Political Neuroscience: Understanding How the Brain Makes Political Decisions

Ingrid Johnsen Haas
Department of Political Science and Center for Brain, Biology, and Behavior
University of Nebraska-Lincoln

Clarisse Warren
Department of Political Science
University of Nebraska-Lincoln

Samantha J. Lauf
Department of Political Science
University of Nebraska-Lincoln

Manuscript draft (2019.11.12). Please cite as: Haas, I. J., Warren, C., & Lauf, S. J. (in press). Political neuroscience: Understanding how the brain makes political decisions. In D. Redlawsk (Ed.), *The Oxford Handbook of Political Decision Making*. Oxford University Press.

Corresponding Author:

Ingrid J. Haas, Ph.D.
Department of Political Science
University of Nebraska-Lincoln
531 Oldfather Hall
Lincoln, NE 68688
Phone: 402-472-2173
Email: ihaas2@unl.edu

Summary

Recent research in political psychology and biopolitics has begun to incorporate theory and methods from cognitive neuroscience. The emerging interdisciplinary field of political neuroscience (or neuropolitics) is focused on understanding the neural mechanisms underlying political information processing and decision making. Most of the existing work in this area has utilized structural magnetic resonance imaging, functional magnetic resonance imaging, or electroencephalography, and focused on understanding areas of the brain commonly implicated in social and affective neuroscience more generally. This includes brain regions involved in affective and evaluative processing, such as the amygdala, insula, anterior cingulate, and orbitofrontal cortex, as well as regions involved in social cognition (e.g., medial prefrontal cortex), decision making (e.g., dorsolateral prefrontal cortex), and reward processing (e.g., ventral striatum). Existing research in political neuroscience has largely focused on understanding candidate evaluation, political participation, and ideological differences. Early work in the field focused simply on examining neural responses to political stimuli, whereas more recent work has begun to examine more nuanced hypotheses about how the brain engages in political cognition and decision making. While the field is still relatively new, this work has begun to improve our understanding of how people engage in motivated reasoning about political candidates and elected officials and the extent to which these processes may be automatic versus relatively more controlled. Other work has focused on understanding how brain differences are related to differences in political opinion, showing both structural and functional variation between political liberals and political conservatives. Neuroscientific methods are best used as part of a larger, multimethod research program to help inform theoretical questions about mechanisms underlying political cognition. This work can then be triangulated with experimental laboratory studies, psychophysiology, and traditional survey approaches and help to constrain and ensure that theory in political psychology and political behavior is biologically plausible given what we know about underlying neural architecture. This field will continue to grow, as interest and expertise expand and new technologies become available.

Keywords: political neuroscience; neuropolitics; political psychology; biopolitics; political cognition; emotion; political ideology; neuroimaging; political decision making

Introduction

Political science has historically drawn on multiple fields for inspiration, and in recent years this interdisciplinary focus has grown to include ideas and methods from psychology, biology, and neuroscience. The field of political neuroscience (or neuropolitics) is focused on the use of neuroscientific methods and theory about brain structure and function to improve our understanding of how people make decisions about politics. This field is closely tied to political psychology, which is an interdisciplinary field focused on the interplay between individual human psychology and political behavior. This increased interest in the brain follows a similar trajectory to that of psychology, where the impact of neuroscience has been increasing over time. This approach is most relevant for the study of individual-level decision making about politics, as opposed to work in political science more focused on tracking aggregate choice.

Starting in the early 2000s, scholars began discussing potential ties between political psychology and social neuroscience, focusing on both the strengths and limitations of this interdisciplinary approach (e.g., Cacioppo & Visser, 2003; Lieberman, Schreiber, & Ochsner, 2003). Some political scientists have also argued that the field should move in this direction, given clear ties between social and political behavior (McDermott, 2009). While the field of political neuroscience is still relatively new, it has already begun to shape research focused on how people engage in political information processing and decision making. Recent reviews of research from the past two decades have focused on the contribution of political neuroscience in a variety of topic areas, including racial attitudes, motivated reasoning, political ideology, political attitudes, political cognition, and emotion, as well as other individual differences in political behavior (Haas, 2016b; Jost, Nam, Amodio, & Van Bavel, 2014; Schreiber, 2017).

Political psychologists who are interested in political cognition and decision making may find neuroscientific methods useful for answering questions about the psychological and neural mechanisms that give rise to political behavior. For young scholars or those who are particularly ambitious, this might mean learning new research methodologies to incorporate into one's own

research program. For others, it might mean seeking out social neuroscientists interested in research collaboration. At a minimum, there is value in reading this literature in that it can help to improve political scientists' understanding of the human brain and may help constrain research and theory even in the absence of researchers using these methods directly.

This chapter provides a brief overview of research methods used in political neuroscience, and then outlines some of the contributions of this field and remaining questions in three main topic areas: political ideology, political candidate evaluation, and voting and political participation. This is followed by a summary of the current state of the field and discussion of possible avenues for future research.

Research Methods in Political Neuroscience

Researchers working in the field of political neuroscience have adopted methodological approaches commonly used in social and cognitive neuroscience, including electroencephalography (EEG) and magnetic resonance imaging (MRI), both structural and functional (fMRI). There are new methods being used by neuroscientists as well, such as magnetoencephalography and transcranial magnetic stimulation, however, to our knowledge these have not yet been used in studies of politics and will not be discussed here. Below, we provide a basic introduction to EEG and MRI and discuss the strengths and limitations of each method for the study of political decision making.

Electroencephalography

EEG is a technique designed to measure neural activity through observation of electrical activity on the scalp. Neurons communicate using electrical signals, and this technique relies on measuring these electrical signals. To collect EEG data, a researcher outfits a participant with a cap filled with electrodes that rest on the scalp to pick up the signal. The data produced indicates variation in electrical activity over the period of time data is collected. Typically, cognitive psychologists present participants with a series of stimuli (e.g., pictures, words) in close succession during EEG, and then analyze the data by looking at changes in electrical

activity in response to specific stimuli. This is typically referred to as an event-related potential (ERP; see Luck, 2014, for an overview). However, it is also possible to analyze the data in terms of oscillations in electrical frequency over a longer period of time.

The strengths of EEG are that it provides excellent temporal resolution (on the order of milliseconds) and is relatively inexpensive (compared to MRI). Using EEG (or ERP), it is possible to examine rapid responses to specific stimuli in detail. The main downside is that the spatial resolution of EEG is limited, in that it is not possible to determine where in the brain the signal originated with a great degree of spatial accuracy. Because EEG is measured at the scalp, it is better able to distinguish signal coming from cortical (versus subcortical) brain regions. In other words, it is easier to measure signal from a region like the prefrontal cortex (PFC) than a region like the amygdala.

