

Special Thematic Section on "Societal Change"

A Complex Systems Approach to the Study of Ideology: Cognitive-Affective Structures and the Dynamics of Belief Systems

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Abstract

We propose a complex systems approach to the study of political belief systems, to overcome some of the fragmentation in the current scholarship on ideology. We review relevant work in psychology, sociology, and political science and identify major cleavages in the literature: the spatial vs. non-spatial divide (ideologies as reducible to a spatially organized set of dimensions vs. as complex conceptual structures) and the person-group problem (ideologies as driven by psychological needs of individuals vs. by institutional and power structures of society). We argue that construing ideologies as conceptual networks of cognitive-affective representations embedded in social networks of people may provide a path for bridging these existing gaps and epistemological disputes. Tools from cognitive science and computational social science such as cognitive-affective mapping, connectionist simulations, and agent-based modeling are appropriate methods for a new research program that substantiates our complex systems perspective on ideology.

Keywords: ideology, belief systems, complex systems, social change, cognitive-affective mapping, computational modeling

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Societal change is closely related to changes in the dominant ideologies of a society. We understand ideologies as systems of socially shared ideas, beliefs, and values used to understand, justify, or challenge a particular political, economic, or social order. Such belief systems may encourage, obstruct, or follow major social changes. For example, the spread of social democratic ideas has contributed to the creation of welfare states in many nations, suggesting that ideological change can sometimes cause societal change. Alternately, conservative ideology in the United States and Canada is at odds with changes towards a more environmentally sustainable economy, deemed desirable by many scientists, providing an example of how ideology can stifle social change. Consequently, if we want to deepen our understanding of the mechanisms that underlie these social changes, we need a good

theory of the structure and dynamics of societies' predominant belief systems. Unfortunately, the study of ideology has been stymied by decades of methodological and theoretical fragmentation, eroding ideology's status as a core concept in the social sciences.

The problem is not that the importance of ideology is denied. Terms like liberalism, conservatism, capitalism, communism, secularism, socialism, nationalism, fascism, and fundamentalism pervade discussions of contemporary politics and the events and crises that have marked modern history. Such “-isms” are, for example, widely perceived as driving forces furthering or impeding modernity's progress toward greater freedom and prosperity, as well as culprits behind its worst episodes of mass violence and devastation (e.g., [Bellamy, 2012](#); [Schwarzmantel, 1998](#); [Weiss, 1996](#)).

Yet the mechanics of how ideologies come into being and the causal mechanisms through which they shape social and political behavior remain poorly understood. In large part, this is due to the fragmentation of research on ideology into different disciplines in the social and cognitive sciences, which have made divergent and deeply embedded epistemological assumptions ([Leader Maynard, 2013](#)). Despite isolated progress in understanding ideology at different levels of analysis, from the molecular/neurological to the cognitive/psychological to the social/institutional, an integrated theory of ideology that bridges these levels has remained elusive.

In the present paper, we outline an interdisciplinary approach to understanding the structure and dynamics of ideology that is informed by ideas from complex systems theory and cognitive science, supported by emerging developments in computational social science. We first point to major gaps and disagreements in existing scholarship related to ideology from across social science disciplines. Second, we explain how a complex systems view of ideology might provide ways of bridging at least some of those gaps and contradictions. Third, we propose ways to study the conceptual structure of specific ideologies within our framework, describing a method we have called cognitive-affective mapping. Fourth, we describe interacting psychological and social mechanisms involved in both ideological stability and change. Finally, we briefly discuss next steps in an ongoing research agenda.

The Fragmented State of Scholarship on Ideology

Ideology was once a conceptual workhorse of political analysis. While early scholars, from Marx to Mannheim, disagreed on critical issues ranging from the sources of ideology to the nature of its content, their work collectively emphasized processes through which shared mental representations of the political world emerged and shaped political behavior ([Freeden, 2003](#); [Mannheim, 1949](#); [McLellan, 1995](#)). Many emphasized how ideologies stabilized specific social and power structures. However, from the mid to late 20th century, the study of ideology has progressively splintered, generating substantial methodological and theoretical cleavages.

[Leader Maynard \(2013\)](#) offers a sorting of ideology research by its methodological orientation, dividing existing scholarship into three broad categories: *conceptual*, *discursive*, and *quantitative*. Conceptual approaches to the study of ideology focus on the substantive content of distinct ideologies through the analysis of their component concepts. Discursive approaches focus on the expression of ideology in text, speech, and non-verbal discourse such as imagery and symbols, and the role such discourse plays in shaping political perceptions and behavior. Quantitative approaches tend to focus on establishing relationships between individual traits and political attitudes, through survey and experimental analysis. These three general categories in turn contain many distinct investig-

ative methods, sources of data, research objectives, and conceptual toolkits – with the result that the range of approaches to ideology is now broad in the extreme.

Given these methodological cleavages, it is not surprising that scholars have used ideology in incompatible ways, which has impeded knowledge accumulation. We think there are at least two critical fault lines that stymie attempts to develop an integrated theory of ideology. First, the literature is divided over its approach to conceptualizing ideological content, including whether ideologies should be conceived of as spatial or non-spatial constructs. Second, scholars draw from two fundamentally distinct classes of explanation to explain ideological attachment, one that focuses on the relationship between individual attributes and ideological positioning and another that explains ideological positioning through a focus on society-level social and institutional factors.

Spatial vs. Non-Spatial Approaches to Conceptualizing Ideologies

There are clear differences in the representation of ideological content across research traditions. Within the psychological and political science traditions, attempts to describe ideologies have often taken a spatial approach, with debates over the number of dimensions necessary to classify ideological content. Many of these scholars model ideological positions using Cartesian coordinate systems, in which each axis represents one dimension of a proposed ideational space. On the other hand, more discursive and sociological approaches to ideology have resisted such accounts, arguing that the bulk of interesting ideological variation is far too complex to be captured by crude dimensional models. Instead, such scholars almost uniformly prefer thick descriptive accounts of ideologies.

Spatial Approaches

Within spatial approaches, scholars have debated the appropriate number of dimensions necessary to fully map ideological content. In the simplest account, ideologies are mapped along a single dimension, usually corresponding to popular understanding of left-right political positioning. Despite repeated attempts to supplant one-dimensional characterizations of the ideological state space with more complex characterizations, the approach retains significant academic support (e.g., Jost, 2009; Jost, Nosek, & Gosling, 2008; for criticisms of this approach, see Greenberg & Jonas, 2003; Iyer, Kolev, Graham, Ditto, & Haidt, 2010; Leader Maynard, 2013). US political science scholarship has reinforced this perspective: within the US two-party system, congressional politics and many political attitudes generally can be mapped onto one-dimensional or nearly one-dimensional maps (Poole & Rosenthal, 2007; Stimson, 2004).

Two-dimensional maps of ideological content are also common, where each dimension reflects a unique axis over which ideological positions can vary (e.g., Braithwaite, 1997; Douglas, 1970; Eysenck, 1954; Inglehart, 1997; Rokeach, 1973; Sibley & Duckitt, 2008). Still other scholars invoke a larger number of dimensions; however, since these theories do not lend themselves well to spatial mapping, the language of these theories tends to move away from explicit use of spatial metaphors (e.g., Haidt, 2012; Hofstede, 2001; Zaller, 1992). Generally, it is difficult to arbitrate between competing mappings due to such subtly different domains that each attempts to describe such as risk worldviews vs. moral foundations vs. personality dispositions vs. national value systems.

