulate and the rest of the default state network are constantly and automatically evaluating the environment looking for predators and other threats, or mates and other rewards. The tonically active search in environment (and perhaps within ourselves) for life sustaining strategies and resources should be persistent and only yield metabolic resources when the successful completion of a task demands it.

To be certain of a "true" increase in neural activity within the posterior cingulate then, the work of Raichle et al. suggests that the control task must be a resting baseline. The exception to the rule that the medial posterior cortex does not show a true increase in activity appears to be for social cognition. Marco Iacoboni (2004) and his colleagues found real increases above a resting baseline in the medial posterior cortices and medial prefrontal cortex when subjects were watching film clips of social interactions. Joshua Greene et al. (2001) found a similar pattern when subjects were answering a category of "personal" moral dilemmas. And, other imaging studies have also found true activation for social cognition in this network (see e.g. Mitchell, Macrae, and Banaji 2004; Geday et al. 2003).

In order to see whether the region in the present study was truly showing an increase in the fMRI BOLD signal, I performed a functional region of interest analysis (fROI). Simply looking at the image in **Figure 2**, resulting from a contrast of responses to political and non-political questions and a contrast between political sophisticates and political novices, leaves the possibility that the apparent "activation" was caused by differences in the intensity of deceases in activity which would still appear as an "activation" in the contrast image. I conducted the fROI analysis by creating a mask isolated only the voxels present in the cluster in **Figure 2**. Then, I extracted those voxels from the entire data set and compared the fMRI BOLD signal from the question responding period and the previous resting period. **Figure 3** shows the result of this fROI analysis.

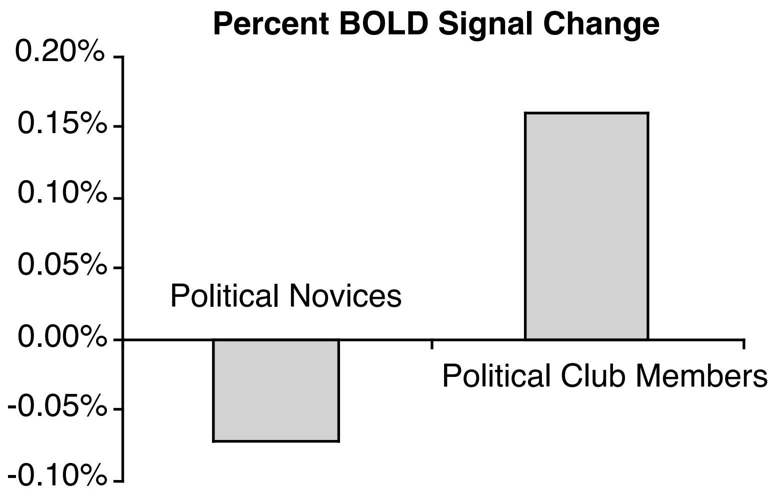

Figure 3. Signal changes in voxels differentially activated in political club members and novices in posterior cingulated cortex and precuneus. Political club members show increased signal compared to a resting baseline when they are answering political questions, whereas novices show decreased signal.

For the political sophisticates, we have a statistically significant increase in the fMRI BOLD signal when the subjects go from resting to answering the political questions. The political novices, however, show a statistically significant decrease in the fMRI BOLD signal when they are answering political questions. Considering the previous discussion, the posterior cingulates of the political novices appear to be responding as if they were performing a typical cognitive task. For the political sophisticates, however, the posterior cingulate is acting as if the subjects were automatically evaluating a social situation.

As another check of this result, I reran the contrasts, this time setting the voxel threshold at Z>3.1 and looking at only clusters with more than twenty voxels. I looked at the activation pattern for the main contrast reported above, as well as for each of the three subject groupings. **Table 1** shows the results of this analysis.

Voxels	Max Z	x (mm)	y (mm)	z (mm)	Side	Anatomy	Group
63	4.16	2	-64	30	Right	Posterior Medial Cortex	(Dem&Rep)-Nov
23	5.05	-36	-52	54	Left	Inferior Parietal Lobule	(Dem&Rep)-Nov
20	-4.72	8	-12	24	---	---------	(Dem&Rep)-Nov
22	6.17	-12	64	14	Left	Medial Frontal Gyrus	Democrat
135	5.35	-4	-52	28	Left	Posterior Medial Cortex	Democrat
32	4.54	0	-40	28	Left	Cingulate Gyrus	Democrat
20	-4.47	44	-8	52	Right	Precentral Gyrus	Novice
53	-5.64	-54	4	-26	Left	Middle Temporal Gyrus	Novice
53	-4.37	-48	-22	-12	Left	Middle Temporal Gyrus	Novice
22	-4.33	-44	26	-14	Left	Inferior Frontal Gyrus	Novice
49	4.87	0	-56	26	Right	Posterior Medial Cortex	Republican
20	-4.75	16	38	8	Right	Anterior Cingulate	Republican

Table 1. Activated and deactivated clusters for a contrast of responses to political versus non-political questions with a voxel based threshold of Z>3.1.

