

**The Cognitive Parsing Model:
Nuclear and Global Psychological Systems in the Transmission of Culture**

Harvey Whitehouse
Institute of Cognition and Culture, Queen's University Belfast

Author:

Harvey Whitehouse
Professor of Anthropology
Director, Institute of Cognition and Culture
2-4 Fitzwilliam Street
Queen's University Belfast
Belfast BT71NN
Northern Ireland, UK
Tel. (0044 2890 973707
Email: h.whitehouse@qub.ac.uk
Webpage: <http://www.qub.ac.uk/icc/staff/harvey-whitehouse.htm>

Word Counts:

abstracts: 331
main text: 12458
references: 1324
total: 14212

100 word abstract. The 'Cognitive Parsing Model' (CPM) is a new method of describing and explaining culture in terms of the changing configurations of psychological mechanisms that underpin behaviour. Our larger aim is to explain various *particularities* of the cultural repertoire within specified populations and historical periods, thereby extending existing research in the cognitive science of culture that has focused primarily on patterns of cross-cultural recurrence. Further, the CPM holds out the promise of being able to *predict* cultural trends, given sufficient information on prior distributed behaviour patterns.

250 word abstract. A major focus in the cognitive science of culture has been the shaping and constraining effects of intuitive cognitive mechanisms, resulting in *cross-culturally recurrent* traits. These types of mechanisms (referred to here as 'nuclear systems') evolved to deal with somewhat specialized inputs (their 'proper domains' of application) and the types of stimuli capable of meeting their input conditions (their 'actual domains' of operation) are correspondingly quite closely circumscribed. Nevertheless, humans also display an extraordinary capacity for innovation and storage of *cumulative* bodies of *culturally particular* information. These capacities depend upon 'global' psychological mechanisms characterized by exceedingly broad 'actual domains' of application. The aim of this article is to introduce the 'Cognitive Parsing Model' (CPM), a new method of describing and explaining the articulation of continuously changing configurations of nuclear and global cognitive systems in the flow of human activity, enabling us to capture the multi-level, dynamic properties of the processes involved. In the future we hope to be able to run graphic simulations of the activation of psychological systems, re-describing the flow of action according to a kaleidoscopic series of changing configurations of nuclear and global activation

patterns. This strategy seeks to establish a scientifically testable method of explaining various *particularities* of the cultural repertoire at specified times and places rather than just a few general features of culture at all times and places. Further, the CPM holds out the promise of being able to *predict* cultural trends, given sufficient information on prior distributed behaviour patterns.

Keywords: CREATIVITY, CULTURAL TRANSMISSION, EVOLUTIONARY PSYCHOLOGY, INTUITIVE SOCIOLOGY, MEMORY, RITUAL

**The Cognitive Parsing Model:
Nuclear and Global Psychological Systems in the Transmission of Culture**

The overwhelming bulk of research on ‘culture’ is not concerned with explanation in any scientifically tractable fashion.¹ Among those engaged in the study of culture who do take the challenges of explanation seriously, there is a tendency to favour one or other of two major strategies. One is to focus on the shaping and constraining effects of factors operating at the level of individual organisms, among which might be included various evolved psychological mechanisms. I will call this the ‘naturalizing’ approach. The other is to focus on the shaping and constraining effects of the human environment, which include distributed systems of information storage. I will call this the ‘historicizing’ approach. Both approaches have their strengths and weaknesses.

The naturalizing approach makes well-substantiated claims about the global recurrence of mental and behavioural traits but seems to fall short in explaining the bewildering diversity of cultural phenomena. For instance, we now have good reason to believe that (barring rare pathologies) children in all human societies acquire certain kinds of knowledge about the world according to a relatively fixed developmental schedule. This leads them to make sense of their encounters with the world in highly structured compartmentalized ways that are fundamentally the same regardless of local cultural particularities.² Nevertheless, if we are seeking to explain particularities rather than global recurrence, the naturalizing approach has rather less to offer.

The historicizing approach focuses precisely on particularities of human environments and might therefore seem to hold out the promise of explaining them. Nevertheless, in order to do so such an approach must still seek out recurrent patterns and their causes, even if at a lower level of generality, since to explain every particularity with reference to a distinct causal mechanism would descend into mere tautology. The historicist search for explanations tends to cluster around two major sub-strategies.

The first, prevalent among economists and certain types of social scientists, is to treat patterns of correlations as equivalent to explanations. Although this approach is capable of producing statistically significant predictions, it clearly has its limitations. By-passing many of the complex factors involved in the production of correlations among variables inevitably limits predictive precision.³ Among the complex factors we need to take into consideration are the ‘micro-mechanisms of cognition’ (Sperber 1985: 78-79) through which all human behaviour must be filtered.

A second and even more pervasive strategy consists of positing *intuitive* causal relationships. For instance, when historians describe the complex circumstances of leaders’ decisions in the past, they appeal (if only implicitly) to our intuitions about people’s intentions and motivations. This interpretive leap of the imagination is a commonplace feature of our responses to all social situations, whether we are writing

about people in history books or encountering them in the present. But we also know (or should know) that we are often wildly mistaken in our intuitive assumptions about what makes other people tick, even when armed with masses of information about their behaviour.⁴ As an explanatory endeavour historiography therefore runs the risk of becoming a corpus of just-so stories, however accurately the events selected may be portrayed.

A similar problem besets not only historians but also social scientists and ethnographers, who seek to establish patterns of causal relationships between *institutions* in society. Here, a commonplace temptation is to treat groups or categories or people (or the patterns of behaviour they exhibit) as *artefacts* (the error of reification) or *agents* (the error of anthropomorphism). These temptations run deeper than the use of convenient tropes. When we talk about the pound rising against the dollar or the role of the church in reinforcing moral values, we appreciate that these are figures of speech, not to be taken too literally. But in some ways we still do take them literally by thinking that stock markets, currency, churches, and moral values are the units of explanation, in much the same way that a person's behaviour may be explained in terms of desires and intentional states or that the shape of a hammer might be explained in terms of its function.

The social institutions to which we attribute causal powers might best be understood as 'intuitive' categories. They are intuitive in the sense that nobody has to make any special effort to teach us that human behaviour and its products are tokens of more general underlying templates – we form that assumption quite naturally. If somebody narrates a familiar story we understand this to be merely a fleeting instantiation of The Story, as if it has an existence that is independent of particular tellings. *Great Expectations* is 'a' book, or so we think, rather than being represented in our minds as a great number of books, and an even greater number of readings and tellings. The same assumptions underpin the way we think about rituals, governments, doctrines, laws, songs, recipes, myths, and all the other 'things' that make up a 'culture', including 'culture' itself. These are all imagined to have an existence beyond the particular instances of them that we happen to encounter in the world. Thinking about institutions in this way seems to place them in some kind of independent ontological realm.⁵ Having hived off much of the world and assigned it to this special realm, we cannot help investing its occupants with quite ordinary properties, like mental states and functions. We are even quite easily persuaded that cultures have a right to life, a commonplace idea in activities as varied as nationalist struggle and cultural tourism.

Why do we find these strange ideas so intuitive? As yet there are no entirely satisfactory answers to that question. Much research on intuitive thinking has focused not on the way we cognize social categories (what we might call 'intuitive sociology')⁶ but on the way we cognize natural kinds (intuitive biology),⁷ the behaviour of persons (intuitive psychology),⁸ objects (intuitive physics),⁹ quantity (intuitive mathematics),¹⁰ and other relatively concrete phenomena. On current evidence it seems quite possible that intuitive sociology is parasitic on these other kinds of intuitive ways of thinking. For instance, some of the ways in which we classify our fellow human beings seem to borrow the principles of intuitive biology, grouping them for instance into imaginary 'races' that have heritable essences.¹¹ One day we may hope to have a fuller understanding of the nature and causes of intuitive sociology. But if the entities this kind of reasoning postulates do not have causal efficacy then what alternative explanatory strategies are available in the study of culture?

The model proposed here seeks instead to map psychological mechanisms, that we have good reason to believe exist, onto recurrent patterns of behaviour that we are able to observe. The claim that we can observe recurrent patterns of behaviour should not be too contentious, although it is not as simple as it sounds. Recall that the intuitive way of deriving patterns in behaviour involves the mapping of observable events onto abstract templates. This means, for instance, that if I observe on numerous occasions that a particular person pours water into a kettle and places cups and saucers, a teapot, a jug of milk, and a bowl of sugar on a tray, then I am liable to say that the person often ‘makes tea’ and consider that to be the ‘thing’ that requires an explanation. The behaviour we have directly observed, however, is not ‘tea-making’ but rather various repeated acts of filling kettles, gathering crockery, etc. In trying to map psychological mechanisms, rather than the abstract templates of intuitive sociology, onto the recurrent behaviours we observe, we will discover that there are many different but theoretically salient ways of parsing observed behaviour. For instance, one set of psychological mechanisms might force us to attend to the various kinds of cleaning behaviours that are involved in the preparation of crockery and to the ways in which cups, saucers, and other artefacts are arranged on the tray. A quite different set of psychological mechanisms might help to explain the special ways in which the handling of boiling liquids differs from the handling of tepid milk. And yet another set of mechanisms might lead us to focus on the person’s preferences with regard to varieties of tea, milk, and sugar. This method of parsing behaviour would, in other words, be driven by testable theories of psychological mechanisms rather than intuitive inferences about sociocultural templates. If the process is sufficiently exhaustive in its coverage of mechanisms and procedures then it will amount to an explanation of the sociocultural template (in this case ‘tea-making’). If we succeed in this endeavour, then we should nevertheless remember that the template itself could change (nothing stays the same in the world of hot beverages) and we have not explained a phenomenon that has a unitary existence out there in the world. We have merely explained, in a fractionated way, the constituent elements of a widely recognized representation of behaviour, in other words a piece of ‘culture’.

This article attempts to lay out a general framework along these lines, glossed as the Cognitive Parsing Model (CMP). The success of the CPM will hinge, of course, on the quality of our knowledge of the psychological mechanisms underlying behaviour. The best knowledge we have of the way our minds work is the kind of knowledge that finds support from a range of bodies of scientific evidence, including (but not limited to) experimental psychology and the cognitive neurosciences.

Naturalized Cognition and Behaviour

A good example of the kind of research needed on the role of psychological mechanisms in recurrent patterns of behaviour is provided by cognitive anthropologists Pascal Boyer and Pierre Lienard (in press), who have attempted to show that certain aspects of what we intuitively categorize as ‘rituals’ can be explained with recourse to cognitive and neural mechanisms geared to the handling of potentially hazardous materials in the environment. According to the Boyer-Lienard model, normal human minds have a standard evolved system for detecting and responding to such perceived hazards. This system involves a number of complex psychological processes that appear to be anchored in specific features of brain function. Boyer and Lienard distinguish three broad processes in the hazard-precaution system. The first is what they call (following Szechtman and Woody 2004) the ‘Security Motivation System’. The goal of this system is to identify potential

hazards, which it does through the stepwise engagement of three kinds of neural mechanisms. The first is concerned with the appraisal of potential threats. Its activation in turn triggers a motivational system geared to evaluating the nature and seriousness of the threats. And where the threats are deemed sufficiently serious a third system is activated that selects an appropriate response to the potential hazard from a limited repertoire of motor and visceral programmes. Activation of these programmes (leading to precautionary procedures, such as cleaning or isolating and arranging potentially contaminated objects) should normally feedback inhibitory signals to the appraisal mechanism. Boyer and Lienard point out, however, that the Szechtman and Woody model is not sufficient, as it stands, to account for some of the characteristic features of the precautionary procedures that are selected. For instance, why those particular procedures and not others? Why are they performed in a certain order rather than some other? To answer these questions, they introduce a second major system that responds to the elevated arousal occasioned by the Security Motivation System. At the phenomenological level, the operations of this second system produce a nonspecific sense of threat and a tendency to focus on minutiae rather than on overall patterns. This latter process places heavy burdens on working memory leading to a high degree of conscious attention to the performance of rigidly circumscribed procedures.