Non-Spatial Approaches

Critiques of spatial approaches to thinking about ideology have come from both within the psychological and political science traditions, and through the more incompatible and non-dimensional approaches to thinking about ideology that has characterized recent work in sociology and political theory. These approaches hold that ideological positions are better understood as systems of beliefs that are not inherently opposite, but meaningful in light

of the distinctive combinations of symbols or ideas they integrate (e.g., [Conover & Feldman, 1981](#); [Freeden, 2010](#); [Kerlinger, 1967](#)).

From such perspectives, the reduction of ideologies to a small number of dimensions is simply too crude – gutting ideologies of their substantive complexities, which are essential to analyzing their emergence and their impact on human behavior. If ideologies are principally set apart by their complex and varying conceptual configurations ([Freeden, 1996, 2001](#)), their distinct set of historically textured myths and signifiers ([Howarth, Norval, & Stavrakakis, 2000](#)), or their idiosyncratic ways of deploying rhetorical devices ([Finlayson, 2012](#)), then their reduction to a spectrum of attitudinal positions misses what matters. Moreover, such a reduction may tend to reify political oppositions rooted principally in American politics, encouraging their use in other political contexts in which, for example, a Liberal-Conservative divide is not an apposite description of fundamental political fault lines. As an alternative to dimensional modeling of ideologies, non-spatial approaches tend to utilize either thick descriptions of ideological content or symbolic/conceptual maps.

Individual vs. Social Accounts for Explaining Ideological Attachment

Scholars also differ in their relative emphasis of individual characteristics or social interactions as key determinants of ideology. Crudely, this individual-social divide maps onto disciplinary differences. To political psychologists, ideological thinking is driven by a spectrum of psychological needs basic to individuals. On the other hand, sociologists and many political scientists have described the dynamics of ideology as driven by discursive interactions and power relations within societies.

Individualist Accounts

Individualist accounts of ideology link individual traits with ideological attachment and span genetic, physiological, psychological, and political levels of analysis. At a first, genetic level, a growing body of literature suggests a genetic basis for political attitudes, drawing from both twin studies ([Alford, Funk, & Hibbing, 2005](#)) and genome analyses ([Hatemi et al., 2011](#)). A related literature has investigated the physiological basis of political attitudes ([Amodio, Jost, Master, & Yee, 2007](#); [Chiao, Mathur, Harada, & Lipke, 2009](#); [Kanai, Feilden, Frith, & Rees, 2011](#); [Oxley et al., 2008](#); [Schreiber et al., 2005](#)).

In turn, psychologists have presented a diverse set of explanations for ideological attachment at the individual level of analysis. One influential argument suggests that conservatism should be understood as a form of motivated social cognition ([Jost, Glaser, Kruglanski, & Sulloway, 2003](#)). On this view, conservatism can be understood as helping uncertainty avoidance and threat management. A second approach, moral foundations theory, finds substantial differences between the moral concerns that underlie conservative and liberal beliefs ([Graham, Haidt, & Nosek, 2009](#); [Haidt, 2012](#)). Still another literature links personality psychology with ideological behavior (e.g., [Akrami & Ekehammar, 2006](#); [Sibley & Duckitt, 2008](#)).

Social Accounts of Ideology

Social approaches to understanding ideological content analyze processes of social interaction in groups, ranging from small and tightly bounded political movements to entire societies. Rather than seeing the uptake of ideologies or alterations in their content as determined by individual propensities, such approaches focus on the interactive dynamics by which ideologies are created, altered, and propagated. They have typically placed a particular emphasis on discourse as not merely a passive medium through which pre-formed ideological content is communicated but as a central influence on ideological content itself. Political actors deploy discourse strategically in political

contests, creatively shaping existing political language to suit their needs, such as the legitimization of political projects in front of external audiences (Edelman, 1977; Skinner, 1974; Tully, 1983), the mobilization of supporters (Tarrow, 2013), the comprehension of new political events and challenges (Freedman, 1996), or the stabilization of entire social structures (Howarth et al., 2000). Such novel deployments of political language either constitute or provoke ideological changes (depending on whether ideology is conceived of as a discursive or purely mental phenomenon), and theorists from a range of approaches have proposed methods for analyzing the syntactic, mythical, and rhetorical processes involved (e.g., Finlayson, 2012; Howarth et al., 2000; Wodak & Meyer, 2009). These approaches unsurprisingly emphasize the close relationship between ideology and the exertion of, or resistance to, *power*. Both within and between groups, ideologies are deployed as a means of contesting and legitimizing power. They influence the broader exercise of power and are underpinned, in their dissemination, by forms of non-ideological power, such as material control over communications technologies or institutional control over political parties, news networks, or educational establishments (Fairclough, 2001; Simonds, 1989).

Attempts at Integration

Previous attempts to bridge these cleavages have been limited. One synthetic approach, advanced by psychologists, relies on the idea of “elective affinities” – forces that connect people with the ideologies that suit them (Jost, 2009). These forces are a combination of top-down and bottom-up processes. Top down-processes include traditional determinants at political and institutional levels, including elite communication, political parties, and media messaging. Bottom-up processes describe factors at the psychological and biological level (Jost, 2009). Another research direction emphasizes the role of narrative in shaping ideological attachment. By creating meaning, narratives provide ideologies with their psychological resonance (Hammack, 2008; Westen, 2007). An example of this approach is the attempt to integrate moral foundations theory and a “three level account of personality” (Haidt, Graham, & Joseph, 2009). This theory holds that there are three levels of personality. Level 1 consists of dispositional traits, which are decontextualized and universal and include the Big 5 personality traits. Level 2 consists of characteristic adaptations, which include goals, values, and other more context-specific and pliable individual traits. Finally, Level 3 consists of integrative life stories, which are essentially narrative meaning-making structures (McAdams, 1995; McAdams & Pals, 2006).

More generally, the elucidation of cross-scale linkages is critical for a needed effort to bridge individualist and group accounts of ideology. Genetic, physiological, cognitive, discursive, social, material, and political factors all need to be brought together into an integrated cross-scale theory of ideology. No explanatory level is independent and the true determinants of ideology bridge all of these levels of analysis through complex cross-scale interactions. Uncovering such cross-scale linkages for genetic, physiological, and psychological determinants of ideology is increasingly a focus of political psychology. However, social, political, and institutional factors remain more marginal to these research efforts and need to be brought into cross-scale accounts of ideological positioning.

Ideology: A Complex Systems Approach

We thus lack a conceptual apparatus that can bridge the methodological and theoretical cleavages that have fragmented the scholarship on ideology. An integrated understanding of ideology should help bridge the spatial vs. non-spatial and individual vs. group cleavages we have identified above.

Complexity theory appears ideally suited to this task. This body of work originally emerged from research in mathematics, physics, computer science, systems engineering (including cybernetics), and meteorology; more recently, important contributions have come from ecology. Researchers now apply insights from complexity theory to understand the behavior of systems as diverse as financial markets, fresh-water lakes, and mammalian immune systems (Mitchell, 2011).

