

MAPPING MINDS ACROSS CULTURES

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1. INTRODUCTION

Anthropology is the study of the physical, social, and cultural development of humans. It has been considered part of cognitive science since that enterprise was organized in the 1970s (Gardner, 1985; D'Andrade, 1995), but anthropology is also classed as a social science because of its concern with groups and cultural interactions. Ironically, cognitive anthropology has waned as a practice within the community of anthropologists under the influence of postmodernism, at the same time as there has been an explosion of research by cognitive and social psychologists concerned with culture (e.g. Kitayama and Cohen, 2007). These divergences make anthropology an excellent field in which to examine the relevance of cognition in individuals to the operation of societies.

In contemporary social science, the two most prominent accounts of the relation between the social and the psychological are: methodological individualism, the reductionist view that everything social is caused by the actions of individual people; and postmodernism, the holistic view that reality is a matter of social construction. Methodological individualism remains dominant in economics and political science where social events are viewed as arising from individual actions determined by rational self-interest, as in game theory. In contrast, many writers in anthropology, sociology, and history have adopted the postmodernist view that the individual can be largely

ignored in favor of attention to social processes such as discourse and power. Neither of these approaches is adequate to explain complex social phenomena such as culture.

Cultural psychologists have adopted a richer view of the dynamic interdependence of self systems and social systems, arguing that the psychological and the cultural make each other up in a process of mutual constitution that requires them to be analyzed and understood together (Markus and Hamedani, 2007, p. 3). From the perspective of the natural sciences, the idea of mutual constitution is highly puzzling, because constitution in physical systems is a unidirectional, asymmetric part-whole relation. Particles such as protons make up atoms, which make up molecules, which make up cells, which make up tissues, which make up organs, which make up organisms, which make up species. Analogously, in accord with methodological individualism, it would seem that people make up social groups, not vice versa. Can sense be made of the idea that social groups constitute people?

Here is the key insight: the actions of groups result from the actions of individuals who think of themselves as members of groups. What makes a group a group is not the sort of physical bonding that makes a group of cells into an organ. Rather social bonds are largely psychological arising from the fact that the individuals in the group have mental representations such as concepts that mark them as members of the group. The bonding process is not purely psychological, however, as it can also include various kinds of physical interactions that are social and/or linguistic, such as participating in rituals and legal contracts or even just making eye contact. These interactions tie people together into groups just when they result in mental representations (affective as well as cognitive) through which individuals come to envision themselves as

part of the group. Without such envisioning the group cannot continue to function collectively. For example, by going together to church, school, and work bees, church members reinforce the beliefs and attitudes that mark them as members in contrast to other groups. To take a simpler example, a marriage is not simply a legal arrangement, but rather a social group that depends on the development and maintenance of emotional bonds through ongoing emotional interactions (Gottman et al., 2003).

This account does not, however, reduce the social to the psychological, because the psychology of individuals cannot be understood without appreciating the centrality of the social to the self. Many psychologists have observed that group membership and the difference between in-groups and out-groups is an important part of self-identity (Tajfel, 1974; Brewer and Yuki, 2007). What individuals do is greatly affected by how they think of themselves as the result of ongoing interactions with various groups. Individuals are social in that a person's thinking and behavior depends substantially on representation of and interaction with other people. It is an exaggeration to conclude from such interactions that the social constitutes the individual in the way that individuals constitute groups: for a rigorous analysis of constitution, see Findlay and Thagard (forthcoming-b). Nevertheless, the mutual relevance of the social and the psychological shows the need for an alternative to both simplistic individualism and obfuscatory holism.

This chapter proposes such an alternative: the method of multilevel interacting mechanisms, or *MIM*. Historical and cultural explanations need not be restricted to psychological and social levels, but can also benefit from incorporating neural and molecular mechanisms. The value of considering multilevel mechanisms can be shown

by considering explanations of the surprising and disturbing frequency of suicide in aboriginal communities in Canada and elsewhere. This chapter shows how explanation of suicide in aboriginal communities can fruitfully operate on multiple levels with factors including social forces, cognitive-affective structures, and underlying neural and molecular operations.

New tools are required to analyze the mental structures that underlie social interactions, and this chapter applies a new technique called *cognitive-affective mapping* (Thagard, 2010-b; Findlay and Thagard, forthcoming-a). A cognitive-affective map is a diagram that displays not only the conceptual structure of people's views but also their emotional nature, showing the positive and negative values attached to concepts and goals. This technique is based on HOTCO, a model of how people make decisions and other inferences through emotional coherence (Thagard, 2006). Hence cognitive-affective maps can be used not only to describe cultural thought but also to explain resulting actions by members of cultural groups.

From the MIM perspective, dealing with social problems such as aboriginal suicide requires changes at multiple levels. Some of the changes needed are conceptual, for example the replacement of historically inaccurate and pejorative terms like "Indian" by more historically accurate and reputable ones such as "aboriginal", "native American", and "First Nations". Hacking (1999) described the *looping effect of human kinds*, in which adding new ways of categorizing social groups can contribute to changes in the ways in which those groups interact. This chapter introduces the idea of *revalencing*, which means changing the emotional values of the concepts used to guide

social interactions. Hacking's looping effect and revalencing can be understood as the result of multilevel interacting mechanisms, ranging from the social to the molecular.

Another tool helpful for understanding the relation between the individual and social is computational modeling of group interactions. Agent-based modeling has become a standard technique in social science and artificial intelligence (Sun, 2006, 2008), explaining the operations of groups in terms of the computationally intelligent behavior of individuals. This chapter presents a new model, HOTCO 4, that extends agent-based modeling to consider a higher level of group dynamics.

This chapter concludes by addressing core methodological issues about culture, meaning, and the relation between the cognitive and social sciences. It rejects the postmodernist view that the study of humanity is a hermeneutic enterprise eschewing the concepts and methods of sciences such as psychology. But it also rejects the reductionist view that the social sciences can be grounded in the cognitive sciences by simply deriving social phenomena from cognitive phenomena. The method of multilevel interacting mechanisms is neither reductionist nor antireductionist, but instead aims to show how explanations of social phenomena (such as aboriginal suicide) and historical events (such as the Mennonite migration) can profitably draw on new ways of understanding human behavior.

2. MULTILEVEL INTERACTING MECHANISMS

Individual-social interactions can be clarified by adopting the method of multilevel interacting mechanisms (MIM) that has been advocated for the study of creativity (Thagard and Stewart, forthcoming) and the self (Thagard and Wood,

forthcoming). Adapting ideas developed by philosophers of science such as Bunge (2003) and Bechtel (2008), we can define a system as a quadruple, <Environment, Parts, Interconnections, and Changes>, EPIC for short. Here the parts are the objects (entities) that compose the system, and the environment is the collection of items that act on the parts. The interconnections are the relations among the parts, especially the bonds that tie them together, and the changes are the processes that make the system behave as it does. The MIM method is a specification of a general approach to cognitive and social explanations that attempts to incorporate and develop previous insights about the architecture of complexity (Simon, 1962), the epidemiology of representations (Sperber, 1996), explanatory pluralism (McCauley and Bechtel, 2001), systems thinking (Bunge, 2003), cognitive social science (Turner, 2001) and multilevel cognitive modeling (Sun, Coward, and Zenzen, 2005).