Boyer and Lienard argue that this model reveals why humans respond to perceived threats of contamination in highly stereotyped ways (i.e. conforming to rigid procedural rules), entailing such features as redundant repetition and a sense of obligation or compulsion. They argue further that these mechanisms are activated in slightly modified fashion in socially sanctioned rituals, on the one hand, and in the pathological condition known as ‘obsessive-compulsive disorder’ (or OCD), on the other. In the case of socially sanctioned rituals, the contamination-avoidance system is only partially activated – that is, rituals that have become standardized in society serve to mimic some of the input conditions of the contamination-avoidance system without necessarily triggering the arousal occasioned by potential hazards. In the case of OCD, the contamination-avoidance system is activated in its entirety but due to the malfunctioning of certain parts of the system (which need not detain us here) anxiety levels occasioned by the potential hazard are modulated incorrectly and the system becomes trapped in a self-feedback loop that generates obsessive repetition of particular micro-procedures. Despite important differences between the behaviours found in socially sanctioned rituals and OCD patients respectively, Boyer and Lienard argue that this model helps explain many interesting similarities between the two. The link between OCD and religious rituals had been considered in considerable detail in previous research, some of it inspired by Sigmund Freud’s early speculations on the topic. The most impressive contribution to this area of research in modern times has arguably been Fiske and Haslam’s (1997) comparison between OCD symptoms and traits found in socially sanctioned rituals based on an extensive survey of the ethnographic record. What Boyer and Lienard bring to this topic, however, is a plausible account of the precise mechanisms responsible for the similarities between the behaviours of OCD sufferers and some of the actions that widely recur in cultural rituals. Moreover, they set out an elegant model of how the specific behavioural traits arising from the activation of the contamination-avoidance system would have been adaptive for our hominid ancestors.

In considering the evolutionary background to the relationship between psychological mechanisms and recurrent behavioural outputs it is helpful to distinguish between the *proper* and *actual* domains of the mechanisms involved (see

Sperber 1996). The proper domain of contamination-avoidance mechanisms would be actual hazardous materials in the ancestral environment, such as rotting meat, faeces, infected wounds, and other contaminants. These constitute threats to survival (and thus to reproductive success) that our contamination-avoidance mechanisms evolved to protect us from and, consequently, these are the kinds of inputs that will always (in all human populations at all times and places) serve to activate those dedicated mechanisms. But the same mechanisms could be set off by inputs that resemble contaminants, for instance because they are linked by association to feelings of disgust or nausea (some people feel that way about soft egg yoke or butter) or because we see other people handling them in a way that suggests that they are potentially dangerous (inasmuch as many objects used in religious settings, for instance, are treated with special care and attention they are likely to set off our contamination-avoidance mechanisms). These kinds of triggers, which may vary widely among individuals and across populations, do not actually target potential sources of contamination. Consequently they belong to the *actual* but not the *proper* domain of the mechanisms at issue.

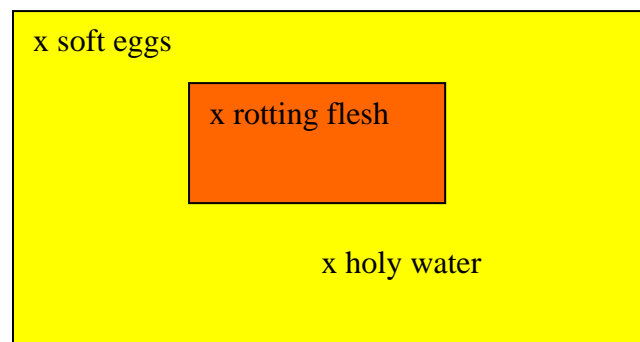


Figure 1: actual (yellow) and proper (orange) domains of the contamination-avoidance system

This kind of argument constitutes the kernal of a naturalizing approach to culture. Humans, like any other complex animals, have behavioural repertoires that are closely constrained and shaped by evolved cognitive mechanisms. But as noted at the outset, those of us who study the particularities of behaviour in real world settings soon find that the appeals of the approach are somewhat limited. Even if we take a small portion of behaviour as observed ‘on the ground’, selected deliberately because it seems to entail the mechanisms we are interested in, we immediately realize that things are more complicated than they seem. Consider the following piece of ethnography deriving from my observations of members of a Pomio Kivung religious movement in Papua New Guinea in the late 1980s, who daily laid out offerings to their ancestors in various kinds of temple (Whitehouse 1995: 67-68):

The task of preparing offerings for the ancestors is supposed to be quite distinct from the task of secular food preparation. When handling the offerings to the ancestors, the women should observe specified internal states. For example, the women should never think about eating the food as they prepare it for (although they may eventually eat their fill of it) the food at this stage belongs to the ancestors and must be prepared with a view to (in the local idiom) 'giving with the palm of the hand' (i.e. freely, generously, and unreservedly). If the cooks think of eating the food in the course of its preparation then it will come from 'the back of their hands' and the ancestors will reject it. In actual fact, it is not the material substance of the food which the ancestors consume, but the respect, goodwill, generosity, deep faith, and devotion which the living supposedly put into its preparation and presentation. It follows that any breach of Kivung morality on the part of the cooks during food preparation renders the offering useless, because such breaches imply lack of devotion and respect (insofar as they 'injure' the ancestors in the sense of causing them offence) and lack of faith (insofar as a true believer would be too afraid to sin during the food preparation). A typical sin on the part of the cooks would be for two of them to gossip about the third's laziness, such gossip being seen (in the local idiom) as the 'theft' or 'killing' of the third person's good name. By cooking for the ancestors separately the women avoid squabbles or covert bad feeling about relative labour inputs. Under no circumstances should a menstruating woman work as cook (if she comes into contact with the food it will be polluted and unacceptable to the ancestors). Sickness and menstruation may reduce the labour power of the cooking group and this usually just means that less food is prepared.

At 2.30 p.m. the village bell is struck with a stick three times by anybody who knows the time ... Of the men who come to take the food from the cook house to the Cemetery Temple when the bell is struck, not all necessarily have set duties to perform, some acting merely as assistants. The men do not communicate with one another except by mouthing, gesticulating, or whispering and they are supposed to observe the same morally sound internal states as the cooks. They enter the Cemetery Temple one by one through the front door and place the food and drink (e.g. bottles of water) on a sideboard.

The temple is internally divided into two rooms. The first room, accessible through the front door, is dedicated to lower ranking ancestors and contains two tables with benches (one for deceased men and boys and the other for deceased women, girls and babies) and a sideboard for storing food. A team of designated (all-male) helpers lays the tables in this room with plates, cutlery and decorative flowers or leaves in vases. Other tasks include the final cleaning of crockery and other equipment with tea towels and the display of elaborate concern with neatness and tidiness in the room. Checks are also made on the provision of additional comforts for the ancestors who will come to 'eat', for example a blanket and pillow in case one of them is 'cold' or 'tired'. Finally, food is dished into plates on the tables.

There can be little doubt that some of the behaviours exhibited Pomio Kivung members in laying out of offerings to the ancestors involve elements of the contamination-avoidance system described by Boyer and Lienard. The fear of menstrual pollution, the overt concern with cleanliness and neatness, emphasis on rules that have no known function (e.g. the rigid adherence to a certain division of labour by sex, the requirement that the temple be entered in single file, the observation of routines carefully marked out by the chiming of the village bell, etc.), are all plausibly connected to operations of the contamination-avoidance system. But

there are many other things going on in this ritual, that would need to be explained with reference to a variety of other kinds of psychological mechanisms. For instance, why are the men unable to speak normally inside the temple? Why do people think the ancestors will be offended if the women think about eating the food during its preparation? Even these two questions (and there are many more we could ask, as we shall soon see) suggest that we need *at least* three more psychological mechanisms to explain what is going on.

To begin with the whispering of the men inside the temple, this is clearly linked to the idea that the ancestors are invisibly present and should be treated respectfully. In this regard, their behaviour differs little (if at all) from the way visitors to a church in England might speak only in hushed tones upon entering. One of the psychological mechanisms responsible for this behaviour might be dubbed ‘agency detection’. As with contamination-avoidance systems significant work has been carried out on the neural and cognitive characteristics of agency detection, as well as its evolutionary foundations.¹² We also have a body of evidence suggesting that humans are easily primed to *overdetect* agents in their environments. Anthropologist Stewart Guthrie (1993) has shown that, regardless of cultural differences, people everywhere require little encouragement to see signs of agency in almost any kind of situation. We curse our computers when they crash, we scream in the dark when an object unexpectedly brushes against us, and we are easily seduced by advertisements that display a vast range of products (from household detergents to Michelin tyres) behaving like people. Being sensitive to the presence of possible agents would have conferred considerable benefits in the conditions in which our ancestors evolved. Clearly, any failure to pay attention to signs that a predator is present would have been far more costly than the experience of innumerable false alarms (Barrett 2000). So when my friends in Papua New Guinea lowered their voices to a whisper inside the temple, it was (partly) because their agency-detection systems were delivering powerful intuitions that there were ancestors around. We can represent this scenario in much the same way as the contamination-avoidance system, by specifying examples of behaviours that belong to its proper and actual domains of operation.

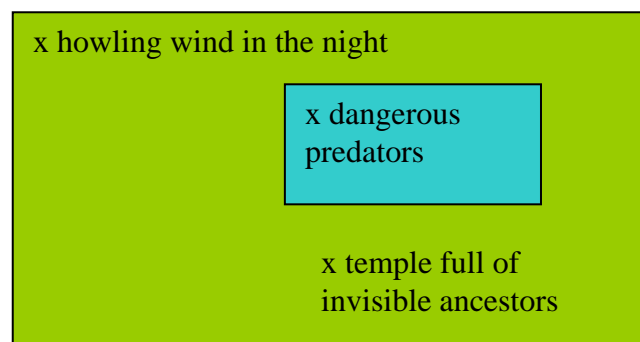


Figure 2: actual (green) and proper (blue) domains of the agency-detection system

Although we are now beginning to make a little headway in explaining what was happening in Kivung temples, we have a much longer journey ahead. What about the food preparation problem (that the women shouldn't think about eating the food themselves)? This part of the puzzle clearly requires at least one more psychological system, one that is dedicated to the development of moral intuitions.