New complexity research on critical transitions (Scheffer, 2009) has helped scholars understand phenomena such as the sudden outbreak of ethnic conflict and violence (e.g., Hagan & Rymond-Richmond, 2008; Straus, 2008); the recent financial crisis, which was largely unforeseen by conventional economists (Colander et al., 2009; Helbing & Kirman, 2013); and the Arab spring (Lang & De Sterck, 2012). But, overall, efforts to apply complexity theory to social systems are still in their infancy (e.g., Helbing & Carbone, 2012) and have often relied on crude analogies to patterns seen in biology or physics.

By applying complexity theory to the study of ideology, we are trying to ground the social sciences in the cognitive sciences (Sun, 2012). Using methods such as cognitive-affective mapping, neural-network modeling, and agent-based simulations, all explained in more detail below, we hope to specify the mechanisms of ideological stability and change across the individual and social levels of explanation.

Our approach thus aims simultaneously to enhance the application of complexity theory to social phenomena by using cognitive science models and to enhance the application of cognitive science to social phenomena by using complexity theory. The emergence of ideologies – including their generation, acceptance by individuals, and spread through societies – should be particularly amenable to an approach that grounds ideas concerning nonlinear dynamics and critical transitions in mathematically specified and computationally modeled cognitive and social mechanisms.

Basic Features of Complexity

Complexity is often equated with certain kinds of system behavior. A system is categorized as complex if it exhibits behavioral properties such as emergence, nonlinearity (disproportionality of cause and effect), path dependency, and multiple equilibria. Of greater interest and explanatory value, though, are the factors that cause such complex behavior. With regard to such causes, we argue that complex systems can be divided into two sub-categories: non-adaptive and adaptive. The former includes systems such as Earth's atmosphere, while the latter includes systems such as ecologies and economies.

In both types of system, particular patterns of causation are the fundamental source of complexity. Specifically, complex systems have dense and recursive causal connections, each of which is characterized by a set of necessary and sufficient conditions. Dense and recursive causal connections allow for positive and negative feedback loops. Necessity and sufficiency conditions – or what we call “and/or causal aggregators” – allow for varied combinations of multiplicative and additive causation. Density and recursivity of connections along with and/or causal aggregators produce, in combination, the observed behavioral properties of complexity.

A complex system's equilibria are basins of attraction in the system's state space. A state space, in turn, is a multi-dimensional space in which each dimension is a variable that describes an aspect of the system's behavior. A point in the state space fully describes the system's behavior at a particular time, and the trajectory of that point through the state space represents the system's behavioral history in time. An attractor is a point in the state

space that the system moves towards, and a basin of attraction is the region around that point into which such movement occurs.

Like their non-adaptive cousins, adaptive complex systems exhibit density and recursivity of connections along with and/or causal aggregators. Their behavior can be described as a trajectory through a specified state space. In addition, however, they have features that contribute to their particular form of complexity. Specifically, all adaptive complex systems have quasi-autonomous units or “agents” with internal representations of their external environment.

Together these representations make up a “schema” that includes heuristics for how the system should respond to changes in its surrounding environment. In non-human organisms, or in systems made up of such organisms, schemata are largely encoded in the constituent species’ genotypes. In human societies, they are encoded in the human genotype, but also in human memories, written materials, institutions, shared culture, and the like (Gell-Mann, 1997). Schemata evolve under selection pressure from the external environment, which often includes agents with other schemata.

Application of Complexity Concepts to Ideology

The concepts described above can help researchers probe aspects of ideology that might be otherwise opaque. Ideologies emerge from the complex causal interaction of cognitive, affective, and social factors. As is true with all complex systems, they evolve in ways that can be surprising and hard to predict. Social belief systems can also undergo sudden shifts between equilibria following seemingly minor changes in people’s beliefs or external conditions.

Complexity theory’s capacity to cope with multi-level causality is particularly valuable to ideology research, because ideology exists neither solely in the individual mind nor in the social group. It is rather the emergent product of interaction between networks of mental representations at the individual level and networks of social communication at the group level.

If we construe ideologies as complex systems, we have (at least) two levels of systems embedded in each other. At the individual level, the elements are ideas, beliefs, and values, whose interactions give rise to a person’s understanding of society, which in turn guides individual political behavior. At the group level, the elements are individual minds whose interactions give rise to discourses and power dynamics, which in turn guide collective action and societal change. We thus conceive of an ideological system as a network of minds, where minds are networks of concepts. This general idea is depicted in [Figure 1](#).

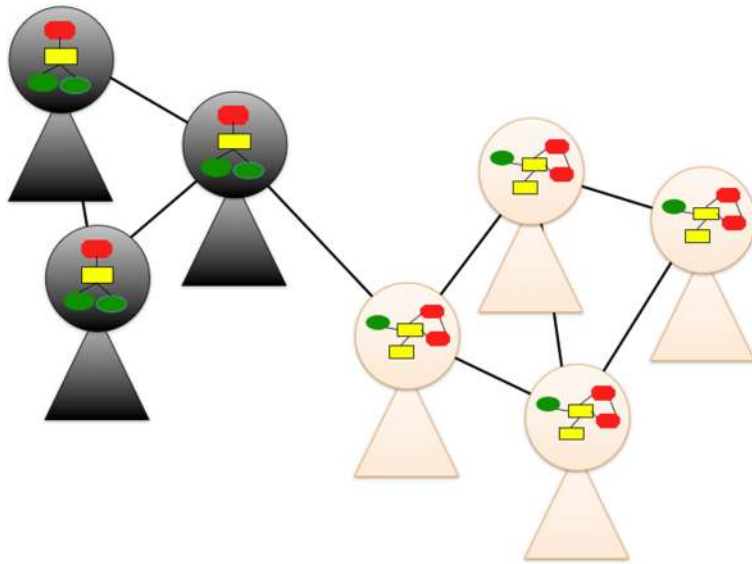


Figure 1. Ideologies as networks of concepts embedded in networks of people.

To understand ideological change that goes along with broader social change, it is important to see that the different levels of networks may influence each other's structures dynamically. People may be attracted to (or repelled from) other people when they realize the similarities (or differences) in their individual belief systems; changes in conceptual network structures may thus cause changes in social network structures. Conversely, people may alter their individual system of representations when exposed to different people in a changing social network, as people create shared realities when interacting with others (Hardin & Higgins, 1996; Heise, 2007; Jost, Ledgerwood, & Hardin, 2008).

Ideology and Emotional Coherence

An ideology is not just any assortment of principles and concepts. The notion connotes a system of related ideas, beliefs, and values, recognized as such in common by multiple individuals, and therefore contributing to the formation and definition of a group identity. In Figure 1, this socially shared belief system is represented by the colored conceptual networks, which have the same structure across individuals who belong to one group, and different structures across individuals who belong to different groups. Ideology thus serves as a crucial bridge between individual minds and collective behavior, and any complete explanation of ideological formation and change must therefore integrate the individual-cognitive and group-social levels of analysis. What is needed, then, is a method for representing individual minds as complex cognitive systems, and tools to model how interactions between multiple agents and their cognitive systems generate emergent social patterns and properties.

