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Peter Q. Deeley*

THE RELIGIOUS BRAIN

Turning ideas into convictions

This paper is a critical review of anthropology and cognitive science that proposes social, cognitive, and neural mechanisms that convert culturally transmitted ideas into beliefs, discussed in relation to Geertz's classic definition of religion ('Religion as a cultural system', 1966). Literal and analogical uses of language, and a capacity for mentalizing thought, allow the creation of systems of symbols that vary between groups, contributing to the systematic group-level differences that we refer to as 'culture'. A combination of social referencing, mentalizing, and emotion perception enables enculturation to occur by attention to stable, repetitive conjunctions of meanings and emotions in the social environment, promoting the formation of cognitive-affective schemata. In addition to informal enculturation in routine social interaction, cultural systems such as religions organize and protect transmission of valued knowledge. Religious rituals are culturally invented symbolic displays that transmit conceptions of the world and imbue them with emotional and motivational significance. Two kinds of ritual are distinguished: high frequency, low arousal rituals belonging to a 'doctrinal' religious mode, and low frequency, high arousal rituals belonging to an 'imagistic' religious mode (Whitehouse 2000). 'Doctrinal' rituals allow the extraction of semantic memories and associated emotions through repeated participation and exposure. 'Imagistic' rituals are particularly associated with intense emotion, episodic memory formation, and the formation of social ties. Religious rituals, especially imagistic rituals, employ two major strategies to convey conceptions of the world and invest them with a heightened sense of reality and emotion: (1) a 'sensory' route evokes salient thought and experience by orchestrating multiple reinforcing social-emotional signals and other stimuli, engaging attention, emotion, and arousal; (2) a 'semantic' route uses enigmatic verbal and non-verbal symbols to engage an analogical/right hemispheric processing strategy to make sense of what is authoritatively presented as real but incompletely understood. Both routes are hypothesized to activate the mesolimbic dopamine system amongst other components of cognitive-affective processing, so that the 'moods and motivations' evoked by the ritual performance seem 'uniquely realistic'. These social, cognitive, and neural processes constitute ways in which religious ideas are turned into convictions.

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Almost 40 years ago, the anthropologist Clifford Geertz defined religion as:

(1) a system of symbols which acts to (2) establish powerful, pervasive, and long lasting moods and motivations ... by (3) formulating conceptions of a general order of existence and (4) clothing these conceptions with such an aura of factuality that (5) the moods and motivations seem uniquely realistic.

(Geertz 1993 [1966])

This paper is a critical review of recent developments in anthropology and the cognitive sciences in an attempt to provide a contemporary account of each component of Geertz's definition of religion, and the links between them. In other words, the aim is to explain why human beings create symbolic culture, and how it influences cognition and behaviour, with a special focus on how individuals acquire religious beliefs and behaviours that are typical of their social group. To begin, we will consider characteristics of symbolic cognition and communication, to see how systems of symbols can convey 'conceptions of a general order of existence'.

Characteristics of symbolism and symbolic communication

Symbolic culture – phenomena such as art, languages, rituals, gender ideologies, and magico-religious myths – is based on the cognitive ability to create representations of the world, whether of the social and physical environment or the inner world of experience. These representations are *symbolic*, in the most general sense that they stand for something else, whether real or imaginary (Noble & Davidson 1996, p. 63). Theories of symbolism have identified a range of characteristics that distinguishes it from other kinds of communication, such as the social signalling displays of non-human primates.

Symbols are *general*, in the sense that 'virtually anything can be used to represent virtually anything else: spoken words, printed words, pictures, video images, numbers, graphs ... can be exploited to stand for something that someone wants to symbolize' (DeLoache 2004, p. 67). Symbols are *intentional*, in the philosophical sense that symbols are about something, and in the psychological sense of being used for a purpose; as DeLoache says, 'nothing is inherently a symbol; only as a result of using it with the goal of referring does it take on a symbolic role' (p. 67).

The meanings evoked by symbols are based on *concepts* constructed from higher order abstraction of features from sensory information, or from simpler concepts (Mesulam 1998). *Dual reference* describes the dual nature of symbols, whereby 'a symbolic artefact such as a picture or a model is both a concrete object and a representation of something other than itself'. Dual reference requires an ability to 'represent the concrete object itself and its abstract relation to what it stands for' (DeLoache 2004, p. 69).

In addition to dual reference, humans can also generate reference independently of the immediate presence of physical stimuli with which the symbol is or can be associated; this is referred to as *offline representation* (Boyer 2000). This is a prerequisite for *generativity* or *creativity* (reference to novel ideas, things or events, some of which may be entirely imaginary).

Cognitive and neural bases of symbolism

The 'social brain' hypothesis was introduced to explain primates' unusually large brains, but is also relevant to understanding the origins of symbolic cognition and communication. It proposes that the cognitive demands of living in complex bonded social groups have been the principal source of selectional pressures on primate brain evolution (Dunbar 2003). Adaptation to primate societies requires 'an ability to represent long, linear dominance hierarchies, to remember who is doing what to whom, and to manipulate this information to one's own advantage' (Ghazanfar & Santos 2004). Many primate species can classify group members according to their individual attributes and their membership in higher order groups despite living in dispersed societies (Barrett *et al.* 2003; Kamil 2004). These cognitive demands have influenced the evolution of unimodal sensory cortices, to detect species-specific social signals; and transmodal association cortices, to support abstract relational information processing (Dunbar 2003; Mesulam 1998).