Food that is prepared for the ancestors with thoughts of greed or hunger is considered by Kivung members to be harmful to the ancestors. Such behaviour is described as 'killing' the ancestors. In the local idiom, 'killing' refers not only to homicide but to all harm-causing behaviour. And as such its use elicits ideas of a moral nature that have universal foundations. Since Elliott Turiel's work in the 1980s, psychologists have realized that moral rules involve intuitions that are somewhat different from rules of mere convention. For a start, moral rules are fundamentally similar the world over, while conventional rules may differ very widely. One of the core features of moral rules is the intuition that causing *harm* to others is wrong. Moral violations everywhere are considered to be more serious than conventional violations. And, crucially, moral rules are felt to hold true whether or not they are upheld by a figure of authority (that is, people intuitively judge harming behaviour to be wrong even if it is condoned or not explicitly forbidden by authorities). This appears to be the case even when we are talking about divine or supernatural authority. For instance, in a study of Armish teenagers, Nucci found that all participants considered that working on Sunday would be acceptable if God had not forbidden it but agreed that hitting people would be wrong whether or not God forbade it (Nucci 1986).

From Piaget onwards many psychologists have assumed that the development of moral thinking is a consequence of empathy towards others based on being able to imagine oneself to be in their shoes. But Shaun Nichols (2004) has shown that individuals who have very limited perspective-taking capacities (i.e. children under the age of four and people with autism) nevertheless are quite competent at distinguishing moral from conventional rules. In response to this kind of evidence, Blair (1995) has argued, following Lorenz (1966) that social animals like dogs and humans have evolved mechanisms of limiting aggression between individuals of the same species. For instance, dogs stop attacking in response to submission cues. Blair argues that in humans the activation of a Violence Inhibition Mechanism (VIM) in response to distress cues in others sets off a search for meaning, resulting in a negatively valenced interpretation of an event (i.e. the moral evaluation that what is happening is wrong). He has shown in a series of ingenious studies that psychopathic criminals do not respond to distress cues (in photographs) in the same way as normals and further that they cannot distinguish between morality and convention in the way most people can. He concludes from this that they have a defective VIM. But as Nichols (2004) has shown, the VIM account has a number of drawbacks of its own. First, even though small children and people with autism have problems with perspective-taking, they are aware that people experience desires and suffer pain. We cannot therefore completely rule out the possibility that moral intuitions depend upon some rudimentary perspective-taking abilities. Second, the VIM approach cannot account for the sense that something is wrong as opposed to merely being bad. That is, even if we do feel bad when we see distress cues it doesn't follow that we judge what we see to be wrong. Seeing people have accidents or fall prey to natural disasters should activate VIM (if such a mechanism exists) but not lead us to conclude that what we've seen is morally wrong.

Nichols builds an alternative to both the Piagetian and VIM accounts, by offering a unique synthesis of both. His starting point is that in the course of development people acquire 'normative theories' consisting of sets of rules for how to behave. In order for these stipulations of convention to become moral rules, they must be emotionally valenced such that people *feel* it is wrong to break those rules. Such feelings are triggered when we witness people harming others. On this account, moral rules are rules of convention backed by affective systems. In support of this, Nichols has conducted experiments showing that affective systems concerned with themes other than causing harm produce intuitions of a moral kind that differ from those pertaining to more neutral conventional rules. For instance, he used behaviours that would be considered disgusting rather than harmful to demonstrate the point. As with harmful behaviours: 'The disgusting violations were regarded as less permissible, more serious, and less authority contingent than the neutral violations' (2004: 22). And just as Blair observed that psychopaths found it harder to distinguish harmful behaviours (moral infractions) from violations of neutral norms (infractions of conventions), so Nichols observed that people with a high tolerance for disgusting behaviour found it harder to distinguish disgusting behaviours (moral) from violations of neutral norms (conventions), in terms of our key parameters of seriousness, permissibility, and authority contingency. Thus, these parameters seem to be 'mediated by affective response' (2004: 24).

Nichols considers two possible ways in which normative rules might come to be emotionally valenced and thus moral. One possibility is that there is a developmental stage during which certain kinds of neural mechanisms start to be activated as a response to negatively valenced (e.g. harmful) actions. Once these responses become associated with particular norms, they result in stable moral attitudes (although the responses that kick-started them may pass, having been part of a transient developmental phase). A second possibility is that the emotional valence has to be present on-line in order to generate moral responses. Various kinds of moral deficits, for instance as observed in criminal psychopaths, would thus be due either to abnormal development or due to the ongoing lack of some normal mechanism throughout life. Nichols also considers the possibility that the establishment of moral rules (or their failure to become established) may involve both developmental and on-line factors.

If the Nichols model, or something like it, turns out to be correct then the moral thinking system, like all other features of intuitive cognition, has an evolutionary history that needs to be unpacked. Although that is a task to be undertaken elsewhere, we should note that an obvious adaptive value of this system is that it serves to limit intra-species violence, a point made in some detail by Blair (see above). That function might belong to its proper domain. But moral intuitions can also be activated in relation to other species, as happens among animal rights campaigners (see Milton 1993) or even in relation to imaginary beings, such as the Pomio Kivung ancestors (see Figure 3).

Rudimentary perspective-taking may, as Nichols proposes, be a necessary ingredient of moral thinking. But there are also mechanisms in normal adults that are capable of far more sophisticated forms of reflection on what other people may be thinking or feeling. Among experimental psychologists, these mechanisms are commonly referred to as 'Theory of Mind' (or ToM). Some of the most revealing studies of ToM come from developmental psychology, focusing on the emergence of mindreading capabilities in the course of childhood (Carey 1985, Gopnik and Meltzov 1997, Bloom 2000). Another important area focuses on deficits in ToM functioning

among people with autism (Baron-Cohen 1995). In addition we now have an increasingly detailed picture of the neurological mechanisms involved in ToM (Baron-Cohen, Tager-Flusberg, and Cohen 2000; Williams, Whiten, Suddendorf and Perrett 2000).

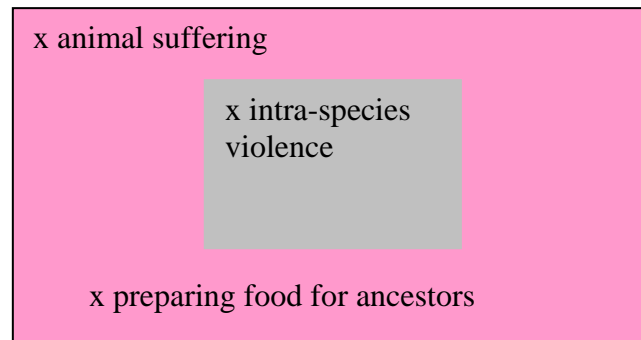


Figure 3: actual (pink) and proper (grey) domains of the intuitive morality system

Mature ToM mechanisms provide humans with the ability, indeed the nagging obligation, to generate inferences about intentional states that drive the behavior of people around them. First-order ToM mechanisms deliver intuitions about the possible intentions of other actors, and they begin to emerge early in development. By around age four to five, children realize that people's behaviors are driven by intentions that may or may not be based on accurate information and that it is therefore possible to manipulate their behavior through duplicity and deception. Second-order ToM mechanisms appear a little later, around age six or seven, allowing us to speculate not only on the intentional states of Jim and Mary but on the speculative inferences that they in turn might be making with regard to the states of mind accompanying our own behavior. Second order ToM abilities enable us to construe behavior as communicatively driven (Jim does x because he knows that Mary is likely to interpret x in a certain way). The relatively late appearance of this cognitive capacity would be consistent with the hypothesis that it is a relatively recent adaptation in evolutionary time (i.e. based on the assumption that ontogeny broadly replicates phylogeny).

In our Kivung ritual, every action that involves the agency-detection system has the potential to trigger ToM mechanisms as well. For instance, the preparation of food for the ancestors is carried out on the understanding not only that the ancestors are around (an intuition delivered by the agency detection system) but that the ancestors can 'read' ones thoughts. These mindreading capacities attributed to the ancestors mean that even if a cook is careful never actually to eat any of the food being prepared, the ancestors will know immediately if she fantasizes about doing so. The idea that ancestors know what you are thinking carries important social consequences. Normally we predict the likely behaviours of others and calculate the risks of them finding out things we don't want them to know, on the assumption that

people have an imperfect knowledge of what is going on and may not know things we do (or worse, may know things we don't). The idea that supernatural agents, a group of ancestors in this case, have access to all our thoughts introduces a whole new level of complexity to these kinds of calculations. In particular if other people think that you think that the ancestors will find out and punish your wrongdoing (even when no earthly agent has any power to find out these things) then this has implications for your reputation in the eyes of others. A cook devoutly preparing offerings for the ancestors may accrue the respect and trust of others, or risk incurring censure and punishment, in ways that a cook preparing dinner for her husband may not.

Archaeologist Steven Mithen (1996) has suggested that the evolution of ToM mechanisms may have been connected to the emergence of more finely-tuned cognitive machinery for agency-detection (discussed above). *Both* types of mechanisms had evolutionary advantages for humans as *hunters* (even though agency detection may have initially emerged as a defence against potential predators). Being able to track quarry required the ability to 'read' the intentions of game animals, based on close study of their behaviour. The ability to guess more or less accurately the intentions of other people would also have been valuable in the development of increasingly cooperative techniques of hunting. If Mithen is correct, then the proper domain of advanced ToM mechanisms would include sophisticated forms of social co-operation and the tracking of game. Attribution of special mindreading capacities to supernatural agents (such as the Kivung ancestors) would be part of the actual domain of these cognitive capacities (see Figure 4).¹³

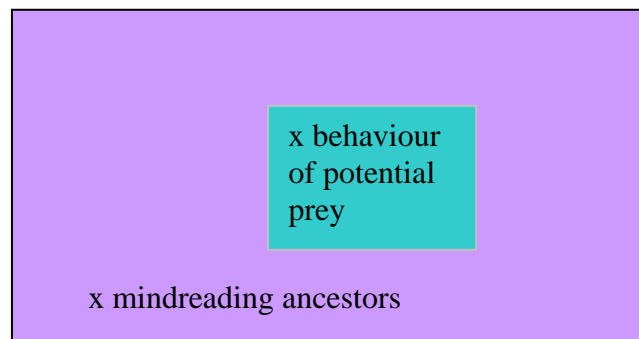


Figure 4: actual (lavender) and proper (turquoise) domains of Theory of Mind mechanisms

Now, we could in principle go on like this for some time, picking out bits of the Kivung ritual that seem to satisfy the input conditions of various postulated cognitive mechanisms and then deciding whether these behaviours belong to the proper or actual domains of those mechanisms. If we were to do that we would no doubt find that many behaviours require explanation with recourse to more than one (perhaps many) psychological mechanisms. After all, we have observed that it would

be insufficient to explain the behaviour of cooks preparing offerings to the Kivung ancestors only with reference to intuitive morality. This same behaviour also involves ToM mechanisms since the ancestors are attributed special mindreading capabilities (and will know if one of the cooks even thinks about eating the food she is preparing). And we have also noted that this part of the ritual excited mechanisms dedicated to intuitive moralizing, since an offering given from the ‘back of the hand’ would harm the ancestors. But we need not stop there. Preparing food for the temple also involves the contamination-avoidance system, since the idea of tainted offerings gives overt expression to pollution anxieties. And there are many more candidate mechanisms that could be implicated in one way or another in just this single feature of the ritual process. If we were to try to depict the situation in terms of our actual/proper domain diagrams, we would end up with a series of superimposed figures (see Figure 5). This is all to the good, of course. The more we reveal about the psychological foundations of different features of observed behaviour, the closer we might get to truly explaining it.