We find medial posterior cortical activations in the main contrast between sophisticates and novices, but also for the Democratic Club members and the Republican Club members separately. We don't have a statistically significant deactivating cluster in the medial posterior region for the political novices, but the fROI indicated that the BOLD signal was decreasing from the resting baseline. Two other things are worthy of note in this table. First, we have a statistically significant activation in the medial prefrontal cortex for the Democratic Club members as would be predicted by the involvement of the default state network in social cognition. And, we have a pattern of significant deactivations in the political novices.

Although decreases in cerebral blood flow have been found to correlate with decreases in neural activity just as increases in blood flow correspond to increases in neural activity, deactivations have been studied far less in the brain imaging community.

Many brain imaging data analysis software packages have defaults that report only the activations. This lack of interest in deactivations appears to have some interesting sociology of science roots, but work like Raichle's indicates that it is a serious failing. One explanation of a wide spread pattern of deactivations, as we have in the political novices, is that the subjects are reallocating their mental resources towards some cognitive task (McKiernan et al. 2003). That explanation would be consistent with the deactivation in the posterior cingulate.

With all of these deactivations reallocating blood flow away from particular brain regions and an indication that an intentional cognitive task is the beneficiary of the deactivations, we would expect to see some significant area of activation in the novice brains. However, even a more liberal thresholding of the data ($Z>2.3$) without any voxel level thresholding, yields no substantial activations in the political novice brains. Instead, as we see in **Figure 6**, we have a pattern of deactivations, including, as we see at the crosshairs, a deactivating cluster in the medial prefrontal cortex.

As a novice player, I start off the rare game of chess without any preset strategy of moves. Serious players, however, draw from a range of well-defined opening moves. Experts appear to be able to use their experience and select successful perceptions and strategies as if choosing from an index. Novices have not organized their perceptual or procedural memories and thus must perform brute force searches using trial and error (Larkin et al. 1980). The ability to rely on procedural as well as explicit memory means that experts in a variety of domains can develop a coherent and automatic strategy for problem solving (Anderson 1999). Consistent with this line of research into the development of expertise, the pattern of deactivations in novices without an activation may represent the diversity of cognitive strategies that novices are using to accomplish the required task of responding to a political question. If the different politically novice subjects were using different cognitive methods to respond to the question, then we would not get any statistically significant positive changes in cerebral blood flow.

Disaggregating the novice data by individual subjects shows that only two of the six subjects share a common positive activation. This activation is located in the inferior posterior lobe, an area known for its role in spatial awareness (Posner and Raichle 1997). Thus, the presence of only one shared activation in the individual level data supports the inference that there is no common activation for the group of novices and the interpretation that they are using diverse cognitive strategies.

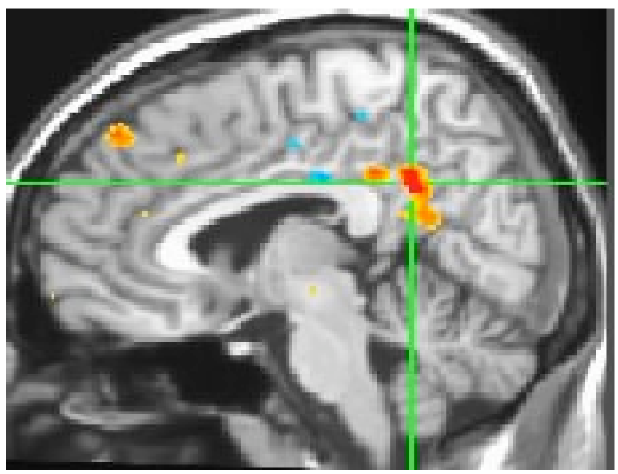

Figure 4. Mean BOLD fMRI signal response in Democratic club members for responding to political questions contrasted with non-political questions.