The transition to symbolic cognition and communication is likely to have been built on related specializations of social executive functions in our hominid ancestors (Deacon 1997; Dunbar 2003). Executive functions include abilities such as attention, working memory, representation of context, temporal sequencing, abstraction, planning, and monitoring. All of these abilities contribute to symbolic cognition, which depends on an ability to construct abstract or 'higher order' conditional associations, in which signs generate meaning by construing or detecting an implicit system of relationships between them. As Deacon puts it, symbol acquisition 'requires a predisposition for working with difficult conditional associative relationships, maintaining items in working memory under highly distractive conditions', and 'using negative information to shift associative strategies from concrete stimulus driven links to abstract associations' (Deacon 1997, p. 264). Human cognition is now characterized by a predominance of abstract symbolic processing, which reflects 'the significance rather than the surface properties of sensory events', and creates 'a highly edited subjective version of the world' (Mesulam 1998, p. 1013).

Language, mentalizing, and culture

It has been widely observed that the evolution of language has enabled the creation and transmission of culture (Deacon 1997). As Mesulam put it, 'through the advent of language and the resultant ability to communicate abstract concepts ... each individual intelligence can become incorporated into an interactive lattice that promotes the transgenerational transfer and accumulation of knowledge' (1998).

Despite its importance, language in itself is insufficient for symbolic culture to develop. Much of the content of symbolic culture concerns the actions and intentions of imagined agents (in myth or story, for example), and as such requires an ability for an audience to interpret the behaviour of story protagonists as determined by their beliefs, goals, and other mental states. This ability has come to be termed mentalizing, perspective-taking, or 'Theory of Mind', and is supported by a distinct neurocognitive network (Gallagher & Frith 2003; Leslie 1994). If we consider the

sentence, 'Peter *supposes* that Sarah *thinks* that Simon *believes* that Sarah *would like* to go out with Peter' (Dunbar 2000), we find four levels of intentionality (i.e. representation of mental states). Present evidence suggests that, at best, chimpanzees can manage second order intentionality (in other words, represent a single other's perspective as different from that of the chimpanzee) (Dunbar 2000).

Mentalizing is a form of symbolic cognition in that it depends on higher order conditional associations between abstract representations. In Leslie's terms, the ability to represent mental states in this way involves 'decoupling' a representation of imagined states of affairs from reality (Gallagher & Frith 2003; Leslie 1994). This 'decoupling' of representations from reality allows more than one perspective to be held in mind at any one time (Gallagher & Frith 2003). Mentalizing enables lying and pretend play, and, by extension, 'the ability to believe that the world is other than it really is' (Dunbar 2000, p. 239). As such, it is a prerequisite for understanding reports about the motivations and mental states of others, whether in myth, gossip, or movies.

Mapping across domains

A combination of mentalizing and literal uses of language accounts for the capacity to understand and communicate some complex interpretations of the world (for example, the cogitations of Peter about Simon and Sarah cited above). Yet the 'conceptions of a general order of existence' suggested by Geertz to be typical of religions involve ideas and uses of language that cannot be understood literally – that is, as evoking their ordinary meanings or referents. As Geertz observes, the Bororo man who states, 'I am a parakeet' does not mistake other members of the parakeet clan for the actual bird, or vice versa. Rather, the statement expresses membership of a clan 'whose members regard the parakeet as their totem, a membership from which, given the fundamental nature of reality as the religious perspective reveals it, certain moral and practical consequences follow'; for example, mutual cooperation, not marrying one another, not eating mundane parakeets, and so on (Geertz 1993 [1966], p. 122). Much of any world imagined through symbolic culture is built up from such richly figurative, analogical, or metaphorical extensions of literal meanings, although clearly, the analogical character of the concepts and language does not preclude the sense that their referents are in some sense *real*.

The cognitive archaeologist Mithen argues that analogical thought arose in anatomically modern humans when a capacity for combining different domains of knowledge emerged. This allowed items within discrete domains of knowledge and reference to be re-represented in terms of something else, so that – for example – different human groups can be represented as animals (totemism); animals can be represented as humans or possessing human-like qualities (anthropomorphism); features of animals and humans can be combined to create imaginary beings (therianthropes); and artefacts can be created to represent animals or humans (painting, statuary, and decoration of utilitarian objects) (Mithen 1996). Mithen has described this ability of 'mapping across domains' of knowledge – the social world, the animal and plant world, and the world of material-technical knowledge – as 'cognitive fluidity', which is similar to Karmiloff-Smith's notion of 'representational

re-description' (Mithen 1999). In Mithen's view, the emergence of cognitive fluidity underlay the explosive growth of symbolic culture evident from the Upper Paleolithic onwards (c. 35,000 ya), partly because cultural transmission was facilitated by the creation of artefacts that anchored complex concepts in material form (such as the half-man half-lion figure from a cave in Hohlenstein–Stadel in Germany, dated to c. 30,000 ya) (Mithen 1996, 1999).

Systems of symbols

In cognitive terms, analogical thought involves an additional exploitation of abstract relational cognition, allowing a flexible, creative appropriation of existing concepts (Glucksberg 2003). Analogy allows unobservable things or events to be imagined and referred to, whether in science, religion, or any other cultural domain (gas molecules as billiard balls, God as a Father). The 'system of symbols' of a society or social group are typically constructed out of sets of analogical correspondences, in which the organization of one aspect 'mirrors' that of another – the structure of time, the world, domestic space, food, the body, gender, the family, the clan, the spirit world, and so on (Douglas 2000).