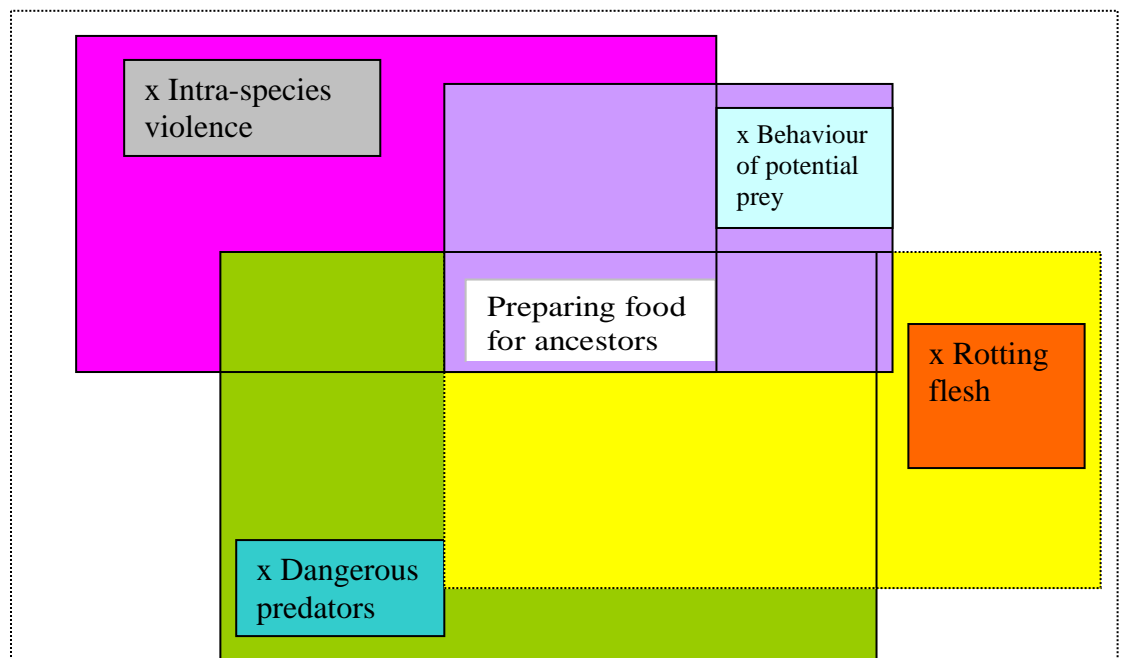


Figure 5: intersecting psychological systems

Some cognitive scientists believe that if we persist in this type of exercise for long enough we will end up with an exhaustive account of the Kivung ritual, and all other rituals that exhibit similar features. I do not share that view. Although we could certainly do a great deal more to explain our Kivung ritual (and millions of other recurrent behaviours like it, all around the world) by pursuing this strategy to its limits, we will eventually discover that there are important features of the observed behaviour that cannot be understood in that way, either because the approach is too narrow to encompass all the relevant facts (a problem of lack of comprehensiveness of the approach) or because the approach only specifies universal generic cognitive mechanisms and therefore cannot predict the variability with which mechanisms and behaviours are activated from one place to the next (a problem of lack of particularity

of the approach). Both problems have always haunted the naturalizing approach to explaining culture, as noted at the outset. But I will argue that they can also be overcome within the ambit of the original theory if we take into account human capacities for creativity and the storage of novel information.

Creativity, Memory, and Behaviour

The tendency of naturalizing approaches has been to focus exclusively on psychological mechanisms that generate the same kinds of predictable outputs (behavioural repertoires) whenever a given trigger in the environment meets their input conditions. Understanding such mechanisms takes us a long way in explaining the behaviour of most mammals, ourselves included, but the case of humans is complicated by the fact that we have an extraordinary capacity for innovation and learning and therefore for the transmission of cumulative bodies of *acquired knowledge*. Only some of our psychological mechanisms confer this advantage, but they do so in ways that have consequences for the operation of all the kinds of mechanisms discussed above.

To understand why, it is helpful to return to ethnographic case material. Our Kivung ritual does not end with the laying out of offerings. Once the tables have been carefully prepared, and various minor rites have been performed, everyone leaves the temple – except for one man, who remains inside. This man observes a vigil, listening and watching for signs that the ancestors are present (Whitehouse 1995: 70-73):

The official who keeps a vigil in the Cemetery Temple (between approximately 1.50 p.m. and 3.45 p.m.) plays the part of a kind of observer. His Pidgin title of *kuskus* (literally 'clerk' or 'bookkeeper') associates him with Western government structure, particularly the officials who keep records on what is said at meetings. I will refer to the *kuskus* as a 'witness'... After entering the temple, the witness goes to sit in a small cubicle, built in the corner of an external wall and a wall dividing the two rooms of the house. According to Kivung ideology, he remains seated until 3.45 p.m. During the period that he sits there, the witness may hear a knocking at the door indicating the arrival of the ancestors, or he may hear a faint clattering of plates, cutlery or bottles, or the creaking of a door. Such sounds are caused by the ancestors who have come to receive the offerings. Although they create noises, the ancestors are never visible. An analogy with the wind is often made, for just as the wind moves the branches of trees yet is itself invisible so the spiritual substance of the ancestors moves objects in the Cemetery Temple thereby creating noise. These noises always cease before 3.45 p.m. and their cessation may be marked by another sound of knocking on the door. When the noises have stopped, it means that the ancestors have finished 'eating' and have departed. Sometimes the witness hears nothing in the course of his vigil.

The task of the witness is to keep a mental note of any noises which occur during his vigil, representing evidence that the ancestors came to receive the offerings. All the men who act as witnesses are supposed to possess considerable courage and moral fibre since proximity to spirits, even the 'good' ancestors, is held to be dangerous to those who possess inadequate conviction and faith and who therefore have reason to fear the wrath of God and the ancestors. The nature of such danger is twofold: in the face of presumptuous behaviour on the part of the morally weak, the ancestors may

confer sickness upon them and also the fear of the morally weak can itself cause sickness.

At 3.45 p.m. the village 'bell' is struck three times once again, indicating that it is time for those villagers wishing to eat and to hear the news from the witness (this could be anybody in the community) to gather outside the front door of the Cemetery Temple. The man in charge of the boss' room is the first to arrive at the cemetery. He knocks on the door of the Cemetery Temple, announces his identity, then opens the door and enters. The witness remains seated in his cubicle while this man checks the plates containing food, first in the 'lower' room and then in the boss' room. He may find that the food has not been disturbed, or he may notice that the rim of one or more of the plates has been splashed with food or that there are other signs of disturbance (e.g. a hole in a taro tuber where a morsel of food has been removed). If such signs are discovered he will show them to the witness who, until that moment, presumably does not know of their existence. Meanwhile, a team of helpers removes the food from the house and places it on leaves and tables in the open air. Then the witness and man in charge of the boss' room emerge from the Cemetery Temple into the light to find another kind of official (an 'orator') standing there with his back to them, facing a gathering of some or all of the villagers (depending on who wanted to come). The man in charge of the boss' room goes to join the throng while the witness goes to stand a little to one side and behind the orator. The hushed chatter of those gathered sinks into silence while the witness whispers into the orator's ear, informing him either that the ancestors did not come or that he heard certain noises and the food was disturbed indicating that the ancestors did come. The orator in turn conveys this information to the gathering. If the ancestors did not come, it means that the living have committed some offence, thereby contaminating the offering and rendering it unacceptable to the ancestors. In such a case, the orator urges the people to consider how they have caused offence (it may be that all, some or just one of them is/are to blame). He tells them that a monetary collection must be performed soon to wipe the slate clean and restore moral purity in the village. He probably reiterates the impossibility of being reunited with the ancestors if evil continues to flourish among them, or he may focus on the horrors of damnation. If the ancestors have come, the orator relates the evidence to his audience and urges everyone to continue along the righteous path which they have evidently found and to strengthen themselves against corruption by Satan... After brief applause, the orator, the witness and the whole gathering repeat together the Lord's Prayer, and everybody shakes hands. The Lord's Prayer has a special significance for Kivung members insofar as it seems to focus on the themes of returning ancestors ('Thy kingdom come...'), the harmony of the group ('...as we forgive those who trespass against us'), and other central principles of Kivung doctrine.

It is clear that many of the details of what happens in these additional parts of the ritual involve the same psychological mechanisms we have already considered. For instance, the witness's agent-detection systems are highly primed for signs of ghostly presence, since observing these events is the ostensible purpose of his vigil. The evidence as to whether or not the ancestors came to 'eat' the offerings is taken as an indication of what the ancestors are thinking about the living and this requires the activation of ToM mechanisms. But there are other cognitive systems involved in all

of this, one of which may be dubbed the ‘Cross-domain Analogical Thinking system’ or ‘CAT system’.

The CAT system is one of the most powerful mental tools in the human repertoire, since it enables us to borrow knowledge from one domain of experience and to use it to solve problems in completely different domains. Classic studies of analogical thinking present subjects with a problem and its solution and test the extent to which they are capable of applying this information to other kinds of problems. For instance, Gick and Holyoak (1980, 1983) would tell people a story about a military general who realized that he needed a large number of troops to storm a fortress. Unfortunately the roads leading to the fortress were all too narrow for him to deliver his troops to the target in sufficient numbers at one time. His solution was to divide his men up across the countryside so that they could all converge on the fortress at a pre-arranged time. Later, subjects in the experiment were told about the problem of a surgeon who needed to destroy a tumor but could not cut it out without damaging the surrounding organs. He had the idea of using a laser to attack the tumor in a more precise fashion but also realized that this would damage healthy tissue at the point of entry. The rationale is that subjects should use the general and fortress story to solve the surgeon’s dilemma. They should propose that, just as the general attacked from several directions, the surgeon should direct the laser at the tumor from many different angles thus converging in a sufficiently powerful ray to destroy the growth but without causing any damage upon entry to the body. These kinds of studies have produced mixed results. Overall it is clear that people are more likely to produce spontaneous analogies to solve problems in real-world conditions than in artificial laboratory settings (Kokinov and Petrov 2001), a situation that has come to be known as the ‘analogical paradox’ (Dunbar 2001).

One possible explanation for this paradox may be summed up by the old adage that necessity is the mother of invention. Real generals and real surgeons have to find ways out of the problems they encounter whereas participants in a psychological study generally lack the motivation to draw analogies between inconsequential stories. In the real world, analogical thinking delivers solutions to problems thick and fast. When seeking to persuade others to their way of thinking people routinely produce a rich variety of analogies, usually with strong emotional overtones (Thagard and Shelley 2001). It is a commonplace stereotype that politicians mix their metaphors but this may be because politicians’ analogies are so prolific that they are hard for their producers to track in working memory.