Thagard and Wood (forthcoming) argue that the self can best be understood as a multilevel system, operating at social, individual, neural, and molecular levels, which are the levels that can be used to explain emotions, consciousness, and other important aspects of thinking (Thagard 2006, 2010a). At the social level, the set of parts consists of individual persons. The social parts are influenced by an environment that includes all the objects that people causally interact with, including natural objects, artifacts, and social organization. The interconnections at the social level consist of the myriad relations among people, ranging from mundane perceptual ones such as one person being able to recognize another, to deeper bonds such as being in love, to larger group relations such as belonging to the same sports team. The changes at the social level consist of the

many kinds of human interaction, ranging from talking to playing games to sexual intercourse.

At the individual level, the self consists of particular behaviors and the many mental representations such as concepts and rule-like beliefs that people apply to identify themselves and others. Behaviors are properties of individuals, and mental representations can be considered as parts of them if one replaces a commonsense, dualist view of the mind with a scientific one that takes minds to be information-processing brains (Thagard, 2010a).

For the neural subsystem, the most important parts of the brain are neurons, which are cells that also exist in related parts of the nervous system such as the spine. The interconnections of the neural system are largely determined by the excitatory and inhibitory synaptic connections between neurons, although glial cells in the brain and hormonal processes are also relevant (Thagard, 2006, ch. 7). The environment of the neural system is better described at a smaller scale than the level of whole objects appropriate for the psychological and social levels. For example, photons of light stimulate retinal cells and initiate visual processing in the brain, and sound waves affect the structure of the ear and initiate auditory processing. Thus the environment of the neural system consists of physiological inputs that influence neural firing. Finally, the changes in the neural subsystem include alterations in firing patterns resulting from excitatory and inhibitory inputs from other neurons, as well as alterations in the synaptic connections.

Moving down to the fourth level, molecular mechanisms are highly relevant to understanding neural and psychological aspects of the self. Neurons are cells consisting

of organelles such as nuclei and mitochondria, and the firing activity of neurons is determined by their chemical inputs and internal chemical reactions. Aspects of the self such as personality are influenced by biochemical factors including genes, neurotransmitters, and epigenetic factors that modify the expression of genes. Genetic effects on behavior are shown by studies that find higher correlations between some features in identical twins than in non-identical ones, for example in tendencies toward mental illnesses such as schizophrenia. Humans have variation in genes that determine the receptors for more than fifty different neurotransmitters that affect neuronal firing. In sum, a self is a system consisting of subsystems at four levels – social, psychological, neural, and molecular – each of which includes environment, parts, interconnections, and changes.

The resulting view of the self treats it neither as reducible from psychological and biological processes nor as a mere social construction. Figure 1 presents the self as a complex system of multiple interacting mechanisms. Note that causality runs both up from biological processes and down from social processes.

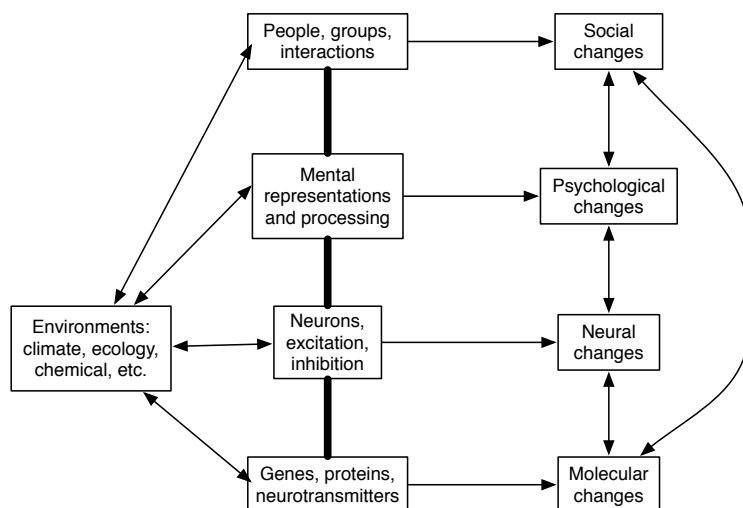


Figure 1. Diagram of the self as a multilevel system. Lines with arrows indicate causality. Thick lines indicate composition.

Figure 1 provides a schema for filling out explanations of the kinds of social phenomena described later, such as why suicide is so common among aboriginals, why the Mississaugas sold southern Ontario to the British, and why Mennonites migrated to Waterloo region. The individual, psychological level that is captured in part by cognitive-affective maps described in section 3 is an important part of the story, but full-blown cultural explanations should also pay attention to social, neural, molecular and environmental, factors. Like people in general, social scientists have a preference for single-factor explanations, but the complexity of the cultural world demands viewing it as a complex system with many interacting causal influences. Computer models such as those described in section 6 can also be a valuable tool for representing such complexity.

3. COGNITIVE-AFFECTIVE MAPPING

As a case study of the interpenetration of cognitive and social explanations, consider the history of Waterloo, Ontario. It is a prosperous city of 120,000 people with two universities, several insurance companies, and many high technology companies, including Research in Motion where the Blackberry was invented. Europeans first settled the region in the early 1800s, when a group of Mennonite farmers from Pennsylvania purchased land from British speculators who had bought the land from the Six Nations (Iroquois) tribes led by Joseph Brant. More than a thousand square miles of land along the Grand River had been given to the Six Nations by the British, whom they had supported during the American War of Independence, in compensation for loss of traditional Iroquois land in upper New York State. In order to make this gift, the British

bought the Grand River valley from the Mississaugas, a native group that had settled southern Ontario after replacing the original Iroquoian people. In a deal of dubious legality, the British had also bought the land now occupied by the city of Toronto from the Mississaugas. These developments raise many fascinating historical questions, including:

1. Why did the Mississaugas sell much of southern Ontario to the British?
2. Why did the Mennonite settlers move from Pennsylvania to Waterloo region?

Answering such questions requires attention not only to cognitive processes operating in individual minds but also to social processes of the sort that have been studied by anthropologists and sociologists.

To understand the actions of people from groups as culturally different as Mennonites and Mississaugas, we need a way of grasping the structure of their concepts, beliefs, and attitudes. The technique of cognitive-affecting mapping originated as a way of understanding and facilitating conflict resolution (Findlay and Thagard, forthcoming), but also has direct relevance to fostering cross-cultural communication. Researchers in psychology, computer science, and other fields have used the technique of *cognitive maps* (also known as conceptual graphs, concept maps, and mind maps) to represent the conceptual structures that people use to represent important aspects of the world (e.g. Axelrod 1976, Novak 1998, Sowa 1999). But such maps fail to indicate the values attached to concepts and other representations such as goals, and therefore are inadequate to capture the underlying psychology of conflicts and other important social phenomena. They lack an appreciation of *affect*, which is the complex of emotions, moods, and motivations that are crucial in human thinking.

A cognitive-affective map is a visual representation of the emotional values of a group of interconnected concepts. It employs the following conventions:

1. Each concept is represented by a node (vertex). Favorable nodes are represented by green circles. Unfavorable nodes are represented by red hexagons. Neutral nodes are represented by yellow rectangles. Degree of favoring and disfavoring is represented by thickness of lines and darkness of color.
2. Each link between concepts is represented by a line. Supportive links are represented by solid lines. Conflictive links are represented by dotted lines. The strength of support of conflict is represented by thickness of lines.