How far, then, have we accounted for the components of Geertz' definition of religion? The human capacity to create and share 'conceptions of a general order of existence' rests on distinctive features of symbolic cognition and communication. Features of symbolism (such as dual reference, offline representation, and so on), are based on coordination of a range of associative transformations of incoming sensory information or internal representations. The sensory and association cortices supporting this processing have evolved under specific socio-ecological conditions, with human cognition distinguished by the fact that various kinds of symbolic cognition develop as normal features of our species. In addition to literal referential language, mentalizing and a capacity for analogical thought are essential for symbolic culture (as it has existed for at least 30,000 years) to be invented, communicated and understood. In particular, these cognitive abilities allow the creation of systems of symbols that vary between groups, contributing to the systematic group-level differences that we refer to as 'culture'.

Yet we still have to explain why some kinds of conceptions and behaviour are widely distributed (such as religious beliefs and behaviour), and also why these conceptions are regarded as real and motivating. To address these questions, we must go on to consider the relations between symbolic culture and individual cognition.

Shared symbol systems and individual cognition

A fundamental question for anthropology and cognitive science concerns how the extrapersonal realm of symbolic culture influences intrapersonal cognition – processes such as learning, reasoning, emotion, and motivation.

Cognitive anthropologists have used models derived from cognitive psychology in an attempt to characterize how the public forms of symbolic culture (such as objects, actions, words, song, smells) are interpreted by individuals, through processes that

both render symbolic culture meaningful, and constrain its development. There are two main approaches to cognitive anthropology: a neo-associationist school, using connectionist models of learning; and what could be termed an 'innatist' school, influenced by evolutionary psychology and modularity theory. As a broad generalization, the neo-associationist school has focused on how culture influences individual cognition, while the innatist school has focused on how species-typical cognitive constraints motivate and constrain particular cultural forms (such as religious concepts, or folk psychology).

Despite their differences, both schools have made use of the schema theory to model the relations between cognitive processes and cultural symbols and practices. Schemata are 'networks of strongly connected cognitive elements that represent the generic concepts stored in memory' (Strauss & Quinn 1997, p. 6). Cultural schemata (or cultural models) are those schemata that are widely distributed in a population, such that "culture" is merely a name for *all* of the learned schemas that are shared by some people, as well as all of the diverse things from which these schemas are learned' (p. 38).

A major question concerns the extent to which the acquisition and construction of schemata is guided by species-typical learning biases, or, alternatively, whether the principal constraints are imposed by structured regularities in the environment and behaviour which influence associative linkages between the elements which make up a schema. We will consider the 'innatist' view first, in order to address the question: are there species-typical cognitive mechanisms that explain the widespread distribution of religious and other kinds of supernatural belief?

Are there innate cognitive constraints on religious beliefs?

Innatist approaches to cognitive anthropology posit the existence of evolved domain-specific cognitive modules that are dedicated to particular tasks – examples cited include face recognition, language acquisition, and attribution of mental states (Sperber & Hirschfeld 2004). Features taken to support the view that a cognitive function is subserved by a module include that it is present in all normal members of the species; has a characteristic developmental sequence; specific neuroanatomical substrates; and a plausible evolutionary history. Cultural transmission is viewed as too rapid and efficient to be explained in terms of general abilities to learn, imitate, and communicate; rather, modular learning biases facilitate cultural learning, but also impose strong constraints on the creation of cultural domains of knowledge and behaviour. A corollary is that cross-cultural research should reveal similarities in the cognitive principles underlying the organization and learning of information (Sperber & Hirschfeld 2004).

This approach has been applied to the study of supernatural concepts and extended to a theory of the formation of religious beliefs (Barrett 2000; Boyer 2000, 2002, 2003). Research on concept formation suggests that humans reason about objects depending on the kind of thing to which they are judged to belong. A range of 'ontological' categories or 'domain concepts' have been identified – person, artifact, animal, inanimate natural object, plant, amongst others (Boyer & Ramble 2001). Each domain is associated with an 'intuitive ontology', a set of expectations

associated with items belonging to that domain. When an object is classified as belonging to a category, these ‘intuitive’ assumptions are triggered, going beyond the information given and constraining reasoning about the expected properties of the object.

Boyer and others argue that religious concepts acquire salience (are more attention-grabbing and memorable) by violating assumptions for the domain to which their referent ostensibly belongs. Violations of are two types: a *breach* of expectations for a particular category (spirits move through solid objects, violating assumptions about solid objects); and *transfer* of properties from another ontological domain (a plant with psychological properties transferred to it, so it can remember, plan, deceive, and so on).

A further proposal is that religious concepts tacitly activate non-violated assumptions by default (a spirit is classed as a person, hence we apply assumptions relevant to a person which do not need to be spelt out – it can remember, think, feel, etc.). This facilitates learning, since the key information about a supernatural concept is conveyed by indicating its ontological category membership, and then indicating the limited respects in which it differs from typical members of the category. All other knowledge about the novel concept can be predicted from its category membership.