During my field research on the Pomio Kivung, I found that the discourse of religious adherents was replete with analogies (*tok piksa* or ‘talk picture’ in Pidgin). Consider, for instance, the role of witness, which as noted in my original ethnography was construed as analogous to the role of bookkeeper in government meetings. This analogy had immense significance for Kivung followers, because they believed that the ancestors formed a ghostly assembly, itself modelled on earthly governments. According to my informants, this other-worldly government would soon return to ‘this world’ establishing a new system of administration and a powerful industrial base in the heart of their rainforest environment. People had detailed ideas about why and how this would happen and their ritual practices, including the temple rituals, were seen as part of the normal functioning of the ghostly assembly by close analogy with the House of Assembly in Port Moresby (the capital of Papua New Guinea). Moreover, when orators delivered their sermons at the end of the temple rituals, they prided themselves on their capacity for impassioned rhetoric, especially the ability to

summon up new and exciting analogies. As I noted in my original ethnography (Whitehouse 1995: 81):

The orators stir up a deep horror of the Devil and his many wives (evil female spirits), by stressing how sinners are separated from their social universe and sucked into a wilderness of hunger, fear, and loneliness and by focusing on the horrors of eternal damnation. The orators speak in elaborate and grisly metaphors which capture the imagination and instil fear into would-be sinners. They employ rhetoric and raised voices, charged with emotion. In view of the frequency of these meetings, the key speakers have highly developed oratory skills and powers of persuasion.

The CAT system figures prominently not only in the speeches of accomplished orators but in the daily discourse of ordinary Kivung followers. My fieldnotes soon became filled with colourful analogies and elaborate metaphors used to illustrate and justify the movement's doctrines. Mark Turner has argued that this predilection for parable is fundamental to all human thought. The title of his well-known book, *The Literary Mind*, amply makes the point. To the extent that this analogical impulse is a pervasive feature of human thought (even if somewhat muted in the laboratory) it is hard to envisage a domain of human behaviour that does not in some way provide grist for its mill. For this reason the actual domain of this system is very much larger than that of the systems we considered in the last section, and indeed potentially encompasses all of them, since there are no inputs to our nuclear systems that are not also, at least in principal, available as inputs to our analogical machinery.

Nevertheless, like all the other systems surveyed thus far the CAT system has a proper domain that is smaller than its actual domain. According to archaeologist Steven Mithen (1996), the capacity to make analogical connections between domain-specific forms of intelligence was a somewhat recent evolutionary adaptation in the hominid lineage. Mithen assembles a range of evidence suggesting that Early Humans possessed advanced forms of specialized intelligence in the domains of social thinking, technology production and use, and natural history. But these specialized forms of intelligence were 'cut off' from each other, so that there was no means of using technical intelligence to solve social problems or of using knowledge of natural kinds to organize social categories and statuses. The 'joining up' of these specialized capacities in Modern Humans explains the sudden profusion, in the archaeological record, of artefacts used as social markers (e.g. worn as body decorations) and of more complex forms of social organization based on analogues with natural taxonomies. Among the selective pressures fuelling this transformation, according to Mithen, was the need for sexually mature females to solicit assistance from male partners in the raising of dependent offspring. Although vocal communication initially evolved as part of social intelligence systems, 'snippets' of strategically important information normally handled by other forms of specialized intelligence started to become accessible in the same way, opening the floodgates to truly cross-domain patterns of analogical thinking. On this view, the proper domain of the CAT system was the extraction of 'energetic investment' from males to facilitate rearing of increasingly dependent offspring (Mithen 1996: 192-194). Of course, the CAT system could be understood more broadly as an outcome of evolutionary pressures towards more creative problem-solving in a number of spheres. Once fully established, the CAT system was capable of linking the outputs of literally any other cognitive system (see Figure 6). To distinguish this type of system (and we must bear in mind that there

may turn out to be a number of them¹⁴) from those that have much smaller actual domains, I propose to refer to the latter as ‘nuclear systems’ and the former as ‘global connection systems’.

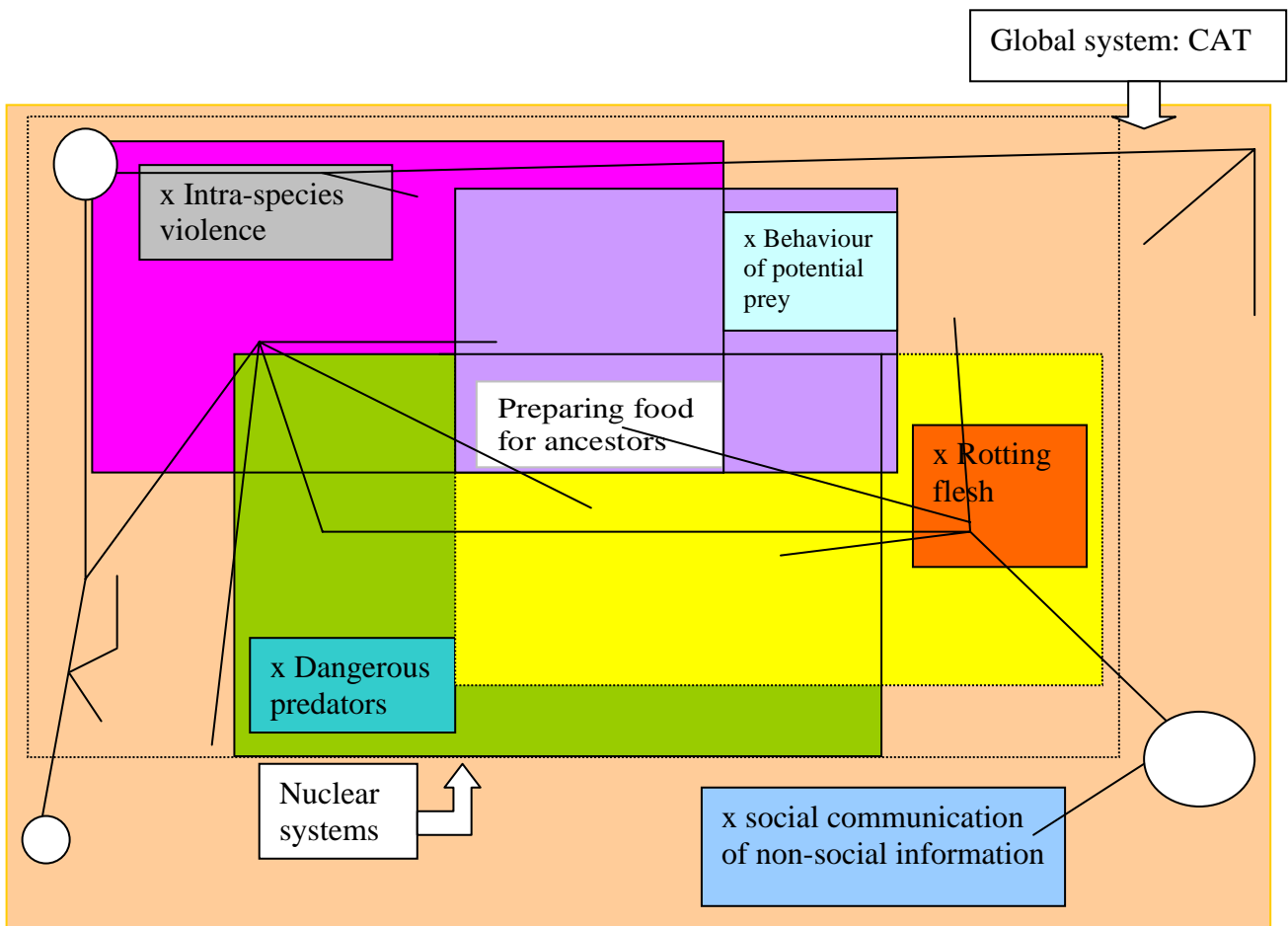


Figure 6: articulation of nuclear and global connection systems

Nevertheless, innovations delivered by creative thinking (which may well involve a number of systems, including the CAT system) would be of limited value if they could not be passed on from one generation to the next. For that type of cumulative learning to take place, we require a cognitive system that is capable of encompassing at least some key features of the outputs of all the other mechanisms in our cognitive repertoire and to establish ways of binding them together into relatively durable networks of information packets. One such evolved system in humans is ‘semantic memory’.¹⁵ Semantic memory is typically defined in contrast with ‘episodic memory’.¹⁶ Episodic memory refers to our capacity to recall distinctive moments in our lives. All mammals and birds possess a significant capacity for episodic remembering, such that specific types of cues trigger recall for relevant information about past experience. In apes, this type of remembering is rather highly developed. Chimpanzees, for instance, can recall quite large volumes of information but only in ways that are tied to *concrete encoding experiences*. For this reason, Merlin Donald describes ape culture as ‘episodic’, meaning that all new information, even the

sort that is acquired through creative innovation, is tied to unique situations or episodes. One of the most strikingly distinctive features of human cognition is the capacity to store *general knowledge* about the world (objects, stories, people, dates and sequences, theories, and so on) in a manner that is quite independent of episodic recall (indeed, in the case of much of our general knowledge, we are helpless to recall the circumstances in which we first acquired it). This is what we mean by ‘semantic memory’. As Donald has argued in considerable detail, the evolution of semantic memory in the hominid lineage constituted a major cognitive breakthrough of unrivalled significance for the cumulative storage of cultural information.

The extraordinary value of semantic memory is that it enables each one of us to become a walking, talking encyclopedia – a storehouse for knowledge. The evolution of such a system means that we can stockpile many of our greatest creative inventions and discoveries and pass these on to future generations. In order to exploit that capacity, however, there are some costs. While much of the information in semantic memory would be gathered informally through everyday experience, expert knowledge must be built up through long-term study involving regular review and rehearsal of the information acquired. In modern urban environments this involves formal schooling and examinations and it also increasingly involves the use of external data storage devices (ranging from traditional libraries to advanced digital archives) to extend our limited cognitive capacities. In the ancestral environment in which semantic memory mechanisms evolved, however, the first emergence of even rather limited capacities for explicit (teachable) information storage would have been revolutionary. Instead of having to rely on the outputs of nuclear systems (such the contamination avoidance repertoire) or even global connection systems (such as analogical thinking) to decide how to respond to new situations, our ancestors could begin to rely on the lessons learned by their forebears.¹⁷

This meant that the actual domains of all kinds of cognitive systems were greatly enlarged. In the case of our global connection systems – such as the CAT system – the expansion of potential inputs would have been vast. And as storage capacity became enlarged through the development of the semantic memory system, our access to creative innovations from the past would have grown accordingly. This expansion, however, would still have been structured and constrained in various ways by our nuclear systems. For instance, our capacity to store information about the natural environment would have been constrained by nuclear systems dedicated to the construction of taxonomic databases and our knowledge about potential contaminants would have been constrained by nuclear systems that were naturally aroused by things that look rotten or smell bad. As intuitive botanists and healers, our capacities to harness and extend natural processes and to protect ourselves from diseases were inevitably based more on trial and error than on well-founded theories. Yet trial and error, driven by intuitive nuclear systems, is still capable of producing prodigious bodies of knowledge. Informal hypotheses generated by global creative systems, and ‘stored’ in semantic memory, could now be passed on and developed over many generations. So successful has this process been in human history that modern theory-driven science, which seeks to transcend the constraints of our nuclear systems, nevertheless is increasingly demonstrating the efficacy of many traditional remedies.¹⁸