Figure 2 schematizes this kind of representation. The use of green for positive and red for negative is modeled after traffic lights, following Giaccardi and Fogli (2008).

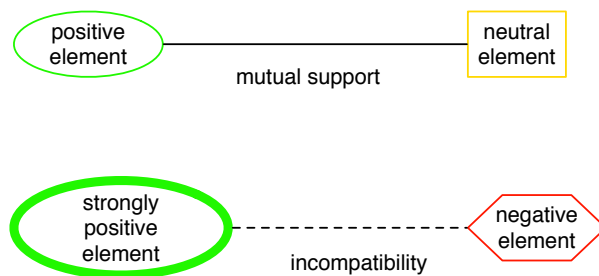


Figure 2. Schema for a cognitive-affective map. Use of color is optional depending on the medium used.

Concept maps have long been used by cognitive anthropologists to understand the concepts, schemas, and connectionist underpinning of thoughts across cultures (see e.g. D’Andrade, 1995), but the resulting models ignored the emotional character of the underlying thinking. Cultures differ not only in having different concepts and connections between them, but also in attaching different values and emotional reactions

to the concepts. Cognitive-affective maps are intended to depict conceptual and emotional mental states of individuals who are typical of members of a group.

Cultural differences can be made clear by cross-cultural examples drawn from Ontario history. No information is available to map the attitudes of the Mississaugas in the early 1800s when they signed treaties with the British that ceded large tracts of land that even then were much more valuable than the goods exchange for them (a thousand British pounds for each of the Grand River valley and the Toronto area; see Bellegarde, 2003; Gibson, 2006). But it is clear from historical investigations that the general conceptual scheme of the Mississaugas was very different from that of the British administrators with whom they were negotiating. The Mississaugas had spiritual beliefs similar to those of other speakers of the Anishinabe languages, including people variously known as Ojibway, Algonquin, and Chippewa. A cognitive-affective map can be a useful tool for displaying just how much the Anishinabe views differed from the more familiar Christian mythology of the British.

Figure 3 is a highly simplified exhibition of some of the key concepts of Anishinabe spirituality, based largely on Johnston (1995). The central concept is *Manitou*, which is a supernatural spirit or mystery. Johnston (p. xv) writes: “According to tradition, Kitchi-Manitou (the Great Mystery) created the world, plants, birds, animals, fish and the other manitous in fulfillment of a vision.” This makes Kitchi-Manitou analogous to the Christian creator, but otherwise the Anishinabe ontology is very different from the Christian one. For Christians, only humans are transcendental beings with immortal souls, but for the Anishinabe all animals, plants, and the earth itself are manitous. Like many indigenous peoples, the Anishinabe did not employ the

European concept of land as private property, so the value of land derived from its shared use rather than from ownership (Gibson, 2006; Rogers and Smith, 1994).

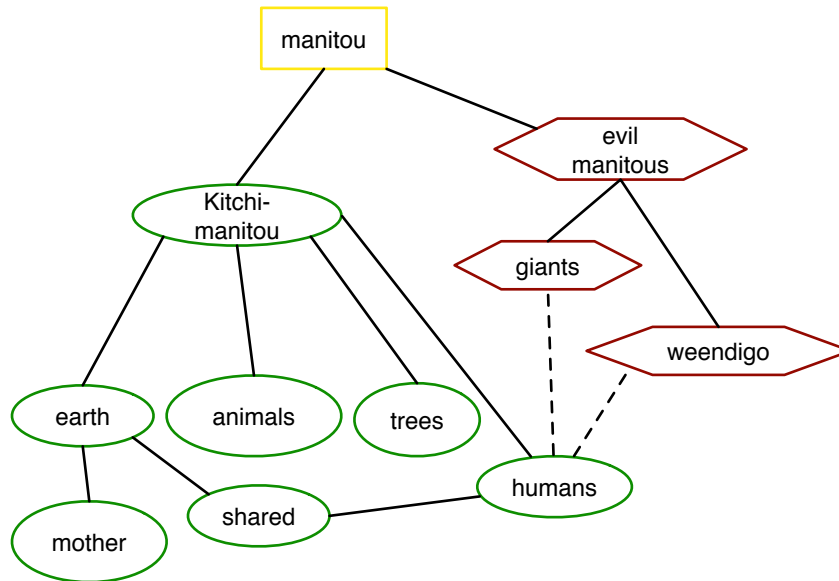


Figure 3. Cognitive-affective map of Anishinabe view of the world.

Emotionally positive concepts are in circles, negative concepts are in hexagons, and the square indicates neutrality. Solid lines between concepts indicate mutually support, whereas dotted lines indicate conflict.

Of course, figure 3 is only the beginning of an explanation of why the Mississaugas agreed to sell cheaply two valuable parts of what is now Southern Ontario. Because the Mississaugas viewed the land as shared rather than owned, they were not giving up ownership if it. Other important factors include the Mississaugas' acquired dependence on European manufactured goods such as rifles and cloth, and the fraudulent nature of some of the agreements. According to the Indian Claims Commission of Canada, the first Toronto transaction of 1787 was evidenced only by a blank deed, and the British Crown may have failed in 1805 to disclose to the Mississaugas the invalidity

of the 1787 surrender and the increased territory involved in the new purchase (Bellegarde, 2003). In January, 2010, the Canadian government offered the Mississaugas \$145 million to settle the long-standing land claims.

Hence fraud and colonial oppression figure large in explanation of why the Mississaugas sold their land, but in the background has to be a question about their understanding of land ownership. Their spiritual beliefs emphasized shared use over private ownership, and in any case the Mississaugas may have been aware that the relevant areas had previously been inhabited by Iroquian tribes such as the Hurons and Senecas. The Mississaugas had only moved into the Toronto area around 1690 (Toronto.ca, 2010).

Compare the alleged sale of Manhattan to the Dutch for \$24. According to one source:

The “sale” of Manhattan was a misunderstanding. In 1626 the director of the Dutch settlement, Peter Minuit, “purchased” Manhattan for sixty guilders worth of trade goods. At that time Indians did everything by trade, and they did not believe that land could be privately owned, any more than could water, air, or sunlight. But they did believe in giving gifts for favors done. The Lenni Lenape—one of the tribes that lived on the island now known as Manhattan—interpreted the trade goods as gifts given in appreciation for the right to share the land. We don't know exactly what the goods were or exactly how much a guilder was worth at that time. It has been commonly thought that sixty guilders equaled about twenty-four dollars. But the buying power of twenty-four dollars in 1626

is not known for sure. To Europeans, ownership of land was synonymous with wealth, power, and prestige. To purchase land meant that the purchaser had the exclusive right to own and use it. The Lenni Lenape did not realize that the Dutch meant to hold the land for their exclusive use (National Museum of the American Indian, 2007, p. 36).

Similarly, it is possible that the Mississaugas viewed the transactions with the British very differently from the British conception. Cognitive-affective maps can help to highlight the relevant cultural differences.