The theory predicts that supernatural concepts enjoy a transmission advantage in human groups, since they are more salient and hence more likely to be remembered and communicated. This mnemonic advantage is one reason cited for why some supernatural concepts become objects of belief. A further reason is that some supernatural concepts are inferentially richer than others, conveying an additional transmission advantage because of their explanatory usefulness. Belief in supernatural agents is extremely widespread in diverse human populations, because – in this view – such agents have explanatory relevance to a wide variety of possible circumstances. Hence, a supernatural agent with access to a person’s innermost thoughts (a breach of intuitive psychology) might invisibly cause a person to trip (a breach of intuitive physics) because they failed to fulfil a vow, neglected their duties of prayer, told a lie, and so on (reflecting more normal assumptions about social reciprocity, moral obligations and accountability) (Boyer 2002). This potentially explains and meaningfully connects a wider variety of circumstances than explaining tripping by the presence of an invisible sofa, for example; in other words, supernatural agency concepts are inferentially rich. Additional factors cited by Boyer to explain the formation of religious beliefs are what he terms ‘minor reasoning errors’ of the kind researched by social and cognitive psychologists; for example, consensus effects (accepting views that are normative in a social group) and confirmation bias (recalling positive instances that seem to support a supernatural belief, not noticing or remembering negative instances) (Boyer 2002).

Boyer and Ramble (2001) conducted a cross-cultural study of free recall of items within stories to test the hypothesis that domain-level violations are recalled better than other conceptual associations in samples from France, Gabon, and Nepal. The stories featured artefacts and people, and contained counterbalanced lists of items that either conformed to intuitive expectations, or violated them. Care was taken to exclude counterintuitive items that had direct associations with culturally familiar religious concepts. Debriefing tests were also administered to check the ‘oddity’ of the situations described in the stories, and their familiarity – that is, whether

participants felt they had encountered similar items in stories, films, and so on. Hence the aim was to test how the structure of conceptual *templates* affected recall in diverse populations, independently of locally familiar *concepts* that exemplified a particular kind of template.

The results supported the main hypothesis that violations of intuitive expectations (either a breach of relevant domain expectations or a transfer of expectations from one domain to another) produce a recall advantage.

Problems with the innatist model of religious belief formation

Nevertheless, other results from Boyer and Ramble's study suggest that the innatist model of religious cognition needs to be significantly modified. The Nepalese sample comprised literate Tibetan monks of the Bon order living in Kathmandu. Bonpo monks are familiar with numerous stories relating the exalted abilities of yogins, and are thus familiar with a conceptual template of a person with special powers. Like the Gabonese sample (who used a similar story design), the monks recalled artefact domain violations better than 'intuitive' conceptual associations or kind-level violations (the latter are exaggerated 'intuitive' properties, such as a bucket that weighs ten tonnes). Yet contrary to expectations, and unlike the Gabonese sample, the monks showed no recall advantage for person domain violations over kind violations or standard expectations.

The result suggests that culturally unfamiliar template violations (about artefacts) are recalled better than culturally familiar template violations (about persons – i.e. novel concepts that are exemplars of a familiar *template* of person violations, even if they have not been previously encountered, and do not trigger associations with known concepts). But this would seem to diminish the mnemonic effects of template violations in contributing to belief formation, since in this case the monks are more likely to believe in concepts that they are less likely to remember. To put it another way, the result implies that stories about great yogins – which are locally familiar instances of a conceptual template of a person with special powers – are held as credible despite a relative lack of salience, raising the question: what additional processes maintain their status as beliefs? This assumes, of course, that the relative lack of salience of novel person template violations holds for culturally familiar person template violations, such as specific stories about yogins. If such a relationship does not hold, it raises the question: what processes confer salience on person template violations that are believed in, compared to those that are not? Either way, the effects of local enculturation on memory for concepts, and belief-formation, must be taken into account.

The result also raises a significant question about the extent to which judgements of what is 'intuitive' and 'counterintuitive' are culturally relative. Does high exposure to 'breaches' of person expectations in Tibetan culture make such 'breaches' less counterintuitive? The results would suggest so. Hence, in contrast to the view that domain concepts reflect the operation of encapsulated mental modules that operate uniformly irrespective of cultural context, the Bonpo results point to culture-specific effects on the construction of domain concepts and their effects on cognitive

processes such as memory formation. This conclusion is more in keeping with the view that cognition is deeply influenced by locally acquired knowledge structures of the type emphasized by social anthropologists, and their neo-associationist counterparts.

Boyer's proposals regarding how 'supernatural' concepts become religious beliefs is also unconvincing as presently formulated. The notion that supernatural agents are believable because of their inferential richness (or 'relevance') is a compelling hypothesis, but immediately raises the question of what additional processes operate to select some versions as plausible in some circumstances, but not others, and why many individuals (atheists) are able to reject all such notions as incredible in principle. This raises, in turn, the question of what other schemata and processes influence epistemic judgements (our rapid discriminations of what accounts of the world are believable or not). Similarly, the invocation of 'minor reasoning errors' does little to differentially explain why specific religious beliefs are held, since all ideas (not just religious ideas) are potentially subject to the effects of reasoning errors. In addition, few anthropologists would dispute that 'consensus effects' operate in social groups – the question is: what are the mechanisms by which they operate?

A more fundamental criticism of this account of belief formation, however, is that it is an account of reasoning and memory rather than of *belief per se*. All of the components of the model – domain-based reasoning, inferential relevance, and minor reasoning errors – all presuppose as yet unspecified mechanisms for tagging specific ideas as real and motivating.