One of the areas of human striving in which the constraints of intuitive thinking are somewhat loosened is the domain of *religion*.¹⁹ Speculations about entities that don’t exist (or that we cannot prove exist) and about origins that are little understood (i.e. concerning which we have limited evidence) present us with

seemingly unlimited opportunities for cosmological innovation. Armed with tools for creative reasoning, such as the CAT system, modern humans were free to develop belief systems of extraordinary diversity. Connections made between one cluster of ideas and another could now be fixed in semantic memory through regimes of teaching and rehearsal. This fixation of the implicational or analogical links between otherwise quite unconnected ideas allowed the first emergence of what might be called ‘doctrinal systems’.²⁰

We have to be very careful at this point in the argument, however, because we teeter on the brink of ontological error. A doctrinal system is not a unitary ‘thing’ out there in the world, still less a ‘being’ of some kind with intelligent purposes of its own, but rather a series of countless iterations and reiterations stored in semantic memory as a set of templates (commonly called ‘schemas’ or ‘scripts’ by psychologists) that inform and guide our thinking and behaviour

To return to our ethnographic example, Kivung followers all told me strikingly similar things about the origins of the world, the history of their struggles with neighbouring groups, their experiences of colonization by the Germans and then the Australians, about their hopes for deliverance by their ancestors, the sacrifices this entailed, the meanings of the rituals they had to perform, and so on. This amounted to a substantial body of knowledge that gradually filled up my fieldnotes, to a point where I began to realize that everything was connected to everything else either by implication or by analogy. That insight was not my own special discovery, for it was more or less explicitly illustrated by every sermon I ever heard delivered by the Kivung’s orators and other officials (and I heard a lot of them). What the orators knew, long before I came to know it as well, was that the cosmology and doctrine of their religious tradition formed an integrated network of connections that could be explored in speech, often in ingeniously creative ways, but only by traversing well-worn tracks between the component concepts and networks of concepts. What gave these tracks their relative fixity was, as with a real track, the fact that people went over them time and again rather than randomly deviating and criss-crossing them. In the Kivung, unauthorized innovation on matters of doctrine and narrative was heavily sanctioned. And heresy could not be committed inadvertently since regular reiteration of the orthodox canon ensured that innovations would always be noticed. This is one of the great accomplishments of semantic memory – that it facilitates not just recall for individual items but for elaborate networks of connections among them. Since semantic memory capacities evolved as a means of domain-general information storage all recurrent patterns of events in the world constitute its proper domain, including all the outputs of nuclear and global connection systems. I shall refer to semantic memory as a ‘global storage’ system.

Thanks to the presence of global storage systems in the human cognitive repertoire, cultural innovation never starts from scratch. The case of Kivung religion shows, even when we focus only one type of ritual performed in one of its temples, that nuclear and global connection systems shape and constrain what people say and do at every turn. But no matter how closely we focus on those systems they will never enable us to explain why the Kivung tradition embraces particular configurations of systems and outputs while another tradition elsewhere embraces another. What is it that gives religious traditions their local and historical particularity, even though their members are all equipped with the same cognitive toolkits? The answer lies in the operations of global storage systems like semantic memory that impose a degree of fixity on particular configurations of representations, resulting from cumulative past experiences.

In talking about ‘a degree of fixity’ I do not mean to suggest that cultural systems really are fixed – only that they are somewhat resistant to change. Once an elaborate network of schemas has become distributed in the memories of a population, it can certainly be changed but if that process happens swiftly then people will notice and could object (and may well have more or less explicit methods of co-operatively punishing unauthorized innovators). Slower processes of change (over years or generations) would of course be less noticeable except when one deliberately reflects on the subject (as an historian, or when engaged in autobiographical rumination). There are of course many ways in which distributed semantic schemas can change but at least some gross features of historical transformation owe their existence to the dynamic interaction between nuclear systems, on the one hand, and global systems, on the other.

Every time a mental representation is activated there is a risk that it will be transformed. Insofar as rehearsal reduces the risks of memory distortion and decay, frequently-activated schemas in a population will tend to be more robust than irregularly-activated schemas. To the extent that frequency of activation is modulated by the presence of artefacts, such as texts and iconography, it makes some sense to understand semantic memory as augmented by ‘extended’ global storage systems.²¹ And to the extent that we can rely on others to reproduce specialized knowledge on behalf of others, it makes sense also to talk about ‘distributed’ global storage systems (Hutchins 1995). But no matter how important external mnemonics and expert knowledge may be in the reproduction of cultural schemas, the persistence of those schemas over time depends crucially on regular rehearsal (if only among specialists). When transmissive frequency falls below a critical level, there will be a risk of distortion. Distortions, however, are never random. All else being equal, the filling of gaps in semantic memory will be influenced most directly by intuitive ‘nuclear’ systems. This weighting of cultural innovation in favour of intuitive thinking has been dubbed the Cognitive Optimum Effect.²² The idea is that people readily ‘default’ to the easiest ways of representing information, in the absence of strong inducements to engage in more cognitively challenging ways of thinking. Among American Christians, for instance, it has been shown that ‘theologically correct’ ideas about divine omnipresence are easily overridden by more intuitive notions that God can only respond to one prayer at a time (Barrett and Keil 1996). And we have growing evidence that ‘theologically incorrect’ religious ideas (i.e. more intuitive versions of authoritative teachings) are much more pervasive among rank and file members of religious traditions than among religious experts (Slone 2004).

Tensions between the ‘theologically incorrect’ outputs of nuclear systems and the more cognitively challenging concepts of religious experts figure prominently among the causes of religious reformations, not only in Christianity but it would seem in all doctrinal religions.²³ Religious reform is always at least partly an attempt to rectify theological incorrectness by establishing an uncompromising vision of the one true doctrinal system subjecting adherents to an extraordinarily intensive regime of high-frequency repetition of its cardinal concepts. But heavy repetition also carries costs, not just in terms of time and labour but potentially also in terms of morale and the maintenance of authority. High-frequency repetition of religious doctrine and intolerance of competing perspectives can lead to disaffection and ultimately to the formation of religious splintering and sectarian division. In such cases, the influence of nuclear systems (e.g. concerned with coalition-formation and the punishment of defectors) may figure prominently but theological innovation is very often driven by the same kinds of global systems that animated the original movements of reform,

rather than by the so-called ‘cognitive optimum effect’. These different consequences of nuclear and global cognitive systems are capable in principle of being theorized systematically, ultimately holding out the possibility of being able to predict patterns of sociocultural transformation, given sufficient contextual information.

Representational, Descriptive, and Explanatory Challenges

This paper has attempted to sketch the bare outlines of a Cognitive Parsing Model (CPM). If we were to apply the model in a systematic way to a particular ethnographic or historical setting, the types of scenario depicted in Figure 6 would become vastly more complex and the grounds for postulating the engagement of particular psychological systems would have to be set out in far greater detail. In doing so, we may well come to realize that any given unit of behaviour involves the activation of numerous nuclear and global systems. To the extent that observed behaviour varies across space (i.e. among performers) and time (i.e. from one performance to the next), it should be possible to specify degrees of continuity and change (regionally and historically) with regard to the activation of particular configurations of nuclear and global psychological systems at the population level. Such an approach, however, raises formidably complex methodological issues as well as some major representational challenges.

Representing the intersections of nuclear and global systems in static diagrammes is insufficient to convey the multi-level, dynamic properties of the processes involved. We need a method of showing our intersecting systems transformationally so that we can observe in real-time simulations the changing patterns of connections between the systems activated at various stages of a given individual’s observed performance. In the case of our Kivung ritual, we might start by attempting to specify the complete range of nuclear systems activated in the course of a given person’s performance of the standard procedures. We could represent these nuclear systems as a series of boxes with continuously reconfiguring intersections that ‘light up’ (indicating local activation) at different moments in the procedural sequence. Global systems could be represented as much larger boxes enclosing all our nuclear systems. *Global connection* systems might become illuminated at various stages of the ritual, as for instance when the Kivung orators draw analogies between various doctrinal and narrative schemas, leading to rapidly transforming configurations of nuclear activations, graphically represented as a series of lightning flashes. In order to represent the diachronic operations of *global storage* systems, such as the SMS, we could modulate the brightness of the ‘lightning flashes’ generated by connection systems. The dimmest flashes would represent relatively poorly reinforced configurations of connections whereas the brightest flashes would represent configurations of connections that have been more heavily reinforced.

The reinforcement of global connections is partly a matter of prior activation of particular configurations of representations. For instance, Kivung members often evaluate behaviour in terms of their version of the Old Testament Ten Commandments, and will readily draw analogies between idle gossip and homicidal acts. In terms of our nuclear psychological systems, these two behavioural templates could easily be unconnected: gossip stimulating our ‘ToM’ mechanisms (speculating on the intentions of others) and murder exciting our moral system (activating concerns about harming others). But a global connection is drawn between gossip and homicide by explicit analogy, based on the personification of ‘reputation’ and the attribution of ‘mortality’. That is, if Reputation is a mortal person, then Reputation can be ‘killed’ through gossip, in violation of God’s commandment forbidding murder. This is such a

commonly repeated idea in Kivung communities that it constitutes a ubiquitous semantic schema. Through reiteration, the analogy has come to be reinforced historically, and would thus be represented as a bright flash in the global connection systems of most individuals. Any attempt to create novel connections, for instance between gossip and bathing, would be represented as a very dim flash, due to lack of reinforcement.

In the future, it may be possible to run graphic simulations of the activation of psychological systems alongside movie footage of a given ritual performance (e.g. on a split screen), re-describing the flow of action according to a kaleidoscopic series of changing configurations of nuclear and global activation patterns. At any given time we could ‘freeze frame’ and examine more closely the particular configurations of intersections and interconnections currently ‘lighting up’, making it possible to analyze the behaviour as a series of cross-sectional snapshots as well as to identify the structure of behavioural processes as continuous parcels.

Numerous observations of the same rituals (or other procedural sequences) on the part of many individuals would make it possible to identify recurrent patterns in the CPM. We cannot know in advance what these patterns would look like but it may turn out that some elements of our intuitive ways of categorizing cultural phenomena match the categories of the CPM. For instance, what we intuitively classify as ‘rituals’ may have sufficiently distinctive features (e.g. in terms of overall structure and sequencing or in terms of the most recurrent types of configurations of systems and connections) that they may be classed together by the CPM. Equally, it may turn out that the intuitive category ‘ritual’ has no special properties according to the CPM and might therefore be classified in a novel category of its own (or as a conglomeration or sub-set of particular intuitive categories).

Overcoming the challenges of re-describing and representing intuitive cultural categories in terms of the CPM is only part of the battle. Another crucial challenge is to *explain* the presence of these categories and their defining properties. For those in the ‘naturalized cognition’ camp, explanation has traditionally been a matter of specifying the shaping and constraining effects of particular nuclear systems, all else being equal. But by building our model in such a way as to incorporate the systems responsible for ‘historicized cognition’, we no longer need (or want) to hold ‘all else equal’. Indeed, the point is to show how a comprehensive account of the cognitive underpinnings of behaviour can explain the *particularities* of the cultural repertoire at particular times and places rather than just a few general features of culture at all times and places (valuable as that has been). But describing *how* recurrent patterns identified by the CPM are generated cannot in itself explain *why* those patterns came to take those recurrent forms, rather than others. To address that problem, we first need to track changes in those particular patterns over time. How are the defining features of categories picked out by the CPM created in the first place? Are there distinctive features of the way patterns of intersections between nuclear mechanisms, or sequences of activation of these patterns, develop historically? Are these kinds of trends influenced by the ways in which global connections and global storage systems are activated? And what kinds of time-depths are required for different types of transformations? Although here again we cannot foresee what the answers to questions like these will be, once we have a more systematic account of the general patterns and trends, it may be possible to infer a body of generalizable rules, stipulating how particular categories of the CPM emerge and evolve over time. The discovery of such rules might provide us with opportunities for *prediction*, given

sufficient information on the state of development of particular, localized behaviour patterns.