We draw upon Thagard's (2006) theory of emotional coherence, which is based on the (localist) connectionist approach in cognitive science. On this view, mental representations can be construed as neural networks in which the nodes represent individual beliefs with various connections (links) between them. Clusters or sets of concepts form beliefs, images, or other cognitive structures. Meaning emerges from the interconnections between multiple cognitive elements, structures and processes as much as from their relationship to entities in the material and social worlds (Markus & Hamedani, 2007). Coherent belief systems emerge from a process of parallel constraint

satisfaction; the nodes in a network mutually exchange and inhibit activation according to their connections with other nodes until the whole network stabilizes in a stable pattern where a cluster of concepts that go together is activated while other concepts are inhibited (Read & Simon, 2012; Thagard, 1989, 2000). We propose that a stable state of such a network corresponds to the structure of an ideology, with patterns of correlated beliefs that are often difficult to explain rationally. For example, in the case of conservatism, it is not immediately clear why individuals who oppose higher taxes also favor (costly) longer prison terms for criminals. We believe that such seemingly odd attitudinal correlations can be explained by coherence mechanisms operating on larger socially shared conceptual structures. In the next section, we describe a method called cognitive-affective mapping, which we have used for studying ideological content.

Neural networks of this kind exhibit many of the properties of complex systems described above, especially disproportionality of cause and effect. We propose that coherent belief systems can be conceptualized as the attractors of the cognitive system. Depending on the configuration of attractors in a belief network, large changes can have no effects (like when an individual has a very firm opinion on some issue and is not impressed by contradictory information), or small changes can have tremendous effects (like in a conversion experience) (Read & Simon, 2012). This property of neural networks explains why belief revision and ideological change at the level of the individual mind is often disruptive and interpretable as a gestalt shift rather than a gradual process (Thagard & Findlay, 2011).

Ideologies are often deeply emotionally embedded and central to an individual's sense of who they are, that is, their identity. Representations of the self and relevant social identities are core concepts in individuals' belief networks. These identities are rooted in affective experience and closely connected to a person's self-sentiment (MacKinnon & Heise, 2010), which constrains their patterns of experience and behavior. In general, recognition of the inexorable link between cognition and emotion – that feeling is integral to knowing – has become increasingly relevant to cognitive science. Thagard argues that earlier views of cognition as computational processes of deliberative, “cold” coherence are incomplete, putting forward instead a theory of cognition as a process of emotional, “hot” coherence (Thagard, 2006). Emotions are mental states, which cannot be separated from cognitive elements (Duncan & Barrett, 2007). Concepts, beliefs, and goals all come with emotional valences that shape coherence assessments as much as does logical reasoning. Emotions are also involved in cognitive processes such as the rejection or revision of beliefs. Therefore, the emotional values associated with concepts, far from being hindrances to rational decision-making as often assumed, are in fact indispensable elements of human perception, understanding, and rationality (e.g., Damasio, 1994; Duncan & Barrett, 2007; Heise, 2007; Loewenstein, Weber, Hsee, & Welch, 2001; Osgood, May, & Miron, 1975; Thagard 2006).

Connectionist models of the mind can incorporate the impact of affective processes on judgments and behaviors by representing dimensions of emotional experience such as valence, potency, and arousal (Fontaine, Scherer, Roesch, & Ellsworth, 2007; Osgood et al., 1975) as special nodes that are highly interconnected with beliefs and concepts, thus modeling the crucial role of emotion in human decision-making and action (Schröder & Thagard, 2013a; Thagard, 2006; see also the section on cognitive-affective mapping below). This method allows one to model emotional biases in the perception and interpretation of political events at the level of individual minds (Schröder & Thagard, 2011). Empirical evidence for such effects of motivated cognition is abundant (e.g., Westen, 2007; Westen, Blagov, Harenski, Kilts, & Hamann, 2006; for a review, see Kunda, 1990). In general, the theory of emotional coherence is compatible with the different variants of consistency theories in social psychology, which state that the human mind strives for consistency and experiences “incongruent”, “imbalanced”, “dissonant”,

or “deflected” representations as aversive (e.g., [Festinger, 1957](#); [Heider, 1946](#); [Heise, 2007](#); [Osgood & Tannenbaum, 1955](#); [Read & Simon, 2012](#)).

The Relationship Between Individual and Collective Identity

However, any effort to apply cognitive science ideas at the level of the social group will run into problematic questions as to the nature of agency at the individual and collective levels. Cognition takes place in the brain of an individual. Yet in fields of study where the units of analysis are more often than not communities, institutions, or social movements, these units are often conceived as thinking, acting, and feeling as a collectivity (“America invaded...”, “banks reacted...”, and so on). Does this reflect merely, at worst, fallacious thinking or, at best, a metaphorical pointer, a convenient way of speaking to a more complex reality? Closer examination of collective behavior tends to reveal more going on than merely an instrumental assemblage of individual minds. Social behavior depends on the ability of groups to attribute shared meaning to objects, behaviors, and words through language. Collective-meaning making is a fundamental process for human societies, and it is at the heart of political decision-making. But can we really attribute beliefs to social groups; is there such a thing as collective cognition? And, if not, because groups do not have brains, how can the processes and results of collective sense making be conceptualized? It is precisely this impasse between the individual and social levels of analysis that a comprehensive model of ideological formation and change must resolve.

Cognition is a process that consists of interacting mechanisms on multiple levels, including the neural, molecular, psychological, and social ([Thagard, 2010a](#)). Given that groups do not have brains, and collective mental representations are therefore not properly construed as real entities, we argue, following Thagard, that the individual-group problem can also be conceptualized in terms of multilevel interacting mechanisms: the interaction between individual-level mechanisms (molecular, neural, and psychological processes) and group-level mechanisms (communication, sensory interaction) creates the bonds that hold a group together. The key to collective cognition is the individual who thinks about himself as a member of the group ([Thagard, 2010a](#), p. 274). Concepts that represent the self, the group, and core values relevant to the group become thus part of the conceptual network constituting an individual’s belief system.

Writing about conflict, [Ellemers \(2012\)](#) confirms this view of the person-group relationship by exploring the conditions under which “the group self” – thinking about oneself as a member of a group – becomes more important than the individual self. Individuals acquire and change group-related beliefs through interactions with other people and with other elements of the group (e.g., certain spaces and office buildings, the use of collective resources and property, or the experience of events). This process of social communication and physical-sensory interaction works both ways: a group member not only receives information about the group and develops an understanding of the group as a collective entity; she also contributes to other people’s mental representations and experiences of the group. The nature of the group depends on this recursive process between individual cognition of and social interaction between group members.

The same person-group dynamic exists for emotions. Social psychologists have developed a theory of intergroup emotions according to which individuals experience emotions on behalf of the group whenever their social identity rather than their individual identity is salient ([Mackie, Devos, & Smith, 2000](#); [Smith 1993, 1999](#)). Building on social identity theory (e.g., [Tajfel, 1982](#)) and appraisal theory (e.g., [Scherer, Schorr, & Johnstone, 2001](#)), group-level emotions have been shown to be distinct from individual emotions and correlated with group identification. They are socially shared and mediate attitudes and behavior ([Smith, Seger, & Mackie, 2007](#)).