With respect to political decision making, EEG is most likely to be useful for questions about rapid responses to political information, and questions about how those rapid responses might differ across the population. For example, one could present participants with a series of candidate names or pictures and examine the nature of the electrical response. One could then compare those responses between Democrats and Republicans, or partisans versus nonpartisans. This approach is less ideal for questions about which specific brain regions might be involved in producing the response, although it can provide a rough approximation of where the signal originated.

Structural Magnetic Resonance Imaging

MRI was developed in the 1970s and started being used by cognitive neuroscientists in the 1980s (Raichle, 2009). Structural MRI is often used in clinical settings to image the size, shape, density, and health of the brain (as well as other organs), but it is also used for research in nonclinical populations. MRIs are typically large enough that a participant's entire body fits inside the scanner, but for head scans participants are usually positioned about halfway into the machine. There are also head-only MRIs available on the market, which are much smaller and

specialized for brain scans. Structural MRI takes a series of images that are then combined to produce high-resolution 3D images of the brain. This image data can then be analyzed to answer questions about brain structure.

The primary strength of structural MRI is in producing high-resolution spatial representation of brain structure. It can provide information about the size and density of brain regions. It is important to note, however, that the correspondence between brain structure (size and shape) and brain function (how the brain works) is not completely understood. While there has been an assumption that structure and function should be related, it may not be the case that structure and function perfectly correspond (see e.g., Frost & Goebel, 2012; Honey et al., 2009; Segall et al., 2012). In other words, differences in structure may or may not be associated with differences in function. A second important caveat is that structural MRI provides a snapshot in time—it does not tell us whether that structure has remained stable over time. Structural differences could be genetic or biological, or they could be the result of differences in life experience given that the brain is fairly plastic and can change over time in response to environmental challenges. For example, research has demonstrated changes in gray matter after participants engage in training tasks (Draganski et al., 2004), structural change in amygdala volume in response to stress-reduction interventions (Holzel et al., 2010), and even structural change in the hippocampus among London taxi drivers (Maguire et al., 2000). Moving forward, longitudinal studies of brain structure will be useful for disentangling these different causal possibilities.

Other methods in structural imaging allow for more direct tests of which brain regions are necessary for specific cognitive processes, such as lesion studies, which rely on patient populations with known neurological structural impairments (see e.g., Damasio & Damasio, 2000). Because specific regions of the brain are thought to be associated with specific processes (e.g., the hippocampus and factual or event-based memory), if those regions are impaired for some people, they should perform differently than healthy participants on process-

relevant tasks (e.g., recalling facts about information presented in the study, or declarative memory; Coronel et al., 2012). Although there have only been a few studies conducted of interest for political scientists using this method, it has been foundational to cognitive neuroscience more broadly as it provides a rare opportunity to test hypotheses related to how specific regions of the brain are integral to cognitive function.

The limited research in political neuroscience using structural MRI has primarily focused on individual differences in brain volume (e.g., Kanai, Feilden, Firth, & Rees, 2011). This work has typically focused on a small number of regions of interest within the brain (e.g., amygdala, insula, anterior cingulate cortex) and examined whether those structures vary in relation to factors like political ideology. Some additional work in political neuroscience has relied on the lesion method to explore regions of the brain that are implicated in the evaluation of political candidates and voting decisions (Coronel et al., 2012; Xia, Stolle, Gidengil, & Fellows, 2015). The existing work is cross-sectional, so it will be useful to conduct longitudinal studies to gain greater understanding of the causal relationship between brain structure and political behavior.

Functional Magnetic Resonance Imaging

MRI can also be used for functional imaging, which relies on newer data acquisition methods with the same machine. Functional MRI (fMRI) has been used by cognitive neuroscientists since the 1990s (Raichle, 2009). This methodology is a bit more complicated but, in a nutshell, relies on measurement of cerebral changes in blood flow, referred to as the blood-oxygen-level dependent (BOLD) signal. fMRI data collection can be task-based or rely on acquisition of data during resting state (in the absence of a specific task). In task-based acquisition, participants complete an experiment while lying in the scanner. Typically, this would involve presenting a series of images, words, or short sentences on a computer screen, and having participants provide a behavioral response using a button box that can register responses while in the scanner. The data can then be used to investigate brain function associated with specific stimuli—for example, a comparison of positive versus negative words or

images. Collection of resting state data has become more popular, although there are questions about what exactly this data represents (see e.g., Cole, Smith, & Beckmann, 2010). This data is collected while participants are simply laying in the scanner and is typically analyzed through investigation of individual differences in intrinsic functional connectivity among brain regions at rest. This type of data seems to be correlated with a wide variety of factors, but it is difficult to know exactly what it represents given that participants could be imagining any number of things while resting in the scanner. To our knowledge, resting-state MRI has not been used in studies of political decision making.

Functional MRI provides superior spatial resolution compared to EEG, in that it is possible to localize activation to a specific functional brain region, and sometimes subregions within a larger region (e.g., specific regions of the PFC). The precise nature of localization is dependent on the data acquisition parameters, data analytic techniques, and the underlying physiology of the BOLD signal. Data is collected in three-dimensional voxels which are usually somewhere between 1 to 3mm cubed. During analysis, this data is often smoothed (blurred) to 2-3 times that size to deal with error, so analysis might show activation in a voxel that is somewhere between 3-9mm. This is much larger than an individual neuron, but still fairly specific in terms of pinpointing activation in a specific functional region. The main downside of fMRI is temporal resolution, although this has improved somewhat over time and will likely continue to do so. Stimuli are typically presented for seconds (rather than milliseconds like with EEG) and the BOLD response usually peaks approximately 5-10 seconds after stimulus presentation (Berkman, Cunningham, & Lieberman, 2014). Therefore, this data is modeled in terms of seconds rather than milliseconds. MRI (both structural and functional) can also be cost-prohibitive. The cost of acquiring and maintaining an MRI is millions of dollars, and usage costs for researchers are typically hundreds of dollars per hour. For example, the current rate at the University of Nebraska-Lincoln is US\$550 per hour of scan time (similar to the cost at other large public universities in the United States).

Political neuroscience studies using fMRI have typically relied on task-based data collection—for example, showing participants images of political candidates or descriptions of policy issues while in the scanner. Some of the first studies simply showed stimuli to participants and measured their neural response, while more recent studies have used more complicated experimental designs and integrated behavioral responses during or after the scan. This work has examined a variety of questions, such as the neural mechanisms underlying candidate evaluation and motivated reasoning, as well as individual differences in brain function associated with factors like political ideology.