A hypothetical scenario might run as follows. A detailed empirical study of the way people in the Kivung talk about gossip as a violation of the commandment forbidding murder might show that long-term reiteration of the schema, stored in the SMS, results in reduced activation of the nuclear systems normally excited by the notion of homicide (e.g. the moral concern with harming others). In other words, repetition leads to the establishment of a 'dead metaphor', much as might be claimed for the English notion of 'character assassination'. We may discover, however, that there are certain rules that govern the re-activation of psychological mechanisms that have become situationally dormant in this way. For instance, whereas a newcomer to the Kivung who has only just grasped the gossip-murder connection might experience activation of both ToM and moral systems as a result of the 'firing' of the gossip-murder schema, a more long-standing member of the religious tradition might only be able to have those nuclear systems activated independently of the global connection. This could help to explain why orators' speeches incorporate strikingly novel and grisly ways of describing and condemning the sin of murder before proceeding to draw the link with gossip. We could of course also discover that there are alternative ways of reinforcing the conceptual connections established within global systems. For instance, we may find that if the link between murder and gossip is created in a fashion that is sufficiently surprising, consequential, and emotionally arousing, then the resulting episodic memory for that experience will be reactivated subsequently. Insofar as recall involves re-activation of the mechanisms entailed in the encoding process, the schema may be capable of triggering relevant nuclear systems for years to come, in contrast with the 'dead-metaphor problem' in reinforcement scenarios that rely on repetition. Discovering rules of this kind would constitute a significant step forward in explaining how cultural information is transmitted and in predicting how that information will change under specified circumstances in the future.

The methodological challenges of this approach would be daunting, to say the least. Re-describing intuitive categories in terms of the CPM raises the problem of how to establish evidence of activation of particular cognitive systems. Matching observable triggers to nuclear systems would be difficult enough, particularly given the embryonic stage of development of evolutionary psychology's accounts of these systems. But in the case of global systems there is the added problem that their actual domains are so large we cannot be sure what constitutes a trigger and what does not. For instance, participants in a Kivung ritual may make all kinds of analogical connections between the procedures and artefacts involved that are simply inaccessible to observation. In recent experimental studies (e.g. Richert, Whitehouse and Stewart 2005) we have made some headway in developing methodologies that enable us to monitor analogical thinking in relation to artificial rituals, but there are many potential hurdles in that kind of research especially if conducted in real-world settings. The difficulties associated with the second step, that is *explaining* the emergence and development of categories identified by the CPM, are similarly acute. Bearing in mind that even the re-description of a single ritual performance is likely to require masses of data and to involve scores of cognitive systems, the sheer volume of data required for the discernment of general patterns among recurrent performances, and then for the tracking of cumulative changes in these patterns over time, would present staggering computational challenges.

Nevertheless, many of these kinds of difficulties have been substantially overcome in other scientific disciplines (perhaps the closest analogy would be with

connectionist models of brain function and AI systems), so we should not be unduly pessimistic. The potential payoff is that we may eventually be able to study human culture at the same level of theoretical and methodological sophistication with which scientists have begun to lay bare the mechanisms human biology and, more recently, the human mind.

References

Astington, J.W., Harris, P.L. and Olson, D. (eds.) (1988) *Developing Theories of Mind*, Cambridge: Cambridge University Press.

Atran, Scott (1990) *Cognitive Foundations of Natural History*, Cambridge: Cambridge University Press.

Baddeley, A. D. (1997) *Human Memory: Theory and Practice*, Hove: Psychology Press.

Barrett, J.L. (2000) 'Exploring the natural foundations of religion' in *Trends in Cognitive Sciences*, 4, 29-34.

_____ (2004) *Why Would Anyone Believe in God?* Walnut Creek, Calif.: AltaMira Press.

Barrett, J.L. & Keil, F. C. (1996) 'Anthropomorphism and God concepts: Conceptualizing a non-natural entity' in *Cognitive Psychology*, 31, 219-247.

_____ (1995) 'Classifying Nature across Cultures' in E.E. Smith and D.N. Oserhson (eds.) *An Invitation to Cognitive Science*. Vol.3, Cambridge, MA: MIT Press.

Baron-Cohen, Simon (1995) *Mindblindness: an essay on autism and theory of mind*, Cambridge MA.: MIT press.

Baron-Cohen, S., Tager-Flusberg, H. and Cohen, D.J. (eds.) (2000) *Understanding Other Minds: Perspective from Developmental Cognitive Neuroscience*, Oxford: Oxford University Press.

Blair, R. (1995) 'A Cognitive Developmental Approach to Morality: Investigating the Psychopath' in *Cognition*, 57: 1-29.

Bloom, P. (2000) *How Children Learn the Meaning of Words*, Cambridge MA: MIT Press.

Boyer, Pascal (1990) *Tradition As Truth and Communication*, Cambridge: Cambridge University Press.

_____ (1994) *The Naturalness of Religious Ideas: A Cognitive Theory of Religion*, Bekeley: University of California Press.

Boyer, Pascal and Lienard, Pierre *in press* 'Why Do Humans Perform Rituals? Cultural Rituals and the Psychology of Ritual Behaviour' in *Behavioural and Brain Sciences*.

Brown, C. (1984) *Language and Living Things: Uniformities in Folks Classification and Naming*, new Brunswick, NJ: Rutgers University Press.

- Carey, S. (1985) *Conceptual Change in Childhood*, Cambridge MA: MIT Press.
- Chi, M.T.H. and Slotta, J.D. (1993) 'The Ontological Coherence of Intuitive Physics' in *Cognition and Instruction*, 10: 249-260.
- Churchland, P.M. (1989) *The Neurocomputational Perspective*, Cambridge MA: MIT Press.
- Donald, Merlin (1991) *Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition*, Cambridge MA: Harvard University Press.
- Dunbar, Kevin (2001) 'The Analogical Paradox: Why Analogy Is so Easy in Naturalistic Settings, Yet so Difficult in the Psychological Laboratory' in Gentner, Holyoak, K.J., and Kokinov, B.N. (eds.) *The Analogical Mind: Perspectives From Cognitive Science*, Cambridge MA: MIT Press.
- Fontanarosa, P.B. (ed.) (2000) *Alternative Medicine: An Objective Assessment*, Washington DC: AMA Press.
- Geertz, Clifford (1973) *The Interpretation of Cultures*, London: Hutchinson.
- Gelman, R. (1990) 'First Principles Organize Attention and Learning About Relevant Data: number and the animate-inanimate distinction as examples' in *Cognitive Science*, 14: 79-106.
- Gelman, S.A. (1988) 'The Development of Induction Within Natural Kind and Artefact Categories' in *Cognitive Psychology*, 20: 65-95.
- Gelman, R. and Gallistel, C.R. (1978) *The Child's Understanding of Number*, Boston: Harvard University Press.
- Gelman, S.A., Gottfried, G.M., and Coley, J. (1994) 'Essentialist Beliefs in Children: the acquisition of concepts and theories' in L. Hirschfeld and S.A. Gelman (eds.) *Mapping the Mind: domain specificity in cognition and culture*, Cambridge: Cambridge University Press.
- Gick, M.L. and Holyoak, K.J. (1980) 'Analogical Problem Solving' in *Cognitive Psychology*, 12: 306-355.
- Gick, M.L. and Holyoak, K.J. (1983) 'Schema Induction and Analogical Transfer' in *Cognitive Psychology*, 15: 1-38.
- Gopnik, A. and Meltzov, A. (1997) *Words, Thoughts, and Theories*, Cambridge MA: MIT Press.
- Harris, Paul L. (1989) *Children and Emotion: the development of psychological understanding*, Oxford: Blackwell.
- Hirschfeld, L. (1995). Do children have a theory of race? *Cognition* 54:209-252.

- Hirschfeld, L.A. (1996) *Race in the Making: Cognition, Culture, and the Child's Construction of Human Kinds*, Cambridge MA: MIT Press.
- Hutchins, Edwin (1995) *Cognition in the Wild*, Cambridge, MA: MIT Press.
- Jackendoff, R. (1992) *Language of the Mind: Essays on Mental Representation*, Cambridge, MA: MIT Press.
- Kaiser, M.K. Jonides, J. and Alexander, J. (1986) 'Intuitive Reasoning about Abstract and Familiar Physics Problems' in *Memory and Cognition*, 14: 308-312.
- Karmiloff-Smith, A. (1992) *Beyond Modularity: A Developmental Perspective on Cognitive Science*, Cambridge MA: MIT Press.
- Kokinov, B.N. and Petrov, A.A. (2001) 'Integrating Memory and Reasoning in Analogy-Making: The AMBR Model' in Gentner, Holyoak, K.J., and Kokinov, B.N. (eds.) *The Analogical Mind: Perspectives From Cognitive Science*, Cambridge MA: MIT Press.
- Lorenz, Konrad (1966) *On Aggression*, New York: Harcourt Brace Jovanovich.
- Milton, Kay (ed.) (1993) *Environmentalism: The View from Anthropology*, London: Routledge.
- Mithen, S.J. (1996) *The Prehistory of the Mind*, London: Thames and Hudson
- Metcalf, J. (1986) 'Feeling of Knowing in Memory and Problem Solving' in *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 12(2): 228-294.
- Nichols, Shaun (2004) *Sentimental Rules: On the Natural Foundations of Moral Judgment*, Oxford: Oxford University Press.
- Nucci, L. (1986) 'Children's Conceptions of Morality, Social Conventions, and Religious Prescription' in C. Harding (ed.) *Moral Dilemmas: Philosophical and Psychological Reconsiderations of the Development of Moral Reasoning*, Chicago: President Press.
- Parascandola, M. and Weed, D.L. (2001) 'Causation in Epidemiology' in *Journal of Epidemiology and Community Health*, 55: 905-912.
- Proffitt, D.R. and Gilden, D.L. (1989) 'Understanding Natural Dynamics' in *Journal of Experimental Psychology: Human Perception and Performance*, 15: 384-393.
- Ranney, M. and Thagard, P. (1988) 'Explanatory Coherence and Belief Revision in Naïve Physics' in *Proceedings of the Tenth Annual Conference of the Cognitive Science Society*, pp 11-117, Hillsdale, NJ: Lawrence Erlbaum.
- Resnick, L.B. (1986) 'The Development of Mathematical Intuition' in M. Perlmutter (ed.) *Perspectives on Intellectual Development: Minnesota Symposia on Child Psychology*, Vol.19, Hillsdale, NJ: Lawrence Erlbaum.