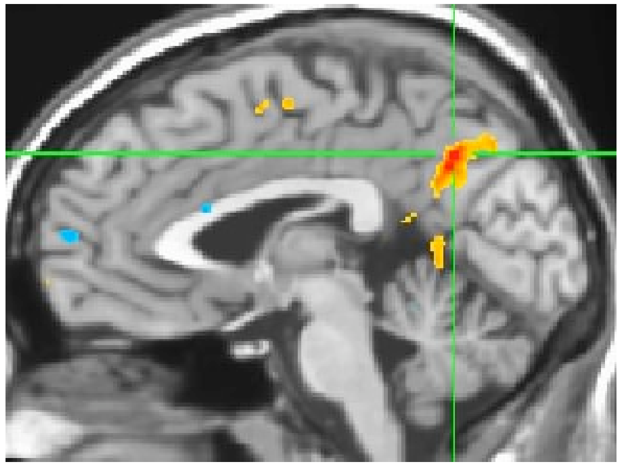

Figure 5. Mean BOLD fMRI signal response in Republican club members for responding to political questions contrasted with non-political questions.

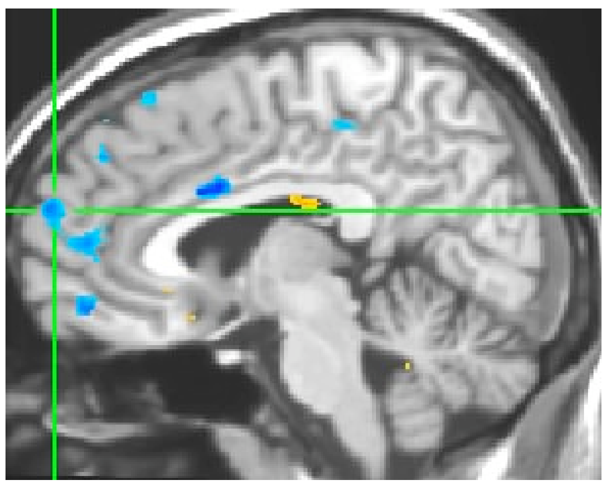

Figure 6. Mean BOLD fMRI signal response in political novices for responding to political questions contrasted with non-political questions.

While the activation pattern in the posterior medial cortex follows the predictions of social psychology's dual process models, we do not have a pattern of activation that follows the particular predictions of the reflective and reflexive systems theories (Lieberman, Schreiber, and Ochsner 2003). The activation of the posterior cingulate in political sophisticates for answering political questions indicates that this is an automatic process for them. For political novices, however, answering political questions is a cognitive task, requiring a decrease in activity in the posterior cingulate so that metabolic resources can be diverted elsewhere. Thus, we have support for the conceptual theory of my previous Political Psychology paper, but not support for the particular mechanisms.

Exploring the Political Science Implications

Before moving onto explore the meaning of the results from this project, it is worth recapitulating those results:

1. Political sophisticates and novices can be differentiated by their use of distinct neural substrates in processing political information
2. Political sophisticates perform like typical sophisticates in having faster response times to political questions
3. The activation in the posterior medial cortex indicates that for political sophisticates answering political questions involves "automatic" processing.
4. The deactivation in the posterior medial cortex indicates that for political novices answering political questions is a "cognitive task."
5. The double dissociation in activations follows the dual process models of social psychology
6. Activation patterns for political sophisticates suggest their political thinking is a form of social evaluation
7. Deactivations throughout the brains of political novices suggest a uniform reallocation of mental resources and the lack of activations suggest that there are variations in the cognitive tools used by novices.
8. Pattern of activations does not support the reflective & reflexive system dual process model's specific predictions of neural substrates. But, the pattern does support the conceptual model.

It is also appropriate to return to the earlier question I posed about what subject in school is analogous to political thinking. For political sophisticates, the answer appears to be recess. For them, political thinking is not an effortful cognitive task, as measured by the activity in the medial posterior cortex. They can respond automatically (see Fazio et al. 1986). Furthermore, they are using a part of their brain that appears evolutionarily suited for the implicit monitoring of social situations.

While political scientists often define our field of study as national or international politics, such concepts are epiphenomena of recent centuries. Aristotle's

(1996 (original work 350 B.C.)) declaration that we are, by nature, political animals is a much broader claim. The evolutionary history of the neo-cortex appears to follow a pattern of increasing size as the relevant social group increases in size. As noted above, this has led some to contend that we have large neo-cortices (which, as you will recall have substantial caloric demands) because they are needed to successfully navigate and coordinate large social groups. We must identify in-groups and out-groups, recognize social hierarchy, negotiate mating opportunities, respect norms of fairness and reciprocity, curry favor with power holders, and avoid or confront threatening rivals.