Figure 3 is a rough attempt to capture the attitude of the British colonials toward land and the natives, who were commonly viewed as savages. A crucial part of the cognitive-affective mapping in intergroup relations is the presence of positive in-group concepts and negative out-group concepts. We will see later that such representations are one reason why the relation between social and cognitive explanations is not reductionist. Section 6 below will discuss the revaluing of concepts involved in replacing the term “Indian” which was based on Christopher Columbus’s erroneous view that he had arrived in India. In figure 4, it might seem odd that there is a link between the concepts *Christian* and *ownership*, but recall that one of the ten commandments is “Thou shalt not steal.”

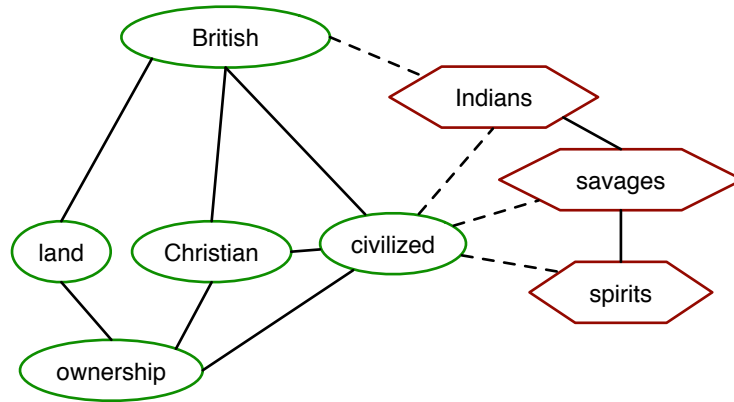


Figure 4. Cognitive-affective map of the British view of themselves and indigenous peoples.

Cognitive-affective maps can also be useful for comprehending why Mennonite settlers made the very difficult overland trek to Waterloo region from Pennsylvania in the early 1800s. According to Epp (1974), their motivations were not just the availability of fertile land, but also freedom to practice their core religious beliefs, which included avoidance of military service and oaths as well as adoption of baptism of adults rather than infants. Like the Amish, the Mennonites were Anabaptists who had been attracted to Quaker-led Pennsylvania by promises of religious freedom, but the American revolution introduced new pressures toward military service. Upper Canada under the British offered renewed possibilities of freedom, as shown in figure 5. Not shown are the positive in-group attitudes toward Mennonites and other Anabaptists in contrast with negative attitudes toward non-believers.

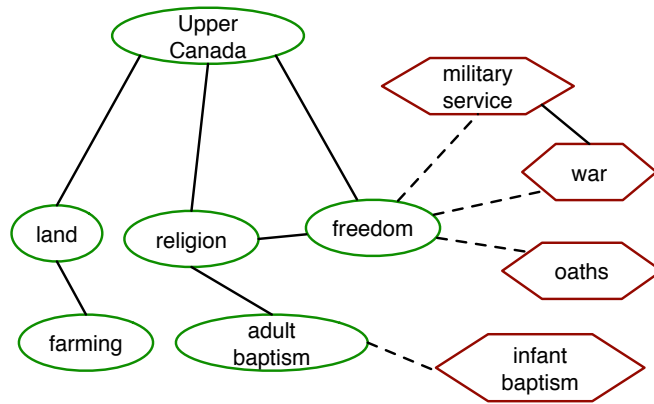


Figure 5. Cognitive-affective map of Mennonites motivated to migrate in pursuit of religious freedom.

This section has shown how cognitive-affective maps can be used to portray the concepts and values that are part of the cognitive explanation of human actions, including ones involving social groups. Such maps are not merely a diagramming technique, since their components correspond directly to a computational model of emotional cognition called HOTCO, for “hot coherence” (Thagard, 2000, 2006). HOTCO is a neural network model in which the nodes have emotional valences as well as degrees of activation. It can also be implemented in more biologically realistic fashion by distributed neural networks corresponding to brain areas recognized for emotional processing, as part of the EMOCON model of emotional consciousness (Thagard and Aubie, 2008; Thagard, 2010a).

The translation between cognitive-affective maps and HOTCO networks is easy: concepts become nodes in HOTCO networks, supportive connections become excitatory links, conflictive connections become inhibitory links, positive values become positive valences, and negative values become negative valences. A software tool, *Empathica*, is currently under development to provide an easy way to draw cognitive-affective maps

and produce HOTCO models (Thagard, 2010b). Even without that tool, production of such maps can be done using any drawing program: (Findlay and Thagard, forthcoming-a):

1. Identify the main concepts, beliefs, and goals of the person being modeled.
2. Identify these elements as emotionally positive or negative, and accordingly represent them by ovals or hexagons.
3. Identify relations between elements that are either complementary (solid lines) or conflicting (dashed lines).
4. Show the resulting cognitive-affecting map to other people to see if it captures their understandings of the person and situation, and revise if needed.

The discussion in this section may misleadingly suggest that the goal of mapping minds across of cultures is to provide an exclusively psychological explanation of social phenomena. Attention to a more recent phenomenon, the prevalence of suicide among Canadian aboriginal peoples shows the need for explanations to operate at multiple levels.

4. EXPLAINING ABORIGINAL SUICIDE

Since Durkheim's (1951) classic study, suicide has been a major topic for sociology, but it has also become a central concern for clinical psychologists (e.g. Joiner, 2010). Sadly, the historical development of native peoples in Ontario, the rest of Canada, the United States, and many other countries has been much less fortunate than the prospering of the Mennonites (Coates, 2004). In particular, the suicide rate among Canadian First Nations (aboriginals) is three times that of Canadians in general (Chandler et al., 2003). The Canadian Mental Health Association States:

Aboriginal people experience a broad range of health issues, and have the poorest health levels in the country. Aboriginal people have shorter life expectancies, experience more violent and accidental deaths, have higher infant mortality rates and suffer from more chronic health conditions.

Aboriginal people are also more likely to face inadequate nutrition, substandard housing and sanitation conditions, unemployment and poverty, and discrimination and racism, all important factors in maintaining health and wellness. ...

Many mental health problems of Aboriginals arise from a long history of colonization, residential school trauma, discrimination and oppression, and losses of land, language and livelihood. Many families were deeply affected by the government's residential school policy. Children were taken from their homes and sent to residential schools, where some experienced violence and abuse and many others lost their language and connection to their traditions, culture and community.

Rates of mental health problems, such as suicide, depression, and substance abuse, are significantly higher in many Aboriginal communities than in the general population. ...

Suicide and self-injury were the leading causes of death for Aboriginal youths. In 2000, suicide accounted for 22 percent of all deaths among Aboriginal youth (aged 10 to 19 years) and 16 percent of all deaths among Aboriginal people aged 20 to 44 years. Suicide rates of Registered Indian youths (aged 15 to 24) are eight times higher than the national rate for

females and five times higher than the national rate for males. In 2005, there were 24 completed suicides in Nishnawbe Aski Nation territory, one of the highest rates in Canada (Canadian Mental Health Association, 2010).