Methods from social neuroscience may provide insight into some of the most fundamental questions within political science. The remainder of this chapter carefully examines how political neuroscience has enriched scientific understanding of political decision making in relation to (a) political ideology, (b) political candidate evaluation, and (c) voting and political participation.

Political Ideology

At the heart of political science is the study of political ideology and ideological differences. Some researchers have attributed the basis of ideological differences to individual-level variation in a number of domains such as personality (Carney, Jost, Gosling, & Potter, 2008; Gerber, Huber, Doherty, & Dowling, 2011), social identity (Huddy, 2001), values (Feldman, 2003), and even biology (Hibbing, Smith, & Alford, 2014). During the 2000s and 2010s, there has been increased interest in understanding the ways in which ideology may be shaped through biological processes and mechanisms, and political neuroscience can add depth to this vein of research.

Perhaps one of the most prevalent questions in studying ideology is an attempt to understand how political liberals differ from political conservatives. This question is of interest to political scholars and laypeople alike, and much research has examined whether there are biological differences between liberals and conservatives and how these differences are

manifested. The interpretation of research examining correlations between biology, neuroscience, and ideology is subject to a “chicken and egg” problem (Jost, Noorbaloochi, & Van Bavel, 2014). If brain differences are found to be associated with political ideology, it is difficult to determine causal order—neural differences could lead to the development of different ideologies, or, via socialization, ideological differences could lead to differences in neural function. In the absence of longitudinal research designs, it is difficult to determine the extent to which biology shapes ideology or ideology shapes biology, despite evidence that political ideology is associated with differences in both brain structure and function.

Research using structural magnetic resonance imaging (MRI) has examined the relationship between political ideology and brain structure (Kanai et al., 2011), finding that political liberals had increased volume in the anterior cingulate cortex (ACC) relative to conservatives, while conservatives showed increased volume in the right amygdala relative to liberals. Both the ACC and the amygdala are thought to serve multiple functions, but the ACC is most commonly associated with conflict detection (Botvinick, 2007), while the amygdala is associated with processing both negative and positive emotional information (Adolphs, Tranel, & Damasio, 1998; Adolphs, Tranel, Damasio, & Damasio, 1995; Davis, 1992; Hamann, Ely, Hoffman, & Kilts, 2002; Whalen, 1998, 2007) and information that is motivationally relevant (Cunningham & Brosch, 2012; Cunningham, Van Bavel, & Johnsen, 2008; Ousdal et al., 2008; Sander, Grafman, & Zalla, 2003). Other work has demonstrated a link between brain structure and specific ideological principles, such as a preference for the status quo. Nam and colleagues (2018) found evidence of structural differences in the amygdala associated with system justification. Those who were more likely to support the status quo had greater bilateral amygdala volume than those who were more likely to challenge the status quo. Given that individuals who score higher on measures of system justification are also more likely to espouse conservative beliefs (for a review see Jost, Banaji, & Nosek, 2004), the amygdala findings across these studies appear to be consistent. While these findings with respect to brain

structure are consistent with work showing differences in emotional processing between liberals and conservatives (Haas, 2016a; Hibbing et al., 2014), as well as differences in conflict detection (Amodio, Jost, Master, & Yee, 2007; Haas, Baker, & Gonzalez, 2017; Weissflog, Choma, Dywan, van Noordt, & Segalowitz, 2013), it is important to note that the link between these structural differences and brain function has not yet been examined directly in this context.

There are differences in brain function associated with political ideology as well, in the same brain regions where structural differences have been found (i.e., ACC, amygdala) as well as other regions involved in affective processing (i.e., insula). For example, work using electroencephalography (EEG) or event-related potential (ERP) to study conflict detection has shown a link between political ideology and ACC activity during a Go/No-Go Task (Amodio et al., 2007; Weissflog et al., 2013). In general, political liberalism appears to be associated with increased sensitivity to conflicting information relative to conservatism, and these studies suggested that the difference in ERP activity could be localized to ACC. Weissflog and colleagues (2013) also found that this difference in responsiveness to conflict detection was associated with values related to liberal ideology, including a preference for social equality and openness to social change. More recently, Haas and colleagues (2017) used fMRI to investigate ideological differences in neural processing of incongruent information in the context of political candidate and policy evaluation. This study found evidence for ideological differences in ACC and insula activation, such that political liberalism was associated with greater activation in these regions to incongruent information. The insula is a region involved in processing affect (especially negative affect) and integrating emotion with cognition (Gu, Liu, Van Dam, Hof, & Fan, 2013; Harle, Chang, van 't Wout, & Sanfey, 2012). The ACC finding is consistent with EEG findings, where the ACC was also more active for liberals during conflict detection (Amodio et al., 2007; Weissflog et al., 2013).

Other work in political neuroscience has investigated ideological differences in decision making. For example, Schreiber and colleagues (2013) had participants complete a risk-taking task during fMRI. Interestingly, while they found no behavioral differences related to political ideology (i.e., liberals and conservatives showed similar performance on the task), they did find differences in neural activation associated with political ideology. Political conservatism was associated with greater activation in the right amygdala, and liberalism was associated with greater activation in the left insula. These findings may suggest that even when liberals and conservatives reach similar decisions, they may engage in different decision-making processes to reach those outcomes. These findings are consistent with prior work showing larger volume in right amygdala for conservatives (Kanai et al., 2011), and greater activation in insula for liberals in other tasks (Haas et al., 2017). Other work has found insula activation associated with more egalitarian decision making (Dawes et al., 2012). While this study did not measure political ideology directly, egalitarianism is associated with political liberalism, making this finding consistent with other findings discussed thus far.

There has also been interest in using political neuroscience to study differences in emotion processing associated with political ideology. During fMRI, Ahn and colleagues (2014) presented participants with nonpolitical images designed to elicit a range of emotions, including images that were disgusting, threatening, pleasant, and neutral. Using a machine learning technique, they were able to predict political ideology (measured with policy attitudes) from the neural response to disgusting relative to neutral images. Specifically, activation in a network of brain regions including the amygdala predicted political conservatism, while activation in a network including insula predicted liberalism. These findings are potentially consistent with prior research that has demonstrated differences in physiological responses to disgust associated with political ideology (Smith, Oxley, Hibbing, Alford, & Hibbing, 2011). While Ahn and colleagues (2014) did not find differences related to threat, other work has. Pedersen and colleagues (2017) found that economic conservatism was associated with greater connectivity

between the amygdala and bed nucleus of the stria terminalis (BNST) in response to threatening stimuli (i.e., an unpredictable shock). The BNST is believed to act as a relay site within the hypothalamic-pituitary-adrenal axis and regulates response to acute threat (Choi et al., 2007). While this provides some initial evidence for a difference in the neural threat response associated with political ideology, more research will be necessary to fully examine the theory that political conservatism is associated with a negativity bias in emotional processing (Hibbing et al., 2014).