- Richert, R.A., Whitehouse, H. and Stewart, E.E.A. (2005) 'Memory and Analogical Thinking in High-Arousal Rituals' in Harvey Whitehouse and Robert N. McCauley (eds.) *Mind and Religion: Psychological and Cognitive Foundations of Religiosity*. Walnut Creek, Calif.: AltaMira Press.
- Rothbart, M. and Taylor, M. (1990) 'Category Labels and Social Reality: Do We View Social Categories as Natural Kinds?' in G. Semin and K. Fiedler (eds.) *Language and Social Cognition*, London: Sage.
- Scholl, B.J. and Tremoulet, P.D. (2000) 'Perceptual Causality and Animacy' in *Trends in Cognitive Sciences*, 4: 299-308.
- Schooler, J.W. and Melcher, J. (1995) 'The Ineffability of Insight' in S.M. Smith, T.B. Ward, and R.A. Finke (eds.) *The Creative Cognition Approach*, pp 97-134, Cambridge, MA: MIT Press.
- Slone, J. (2004) *Theological Incorrectness: Why Religious People Believe What They Shouldn't*, New York: Oxford University Press.
- Spelke, E.S. (1991) 'Physical Knowledge in Infancy: Reflections on Piaget's Theory' in S. Carey and R. Gelman (eds.) *Epigenesis of the Mind: Essays in Biology and Knowledge*, Hillsdale, NJ: Lawrence Erlbaum.
- Sperber, Dan (1985) 'Anthropology and Psychology: towards an epidemiology of representations' in *Man* (N.S.), 20: 73-89.
- _____ (1996) *Explaining Culture: a naturalistic approach*, London: Blackwells.
- Strauss, Claudia and Quinn, Naomi (1997) *A Cognitive Theory of Cultural Meaning*, Cambridge: Cambridge University Press.
- Szechtman, H. and Woody, E. (2004) 'Obsessive-Compulsive Disorder as a Disturbance of Security Motivation' in *Psychological Review*, 111(1): 111-127.
- Thagard, Paul and Shelley, Cameron (2001) 'Emotional Analogies and Analogical Inference' in Gentner, Holyoak, K.J., and Kokinov, B.N. (eds.) *The Analogical Mind: Perspectives From Cognitive Science*, Cambridge MA: MIT Press.
- Tomasello, Michael (1999) *The Cultural Origins of Human Cognition*, Cambridge MA: Harvard University Press.
- Tulving, E. (1972) 'Episodic and Semantic Memory' in E. Tulving & W. Donaldson (eds.) *Organization of Memory*, New York: Academic Press.
- Turiel, Elliott (1983) *The Development of Social Knowledge: Morality and Convention*, Cambridge: Cambridge University Press.
- Wellman, Henry (1990) *The Child's Theory of Mind*, Cambridge MA.: MIT Press.

- Whitehouse, H. (1992) 'Memorable Religions: transmission, codification, and change in divergent Melanesian contexts' in *Man* (N.S.), 27:777-797.
- _____ (1995) *Inside the Cult: religious innovation and transmission in Papua New Guinea*, Oxford: Oxford University Press.
- _____ (2000) *Arguments and Icons: divergent modes of religiosity*, Oxford: Oxford University Press.
- _____ (2001) *The Debated Mind: Evolutionary Psychology Versus Ethnography*, Oxford: Berg.
- _____ (2004) *Modes of Religiosity: a cognitive theory of religious transmission*, Walnut Creek, Calif.: AltaMira Press.
- Whitehouse, Harvey, and James A. Laidlaw, eds. (2004) *Ritual and Memory: Towards a New Comparative Anthropology of Religion*, Walnut Creek, Calif.: AltaMira Press.
- Whitehouse, Harvey, and Luther H. Martin, eds. (2004) *Theorizing Religions Past: Historical and Archaeological Perspectives*, Walnut Creek, Calif.: AltaMira Press.
- Whitehouse, Harvey, and Robert N. McCauley (2005) *Mind and Religion: Psychological and Cognitive Foundations of Religiosity*. Walnut Creek, Calif.: AltaMira Press.
- Williams, J.H.G., Whiten, A., Suddendorf, T. and Perrett, D.I. (2000) 'Imitation, Mirror Neurons, and Autism' in *Neuroscience and Behavioural Reviews*, 25: 287-295.

Acknowledgements

I am indebted to Justin Barrett, Pascal Boyer, Armin Geertz, E. Thomas Lawson, Pierre Lienard, Luther H. Martin, Ilkka Pyysiäinen, Jesper Sørensen, and Emma Stewart for reading and commenting on an earlier draft of this article. The work was carried out during a two-year period of study leave facilitated by a British Academy Research Readership.

Notes

¹ Without getting bogged down in a lengthy debate about what constitutes ‘science’, I take it that a scientifically tractable approach is one that seeks to explain empirical observations through the testing of hypotheses in valid and reliable ways.

² Genetically-controlled factors may play only a small role in the production of these similarities so this claim does not commit us to any kind of thoroughgoing nativism (see Whitehouse 2001).

³ For a fuller discussion of the strengths and weaknesses of probabilistic approaches to causation, see Parascandola and Weed 2001.

⁴ For a range of concerns about the reliability of ‘folk psychology’; see, for instance, Churchland 1989.

⁵ Thus, according to cultural anthropologist Clifford Geertz, culture is an abstract, *non-physical* structure that exists *outside of people’s heads* (1973:10). Where it exists, however, according to this view is entirely mysterious. (For a fuller critique of Geertz’s faulty ontology, see Strauss and Quinn 1997: 19).

⁶ Also sometimes referred to as ‘naïve sociology’ (e.g. Jackendoff, R. 1992, Hirschfeld 1995).

⁷ Atran 1990, 1995; Brown 1984; R.Gelman 1990; S.A. Gelman 1988; Gelman, Gottfried, and Coley 1994.

⁸ Classic work on this topic includes: Astington, Harris, and Olson 1988; Harris 1989; Wellman 1990; Baron-Cohen 1995.

⁹ Chi and Slotta 1993, Kaiser, Jonides, and Alexander 1986, McCloskey 1983, Proffitt and Gilden 1989, Ranney and Thagard 1988, Spelke 1991.

¹⁰ Gelman and Gallistel 1978, Resnick 1986, Karmiloff-Smith 1992.

¹¹ Atran 1990; Boyer 1990; Rothbart and Taylor 1990. But see also Hirshfeld 1996.

¹² For overviews of work on agency detection systems, see Scholl and Tremoulet 2000 and Barrett 2004.

¹³ Bering and Johnson (2005) have argued that the attribution of special mindreading capacities to supernatural agents might in fact turn out to be part of the proper domain of ToM mechanisms, since the ability to convince others of one’s belief in such agents would have had reputation-enhancing effects with significant implications for individual reproductive success. At present, however, these arguments remain somewhat speculative and the consensus among cognitive scientists of religion is that beliefs in supernatural agents constitute a bi-product of mechanisms that were selected for other reasons (see McCauley and Whitehouse 2005 for a discussion).

¹⁴ The forging of creative connections between distant or previously unconnected domains of knowledge may involve cognitive systems other than analogy-formation. For instance, logical or analytic thinking is also capable of creating novel conceptual connections and appears to operate in ways that differ significantly from what is sometimes called ‘insight-thinking’ (which includes analogical thinking). Whereas progress towards novel connections is *gradual* in logical thinking, it appears to be more *sudden* in the Eureka moments of insight-thinking (Metcalf 1986). And whereas verbalization can adversely affect insight-thinking, this seems not to be the case with logical thinking (Schooler and Melcher 1995). These sorts of differences suggest that logical thinking should be viewed as a separate cognitive system from insight-thinking, even though both are types of global connection systems.

¹⁵ For an excellent overview, see Baddeley 1997: Chapter 13.

¹⁶ Following the distinction first made by Tulving 1972.

¹⁷ One of the most ambitious theories of the cognitive and evolutionary foundations of human culture to date is that proposed by Tomasello (1999; see also Tomasello, Kruger, and Ratner 1993). Tomasello, like me, wants to explain distinctively human capacities for cumulative cultural transmission, whereby the knowledge and skills of one generation can be passed on to the next (a process he and his colleagues have labelled the ‘ratchet effect’). Tomasello argues that creativity is not the key to this, since other primates show highly innovative tendencies as well (1999: 5). Rather, it is that humans uniquely have developed ways of *preserving* the outcomes of innovation. Tomasello thinks that knowledge-preservation can be explained by a cluster of cognitive mechanisms, among which ‘perspective-taking’ (ToM) plays a leading role (1999: 5-12). The present argument differs from Tomasello’s in two key respects. First, humans are strikingly more creative than other primates insofar as our innovative and creative ideas are activated and applied *across* domains, hence my referring to analogical thinking (and other methods of creating cross-domain connections) as ‘global systems’. Second, the mechanisms Tomasello focuses on are implicated in only some aspects of the ratchet effect, and are certainly not sufficient to account for it. Perspective-taking, for instance, undoubtedly plays an important role in most (but by no means all) forms of cultural learning, enabling us to ‘learn not just *from* the other but *through* the other’ (Tomasello 1999: 6, original emphases). But this is not a

crucial feature of all distinctively human types of learning. The malfunctioning of ToM mechanisms in people with autism does not, as Tomasello seems to imply (refs), necessarily imply a catastrophic failure of cultural learning. On the contrary, people with autism often show above-average capacities for acquiring expert knowledge in a wide range of domains (refs). And despite the handicaps of their condition, some autistic individuals have contributed immensely to the store of human knowledge (refs). The most immediate and obvious cause of the ratchet effect is not our capacity to imagine the world through other people's eyes but rather our capacity to *store* the information acquired from others so that it is available to conscious inspection, evaluation, and creative modification in the future. Explicit memory and cross-domain creativity constitute the key to this revolution. To use the terminology developed in this article: perspective-taking, along with the other nuclear mechanisms discussed by Tomasello, contribute significantly only to *some* aspects of learning; our global systems, dedicated to connecting and storing information, play an essential role in *all* forms of cultural innovation and transmission.

¹⁸ For a rounded evaluation of the scientific evidence on this topic, see Fontanarosa 2000.

¹⁹ Elsewhere, I have described these aspects of religion as 'cognitively costly' (see especially Whitehouse 2004: chapter 3).

²⁰ See Whitehouse 1992, 1995, 2000, 2004; Whitehouse and Laidlaw 2004, Whitehouse and Martin 2004, Whitehouse and McCauley 2005.

²¹ Donald goes so far as to argue that extended cognition, or 'external symbolic storage', constitutes a one of three major transitions in hominid cognitive evolution that were necessary for the emergence of distinctively human culture (his other two transitions are, first, the emergence of mimetic capabilities, that is being able to re-enact events, which he argues first appears among *homo erectus* populations, and, second, the development of speech systems). Although it makes some sense to regard extended cognition as a global storage system (facilitating the accumulation of information that could not otherwise be available to recall), we should not forget that artefacts (including inscriptions and computers) have to be interpreted by internal cognition in order to 'store' anything. Moreover, for most of human history, external storage has played a comparatively modest role in cultural transmission. Even rudimentary writing systems are no more than about 6,000 years old and the massive data storage capabilities afforded by computers only began to be realized half a century ago. So we should be cautious in over-estimating the importance of external storage in cultural transmission from the viewpoints of *both* evolution *and* history.

²² Boyer 1994 (see also Whitehouse 2004).

²³ Whitehouse and Laidlaw 2004; Whitehouse and Martin 2004.