The causes of suicide operate at many levels, from the social to the psychological to the neural and molecular. The individual, psychological level can be captured by providing a cognitive-affective map of the kind of negative self-identity that encourages a sense of hopelessness that leads to suicide. Chandler et al. (2003) report that in British Columbia there is a striking difference between first nation groups that have maintained cultural continuity with traditional beliefs and those that have abandoned them: efforts by Aboriginal groups to preserve and promote their culture are associated with dramatic reductions in rates of youth suicide.

The difference is evocatively captured by an Ojibway writer, Richard Wagamese (2010), in an article ironically subtitled “What it means to be an Indian”. He describes the many negative terms applied by the dominant white culture to natives: savage, redman, slow, awkward, lazy, shiftless, stupid, drunken, welfare bum, and so on. He eloquently writes (2010, p. 9): “You learned that labels have weight – incredible, hard, and inescapable. You learned to drink so that you wouldn’t have to hear them.” But Wagamese then describes a transformation deriving from more positive self-identification: “But when you found your people you became Ojibway. You became Anishinabe. You became Sturgeon Clan. You became Wagamese again and in that name a recognition of being that felt like a balm on the rawness where they’d scraped the

Indian away.” When Richard Wagamese reconceptualized himself as a Anishinabe rather than a generic, downtrodden Indian, the change was behavioral and social as well as mental: he adopted different interactions such as native cultural rituals.

Figure 6 displays a small part of a conceptual structure and emotional attitude that can make suicide appealing to aboriginals. A crucial aspect of it is the contrast between the natives as an inferior (emotionally negative) group and whites as a superior (emotionally positive) group. The shift to a more positive identity such as Anishinabe removes this stark contrast by providing natives with a legitimate location in the universe.

The network shown in figure 6 is explanatory, not just descriptive, because of the underlying HOTCO model. The node for suicide gets positive activation and valence because of the inhibitory links it has with the negative nodes for natives and hopeless. In psychological terms, the despondent youths see suicide as a solution to their dismal self-identities as natives and their hopeless situations. That is why the figure includes dashed lines from the suicide node to the natives and hopeless nodes: suicide becomes desirable because it conflicts with two states that are undesirable. Note that the explanation of suicide sketched by figure 6 is psychological at the individual level and is also social, as people represent themselves both by membership in their own native group and by exclusion from the opposing group of white people. Section 5 will discuss this double aspect in terms of Hacking’s idea of the looping effect of human kinds.

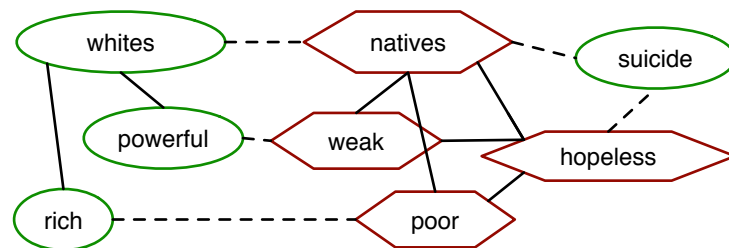


Figure 6. Cognitive-affective map of the appeal of suicide to aboriginal Canadians.

However, cognitive-affective maps only begin to provide an explanation of suicidal behavior, showing some of the social and psychological causes. They can at best capture some of the current psychological state of depressed aboriginals, neglecting the long history of oppression that contributed to feelings of hopelessness. A fuller historical explanation would need to cite other factors such as the residential schools to which generations of aboriginal students were sent for cultural indoctrination often accompanied by physical and sexual abuse. According to a leading researcher on the psychology of suicide, the desire for death usually results from a combination of two psychological states: the perception that one is a burden and the sense that one does not belong (Joiner, 2010). Aboriginals in Canada and other countries have been strongly sent the message that they do not belong, whereas the reintegration with native culture described by Wagamese can restore a sense of belonging.

The explanation of suicide need not operate only on the social and psychological levels, because there is abundant evidence of relevant mechanisms operating at the neural and molecular levels. Concepts and emotional reactions such as those shown in cognitive-affective maps can naturally be interpreted in terms of neural mechanisms (see e.g. Anderson, 2007; Smith and Kosslyn, 2007; Thagard, 2010a). There is accumulating evidence that concepts are patterns of activation in populations of neurons, and that emotional reactions can also be understood as patterns of activation in multiple brain areas combining cognitive appraisal and physiological perception (Thagard and Aubie, 2008). Hence the negative self-representation and feeling of hopelessness shown in

figure 6 can naturally be understood as a neural process operating in the brains of suicidal individuals.

According to Jamison (2000), 90% of people who commit suicide have a diagnosable psychiatric illness such as bipolar disorder (manic depression), which is known to have underlying molecular mechanisms involving neurotransmitters such as dopamine and serotonin (Goodwin and Jamison, 2007). Other molecular factors involved in suicide concern abuse of substances such as alcohol, drugs, and inhalants: sniffing of glue, gasoline, and other noxious fumes is endemic among youths in some Canadian native reserves and among other disadvantaged populations. Substance abuse has a clear molecular basis: psychopharmacology has identified how substances such as alcohol have behavioral effects through neurochemical mechanisms involving neurotransmitters such as dopamine and GABA (Meyer and Quenzer, 2005).

Also relevant to suicide on the molecular level is research showing a genetic component to suicide (e.g. Jamison, 2000; Lemonde et al. 2003; Mitchell, Mitchell, and Berk, 2000), although there does not seem to have been much genetic research relevant to aboriginals or Canadian Mennonites. But there have been very interesting findings among the Amish of Pennsylvania, who are Anabaptists like the Mennonites. In general the Amish have suicide rates much lower than the general American population. A study found that four families accounted for 73 percent of all suicides, even though they represented only 16 percent of the total Amish population (Ginns et al., 1996). Specific associations between suicide and genes for neurotransmitter receptors are under investigation.

5. THE LOOPING EFFECT OF HUMAN KINDS

Wagamese (2010) mentions negative terms such as “wagon burner” that have been applied to North American natives, whose increasingly common preference is to be known by a specific tribal name, in his case Ojibway and Anishinabe. Although the term “Indian” is still in use, for example in the Government of Canada Department of Indian Affairs, Canadian usage now largely replaces it by the general term “First Nations” along with specific tribal names like “Mississauga”. In the United States, “Indian” is being supplanted by “Native American”. These linguistic shifts are analogous to changes in terminology about other disparaged social groups, leading to adoption of terms such as “African American”, “gay”, and “mentally handicapped.”

Some commentators dismiss such linguistic changes as piling political correctness, but the shifts can be better appreciated from the perspective of cognitive-affective maps combined with what Hacking (1999) calls “the looping effect of human kinds”. Hacking differentiates between human kinds and more straightforwardly physical ones such as molecules and galaxies that are not affected by what they are called. In human societies, merely introducing a new term can lead to changes in the society that is being described. How people are characterized affects their behavior and hence changes society, so linguistic changes can have social consequences, which in turn can lead to further linguistic changes.

Such looping effects of categorization influence both cognition and emotion, because concepts serve both to describe parts of the world and also to evaluate them. If over time a concept acquires negative emotional valence, then that concept can have negative effects on behavior, including social contagion that can contribute to substance abuse and even suicide, when the negative self-evaluations of one disadvantaged person

spreads to another. Section 4 described the findings in British Columbia that native tribes who maintained cultural continuity with traditional values did not have the elevated suicide rates found in many Canadian aboriginal communities. Hence changing conceptual schemes, by replacing concepts with negative emotional valences (such as *Indian*) with more positive concepts (such as *Anishinabe*) can be part of a social change that has desirable consequences.