Political neuroscience has begun to provide information about structural and functional brain differences associated with political ideology, but future work should examine how these differences translate into political decisions. Whether the brain shapes ideology, or whether ideology shapes the brain is still up for debate.

Political Candidate Evaluation

Candidate evaluation and selection are important aspects of political behavior that not only attract the interest of scholars but garner a great deal of interest from the mass public. Speculation as to which candidates will be victorious, particularly at the national level, is at the heart of political punditry. Particularly within the context of a primary election, voters are taxed with the burden of selecting a candidate from a string of similarly positioned hopefuls. For example, early in the 2016 U.S. Presidential Election, Republican voters were faced with the daunting task of selecting a single candidate from a field of 17 presidential hopefuls (Bialik, 2016). It is no secret that individuals often rely on heuristics to make quick and cognitively easy decisions about politics (Lau & Redlawsk, 2001), particularly when faced with a field of politically similar candidates.

Political neuroscience has provided insight into some of the underlying neural processes that drive candidate support. For example, in two functional magnetic resonance imaging studies, Spezio and colleagues (2008) found a neural basis for the effect of candidate appearance on electoral outcomes. In the first study, participants evaluated pairs of photos of

actual candidates who competed in the 2006 U.S. midterm elections prior to the election. They found that activation in insula and anterior cingulate cortex (ACC) was associated with candidates being more likely to lose an election. In the second study, participants again saw candidate faces and were asked to evaluate both positive (attractive, competent) and negative (deceitful, threatening) traits. They found similar activation in insula and ACC to losing candidates, and this effect was explained by negative trait judgments (i.e., threat). If, as Todorov and colleagues (2005) contend, appearance-based trait inferences are rapid, reflexive, and largely imperceptible to citizens, the implications for electoral outcomes are substantial. In as quickly as 100 milliseconds, citizens are capable of making appearance-based trait inferences that influence vote choice and these immediate reactions to candidates have been predictive of actual election outcomes (Ballew & Todorov, 2007; Olivola & Todorov, 2010). Using lesion patients, Xia and colleagues (2015) demonstrated that some of these trait assessments differ from others, in that lateral orbitofrontal cortex (OFC) was necessary for competence but not attractiveness judgments. Other work using fMRI has demonstrated that people automatically pay attention to candidate faces, finding that preference for candidates was associated with activation in ventral striatum and preference for a political party was associated with activation in insula and ACC (Tusche, Kahnt, Wisniewski, & Haynes, 2013). The ventral striatum is a region involved in reward processing (Cardinal, Parkinson, Hall, & Everitt, 2002), so this would be consistent with the idea that viewing preferred candidates is somehow rewarding. The finding that in this case insula and ACC were associated with *preferred* political parties suggests that activation in these regions may occur for multiple reasons, as in previous work this activation was associated with candidates who ended up losing elections (Spezio et al., 2008).

The aforementioned research has focused on automatic evaluations of candidates that often reside below the surface of individual cognitive awareness, but it is also important to investigate what happens when people are tasked with carefully considering their options. Traditional self-report measures have been informative in helping to answer this question, but

political neuroscience can help to elucidate the cognitive processes underlying candidate evaluation and selection. Whether or not individual citizens need to be fully informed on candidates' policy positions before they are able to vote "correctly" (i.e., vote for a candidate with policy attitudes most similar to their own) is a long-standing question that political scientists have attempted to address. Political psychologists have also debated the role that memory plays in forming policy-based assessments of candidates, arguing through examination of online- versus memory-based judgments (Hastie & Park, 1986) that memory for specific policy detail may not be necessary once factored into one's overall impression of a candidate (Lodge, McGraw, & Stroh, 1989). Recent neuroscience work has examined these questions in new ways. For example, Coronel and colleagues (2012) examined how lesion patients with amnesia (i.e., damage to hippocampus) formed candidate impressions and made voting decisions. In their study, a group of participants with anterograde amnesia and severe declarative memory impairment were compared to a group of participants without such damage on their ability to vote for candidates with policy attitudes most similar to their own. If declarative memory (i.e., specific memory for candidates' policy positions) is necessary for voting correctly, then the amnesic participants should not vote correctly as often as their neurologically intact counterparts. Yet, the researchers found that the amnesic participants were just as likely to vote for the candidate that aligned with their own preferences as the normal comparison participants, suggesting that memory for policy positions may not be necessary for correct voting.

Partisanship is perhaps one of the most important factors driving candidate evaluation, and a number of political neuroscience studies have focused on examining how partisanship drives political evaluation. Kaplan, Freedman and Iacoboni (2007) used an fMRI paradigm to examine how party affiliation and political attitudes moderated responses to faces of the 2004 U.S. presidential candidates (i.e., George W. Bush, John Kerry, Ralph Nader). They found different activation patterns when participants viewed own-party versus other-party candidates. When viewing candidates that were from the opposing party, they found increased activation in

regions associated with cognitive control (e.g., ACC, prefrontal cortex) and emotion (e.g., insula). They interpreted these results to mean that when looking at the face of an opposing candidate, cognitive control networks were activated in an attempt to regulate the (negative) emotional response. This “us versus them” mentality that is often exacerbated by strong political ties provides individuals the framework necessary to quickly make judgments on same-party candidates while controlling an emotional response to other-party candidates. Especially within a two-party system, heightened partisan motives create a sense of competition that make it imperative for individuals to quickly assess whether a candidate is part of their ingroup or outgroup (Hartstone & Augoustinos, 1995).

Through political neuroscience, researchers are better equipped to understand these cognitive processes and the mechanisms that drive deliberative candidate support. Haas and colleagues (2017) found that people are capable of identifying and recognizing inconsistencies between candidates' party affiliations and their stated policy positions. In this fMRI study, increased neural activity in the insula, ACC, and amygdala was associated with processing incongruent information—namely, when a candidate's party affiliation did not match his stated policy position. As discussed previously, this work also demonstrated an ideological difference such that political liberalism was associated with greater insula and ACC activation to incongruent information, namely for own-party candidates. In other words, liberals were more likely to notice or attend to inconsistencies for Democratic candidates than conservatives were to notice or attend to inconsistencies for Republican candidates. This was also reflected in the fact that more liberal participants took longer to respond on incongruent trials, suggesting they were spending more time evaluating the information before making a decision. While this work suggests that people can and do attend to incongruent or inconsistent information, decades of work on motivated reasoning suggest that people do not always take inconsistencies into account when making political decisions. Why do some people continue to support candidates in the face of a great deal of incongruent information?