So, are there innate cognitive constraints on religious beliefs? We can say that there is some cross-cultural evidence for better recall for concepts that violate domain expectations, but that familiarity with certain kinds of domain violation can markedly reduce this effect. Hence, the species-typicality of the inferential constraints is at least subject to some cultural modulation, and the extent and mechanisms of such effects have yet to be fully investigated and understood (noting that such research is in progress, as summarized, for example, in Sperber & Hirschfeld 2004). As for belief formation, the model is at best question-begging, presupposing a cognitive capacity for belief that in fact is precisely what has to be explained. In terms of providing a contemporary account of Geertz's definition of religion, the innatist school of cognitive anthropology has not moved us beyond, at best, specifying additional constraints on the formation and transmission of 'conceptions of a general order of existence'. We still do not know how specific conceptions come to be regarded as real and motivating amongst particular human groups. Can a neo-associationist approach help?

Neo-associationist approaches to cultural learning

Neo-associationist views of concept formation draw on connectionist modelling: knowledge is built up by learning associations (positive or negative correlations) among the features of a number of specific cases, rather than following innate or acquired rules (Strauss & Quinn 1997, p. 53). A developing schema begins with weights of zero or small connection weights between units in the context of a

general-purpose learning algorithm, with connectional strengths modified by environmental inputs, although the possibility of species-typical initial weights on networks is allowed (Strauss & Quinn 1997). Emotional arousal is viewed as enhancing associative learning, making some schemas more durable, including those learned early in life (p. 89).

The approach aims to identify schemata that are widely distributed in a social group by recording and analysing public symbolic practices such as conversation. However, like innatist perspectives, neo-associationism presupposes a capacity for concepts to be regarded as real and motivating. Nevertheless, the invocation of a role for arousal in learning raises the question of whether social groups can draw on the evocation of emotion to facilitate learning of key schemata, and so – to quote Geertz – invest ‘conceptions of a general order of existence’ with ‘powerful, pervasive, and long lasting moods and motivations’. This leads us to consider the cognitive effects of social–emotional signals, and their elaborate formalization in cultural displays such as ceremonial rituals. We will begin by considering current models of emotion, in particular the cognitive and neural systems that render individuals responsive to emotive stimuli.

Neurocognitive models of emotion

The human brain has evolved to process some stimulus events as intrinsically rewarding (e.g. sweet tastes) or aversive (e.g. very bitter or sour tastes). Such unlearned stimuli are termed *primary reinforcers* (Rolls 1999). The brain rapidly associates neutral stimuli that are linked in time and space to primary reinforcers, so that they evoke similar motivational or emotional responses. These neutral stimuli become *secondary reinforcers* (Rolls 1999, 2000). This model of the neural basis of associative learning is referred to as ‘Hebbian plasticity’, after its original proponent, Donald Hebb. It is sometimes summarized in the phrase, ‘neurons that fire together, wire together’ (LeDoux 1998, Rolls 2000).

In humans, associative learning is integrated with symbolic cognition. Symbol-based mental representations such as word meanings or autobiographical memories routinely acquire emotional associations and hence function as reinforcers in their own right. Human cognition is sufficiently complex to allow meaningful distinctions between types of interaction between self and social world, each associated with differences of cognitive-emotional response (for example, the distinction between guilt and shame – Eisenberg 2000). Human cognition is also distinguished by the capacity for ‘metarepresentation’, allowing emotional responses to become objects of reflection and so contribute to self-awareness; as Harre and Secord put it, ‘humans, alone among animals, can monitor their monitorings’ (Harre & Secord 1972).

The amygdala and orbitofrontal cortex are key association areas that receive and integrate multiple sources of sensory information, represent the motivational or emotional value of primary reinforcers, as well as memorize associations with secondary reinforcers (Davidson & Irwin 1999; Rolls 1999, 2000). Abstract representations are also processed by these evaluation systems (O’Doherty *et al.* 2001; Phelps *et al.* 2001). Both structures, amongst others, help orchestrate arousal system, endocrine and autonomic responses to emotional stimuli (Davidson & Irwin 1999;

Robbins & Everitt 1995; Rolls 1999). The insula and somatosensory cortices represent sensory feedback from the body, contributing to the feelings associated with different kinds of emotional arousal (Craig 2004; Critchley *et al.* 2004; Damasio 2000). Affective neuroscience has made rapid progress in mapping the neural and bodily systems involved in generating emotional responses, and associatively linking them to other cognitive representations (Damasio 1994, 2000; see Rolls 1999 for differing emphases).

Recent neurocognitive models of moral socialization invoke associative learning. Blair proposes that social–emotional signals such as facial expressions of emotions function as innate reinforcers. Aggressive behaviour evokes distress cues in its victims (facial and vocal expressions of fear or sadness), which produce unconditioned responses in the perpetrator and other observers: aversive arousal and behavioural inhibition. Cognitive representations of actions that produce these responses (moral transgressions) acquire aversive emotional associations, constraining subsequent behaviour. This species-typical emotional learning underlies the development of empathy. This ‘affective’ empathy occurs in conjunction with ‘cognitive’ empathy, based on social referencing – the ability to determine another’s gaze direction, and hence work out what they are referring to in a communicative exchange; and mentalizing, which allows the mental states of others to be represented (Blair 1995, 2001, 2003).