The novel term *revalencing* can be used to refer to the kind of conceptual change that takes place when the introduction of new concepts is accompanied by emotional change. The shift from “Indian” to “First Nations” is a kind of positive revalencing, replacing an emotionally negative concept with a positive one as part of an effort to bring about desirable social change, but there are also negative kinds. Propaganda is full of negative revalencing in which groups are increasingly stigmatized by the introduction of new terms with negative emotional baggage, such as “feminazi”, “raghead”, and “camel jockey”.

Hacking’s looping effect of human kinds can be understood as an interaction between social mechanisms such as interpersonal communication and psychological mechanisms of the sort that are reflected in cognitive-affective maps. Revalencing changes such maps by introducing new concepts, by deleting old ones, and most importantly by replacing emotionally negative values with ones that are positive or at least neutral. Given the evidence that emotion is a multilevel process that includes neural and molecular changes (Thagard, 2006), we can infer that the looping effect operates at these levels in addition to psychological and social ones.

Revalencing can be a powerful force in group-group and intercultural relations. Marriage counselors sometimes tell conflicted couples to think in terms of “us” and not just “I” and “you”. Similarly, cultural conflicts such as those between Israelis and Arabs can benefit from using “human” as a universal concept that ought to transcend ethnic and national divisions. Perhaps cognitive-affective maps will serve to reduce human conflicts not only by helping people to recognize differences in how members of diverse groups represent each other, but also by prompting efforts to revalence representations in ways that ease conflict through Hacking’s looping effect.

6. MODELING GROUPS AND INDIVIDUALS: HOTCO 4

In physics, mechanisms are usually characterized by systems of differential equations, whereas in biology they are usually represented by a combination of words and diagrams. In cognitive science, computer programs have provided an effective way of representing mechanisms and applying them to psychological phenomena. In a traditional artificial-intelligence simulation of cognitive processes, the parts (mental representations) are modeled by data structures in a programming language, and the interactions between parts are captured by algorithms that are applied to the data structures to produce changes in them. The environment is usually limited to inputs provided by the programmer, but in a robotic system physical inputs can be generated by sensors such as cameras. Neural network models are a bit different, because mental representations are usually treated as the result of interactions of much simpler neuron-like parts, whose characteristics can also be represented by data structures in a programming language. For both cognitive and neural modeling, building a computer program provides a way of specifying the nature of the mechanisms thought to underlie

thought as well as an effective way of determining whether the system behaves in accord with the psychological and neural phenomena that are to be modeled and explained.

Social models have become increasingly common in artificial intelligence and the social sciences, under such headings as agent-based modeling and distributed artificial intelligence (Sun, 2006, 2008). Current models, however, lack the ability to explain group behavior in terms of intergroup interactions that include the representation of groups by individuals. HOTCO 4 is an initial attempt to model how the behavior of groups can depend on the behavior of individuals that represent groups.

HOTCO (short for “hot coherence”) is a series of computational models of how cognition and emotion interact to produce important inferences such as decision making. The original version extended traditional connectionist constraint satisfaction techniques to model emotional constraints (Thagard, 2000). In artificial neural networks, neuron-like units typically have a property called *activation* corresponding to the firing rate of a real neuron. The activation of a unit representing a concept can then represent the degree to which the concept applies to the current input situation. HOTCO assigns to each unit an additional quantity called a *valence* which represents the emotional value – positive or negative – of the concept. For example, the concepts *baby* and *ice cream* have positive valence for most people, whereas the concepts *death* and *vomit* have negative valence. In the original HOTCO, activations affect valences but not vice versa, in accord with the normative expectation that probabilities should affect utilities but not vice versa.

Psychologically, however, it is common for people’s emotions and motivations to influence their beliefs, so HOTCO 2 was developed to model cases such as the O. J.

Simpson trial where it is plausible that valences had an impact on activations (Thagard, 2006, ch. 8). Inference, however, is not simply an individual matter, since decisions and other conclusions are often reached in social contexts. Accordingly, HOTCO 3 provided a model of emotional consensus in the form of a multiagent system in which the inferences of multiple simulated people are shaped in part by interactions with other people involving forms of emotional communication, including contagion, altruism, and empathy (Thagard, 2006, ch. 5). HOTCO 3 involves a single group of interacting individuals, but pays no attention to the interaction of groups.

The latest version, HOTCO 4, is an attempt to take groups even more seriously. It was inspired by an analysis of the Camp David negotiations of 1978, which produced a rare and dramatic breakthrough in Middle Eastern international relations – an enduring peace agreement between Israel and Egypt following a quarter century of conflict (Findlay and Thagard, forthcoming-a). The negotiations involved some interactions between individuals of the sort that HOTCO 3 models, but there were also group-group interactions at two levels. The main negotiators were Menachem Begin for Israel, Anwar Sadat for Egypt, and Jimmy Carter for the United States. Each leader, however, was assisted by a small team of high-level advisors, so the Camp David negotiations amounted to an interaction among three groups of negotiators. Just as important, the negotiators operated not only with representations of each other, but also with representations of the larger groups to which they belonged. Begin, for example, viewed himself as an Israeli and a Jew, in opposition to Egyptians, Americans, Muslims, and Christians.

The actions of the negotiators as they moved toward a groundbreaking accord cannot be understood in terms of some simple game-theoretic matrix. Findlay and Thagard (forthcoming) use cognitive-affective maps to chart the mental changes in Sadat and especially Begin that led to agreement. These maps include representations that the negotiating leaders had of each other as well as of their own and other groups. The decisions of Begin at the beginning and end of the negotiations have been simulated using HOTCO 2, but there is insufficient knowledge about the internal dynamics of the Israeli, Egyptian, and American delegations to indicate how to produce a HOTCO 4 simulation of group-group interactions.

Hence HOTCO 4 has been applied to a much simpler kind of group-group interactions involving two couples who need to make a joint decision about where to go to dinner. It is not uncommon for established couples to think of themselves *as* a couple, and also to think of other established couples as more than just a pair of individuals. Hence a joint decision involving two couples can involve all of the following for each individual:

- representation of self, which social psychologists call the self-concept;
- representation of the other individuals, including both the individual's partner and the members of the other couple;
- representation of the couple to which the individual belongs;
- representation of the other couple;
- representation of the potential actions to be performed;
- representation of the goals to be accomplished, which can altruistically include not just individual goals but also the goals of each couple.

All of these representations include not only a cognitive judgment about how well they apply to what is represented (corresponding to the activation of a HOTCO unit) and also an emotional evaluation (corresponding to the valence of a HOTCO unit). Clearly these kind of representations make the bonds between human individuals more complex than the instinctual ones found in animal groups such as wolf packs.

To be more concrete, consider two couples, Alice & Bob and Cathy & Doug, deliberating about whether to go together to a Chinese restaurant or a steakhouse. The simplest kind of decision process would be to vote and go with the majority preference, but a more collegial process would involve discussion and interactions in which each individual takes into account the goals of other individuals and also the groups. The group structure is crucial because the style of interaction within the couple is likely to be different from that between couples: the groups really do matter. For example, Alice may communicate differently with Bob than she does with people with whom she is not partnered, and she may deal with Cathy and Doug in a way that reflects in part her conception of them as a couple.