Research on motivated reasoning has shown that people, particularly strong partisans, are more likely to discount the relevance and importance of incongruent information for preferred candidates as a means of supporting their preexisting beliefs (Taber & Lodge, 2006). Much of this research has relied on self-report measures and behavioral experiments to explain this phenomenon; however, neuroscience has made it possible to examine the underlying mechanisms driving motivated reasoning. Westen and colleagues (2006) used fMRI to examine the neural basis of motivated reasoning during the 2004 U.S. presidential election. Participants were presented with information that was either threatening to their candidate, the opposing candidate, or a neutral control target. When participants were engaged in motivated reasoning, they found increased activation in regions involved with cognitive control and processing negative information (e.g., ACC, insula, OFC) as well as regions involved in person perception and social cognition more generally (posterior cingulate, precuneus). This study only examined committed partisans, so it would be interesting to look at how this activation differs for individuals who are more strongly versus more weakly identified partisans in future work. When individuals do not have a strong emotional attachment to a candidate, issue, or outcome, there should be less need to engage in motivated reasoning. In a related study, Kaplan and colleagues (2016) used fMRI to identify neural correlates of maintaining one's political beliefs in the face of counterevidence. Participants in this study were presented with arguments that challenged strongly held beliefs (both political and apolitical). Participants who showed greater resistance to counterevidence showed greater activation in amygdala, insula, and dorsomedial PFC when processing conflicting information and reduced activation in OFC. These results are largely consistent with those observed in the study conducted by Westen and colleagues (2006); however, it is worth noting that the Kaplan study only included political liberals so it is unclear whether these effects would differ in relation to political ideology. Together, these findings demonstrate the prevalence of motivated reasoning and suggest there are emotional constraints on political judgment of both candidates and beliefs.

Voting and Political Participation

Political scientists have long been dedicated to understanding political participation and voting behavior; however, much is still unknown as to why people vote when there is often little incentive to do so. From rational choice explanations that suggest that deciding to vote is an irrational decision (Downs, 1957) to more contested claims that genetic and biological factors influence political participation (Fowler, Baker, & Dawes, 2008; French et al., 2014), numerous theories have attempted to explain why people vote and participate in politics (or choose not to). Widely accepted models of vote choice have focused on social and psychological factors that influence voting decisions and political participation more widely; however, few studies have examined the underlying biological processes and mechanisms that drive political participation and voting behavior.

Political neuroscience has contributed to understanding, at least in part, how citizens' responses to political information contribute to political participation and voting behavior. In a cross-cultural functional magnetic resonance imaging (fMRI) study conducted in the United States and Japan, Rule and colleagues (2010) presented participants with legislative candidates from prior elections. Participants saw a series of faces and were asked whether they would vote for each candidate. They found that voting behavior was associated with neural activation across cultures, in that viewing images of preferred candidates (i.e., those candidates participants voted for) was associated with increased activation in the amygdala in both American and Japanese participants. It is difficult to know exactly what produced the amygdala activation in this case, as the amygdala has been implicated in a variety of different tasks. The amygdala is involved in both affective and social processing, and prior work has shown that it can be active in response to both ingroup and outgroup faces, depending on the task and what is most relevant in that situation (Phelps et al., 2000; Van Bavel, Packer, & Cunningham, 2008).

Political interest has often been linked to political participation (Rosenstone & Hansen, 1993; Teixeira, 1992), and political neuroscience has begun to shed some light on how interest

may motivate participation. Gozzi and colleagues (2010) recruited individuals with high and low interest in politics and had them rate their agreement or disagreement with political statements during fMRI. They found that individuals with higher interest in politics showed greater activation in brain regions associated with reward (ventral striatum) and emotion (amygdala) when they were agreeing with statements they supported. The amygdala activation would be consistent with the view that this information was viewed as positive and relevant for these individuals, whereas activity in the ventral striatum has been associated with reward and positive affect (Elliott, Newman, Longe, & William Deakin, 2003; Knutson, Westdorp, Kaiser, & Hommer, 2000). This may suggest that for some individuals, engaging in political discussion (and perhaps political participation) serves as its own reward.

Political participation does not stop at the ballot box on election night but occurs in a number of ways—from active participation in political events, to donating money, to consumption of political information. Tusche and colleagues (2013) found that activation to preferred political parties in the insula and anterior cingulate cortex also predicted subsequent donations to those political parties, suggesting that neural activation associated with affective preferences may also have direct consequences for motivating political behavior. While the research discussed here provides some initial evidence in terms of how political neuroscience can be used to study political participation, there are still many open questions regarding the mechanisms that drive individuals' decisions to vote and participate in politics.

Conclusion

Political neuroscience has broadened scientific understanding of how the brain contributes to political decision making, political cognition, and political behavior. This chapter focused on the contributions of political neuroscience to three main areas of research—political ideology, candidate evaluation, and political participation. This work has provided evidence for a network of brain regions implicated in political cognition and decision making, including regions involved in processing emotion and affect (amygdala, insula), resolving conflict and integrating

emotion with cognition (insula, anterior cingulate cortex), engaging in more controlled cognitive processing (prefrontal cortex), and reward processing (ventral striatum), among others. Taken together, this work suggests that political behavior is closely tied to psychological concepts like affect, emotion, and motivation.

While political neuroscience has grown in popularity, it is not without its critics. Mainstream political science can be dismissive of the need to look inside the brain to understand politics, especially on a mass scale. Most neuroimaging studies thus far have relied on relatively small, nonprobability samples, so there are challenges involved with external validity. That said, sample size has begun to increase (in magnetic resonance imaging studies in general) and researchers will likely get more creative at finding ways to collaborate and collect data across research sites in a way that may allow for greater representativeness of the data. Given that brain data is correlational, there are also important questions about cause and effect here—for example, does brain structure lead to the development of political ideology, or vice versa. These are questions for which longitudinal designs may be especially useful in order to track the relationship between neural structure and function and development of political ideology across the lifespan. Finally, it is important to ask whether brain data can help us predict real-world outcomes (e.g., voting behavior in actual elections). There are some intriguing possibilities here based on neuroimaging work that has been done in other domains. For example, work in neuroeconomics has been used for neuroforecasting—using brain data to predict aggregate choice in terms of behaviors like song downloads or ad-related sales (see Knutson & Genevsky, 2018, for a review). This has clear implications for the political domain, and future work could examine whether brain data can be used to predict behaviors like political donation or voting on an aggregate level.