We must therefore be clear that whenever one speaks of “the group” (or, by extension, of any particular group) one is referring simultaneously to two different constructs at two distinct levels of analysis. It is easy to conceive of the group as larger than the individual, for example as a collection of individuals and the networks of social communication between them. But the group is also smaller than the individual, insofar as it is a subset of the mental representations that make up an individual’s cognitive-affective system. The group cannot exist without these two necessary conditions in place: first, a collection of individuals with networks of social communication between them, and second, a cognitive construct common to the minds of member individuals according to which the group is conceived and defined. Neither condition can exist without the other; hence, the group is the product of a multi-directional feedback effect between these two complex systems at different levels of analysis. Networks of social communication are required to implant the cognitive construct in the minds of member individuals; yet those networks are themselves shaped by the presence and content of the cognitive construct.

Conceptualizing the group as a sub-system of mental representations as well as a super-system of individuals opens a new approach to the problem of collective cognition, emotion, and agency. Thought and emotion are brain states, and groups do not have brains, only the brains of the individuals that compose them. Only individual minds are capable of emotion, or of retaining mental representations with emotional valence. Therefore, the group, as such, cannot literally think, feel, and act. However, the individual mind that contains a part reflecting the group – the subset of mental representations that amount to the internalized group construct – is capable of thought, emotion, and agency. The systems of mental representations communicated to the individual mind through interaction with the group contain within them not only objects and connectors but an inherent emotional logic and coherence to them. In addition to symbols and narratives, group communication also conveys feelings. Indeed, certain feelings are inherent in the symbols and narratives themselves, and hence will be held in common by members of the group. These clusters of mental representations related to identity are what make up ideologies, and are the sources of collective behavior and agency as emergent properties of cognitive-social systems. Thus even though groups, as such, cannot think and feel, the common adoption of complex systems of mental representations that include emotional valences creates a dynamic that can be considered or at least usefully labeled collective cognition and emotion. Such collective experiences can be enhanced through the immediate interpersonal communication of emotion, in a process called emotional contagion (Hatfield, Cacioppo, & Rapson, 1993).

Cognitive-Affective Mapping: Studying the Conceptual Structure of Ideologies

Having outlined our complex systems approach to studying ideology in the previous section, we now describe an empirical methodology, *cognitive-affective mapping*, which is based on these ideas and can be used to analyze the conceptual structure of ideological content. Drawing from connectionist models of cognition, cognitive-affective mapping was developed by cognitive scientists at the University of Waterloo as a means to graphically diagram belief systems as networks of mental representations (Findlay & Thagard, 2011; Thagard, 2010b, in press). The products of this method – cognitive-affective maps, or CAMs for short – represent an individual’s or a group’s concepts and beliefs about a particular subject, such as another individual or group or an issue in dispute. Elsewhere, we have shown in more detail how CAMs may be useful for analyzing the ideational structure of social disputes and, hence, contribute to conflict resolution (Homer-Dixon, Milkoreit, Mock, Schröder, & Thagard, 2013). Here, we illustrate how CAMs advance the study of ideologies under a complex systems approach. We first describe

the method in general, and then as a brief example provide a CAM of the Tea Party ideology, a recent influential variant of Republican conservatism in U.S. politics (e.g., Williamson, Skocpol, & Coggin, 2011).

The CAM approach adopts the following conventions. Map elements are depicted by shapes:

- ovals represent emotionally positive elements;
- hexagons represent emotionally negative elements;
- rectangles represent elements that are emotionally neutral;
- a superimposed oval and hexagon indicates ambivalence; a single element that can generate simultaneously positive and negative emotional associations (though this symbol should be used sparingly, only where positive and negative aspects of the same element cannot be disaggregated);
- the thickness of the lines in the shape represents the relative strength of the positive or negative value associated with it.

Straight lines between shapes depict relations between elements:

- solid lines represent relations between elements that are compatible or mutually supportive;
- dashed lines represent relations between elements that are incompatible with each other.

The product amounts to a network of interconnected elements, as illustrated in Figure 2.

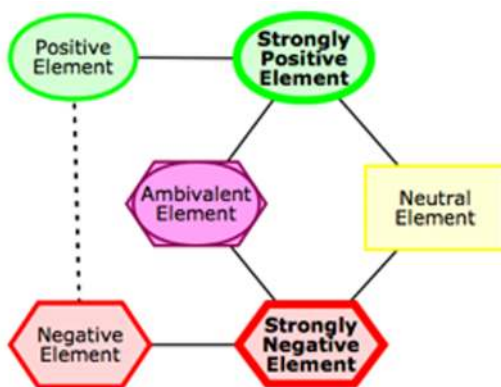


Figure 2. Basic CAM network. Software for drawing CAMs is available for download at no cost at <http://cogsci.uwaterloo.ca/empathica.html>

These rules do not define a full methodology of ideological analysis – not least because the accuracy of the CAMs relies on an interpretative method to gather actual data on real world belief-systems and convert this into a CAM. Such a need is not unique to CAMs, and we shall not elaborate a single specific method here, but two points are worth emphasizing. First, CAMs can be constructed through a variety of different data collections techniques, including dialogic interviews, survey data, textual analysis, and reviews of secondary literature. Second, whatever the techniques, the activity of mapping should be built on attentiveness to the extensive literature on interpretation generated by work on ideology in the fields of intellectual history and discourse analysis. Deriving conclusions about individuals' beliefs from any sort of data is not straightforward. Understanding speech and text in the social context in which it was formulated (Skinner, 1974, 2002; Tully, 1983); discerning insincerity, irony, analogy, and hyperbole (Fairclough, 2010; Skinner, 2002; Wodak & Meyer, 2009); identifying non-obvious ideological implications of semantic and syntactic choices (Fairclough, 2010; Freeden, 1996; Howarth et al., 2000; Wodak & Meyer 2009);

and analyzing the ideological significance of certain rhetorical devices (Finlayson, 2012) are all vital components of successful interpretation.

The CAM method opens the possibility for modeling emergent patterns and properties that might result from the interaction between networks of mental representations that make up individual minds, as well as the multi-level interactions between individual cognitive networks and systems of social communication, as shown in Figure 1 and explained in more detail in the following section. Such an approach satisfies traditional methodological individualism, in that it is predicated on a positivist rejection of mind/body dualism that would otherwise tend toward mystifying ideas and emotions as abstract or intractable aspects of the human condition. Instead, it frames them as mental representations that are the product of brain processes, and that – given the right stimulus – are activated in tandem to generate belief systems. However, it also acknowledges that interactions between these systems can yield emergent patterns independent from those that characterize individual minds (see the next section).

Case-In-Point: The Tea-Party Ideology

As an example for how the CAM methodology could be used to understand the cognitive-affective structure of ideology, we suggest an illustrative CAM of core aspects of the Tea Party ideology, displayed in Figure 3. The Tea Party is a movement within the U.S. Republican party that became influential shortly after the first election of Barack Obama as president of the United States in 2008. Our analysis of this group's collective belief system is derived from a participant observation study and interviews conducted with Tea Party activists by Williamson et al. (2011). The Tea Party "provided conservative activists with a new identity funded by Republican business elites [...], energized disgruntled white middle-class conservatives, and garnered wide-spread attention" (Williamson et al., 2011, p. 25). Central to the ideology that Williamson et al. (2011) attribute to the Tea Party is the rejection of "Big Government" spending. The Tea Party movement is widely accredited with responsibility for moving the Republican party away from the political center to the far right and fueling the vivid resistance against president Obama's "Affordable Health Care Act", which sought to provide all Americans with basic health insurance.