Here is how HOTCO 4 operates, building on the emotional consensus process of HOTCO 3. Each of the four individuals in the two couples reaches a preliminary judgment about what he or she prefers to do – Chinese or steakhouse. This judgment reflects not only the person's own valences for particular outcomes but also those of the other individuals and groups. If no consensus exists, then further deliberation takes place involving both cognitive and emotional communication. Cognitive communication includes introducing new information about the extent to which actions actually do facilitate goals; this process is analogous to the change in information that takes place in

the CCC model of scientific consensus (Thagard, 2000, ch. 7). Just as important, emotional communication takes place through mechanisms such as contagion, where one person picks up on the emotional reactions of another through physiological processes of mimicry and neural mirroring. Other mechanisms of emotional communication include altruism, where one person adopts the valences of another who is cared about, and means-ends information, where one person points out to another how actions accomplish goals. HOTCO 4 and the example describe here have been implemented in the programming language LISP. Not yet implemented in HOTCO is empathy, a kind of analogical thinking that provides a means by which one person can see what it's like to be in another's shoes.

What makes the groups really matter in HOTCO 4 is when the individuals change their preferences based on what they see as the preferences of their own and other groups. For example, Alice will be reinforced in her inclination to eat at a Chinese restaurant if she notices a consensus with her partner Bob, because they are part of the same group. Whether there is a similar impact on her views deriving from a perceived consensus in the other couple will depend on her cognitive-affective representation of the other couple, for example whether they are valued as a fine couple and good company. In this way, the decision of the general group consisting of the two couples depends on group decisions with couples as well as a whole network of mutual representations.

A key question here is: what makes individuals into a group? As section 1 argued, the key bonds for social groups such as couples are representational and emotional: Bob and Carol form a couple because they think of each other and the group they form with positive emotions. If the emotions are negative, then the bond is much

weaker and prone to dissolution, even in the face of legal bonds such as marriage that may also exist. Similarly, a nation or ethnic group is constituted partly by historical background but more importantly by emotional representations, for example Alice's being happy to be in couple with Bob, and Begin's being proud to be a Jew and an Israeli.

Obviously, the interactions of two couples in the current HOTCO 4 simulation are much simpler than the interactions of whole cultures discussed earlier in this chapter. But they serve to work out in greater detail the kinds of social-cognitive-affective mechanisms that are required for broader cultural developments. For the couples as for cultural groups such as the Mississaugas and Mennonites, there need to be cognitive and affective representations of both in-groups and out-groups. HOTCO 4 provides a start at seeing how the actions of groups (in this case couples) can result from the actions of individuals who represent themselves as members of groups. Changes in such representations can have important effects on the behaviors of individuals and groups.

7. GENERAL DISCUSSION

As section 1 mentioned, much work in current social science is dominated by two inadequate methodological approaches: the methodological individualism that prevails in much of economics and political science in the form of rational choice theory; and the postmodernism that prevails in much of anthropology, sociology, and history in the form of vague discussions of discourse and power relations. The cognitive sciences, especially psychology and neuroscience, can provide a powerful third alternative, but not simply by reductively explaining the social in terms of the psychological. Rather, the method of multilevel interacting mechanisms shows how to integrate the social and the

cognitive sciences non-reductively, displaying both psychological effects on social processes, and social effects on psychological processes. Cognitive-affective maps are a useful technique for depicting some of the conceptual and emotional structures that are relevant to both psychological and social explanations of culture.

Like meaning in general, culture is not *just* in the head, but it would be wrong to say that culture just *is not* in the head at all. Meaning and culture are multidimensional processes involving interactions among minds, the physical world, and social relations. This *tri-relational* view of meaning and culture is shown in figure 7, which depicts the interactions of systems rather than reduction of one system to another. Mental representations such as concepts can be understood as patterns of firing in populations of neurons (2010a). Neural populations interact with the physical world both by perceptual processes such as vision that carry information to the world into the brain, but also by physical actions that originate with brain activity and result in changes in the world, for example when a person moves objects around. For meaning and culture, an especially important aspect of the physical world is the social interaction among people who use language and other forms of communication to exchange information (Strauss and Quinn, 1997).

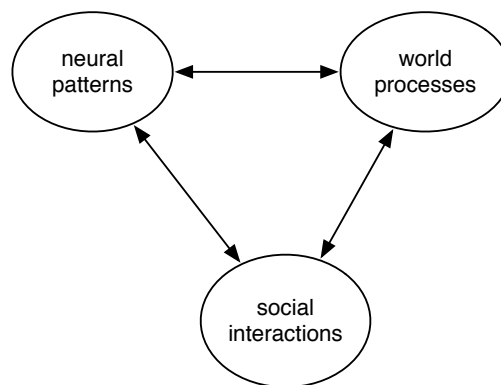


Figure 7. Meaning and culture as tri-relational interactions among minds

(brains), the world, and other people.

Many philosophers misleadingly think of meaning as a kind of *content* (thing, possession) that representations have. Rather, we should construe the meaning of a concept such as *hat* as a complex relational process involving the neural populations that encode the concept, events in the world such as seeing hats and putting them on, and social interactions of people talking about and using hats. Similarly, cultural practices such as wearing different kinds of hats on different occasions (for example cowboy hats at rodeos) require a combination of neural activity, perception/manipulation of the world, and communication with other people involved in the occasion. The shift from thinking of meaning as a thing-like content to a relational process is analogous to similar conceptual changes that have taken place in physics, such as the shift from viewing the mass of an object as a simple quantity to viewing it as a relation with other objects in accord with the law of gravitation.

Further development of a tri-relational theory of meaning will contribute to an integrated understanding of psychological and social processes. This chapter has displayed the relevance of the cognitive sciences to the social sciences using several innovations: the method of multilevel interacting mechanisms, the technique of cognitive-affective mapping, the psychological interpretation of the looping effect of human kinds, and the HOTCO 4 computational model of group-group relations. These techniques have been applied to a range of interesting social phenomena, including the British acquisition of land from the Mississaugas, the Mennonite migration from Pennsylvania to Ontario, and the disturbing rates of aboriginal suicide. There are other

promising and complementary approaches to integrating social and psychological phenomena, for example in neuroeconomics and sociolinguistics. Hence the prospects are excellent for building cognitive social science.