In sum, the field of political neuroscience is still relatively new but has grown substantially since 2000 and will continue to do so (see also Schreiber, 2017). While neuroscience is unlikely to replace traditional methodological approaches in political science, it

can serve as a useful counterpart for questions about the mechanisms that underlie political decision making. There are still many unanswered questions in this field, which makes it an exciting time for new researchers to dive in and get involved.

Further Reading

- Berkman, E. T., Cunningham, W. A., & Lieberman, M. D. (2014). Research methods in social and affective neuroscience. In H. T. Reis & C. M. Judd (Eds.), *Handbook of Research Methods in Personality and Social Psychology* (2nd ed., pp. 123-158). New York, NY: Cambridge University Press.
- Haas, I. J. (2016). Political neuroscience. In J. R. Absher & J. Cloutier (Eds.), *Neuroimaging Personality, Social Cognition, and Character: Traits and Mental States in the Brain* (pp. 355-370). Cambridge, MA: Academic Press.
- Huettel, S. A., Song, A. W., & McCarthy, G. (2014). *Functional Magnetic Resonance Imaging* (3rd ed.). Sunderland, MA: Sinauer Associates.
- Jost, J. T., Nam, H. H., Amodio, D. M., & Van Bavel, J. J. (2014). Political neuroscience: The beginning of a beautiful friendship. *Advances in Political Psychology*, 35, 3-42.
- Luck, S. J. (2014). *An Introduction to the Event-Related Potential Technique*: MIT Press.
- Schreiber, D. (2017). Neuropolitics: Twenty years later. *Politics and the Life Sciences*, 36(2), 114-131.

References

- Adolphs, R., Tranel, D., & Damasio, A. R. (1998). The human amygdala in social judgment. *Nature*, 393, 470-474.
- Adolphs, R., Tranel, D., Damasio, H., & Damasio, A. R. (1995). Fear and the human amygdala. *Journal of Neuroscience*, 15, 5879-5891.
- Ahn, W.-Y., Kishida, Kenneth T., Gu, X., Lohrenz, T., Harvey, A., Alford, John R., . . . Montague, P. R. (2014). Nonpolitical images evoke neural predictors of political ideology. *Current Biology*, 24, 1-7. doi: 10.1016/j.cub.2014.09.050
- Amodio, D. M., Jost, J. T., Master, S. L., & Yee, C. M. (2007). Neurocognitive correlates of liberalism and conservatism. *Nature Neuroscience*, 10, 1246-1247.
- Ballew, C. C., 2nd, & Todorov, A. (2007). Predicting political elections from rapid and unreflective face judgments. *Proc Natl Acad Sci U S A*, 104(46), 17948-17953. doi: 10.1073/pnas.0705435104
- Berkman, E. T., Cunningham, W. A., & Lieberman, M. D. (2014). Research methods in social and affective neuroscience. In H. T. Reis & C. M. Judd (Eds.), *Handbook of Research Methods in Personality and Social Psychology* (2nd ed., pp. 123-158). New York, NY: Cambridge University Press.
- Bialik, C. (2016, May 5). How the Republican field dwindled from 17 to Donald Trump, *FiveThirtyEight*.
- Botvinick, M. M. (2007). Conflict monitoring and decision making: Reconciling two perspectives on anterior cingulate function. *Cognitive, Affective, & Behavioral Neuroscience*, 7(4), 356-366.
- Cacioppo, J. T., & Visser, P. S. (2003). Political psychology and social neuroscience: Strange bedfellows or comrades in arms? *Political Psychology*, 24(4), 647-656.

- Cardinal, R. N., Parkinson, J. A., Hall, J., & Everitt, B. J. (2002). Emotion and motivation: The role of the amygdala, ventral striatum, and prefrontal cortex. *Neuroscience and Biobehavioral Reviews*, 26, 321-352.
- Carney, D. R., Jost, J. T., Gosling, S. D., & Potter, J. (2008). The secret lives of liberals and conservatives: Personality profiles, interaction styles, and the things they leave behind. *Political Psychology*, 29, 807-840.
- Choi, D. C., Furay, A. R., Evanson, N. K., Ostrander, M. M., Ulrich-Lai, Y. M., & Herman, J. P. (2007). Bed nucleus of the stria terminalis subregions differentially regulate hypothalamic-pituitary-adrenal axis activity: implications for the integration of limbic inputs. *J Neurosci*, 27(8), 2025-2034. doi: 10.1523/JNEUROSCI.4301-06.2007
- Cole, D. M., Smith, S. M., & Beckmann, C. F. (2010). Advances and pitfalls in the analysis and interpretation of resting-state fMRI data. *Front Syst Neurosci*, 4, 8. doi: 10.3389/fnsys.2010.00008
- Coronel, J. C., Duff, M. C., Warren, D. E., Federmeier, K. D., Gonsalves, B. D., Tranel, D., & Cohen, N. J. (2012). Remembering and Voting: Theory and Evidence from Amnesic Patients. *Am J Pol Sci*, 56(4), 837-848. doi: 10.1111/j.1540-5907.2012.00608.x
- Cunningham, W. A., & Brosch, T. (2012). Motivational salience: Amygdala tuning from traits, needs, values, and goals. *Current Directions in Psychological Science*, 21, 54-59.
- Cunningham, W. A., Van Bavel, J. J., & Johnsen, I. R. (2008). Affective flexibility: Evaluative processing goals shape amygdala activity. *Psychological Science*, 19, 152-160. doi: 10.1111/j.1467-9280.2008.02061.x
- Damasio, H., & Damasio, A. R. (2000). The lesion method in cognitive neuroscience. *Patient-based approaches to cognitive neuroscience*, 21-34.
- Davis, M. (1992). The role of the amygdala in fear and anxiety. *Annual Review of Neuroscience*, 15, 353-375.