Enculturation

I suggest that the explanation of species-typical moral socialization by a conjunction of social referencing, mentalizing, and associative learning can be adapted to explain enculturation, the process whereby individuals acquire conceptions, motivations, and behaviours that are typical of their social group. The hypothesis here is that a combination of social referencing, mentalizing, and emotion perception orients individuals to locally relevant interpretations of the world, and renders them responsive to displays of the emotional valence and arousal appropriate to the stimuli in question. Hence, enculturation occurs through stable, repetitive conjunctions of meanings and emotions, promoting the formation of semantic memories and emotional and motivational dispositions. The interweaving of local conceptions with ascribed emotional significance is a ubiquitous feature of social existence. As the social anthropologist Valeri wrote of his time amongst the Huauilu of the Moluccas,

one does not have to stay long in Huauilu before one hears the world *maquwoli*, ‘taboo’ ... A child seizes a fruit and brings it to his mouth; his mother raises her voice in alarm and warns ... ‘Don’t, it is taboo’ ... The ethnographer attempts to photograph an innocuous-looking but curious object hanging from a rafter, and he is stopped by a cry: ‘Ia maquwoli’. A cricket jumps inside a house at night and people scramble to put all the lamps out and to cover a pregnant woman, screaming excitedly ... ‘It is very taboo’.

(Valeri 2000)

Valeri’s description suggests how social–emotional signals are used to inflect local conceptions of the world with distinctive emotional associations. Yet routine,

informal social interactions are not the sole source of the cognitive-affective schemata typical of a social group. Knowledge, dispositions and skills that are too difficult to learn through informal means, or are considered too important for their reproduction to be left to chance, are frequently organized into formal institutional systems (Bowker 1987). Religions are a prototypic example of such systems, and – particularly since the work of Durkheim – their ceremonial rituals have been viewed as a prime instrument of transmitting conceptions of the world, investing them with a sense of reality and motivational force (Knight 1999; Lambek 2002).

Characteristics of ritual

Ceremonial ritual is the ab-original form of cultural display, present from the earliest evidence of symbolic burial about 100,000 years ago, and continuing to be deployed even in secular states and contexts (Bell 1993; Mithen 2000). Ritual displays are ‘costly’, involving a high investment of time and resources. They typically (but not necessarily) occur in group settings. In contrast to ordinary speech, the signals are predominantly one-way (i.e. the structure of rituals typically preclude or limit the scope for novel responses by the ritual ‘audience’). The signals are high-amplitude, emotive, and multimedia. As Knight comments, ‘like animal gesture/calls, human ritual displays are characteristically loud, multimedia, emotionally infectious and heavily redundant’ (Knight 1999, pp. 229, 231).

In pioneering work, the British social anthropologist Victor Turner attempted to account for the social efficacy of symbolism and ritual by bridging sociological and psychological levels of explanation. Turner did much of his fieldwork amongst the Ndembu tribe of northern Zambia in the 1950s. When analysing rituals, he identified ‘dominant symbols’ which condensed diverse associations that were built up around them in Ndembu culture. For example, the ‘Milk Tree’ (*mudyi*) was a tree that exuded a milky white sap and formed the focus of a girl’s puberty ritual *Nkang’a*, in which she would be transformed into a marriageable young woman. She would lie under the tree wrapped in a blanket for a whole day while initiated women danced around her and the tree. The ritual place was *ifwulu*, ‘place of dying’, because there the girl ‘died’ from her childhood (Turner 1967, 1983).

By interviewing Ndembu tribespeople, Turner elicited the range of semantic and emotional associations the tree had for Ndembu people. He argued that it possessed two ‘poles’ of meaning – an ‘orectic’ pole (where the associations relate to physiological or appetitive themes, such as mother’s milk, lactation, breasts, and nubility); and a ‘normative’ or ‘ideological’ pole, where the associations related to the principle of matriliney, womanhood, the Ndembu nation, the relation between the girl and her mother, and the values and obligations of motherhood. In other words, the Milk Tree acquired both concrete and abstract associations. Turner used this distinction to answer the question of why

many social norms and imperatives were felt at the same time to be ‘obligatory’ and ‘desirable’: within its framework of meanings, the dominant symbol brings the ethical and jurial norms of society into close contact with strong emotional

stimuli. In the action situation of ritual, with its social excitement and directly physiological stimuli, such as music, singing, dancing, alcohol, incense, and bizarre modes of dress, the ritual symbol ... effects an interchange of qualities between its poles of meaning. Norms and values, on the one hand, become saturated with emotion, while the gross and basic emotions become ennobled through contact with social values. The irksomeness of moral constraint is transformed into the 'love of virtue'.

(Turner 1967, p. 30)

Rituals and associative learning

Turner's theory can be reframed in terms of associative learning of cognitive-affective schemata. Rituals typically employ many stimuli to enhance attention, arousal, emotion, and hence semantic evocation and memory formation. The salience of these stimuli is derived from their composite nature, which typically combines primary reinforcers with secondary reinforcers; further, the sensory properties of primary reinforcers are manipulated to produce 'superstimuli', such as masks exaggerating salient features of facial expressions (Sperber & Hirschfeld 2004). Examples of primary reinforcers widely sampled in ceremonial ritual include: motion, colour, luminosity, emotive facial expressions of masks, accentuated sexual characteristics (cosmetics, oils), sudden loud noises (e.g. fireworks, bells), prosodic accentuations of language (singing, chanting), pain (flagellation, circumcision), temperature (baptism by immersion), smells (incense, perfumes), taste (ritual foods), and multisensory repetitious stimuli which activate arousal systems (see Rolls 1999 for a candidate list of primary reinforcers). Secondary reinforcers are likely to be highly culturally variable, since the public symbols and their associated schemata are learned in local cultural settings. To use LeDoux's terms, the ritual practices inculcate 'emotional memories', patterns of emotional response activated by the public symbols and schemata linked to the ritual practice.