A child on the playground at recess or an early human on the savannah needs to be implicitly aware of the social world and the intentions of others and pays a cost for not being able to do so (see Frith and Frith 1999). Political sophisticates recognize questions about national policy as familiar applications of their implicit social/emotional values to a different context. Their posterior cingulates evolved for evaluating the local politics in the tribe and are now used to automatically evaluate the politics of the nation.

We would not expect the typical political novice to have any problems on the playground or in other social contexts. Normal subjects appear to easily and automatically adjust their attitudes to tune with their social environment (Lowery, Hardin, and Sinclair 2001; Sinclair et al. 2004). But, while they may successfully negotiate office, family, or church politics with implicit skill, the application of these same tools to the national scene does not occur automatically. Converse (1964) posited that ideology was a socially constructed sense of "what goes with what" and noted that political novices did not have a sufficient ideological sense to allow them to provide ideologically consistent responses. Thus, for the political novice, political thinking is not a form of automatic, social cognition. They are not enjoying recess.

Political thinking is, rather, an explicit cognitive task, akin to being in the classroom and being asked to do some assignment, learn some material, or take an exam. The decrease in the posterior cingulate indicates that the political novice must make some intentional effort. The pattern of deactivations without a substantial activation indicates that political novices may not agree which subject the task is in. Some may be treating the political questions as a language or reading task. Others may be processing it as a mathematical challenge. Still others may be trying to recall memories from their social studies or history classes.

What then do we make of the four hypotheses? We have clear support for the first contention that behavioral differences in political sophisticates and novices have neural correlates. The posterior cingulate is differentially activated between political sophisticates and novices in a theoretically sensible manner. We have a true increase in neural activity for the political sophisticates in the posterior cingulate and a set of decreases for the political novices. Political novices and sophisticates do appear to think differently about politics in a manner that is distinguishable with brain imaging.

We also have strong support for the second hypothesis that political sophistication is like other kinds of sophistication. The ideological and temporal consistency identified by Converse (1964) along with the improved response times (Schreiber 2000) fit the general theory of the power law of practice found across domains of expertise. We now also have functional imaging evidence of a transition from controlled to automatic processing, which is one of the hallmarks of expertise in a field (Anderson 1999).

The third hypothesis of this paper is that political cognition is a kind of social cognition. The double dissociation found with posterior cingulate activity increasing with political sophisticates and decreasing with political novices fits the dual process models of social psychology. The function of the default state network fits well with the description by Michael Chance and Alan Mead (1953) of the need for constant monitoring of the social environment in social animals. And, the only other "true" activations of the brain region involved here appear to be in the performance of social cognition activities. So, it looks like we have good evidence to support the expectation of the third hypothesis.

However, the evidence is mixed on the fourth hypothesis. On the one hand, the data fully supports the belief that political sophisticates can use automatic/implicit processes to respond to political questions and that political novices will require controlled/explicit processing. But, the neural architecture of these results was not the predicted reflective and reflexive systems (Lieberman, Schreiber, and Ochsner 2003). For instance, while we predicted activations in the prefrontal lobe for political novices in making deliberate choices about their responses, we had only deactivations. And, while we had expected activation in the amygdala or basal ganglia for the political sophisticates, these areas did not appear to be significantly activated. Thus, while the general claim that political thinking is like learning to ride a bicycle holds, the specific expectations about the neural architecture do not appear supported.

The results of this study suggest that we might reconsider "considerations" as conceptualized by Zaller (1992). While he acknowledges that considerations may have a wide variety of sources (including values and social norms), his model is essentially agnostic about the psychological or normative reality of considerations. His model is a model of information processing and, as such, does not ascribe normative importance to the information being processed.

In John Searle's (1980) famous "Chinese room" argument against strong artificial intelligence, he tells a story of a monolingual English speaker in a room with two large batches of slips of paper with Chinese writing on them. The English speaker also has a set of instructions in English for matching one set of the slips of paper with another set of slips of paper. With much practice, the English speaker becomes so adept at the slip manipulation rules that a native Chinese speaker sliding slips of paper under the door of the Chinese room and receiving slips in response cannot tell that the English speaker does not understand a word of Chinese. Searle uses this parody of the Turing (1950) test for artificial intelligence to argue that no computer could be considered intelligent in the strong sense of the word because for the computer the symbols are processed syntactically rather than semantically, the symbols are meaningless and not grounded in understanding.