- Dawes, C. T., Loewen, P. J., Schreiber, D., Simmons, A. N., Flagan, T., McElreath, R., . . . Paulus, M. P. (2012). Neural basis of egalitarian behavior. *Proc Natl Acad Sci U S A*, 109(17), 6479-6483. doi: 10.1073/pnas.1118653109
- Downs, A. (1957). An economic theory of political action in a democracy. *Journal of Political Economy*, 65, 135-150.
- Draganski, B., Gaser, C., Busch, V., Schuierer, G., Bogdahn, U., & May, A. (2004). Changes in grey matter induced by training. *Nature*, 427, 311-312.
- Elliott, R., Newman, J. L., Longe, O. A., & William Deakin, J. F. (2003). Differential response patterns in the striatum and orbitofrontal cortex to financial reward in humans: A parametric functional magnetic resonance imaging study. *The Journal of Neuroscience*, 23, 303-307.
- Feldman, S. (2003). Values, ideology, and the structure of political attitudes. In D. O. Sears, L. Huddy & R. Jervis (Eds.), *Oxford handbook of political psychology* (pp. 477-508). Oxford: Oxford University Press.
- Fowler, J. H., Baker, L. A., & Dawes, C. T. (2008). Genetic Variation in Political Participation. *American Political Science Review*, 102(02). doi: 10.1017/s0003055408080209
- French, J. A., Smith, K. B., Alford, J. R., Guck, A., Birnie, A. K., & Hibbing, J. R. (2014). Cortisol and politics: Variance in voting behavior is predicted by baseline cortisol levels. *Physiology & Behavior*, 133, 61-67. doi: 10.1016/j.physbeh.2014.05.004
- Frost, M. A., & Goebel, R. (2012). Measuring structural-functional correspondence: Spatial variability of specialised brain regions after macro-anatomical alignment. *NeuroImage*, 59(2), 1369-1381.
- Gerber, A. S., Huber, G. A., Doherty, D., & Dowling, C. M. (2011). The Big Five Personality Traits in the Political Arena. *Annual Review of Political Science*, 14(1), 265-287. doi: 10.1146/annurev-polisci-051010-111659

- Gozzi, M., Zamboni, G., Krueger, F., & Grafman, J. (2010). Interest in politics modulates neural activity in the amygdala and ventral striatum. *Human Brain Mapping, 31*(11), 1763-1771. doi: 10.1002/hbm.20976
- Gu, X., Liu, X., Van Dam, N. T., Hof, P. R., & Fan, J. (2013). Cognition-emotion integration in the anterior insular cortex. *Cerebral Cortex, 23*(1), 20-27. doi: 10.1093/cercor/bhr367
- Haas, I. J. (2016a). The impact of uncertainty, threat, and political identity on support for political compromise. *Basic and Applied Social Psychology, 38*(3), 137-152.
- Haas, I. J. (2016b). Political neuroscience. In J. R. Absher & J. Cloutier (Eds.), *Neuroimaging Personality, Social Cognition, and Character: Traits and Mental States in the Brain* (pp. 355-370). Cambridge, MA: Academic Press.
- Haas, I. J., Baker, M. N., & Gonzalez, F. J. (2017). Who can deviate from the party line? Political ideology moderates evaluation of incongruent policy positions in insula and anterior cingulate cortex. *Social Justice Research, 30*(4), 355-380. doi: 10.1007/s11211-017-0295-0
- Hamann, S. B., Ely, T. D., Hoffman, J. M., & Kilts, C. D. (2002). Ecstasy and agony: Activation of the human amygdala in positive and negative emotion. *Psychological Science, 13*, 135-141.
- Harle, K. M., Chang, L. J., van 't Wout, M., & Sanfey, A. G. (2012). The neural mechanisms of affect infusion in social economic decision-making: a mediating role of the anterior insula. *NeuroImage, 61*(1), 32-40. doi: 10.1016/j.neuroimage.2012.02.027
- Hartstone, M., & Augoustinos, M. (1995). The minimal group paradigm: Categorization into two versus three groups. *European Journal of Social Psychology, 25*(2), 179-193.
- Hastie, R., & Park, B. (1986). The relationship between memory and judgment depends on whether the judgment task is memory-based or on-line. *Psychological Review, 93*, 258-268.
- Hibbing, J. R., Smith, K. B., & Alford, J. R. (2014). Differences in negativity bias underlie variations in political ideology. *Behavioral and Brain Sciences, 37*(3), 297-307. doi: 10.1017/S0140525X13001192

- Holzel, B. K., Carmody, J., Evans, K. C., Hoge, E. A., Dusek, J. A., Morgan, L., . . . Lazar, S. W. (2010). Stress reduction correlates with structural changes in the amygdala. *Social Cognitive and Affective Neuroscience*, 5(1), 11-17. doi: 10.1093/scan/nsp034
- Honey, C. J., Sporns, O., Cammoun, L., Gigandet, X., Thiran, J. P., Meuli, R., & Hagmann, P. (2009). Predicting human resting-state functional connectivity from structural connectivity. *PNAS*, 106(6), 2035-2040. doi: 10.1073/pnas.0811168106
- Huddy, L. (2001). From social to political identity: A critical examination of social identity theory. *Political Psychology*, 22, 127-156.
- Jost, J. T., Banaji, M. R., & Nosek, B. A. (2004). A decade of system justification theory: Accumulated evidence of conscious and unconscious bolstering of the status quo. *Political Psychology*, 25, 881-920.
- Jost, J. T., Nam, H. H., Amodio, D. M., & Van Bavel, J. J. (2014). Political neuroscience: The beginning of a beautiful friendship. *Advances in Political Psychology*, 35, 3-42. doi: 10.1111/pops.12162
- Jost, J. T., Noorbaloochi, S., & Van Bavel, J. J. (2014). The “chicken-and-egg” problem in political neuroscience. *Behavioral and Brain Sciences*, 37(3), 317-318.
- Kanai, R., Feilden, T., Firth, C., & Rees, G. (2011). Political orientations are correlated with brain structure in young adults. *Current Biology*, 21(8), 677-680. doi: 10.1016/j.cub.2011.03.017
- Kaplan, J. T., Freedman, J., & Iacoboni, M. (2007). Us versus them: Political attitudes and party affiliation influence neural responses to faces of presidential candidates. *Neuropsychologia*, 45, 55-64.
- Kaplan, J. T., Gimbel, S. I., & Harris, S. (2016). Neural correlates of maintaining one's political beliefs in the face of counterevidence. *Nature Scientific Reports*, 6, 39589. doi: 10.1038/srep39589