While this identifies mechanisms of implicit emotional learning, other contemporary theories of ritual emphasize its role in the formation of *explicit* memory as a basis for influencing behaviour.

Ritual and explicit memory formation

Explicit memories are conscious 'fact and event' memories, in contrast to implicit memory processes (for example, habit learning, or associative learning) (Rolls 1999; Squire & Knowlton 2000). Semantic memory is memory for facts ('the Pope is the spiritual leader of the Catholic Church'), while episodic memory is memory for discrete, typically emotive or arousing events (remembering footage of John Paul II being shot in 1981). Whitehouse distinguishes two modes of religiosity, the *doctrinal* and the *imagistic*. Doctrinal modes predominate in regional and world religions, typically involving doctrinal codification in conjunction with highly structured and repetitive ritual that allows the extraction of mental representations of a general, propositional nature (for example, the Nicene Creed). In Whitehouse's view, this

mode predominantly activates and relies on semantic memory. The Catholic Mass is perhaps the quintessential example of a doctrinal religious ritual (Whitehouse 2000).

The imagistic mode is more typical of small scale religions or cults, in which revelations are transmitted through sporadic, highly emotive and arousing ritual, 'encoded in memory as distinct episodes, and producing highly cohesive and particularistic social ties' – for example, the Ndembu ritual of N'Kanga described above (Whitehouse 2000, p. 1).

From the perspective outlined above, both modes of religious ritual involve the orchestration of symbols that evoke cognitive responses (semantic associations, episodic memories, feelings, motivations, amongst other aspects of cognition). The salience of symbols is built up by incorporating selected features from a species-typical menu of innate reinforcers into the sensory forms of symbols (e.g. visual brightness, motion, exaggerated facial expressions in masks, brilliant colours in clothing). In addition, symbols and their associated mental representations also function as secondary reinforcers (through prior learning, including previously learned semantic associations). A cognitive difference between the modes is that imagistic practices typically create episodic memories because the ritual strategies are particularly arousing, as well as being less frequent and hence providing less opportunity for semantic schema abstraction. While more 'doctrinal' settings can be the occasion of 'peak' religious experience, the evocation of such experience is not a primary aim or usual effect of such ritual. Nevertheless, 'doctrinal' settings do evoke specific meanings, emotions, and motivational dispositions amongst participants, although the mechanisms of evocation depend on the portrayal of an explicitly meaningful view of self and world to which moods and motivations are intelligibly related. To cite an example given by Geertz, 'in the doctrine of original sin is embedded also a recommended attitude toward life, a recurring mood, and a persisting set of motivations' (Geertz 1993 [1966], p. 124). This is in contrast to the overwhelming emotion that may accompany imagistic practices, parts of which may include periods of deep physical and mental anguish, insecurity, and a struggle to understand prior to moments of deeply felt insight (Whitehouse 2000).

Research on memory formation suggests that strong episodic memories following arousing, traumatic events are subject to 'contamination' by post-event misinformation (Loftus & Bernstein 2004, p. 2004). In other words, schema-based cognitive appraisal, activated by social suggestion, can influence the content and interpretation of episodic memories. Applied to imagistic ritual practices, this underlies the importance of local interpretations in shaping the content and significance of what is recalled.

The distinctions between doctrinal and imagistic modes are not rigid. In Christianity there are many examples of movements that cultivate a more emotive form of ritual practice and worship – for example, the Charismatic movement within Catholicism, Baptist ministries, or Pentecostalism.

From emotive ideas to beliefs

In terms of Geertz's definition of religion, we now have a framework to explain the capacity to invent systems of symbols and the formulation of conceptions of a general

order of existence, as well as an account of how the symbols and conceptions are transmitted, learned, and imbued with ‘powerful, pervasive, and long-lasting moods and motivations’ (Geertz 1993 [1966], p. 90). Nevertheless, a key component of his definition remains unaccounted for: religious symbols clothe conceptions with ‘an aura of factuality’ so that ‘the moods and motivations seem uniquely realistic’ (p. 90). This implies that ideas can be emotive without necessarily being regarded as grounded in reality. The capacity to make rapid epistemic judgements about the reality or otherwise of imagined states of affairs suggests that this is true – an emotive fantasy can be seen as such, when underlying assumptions about reality are re-asserted. As Hume put it, ‘an idea assented to *feels* different from a fictitious idea, that the fancy alone presents to us’ (Hume 2000 [1738]). This raises the questions of what mechanisms mediate the sense of what is ‘really real’, and how are these mechanisms recruited by religions and other cultural systems that aim to transmit ‘conceptions of a general order of existence’, and invest them with a sense of reality?