As Williamson et al. (2011) note, the strong emotional resistance against government-mandated health care among activists was at odds with the fact that many of them felt "considerable acceptance, even warmth, toward long-standing federal social programs like Social Security and Medicare, to which Tea Partiers felt legitimately entitled" (p. 26). Apparently, their sentiment toward government programs was not inherently negative, but highly ambivalent instead – depicted by the superimposed oval and hexagon symbols in the CAM displayed in Figure 3. The ambivalence arises from the fact that representations of social programs are connected on one hand with representations of the self as a hard worker contributing to society and, hence, deserving of the government check (the cluster of ovals on the middle left-hand side of the CAM), but on other hand with the highly negative representations of government, spending, and taxation common to conservative ideologies (a cluster of hexagons on the upper right-hand side of the CAM in Figure 3).

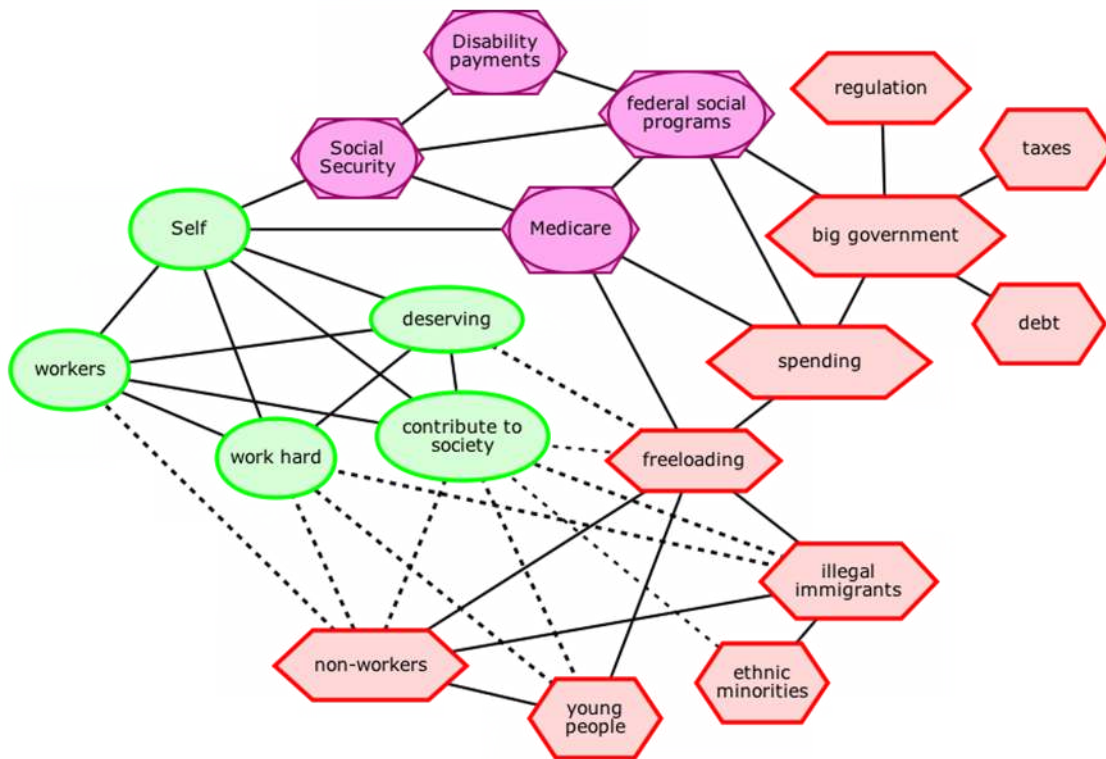


Figure 3. CAM of the Tea Party ideology.

Note that the ambivalence does not result in a somewhat neutral emotion toward government programs, as a linear model would suggest. Rather, the emotional assessment flips back and forth between positive and (passionately) negative, depending on whether the deserving self or the spending government is in the focus of the Tea Partier's attention. This dynamic is well described using complex system concepts, where a small change in some of the elements (here, the activation of a certain conceptual representation) causes a disproportional overall shift in the whole system. Such emotional gestalt shifts can be modeled easily with connectionist neural networks, which underlie the CAM methodology (Thagard & Nerb, 2002). EMPATHICA, the software developed to draw CAMs, can convert a graphical display of someone's mental representation like in Figure 3 into computer code for a neural network model. The code then can be used to analyze phenomena like emotional gestalt shifts, interpretations of political events, and decision-making within Thagard's (2006) Hot Coherence model of human cognition (for an example in politics, see Schröder & Thagard, 2011). The model computes a coherent pattern of conceptual representations corresponding to the mind's overall judgment, as explained in the preceding section. A much more substantive treatment of the CAM methodology with various examples can be found in Homer-Dixon et al. (2013).

Williamson et al.'s (2011) analysis also suggests that resentment towards stereotyped minority groups was key to the Tea Parties' ideological structure. They write that "opposition [to the Affordable Health Care Act] is concentrated on resentment of perceived federal government "handouts" to "undeserving" groups, the definition of which seems heavily influenced by racial and ethnic stereotypes" (Williamson et al., 2011, p. 26). CAMs provide a way to interrogate this class of arguments. Consider the negatively valenced representations of ethnic and racial minorities in the lower middle cluster of hexagons in our Tea Party CAM in Figure 3. They have many inhibitory

connections to the positive cluster of self-related concepts (displayed as dashed lines in [Figure 3](#)), since they denote incompatible representations.

In a neural network modeled on the CAM in [Figure 3](#), activation of these representations would cause the emotionally positive self-related concepts to be suppressed, due to the inhibitory connections between these two clusters of concepts. Hence, the self-related concepts would cease to spread positive valence to the emotionally ambivalent nodes representing government programs. On the other hand, negative valence would spread from the bottom cluster to the upper right-hand cluster representing “Big Government” and from there on to the federal social programs. CAMs can thus illuminate the cascades of affect and cognition that shape an individual’s understanding of their social reality, here Tea Party sentiment towards the extension of the welfare state.

Of course, CAMs only offer partial representations of conceptual networks. Their most important limitation is that they operate entirely at the individual level, neglecting important social mechanisms. In this example, the CAM in [Figure 3](#) cannot account for the fact that individual Tea Partiers formed new groups and that these groups became themselves powerful emotional symbols at the individual level again. In the following section, we place more attention on the group-level mechanisms and their interactions with individual-level cognitive-affective dynamics that we argue helps explain how shared belief systems, as captured by CAMs, come about in the first place and change over time.

Mechanisms of Ideological Change

If an ideology is a network of concepts and beliefs grounded in emotions, as exemplified in [Figure 3](#) for the Tea Party movement, that exists in a similar form in the minds of multiple individuals, then ideological change requires restructuring this network, at least partially, by generating and adopting new beliefs and concepts into existing webs of mental representations. Further, such change would have to take place not only in the mind of an individual, but spread through the group to become a new understanding of social reality. This process of cognitive change faces obstacles at both the individual and the collective scales.