- Knutson, B., & Genevsky, A. (2018). Neuroforecasting aggregate choice. *Current Directions in Psychological Science*, 27(2), 110-115. doi: 10.1177/0963721417737877
- Knutson, B., Westdorp, A., Kaiser, E., & Hommer, D. (2000). fMRI visualization of brain activity during a monetary incentive delay task. *NeuroImage*, 12(1), 20-27. doi: 10.1006/nimg.2000.0593
- Lau, R. R., & Redlawsk, D. P. (2001). Advantages and disadvantages of cognitive heuristics in political decision making. *American Journal of Political Science*, 45, 951-971.
- Lieberman, M. D., Schreiber, D., & Ochsner, K. N. (2003). Is political cognition like riding a bicycle? How cognitive neuroscience can inform research on political thinking. *Political Psychology*, 24, 681-704.
- Lodge, M., McGraw, K. M., & Stroh, P. (1989). An impression-driven model of candidate evaluation. *American Political Science Review*, 83, 399-420.
- Luck, S. J. (2014). *An Introduction to the Event-Related Potential Technique*: MIT Press.
- Maguire, E. A., Gadian, D. G., Johnsrude, I. S., Good, C. D., Ashburner, J., Frackowiak, R. S., & Frith, C. D. (2000). Navigation-related structural change in the hippocampi of taxi drivers. *PNAS*, 97(8), 4398-4403. doi: 10.1073/pnas.070039597
- McDermott, R. (2009). The case for increasing dialogue between political science and neuroscience. *Political Research Quarterly*, 62(3), 571-583.
- Nam, H. H., Jost, J. T., Kaggen, L., Campbell-Meiklejohn, D., & Van Bavel, J. J. (2018). Amygdala structure and the tendency to regard the social system as legitimate and desirable. *Nature Human Behaviour*, 2(2), 133. doi: 10.1038/s41562-017-0248-5
- Olivola, C. Y., & Todorov, A. (2010). Elected in 100 milliseconds: Appearance-Based Trait Inferences and Voting. *Journal of Nonverbal Behavior*, 34(2), 83-110. doi: 10.1007/s10919-009-0082-1
- Ousdal, O. T., Jensen, J., Server, A., Hariri, A. R., Nakstad, P. H., & Andreassen, O. A. (2008). The human amygdala is involved in general behavioral relevance detection: evidence from

- an event-related functional magnetic resonance imaging Go-NoGo task. *Neuroscience*, 156(3), 450-455. doi: 10.1016/j.neuroscience.2008.07.066
- Pedersen, W. S., Muftuler, L. T., & Larson, C. L. (2017). Conservatism and the Neural Circuitry of Threat: Economic Conservatism Predicts Greater Amygdala-BNST Connectivity During Periods of Threat vs. Safety. *Social Cognitive and Affective Neuroscience*, 13(1), 43-51. doi: 10.1093/scan/nsx133
- Phelps, E. A., O'Connor, K. J., Cunningham, W. A., Funayama, E. S., Gatenby, J. C., Gore, J. C., & Banaji, M. R. (2000). Performance on indirect measures of race evaluation predicts amygdala activation. *Journal of Cognitive Neuroscience*, 12, 729-738.
- Raichle, M. E. (2009). A brief history of human brain mapping. *Trends in Neurosciences*, 32(2), 118-126. doi: 10.1016/j.tins.2008.11.001
- Rosenstone, S. J., & Hansen, J. (1993). *Mobilization, participation, and democracy in America*: Macmillan Publishing Company.
- Rule, N. O., Freeman, J. B., Moran, J. M., Gabrieli, J. D., Adams, R. B., Jr., & Ambady, N. (2010). Voting behavior is reflected in amygdala response across cultures. *Social Cognitive and Affective Neuroscience*, 5(2-3), 349-355. doi: 10.1093/scan/nsp046
- Sander, D., Grafman, J., & Zalla, T. (2003). The human amygdala: An evolved system for relevance detection. *Reviews in the Neurosciences*, 14, 303-316.
- Schreiber, D. (2017). Neuropolitics: Twenty years later. *Politics and the Life Sciences*, 36(2), 114-131. doi: 10.1017/pls.2017.25
- Schreiber, D., Fonzo, G., Simmons, A. N., Dawes, C. T., Flagan, T., Fowler, J. H., & Paulus, M. P. (2013). Red brain, blue brain: evaluative processes differ in Democrats and Republicans. *PLoS One*, 8(2), e52970. doi: 10.1371/journal.pone.0052970
- Segall, J. M., Allen, E. A., Jung, R. E., Erhardt, E. B., Arja, S. K., Kiehl, K., & Calhoun, V. D. (2012). Correspondence between structure and function in the human brain at rest. *Frontiers in Neuroinformatics*, 6, 10. doi: 10.3389/fninf.2012.00010

- Smith, K. B., Oxley, D., Hibbing, M. V., Alford, J. R., & Hibbing, J. R. (2011). Disgust sensitivity and the neurophysiology of left-right political orientations. *PLoS One*, 6(10), e25552.
- Spezio, M. L., Rangel, A., Alvarez, R. M., O'Doherty, J. P., Mattes, K., Todorov, A., . . . Adolphs, R. (2008). A neural basis for the effect of candidate appearance on election outcomes. *Social Cognitive and Affective Neuroscience*, 3(4), 344-352. doi: 10.1093/scan/nsn040
- Taber, C. S., & Lodge, M. (2006). Motivated skepticism in the evaluation of political beliefs. *American Journal of Political Science*, 50, 755-769.
- Teixeira, R. A. (1992). *The Disappearing American Voter*. Washington, DC: Brookings Institution.
- Todorov, A., Mandisodza, A. N., Goren, A., & Hall, C. C. (2005). Inferences of competence from faces predict election outcomes. *Science*, 308, 1623-1626.
- Tusche, A., Kahnt, T., Wisniewski, D., & Haynes, J. D. (2013). Automatic processing of political preferences in the human brain. *NeuroImage*, 72, 174-182. doi: 10.1016/j.neuroimage.2013.01.020
- Van Bavel, J. J., Packer, D. J., & Cunningham, W. A. (2008). The neural substrates of in-group bias: A functional magnetic resonance imaging investigation. *Psychological Science*, 19, 1131-1139.
- Weissflog, M., Choma, B. L., Dywan, J., van Noordt, S. J., & Segalowitz, S. J. (2013). The political (and physiological) divide: Political orientation, performance monitoring, and the anterior cingulate response. *Social Neuroscience*, 8(5), 434-447. doi: 10.1080/17470919.2013.833549
- Westen, D., Blagov, P. S., Harenski, K., Kilts, C., & Hamann, S. (2006). Neural bases of motivated reasoning: An fMRI study of emotional constraints on partisan political judgment in the 2004 U.S. presidential election. *Journal of Cognitive Neuroscience*, 18, 1947-1958.
- Whalen, P. J. (1998). Fear, vigilance, and ambiguity: Initial neuroimaging studies of the human amygdala. *Current Directions in Psychological Science*, 7, 177-188.

Whalen, P. J. (2007). The uncertainty of it all. *Trends in Cognitive Sciences*, 11, 499-500.

Xia, C., Stolle, D., Gidengil, E., & Fellows, L. K. (2015). Lateral orbitofrontal cortex links social impressions to political choices. *J Neurosci*, 35(22), 8507-8514. doi: 10.1523/JNEUROSCI.0526-15.2015