For a political novice who has little or no knowledge of national politics, responding to political survey questions might be like being the English speaker in the Chinese room during your first day on the job. Subjects who cannot identify leading political figures, the policy positions of the major parties, or use ideology as a framework for their political thinking might well be processing meaningless symbols and merely "answering questions" rather than "revealing preferences" (Zaller and Feldman 1992). For some folks, however, the symbols of politics have meaning and are connected to deeply held values.

Research on political socialization suggests that the connection between values and political attitudes often occurs at home, through perceptual rather than persuasive processes (see Westholm 1999). While we may form many political attitudes in a personal social context (Katz and Lazarsfeld 1955; Lazarsfeld, Berelson, and Gaudet 1948), even mediated and "impersonal" (Mutz 1998) methods of political communication have a central social dimension to them. The finding here that political sophisticates use a portion of their brain specializing in automatic, social processing to respond to political questions is consistent with the claim in the political science literature that politics, when meaningful, is personal.

Experimental work by James DeNardo (1995) and research in survey data by Michael Alvarez and John Brehm (2002) have both lead to the conclusion that it is informational differences, rather than values that distinguish between the meaningful answers of political sophisticates and the often meaningless responses of political novices. While at first glance undergraduates' responses to a question about deterrence strategy appeared "aschematic", DeNardo found with deeper analysis of the data that they were following orderly heuristics similar to those of policy experts. Like the policy experts, the students had an underlying value structure. However, they did not have the technical knowledge to efficiently apply the values to the policy choices presented.

Similarly, Alvarez and Brehm's sophisticated analysis of survey data led them to conclude that while respondents were sometimes ambivalent or equivocal about policy choices, they were most often uncertain. They knew what their values were, but were unable to apply them to the political questions they faced. Alvarez and Brehm note that this uncertainty about how to apply core values to policy debates provides a political opportunity for politicians and other political elites. By providing coherent and meaningful models for the translation of values into political choices, elites can inform the electorate and structure national discussions. The results of the "Deliberative Polling" experiments by Robert Luskin, James Fishkin, and their colleagues (2002) support the Alvarez and Brehm claim about the opportunity for politicians. The results of the fMRI experiment presented here can be viewed as providing a mechanism for the political sophisticate's mapping of social developed values to national politics and for the failure of political novices to do the same.

It is always worthwhile to end a piece of scholarship with the return to the cynical "so what" questions. What do we gain from knowing the neural mechanisms underlying political cognition? And, is the gain in knowledge worth the cost of brain imaging research? To address the second question (which I am frequently asked), I would note that while the cost of a dedicated research fMRI scanner and support staff is quiet high, the per subject costs for functional imaging research are equivalent to the per subject costs of the American National Election Study. Thus, the economic costs are not disproportionate to our typical modes of inquiry. There are, of course, more significant costs to becoming fluent in geometrically expanding field like cognitive neuroscience.

But, there is a reason for the explosive publication rate of new fMRI studies. The typical "black box" theories of the brain, without attention to neural mechanisms, have been found to conflate phenomena with distinct processes, to make distinctions that are artifacts, and to fail to make new insights that are apparent once the mechanisms are investigated (for a discussion, see Lieberman, Schreiber, and Ochsner 2003). Even Raichle's (1994) basic result that brain areas engaged in a task appeared to have less and less neural activity, was an unexpected one and has shifted the understanding of learning with implications ranging across fields and even driving changes in educational methods (Bransford et al. 2000). Similarly, economists have been finding out that economic decision-making is often a more affective process than a cognitive one (Camerer 2003; Sanfey et al. 2003).

Political sophistication has been an area of intense research for four decades because the stakes are high. As many have noted, the capacity of political novices to meaningfully participate in politics has fundamental implications for our democratic system (see e.g. Delli Carpini and Keeter 1996; Achen 1975). The research in this paper provides evidence about the mechanisms that political sophisticates use to automatically connect their social values to a political context. When viewed in the context of the work by DeNardo (1995), Alvarez and Brehm (2002), and Luskin and Fishkin (2002) as well as the brain imaging work on social cognition by Iacoboni et al. (2004) and Greene et al. (2001), it suggest that political novices need not be stuck in the "Chinese room" generating meaningless responses to unclear questions. Rather, they can learn to apply their social values to the political context and become meaningful participants in the democratic process.

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