The existing cognitive-affective network in an individual’s mind at any given point in time poses a heavy constraint on the possibilities for such restructuring. As the principle of emotional coherence predicts, only those new beliefs can be adopted that are conceptually and emotionally compatible with existing old beliefs ([Skinner, 2002](#); [Thagard, 2006](#)). We might say that the existing ideological structure of a person’s mind creates a path dependency for configurations of ideological content that are possible in the future. In the terminology of complexity theory, a present coherent cognitive-affective belief system constitutes a basin of attraction in the state space of possible belief systems, from which not all conceivable belief systems are accessible. Ideological change – still at the level of the individual mind – is sometimes much more a jump into a new coherent cognitive-affective state than a gradual adjustment of some convictions. In the case of Tea Party activists discussed above, the endorsement of government-mandated health care was not possible in the context of a campaign that displayed so many symbols of identities opposed to those of white middle-class workers, because such an attitude change would have been incoherent and thus unattainable given the existing structure of mental representations displayed in [Figure 3](#). Instead, Tea Partiers’ ideology flipped into a cognitive-affective state in which they perceived the “Affordable Health Care Act” as fundamentally opposed to everything that mattered to their own identity, perhaps even quite contrary to their own rational interests. Correspondingly, understanding the landscape of potential belief systems is critical

to understanding which types of belief changes are possible under what circumstances, and which trajectories of ideological change are less or more psychologically accessible.

The configurations of belief systems possible in the future are also constrained by social structures, which shape the psychological states potentially accessible to individuals embedded in groups. As explained above (see [Figure 1](#)), we conceive of ideologies as networks of concepts embedded in networks of people. The structures of these social networks influence the possibilities for flows of information across individual minds, as they determine who communicates with whom. There is abundant evidence that social networks are organized by a mechanism of homophily, signifying that individuals tend to organize themselves in groups of people so that the similarity of people within groups and their dissimilarity across groups are maximized ([McPherson, Smith-Lovin, & Cook, 2001](#)). Similarity primarily refers to demographic attributes such as age, gender, wealth, and education ([Blau, 1977](#); [McPherson et al., 2001](#); [McPherson & Ranger-Moore, 1991](#)). However, we also expect people organized in local groups to develop synchronized cognitive-affective structures of belief systems; in [Figure 1](#) this is symbolized by the agents densely connected in one group having the same CAM structure and agents in different groups having divergent CAM structures.

This synchronization of minds as a function of group membership follows from the principle of emotional coherence. As individuals communicate with each other, they seek to validate their representations of the world by comparing them to those of their peers, creating a “shared reality” ([Hardin & Higgins, 1996](#); [Jost, Ledgerwood, et al., 2008](#)). Hence, as individuals who belong to the same subgroup of society and feel attached to each other communicate about political issues, they will tend to mutually adapt their cognitive-affective belief systems. Individuals whose views are too discrepant from the predominant views of the group will be motivated to split from the group and rather affiliate with other people who think and feel more like themselves, to avoid the psychological tensions brought about by social interactions that disconfirm one’s own identity ([Heise, 2007](#); [Robinson & Smith-Lovin, 1992](#)). There is thus a mutual dynamic interplay between individual belief systems and social structure in that on one hand groups members tend to synchronize their cognitive-affective maps but on other hand the formation of groups follows the similarity of belief systems.

The organization of society in subgroups of rather homogeneous belief systems poses limitations on the possibility of ideological states in the future that go beyond the emotional coherence mechanisms at the individual level. If an individual receives in social communication a piece of information which is incoherent with their cognitive-affective worldview, they will likely reject it or interpret it in a substantially different way than intended, like in the case of Tea Partiers who became ever more angry about healthcare legislation, not supportive, after receiving information from the Obama campaign. Therefore, it is unlikely that flows of information between the two agents in [Figure 1](#) who are connected across groups will result in a substantial reconfiguration of either agent’s mental representations. Even if such cross-group attitude change happens occasionally, it is probably not sustainable, since the agents will communicate with members from their own group far more often, resulting in a re-structuring of their belief system toward the original state. The cognitive (individual-level) mechanism of emotional coherence and the social (group-level) mechanism of homophily thus work hand in hand in stabilizing or even further increasing ideological divides across subgroups of society.

Societal ideological transitions involve corresponding and recursive reconfigurations of the cognitive-affective belief networks at the individual level and social relations at the group level. Individuals with similarly structured minds, who react to events in similar ways (e.g., the election of Barack Obama for president of the U.S.), find to-

gether in new groups (e.g., the Tea Party). Their socially shared representation of the group then becomes an emotionally powerful symbol itself, further shifting belief systems at the level of individual minds and further changing the social network at the group level by attracting new group members (and perhaps scaring away old ones).

A Methodological Challenge

We think that such complex multi-level interacting mechanisms potentially provide a better and more coherent explanation of the dynamics of ideology than the fragmented narrower approaches reviewed in the first part of this paper. However, the classical methodological approaches of the social sciences, whether linear statistical models or qualitative methods, are arguably not suitable for this endeavor. If we want to advance the study of ideology in the direction outlined here, we need to capitalize on new possibilities provided by the recent emergence of computational social science.

Computational social science is an approach to study the properties of social systems with modeling and simulation tools that are capable of capturing the nonlinearity and recursivity of complex systems. Although a computational approach to understanding social dynamics is not quite a new idea in principle (e.g., Heise, 1977; Heise & Simmons, 1985; Schelling, 1971), the ever-growing availability of computing power and behavioral “Big Data” at unprecedented scale have fueled more recent calls for a paradigm shift in social science toward a better understanding of societies as complex systems by means of computational modeling techniques (e.g., Gilbert & Troitzsch, 2005; Helbing & Carbone, 2012; Lazer et al., 2009). The most important tool for our endeavor of achieving a better understanding of ideological transitions is agent-based modeling, a computational technique to study multi-level interactions between individual behaviors and social dynamics (e.g., Bonabeau, 2002; Epstein & Axtell, 1996; Helbing & Baliotti, 2012; Squazzoni, 2012).

Agent-based modeling is in many ways comparable to the connectionist approach of modeling cognitive-affective systems at the individual level. Elements have connections with other elements to exchange information. The operations of the single elements are relatively simple, but complex processes at the system level emerge from the multiple interactions between all the elements. In localist neural networks, which implement CAMs (see the preceding section), the elements represent concepts and the system represents an individual mind. In sociological agent-based models, the elements represent people and the system represents a group or society.

Many agent-based models of social phenomena are not psychologically realistic. In some cases, the assumptions about individual information processing are far too crude (e.g., an agent does whatever the majority of its neighbors do) and the agents lack rich mental representations (e.g., political opinions are represented as numbers between -1 and 1). In other cases, the assumptions are far too demanding (e.g., an agent has full information and decides rationally through multi-attributive utility maximization). For a review and critique, see Sobkowicz (2009) or Sun (2006).

For the study of ideology in a complex systems framework, we propose to use the emotional coherence framework as a cognitively plausible yet computationally tractable model of individual agent behavior. As shown in Figure 1, such a model would consist of a network of individual minds, which, in turn, would be modeled as networks of concepts. The feasibility of such an approach has been demonstrated by Wolf and colleagues (Wolf, Neumann,

Schröder, & de Haan, 2012; Wolf, Schröder, Neumann, & de Haan, 2013). These authors have developed an agent-based model of innovation diffusion, which is based on the theoretical framework described here. Based on empirical work involving qualitative focus group discussions and a quantitative survey of a representative sample, they modeled how individuals perceive electric vehicles (using a variant of the CAM methodology described previously) and how these individuals exchange information in a realistically designed social network (using an algorithm implementing the principle of homophily also described previously). Wolf and colleagues then used the agent-based model to simulate different scenarios of the likely future market penetration of electric vehicles contingent on different policy scenarios (e.g., a tax reduction granted for owners of electric cars). This approach is very similar to the one advocated here about the dynamics of ideology, as it is assumed that present cognitive-affective configurations of individual minds in conjunction with communicative configurations of people in a social network constrain the transitions of the social system that are possible in the future. Similarly, we would hope to be able to derive expectations of plausible ideological change from a mapping of people's current belief systems, as described above.