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REFERENCES

- Anderson, J. R. (2007). *How can the mind occur in the physical universe?* Oxford: Oxford University Press.
- Axelrod, R. (Ed.). (1976). *Structure of decision: The cognitive maps of political elites.* Princeton, NH: Princeton University Press.
- Bechtel, W. (2008). *Mental mechanisms: Philosophical perspectives on cognitive neuroscience.* New York: Routledge.
- Bellegarde, D. J. (2003). *Mississaugas of the New Credit First Nation inquiry.* Ottawa: Government of Canada Indian Claims Commission.
- Brewer, M., & Yuki, M. (2007). Culture and social identity. In S. Kitayama & D. Cohen (Eds.), *Handbook of cultural psychology* (pp. 307-322). New York: Guilford.
- Bunge, M. (2003). *Emergence and convergence: Qualitative novelty and the unity of knowledge.* Toronto: University of Toronto Press.
- Canadian Mental Health Association (2010). Aboriginal people/First nations. Retrieved Dec. 6, 2010, from http://www.ontario.cmha.ca/about_mental_health.asp?cID=23053
- Chandler, M. J., Lalonde, C., Sokol, B., & Hallett, D. (2003). Personal persistence, identity development, and suicide: A study of native and non-native North American adolescents. *Monographs of the Society for Research in Child Development*, 68(2), 1-138.
- Coates, K. S. (2004). *A global history of indigenous peoples: Struggle and survival.* Houndmills: Palgrave Macmillan.
- D'Andrade, R. (1995). *The development of cognitive anthropology.* Cambridge: Cambridge University Press.
- Durkheim, E. (1951). *Suicide* (J. A. Spaulding & G. Simpson, Trans.). New York: Free Press.
- Epp, F. H. (1974). *Mennonites in Canada, 1786-1920.* Toronto: Macmillan.
- Findlay, S. D., & Thagard, P. (forthcoming-a). Emotional change in international negotiation: Analyzing the Camp David accords using cognitive-affective maps. *Group Decision and Negotiation (conditional on final revision).*

- Findlay, S. D., & Thagard, P. (forthcoming-b). How parts make up wholes: The dynamics of composition and emergence.
- Gardner, H. (1985). *The mind's new science*. New York: Basic Books.
- Giaccardi, E., & Fogli, D. (2008). Affective geographies: Toward a richer cartographic semantics for the geospatial Web AVI'08 (pp. 173-180). Napoli.
- Gibson, M. M. (2006). *In the footsteps of the Mississaugas*. Mississauga, ON: Mississauga Heritage Foundation.
- Ginns, E. I. e. a. F. (1996). A genome-wide search for chromosomal loci linked to bipolar affective disorder in the Old Order Amish. *Nature Genetics*, 12, 431-435.
- Goodwin, F. K., & Jamison, K. R. (2007). *Manic-depressive illness: Bipolar disorders and recurrent depression* (2nd ed.). Oxford: Oxford University Press.
- Gottman, J. M., Tyson, R., Swanson, K. R., Swanson, C. C., & Murray, J. D. (2003). *The mathematics of marriage: Dynamic nonlinear models*. Cambridge, MA: MIT Press.
- Hacking, I. (1999). *The social construction of what?* Cambridge, MA: Harvard University Press.
- Jamison, K. R. (2000). *Night falls fast: Understanding suicide*. New York: Vintage Books.
- Johnston, B. (1995). *The manitous: The spiritual world of the Ojibway*. New York: HarperCollins.
- Joiner, T. (2010). *Myths about suicide*. Cambridge, MA: Harvard University Press.
- Kitayama, S., & Cohen, D. (Eds.). (2007). *Handbook of cultural psychology*. New York: Guilford Press.
- Lemondé, S., Turecki, G., Bakish, D., Du, L., Hrdina, P. D., Bown, C. D., et al. (2003). Impaired repression at a 5-hydroxytryptamine 1A receptor gene polymorphism associated with major depression and suicide. *Journal of Neuroscience*, 23(25), 8788-8799.
- Markus, H. R., & Hamedani, M. G. (2007). Sociocultural psychology: The dynamic interdependence among self systems and social systems. In S. Kitayama & D. Cohen (Eds.), *Handbook of cultural psychology* (pp. 3-39). New York: Guilford.
- McCauley, R. N., & Bechtel, W. (2001). Explanatory pluralism and the heuristic identity theory. *Theory & Psychology*, 11, 736-760.
- Meyer, J. S., & Quenzer, L. F. (2005). *Psychopharmacology: Drugs, the brain, and behavior*. Sunderland, MA: Sinauer Associates.
- Mitchell, B., Mitchell, D., & Berk, M. (2000). The role of genetics in suicide and the link with major depression and alcoholism. *International Journal of Psychiatry in Clinical Practice*, 4, 275-280.
- National Museum of the American Indian (2007). *Do all Indians live in tipis?: Questions and answers from the national museum of the American Indian*. New York: Harper.
- Novak, J. D. (1998). *Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Rogers, E. S., & Smith, D. B. (Eds.). (1994). *Aboriginal Ontario: Historical perspectives on the first nations*. Toronto: Dundurn Press.

- Simon, H. (1962). The architecture of complexity. *Proceedings of the American Philosophical Society*, 106, 467-482.
- Smith, E. E., & Kosslyn, S. M. (2007). *Cognitive psychology: Mind and brain*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Sowa, J. F. (1999). *Knowledge representation: Logical, philosophical, and computational foundations*. Pacific Grove, CA: Brooks Cole.
- Sperber, D. (1996). *Explaining culture: A naturalistic approach*. Oxford: Blackwell.
- Strauss, C., & Quinn, N. (1997). *A cognitive theory of cultural meaning*. Cambridge: Cambridge University Press.
- Sun, R. (2008). Cognitive social stimulation. In R. Sun (Ed.), *Cambridge handbook of computational psychology* (pp. 530-548). Cambridge: Cambridge University Press.
- Sun, R. (Ed.). (2006). *Cognition and multi-agent interaction: From cognitive modeling to social simulation*. Cambridge: Cambridge University Press.
- Sun, R., Coward, L. A., & Zenzen, M. J. (2005). On levels of cognitive modeling. *Philosophical Psychology*, 18, 613-637.
- Tajfel, H. (1974). Social identity and intergroup behavior. *Social science information*, 13, 65-93.
- Thagard, P. (2000). *Coherence in thought and action*. Cambridge, MA: MIT Press.
- Thagard, P. (2006). *Hot thought: Mechanisms and applications of emotional cognition*. Cambridge, MA: MIT Press.
- Thagard, P. (2010a). *The brain and the meaning of life*. Princeton, NJ: Princeton University Press.
- Thagard, P. (2010b). EMPATHICA: A computer support system with visual representations for cognitive-affective mapping. In K. McGregor (Ed.), *Proceedings of the workshop on visual reasoning and representation* (pp. 79-81). Menlo Park, CA: AAAI Press.
- Thagard, P., & Aubie, B. (2008). Emotional consciousness: A neural model of how cognitive appraisal and somatic perception interact to produce qualitative experience. *Consciousness and Cognition*, 17, 811-834.
- Thagard, P., & Stewart, T. C. (forthcoming). The Aha! experience: Creativity through emergent binding in neural networks. *Cognitive Science*.
- Thagard, P., & Wood, J. V. (forthcoming). Who are you? The self as a system of multilevel interacting mechanisms. *unpublished manuscript - University of Waterloo*.
- Toronto.ca (2010). Toronto culture – Exploring Toronto's past – Natives and newcomers, 1600-1793 Retrieved Dec. 6, 2010, from <http://www.toronto.ca/culture/history/history-natives-newcomers.htm>
- Turner, M. (2001). *Cognitive dimensions of social science*. Oxford: Oxford University Press.
- Wagamese, R. (2010). One native life. *Canadian Dimension*, 44(Mar/Apr), 8-9.