Discussion: Limitations and Future Work

We have proposed the use of a complex systems approach to the study of ideology because we believe that such an approach provides a way of overcoming the fragmentation across disciplines, methodological approaches, and levels of explanation that characterizes the state of scholarship on ideology to date and impedes progress toward a holistic understanding of ideological dynamics in society. In particular, we have identified two major divides in the literature, spatial vs. non-spatial and individual vs. group approaches, which we seek to overcome with our research agenda.

Cognitive-affective mapping provides a pathway for the formal analysis of ideologies within our framework, as exemplified by the CAM of core aspects of the Tea Party movement's ideology displayed in [Figure 3](#) above. This approach allows us to bridge conceptual, discursive, and quantitative paradigms (cf. [Leader Maynard, 2013](#); see above), since it can translate various sorts of data on ideology into CAMs, with such translation ideally informed by interpretative methods of discursive and conceptual analysis, and then analyze those CAMs with mathematical and computational tools. Embedding such CAMs, possibly divergent across different subgroups of society, into agent-based models will enable us to study the multi-level interactions between individual representations and group processes that underlie specific instances of ideological transitions.

Our approach also helps mitigate the divide between spatial and non-spatial models of ideological content. To recall, the former try to identify parsimonious sets of dimensions that describe all ideological state spaces; all possible ideologies are (ideally) given by configurations along those dimensions. In contrast, non-dimensional approaches construe ideologies as complex mental configurations, which resist being adequately defined by small numbers of dimensions and are more amenable to thick description or symbolic mapping. Our cognitive-affective mapping method is compatible with the non-dimensional approach, since it is precisely an attempt to symbolically capture the structure of mental representations. At the same time, by providing a tractable empirical tool to map the large-scale conceptual networks of different ideologies, the approach may also allow the derivation of a quantifiable semantic space where each concept's network location can be located in terms of its connections to other concepts. We could then use statistical techniques to describe the underlying topography of an associated ideological state space. Such complexity-derived concepts as basis of attraction and attractors consequently

provide an intellectual framework to interpret spatial representations of thickly-described and symbolically-dense belief systems.

Conducted at large scale, that is, with hundreds of general social concepts and across many languages and cultures, analyses of semantic spaces have often revealed three general and ubiquitous dimensions to underlie the organization of the vernacular (Osgood et al., 1975; Osgood, Suci, & Tannenbaum, 1957). The first is an evaluation dimension, which distinguishes good from bad things and is similar to the shape-coded valence dimension we use in our cognitive-affective mapping approach. The second dimension, potency, relates to power and control, with opposing poles of weak and little vs. small and big. The third dimension is called activity and opposes dynamic/active and calm/passive concepts. Interestingly, these basic dimensions of meaning correspond to the basic dimensions of emotion and affective experience (Fontaine et al., 2007; Osgood, 1962; Osgood et al., 1975). Scholl (2013) argues that these dimensions reflect basic questions about coordination, social organization, and the distribution of resources, which groups of all kind have had to answer over the history of humanity (and, possibly, some of humans' ancestors). Similar questions are at the core of ideologies, which are belief systems established to explain and justify given societal arrangements. To our knowledge, no studies so far have attempted to integrate dimensional models of ideology with the evaluation-potency-activity dimensionality of emotion, but we would not be surprised to find such links, given our view that emotions provide basic constraints on the conceptual structure of belief systems.

Our discussion here leaves some important questions under-examined. We have only mentioned in passing the need to integrate the ideological data-interpretation methods from disciplines like intellectual history and discourse analysis into a complex-systems approach to ideology. Establishing a fully fleshed-out account of how to rigorously translate interviews, surveys, texts, or other primary sources of ideological data into CAMs is therefore a task for future work. We have also not provided any comprehensive list of individual and social mechanisms of ideological change. Nor have we developed richer models of social communication and learning, incorporating an awareness of factors like personal relationships, epistemic authorities, or media-technology in enhancing ideological dissemination (Hardwig, 1985; Liebes, Katz, & Ribak, 1991; Rydgren, 2009; Simonds 1989). These all remain tasks for the future.

Our embedded-networks approach also has principled methodological limitations. At the level of individual belief systems, the simple connectionist approach that underlies the CAM methodology is not suitable for accommodating richer nested forms of representations, propositional reasoning, and intentional decision-making, which certainly play a role in understanding ideology. For example, our way of representing individuals' identities and the groups to which individuals belong, as simple concepts of equal status as all other concepts in a one-layered network is certainly a simplification. It would be much more accurate to model concepts as hierarchical data structures that allow for multiple bindings such as "I as part of the group, which holds certain values". Recent advances in cognitive science such as the development of Eliasmith's (2013) semantic pointer architecture of cognition might help us move beyond those limitations in the future. Semantic pointers are distributed patterns of activity in neural networks that have symbol-like properties through their capacity to build nested and combined representations of representations. While compatible with the present connectionist approach, the semantic pointer architecture allows us to model richer phenomena like the interference of deliberate, intentional processes with the more passive, automatic processes described by simple associative neural networks (Schröder, Stewart, & Thagard, in press; Schröder & Thagard, 2013a, 2013b). Applied to ideological change, this would allow us to model deliberate attempts to resolve some recognized inconsistencies in a person's own or other belief systems.

At the level of social structure, our approach does not account for the important role of societal institutions in the creation, maintenance, and transformation of belief systems. The formation of groups with similar belief systems as in [Figure 1](#) does not happen in a void, but is highly structured by institutions like the education system, the media, the law, or the electoral system. For example, scholars have repeatedly attributed the pervasiveness of the left-right dimension of political ideology on the properties of the U.S. political institutions (e.g., [Braithwaite, 1998](#); [Poole & Rosenthal, 2007](#)). Our present model does not yet account for such factors.

Although some of these significant limitations will be addressable in future work, we stress that the CAM method and broader complex-systems approach is not appropriate for every form of ideological research. Perhaps most emphatically, it is not primarily orientated around the in-depth analysis of the content of individual beliefs or concepts, and is not intended to rival the most sophisticated approaches of intellectual history and political theory in this regard. Nor is it the most efficient method for establishing the correlates of surveyed political attitudes, or for revealing or critiquing mechanisms of discursive dissimulation and language-power. We do believe a complex-systems approach has contributions to make to all of these endeavors, since it is not silent on them, but they are not its primary aims. It is impossible to unify all the different approaches to the study of ideology under one paradigm. But almost all these approaches are in some sense concerned with analyzing ideological change and its relationship to broader social change. We are optimistic that a complex systems account that does justice to at least several major perspectives has great potential to enhance our capacity to conceptualize and analyze such change. In doing so, it should give new momentum to a field that was once at the center of attention in the social sciences.

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Competing Interests

The authors have declared that no competing interests exist.

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