Dopamine and the ‘aura of factuality’

In the neo-associationist model of cognition, the associative strength of connections between cognitive elements (meanings, sensory images, episodic memories, prepotent motor responses etc) can be modified by emotional arousal. Here we propose that a neurotransmitter system – the dopamine system – is particularly involved in investing schemata with a sense of salience and reality, so contributing to the formation of what Quine and Ullian termed ‘webs of belief’ (Quine & Ullian 1970). We will work back from a theory of psychopathology to normal cognition.

Kapur has proposed a theory to account for the mechanism by which psychosis – delusions and/or hallucinations – arises in schizophrenia (Kapur 2003; Kapur & Mamo 2004). He begins by citing the ‘motivational salience’ hypothesis of dopamine function, according to which activity of the dopamine arousal system ‘mediates the conversion of the neural representation of an external stimulus from a neutral and cold bit of information into an attractive or aversive entity ... In particular, the mesolimbic dopamine system is seen as a critical component in the “attribution of salience”, a process whereby events and thoughts come to grab attention, drive action, and influence goal-directed behaviour because of their association with reward or punishment’ (Kapur 2003, p. 14).

This model of dopamine function forms the background to Kapur’s account of psychosis as a ‘disorder of aberrant salience’. He proposes that in psychosis ‘patients develop an exaggerated release of dopamine, independent of and out of synchrony with the context. This leads to the assignment of inappropriate salience and motivational significance to external and internal stimuli’ (2003, p. 15). In the early phases of psychosis, this aberrant attribution of salience is experienced as a ‘somewhat novel and perplexing state marked by exaggerated importance of certain percepts and *ideas*’ (2003, p. 15, italics added). Kapur quotes subjective reports of patients reflecting on the early stage of psychosis; for example, ‘my senses seemed alive ... Things seemed clearcut, I noticed things I had never noticed before’; another stated, ‘I felt there was some overwhelming significance in this’, and another said, ‘I felt like I was putting a piece of the puzzle together’ (2003, p. 15). What is

striking about these comments is the intensification of the sense of *significance* and *meaningfulness* of experience, which are properties of *ideas*, not primarily of percepts alone. In other words, it is not only the emotional valence of aspects of the world that stand out, but the sense of the *reality* with which they are perceived and thought about; in fact, this psychotic phase is more a phase of ‘hyper-reality’ than ‘hyper-emotion’ – to quote Knight’s description of ritually evoked experience, the preoccupying perceptions and ideas of psychotic patients seem ‘more real than reality itself’ – i.e. more ‘real’ than routine, everyday experience (Knight 1999).

In Kapur’s view, delusions arise when patients impose explanations on these experiences of aberrant salience in order to make sense of them, producing ‘insight relief’, forming ‘a guiding cognitive scheme for further thoughts and actions’ (2003). Hallucinations arise from ‘the abnormal salience of the internal representations of percepts and memories’ (p. 16).

Antipsychotic drugs, through dopamine receptor blockade, work to dampen the aberrant salience of the internal representations that preoccupy the patient. By attenuating the salience of ideas and percepts, the patient has an opportunity ‘to “work through” her symptoms toward a psychological resolution’ (2003, p. 17). He continues, ‘symptom resolution may have much in common with the mechanisms whereby all humans give up on cherished beliefs or frightening dreads, and it may involve processes of extinction, encapsulation, and belief transformation – fundamentally psychological concepts’ (p. 17).

The social modulation of dopaminergic function

When considering enculturation, we wish to understand the processes whereby collective ‘cherished beliefs’, ‘frightening dreads’, and many other mental representations are *acquired* rather than given up. In contrast to the psychotic patient who develops ‘an exaggerated release of dopamine, independent of and out of synchrony with the context’, in enculturation we propose that dopamine release is ‘dependent on’ and ‘in synchrony’ with social context. Dopamine release is modulated by the orchestration of reinforcing stimuli in cultural displays and social interactions, in conjunction with other emotion processing systems outlined above. Modulation of dopamine release critically contributes to ‘tagging’ ideas and percepts with an enhanced sense of reality and motivational salience, powerfully engaging interpretation and contributing to the formation of new, powerful beliefs that become incorporated into larger cognitive schemas.

Cultural displays and the evocation of ‘meaning’

While the theory outlined above may help to explain why arousing sensory stimuli are employed in cultural displays to facilitate memory and belief formation, why should cultural displays such as rituals be characterized by the use of symbols (actions, dress, objects, speech, etc.) which seem to *imply* possible interpretations rather than explicitly stating them? After all, if cultural displays such as rituals are instruments of enculturation, why leave the transmission of key concepts and values to chance by

relying on such ambiguous media? This point is particularly true of what Whitehouse terms the ‘imagistic’ mode of religious practice, but may also be true of doctrinal modes of practice to the extent that they involve the use of implicitly meaningful speech, actions, artefacts, and so on in addition to explicit, doctrinal discourse. The *Nkang’a* puberty rite discussed above – a good example of an imagistic practice – contains many enigmatic, but nonetheless implicitly meaningful components – for example, riddles, ritualized speech involving unfamiliar words, and mimesis of social conflicts, in addition to the dominant symbol of the Milk Tree itself, its milky white sap, the ordeal of lying motionless before it, and so on (Turner 1967, p. 24).

Answers to these questions are suggested by recent research on semantic processing, and in particular on different modes of semantic processing and their neural bases. This research also directly relates to the role of dopamine in enhancing the salience of experience and meaning, and so helps to explain why imagistic rituals are characterized both by sensory-affective stimuli and by enigmatic, implied semantic relationships in symbolism.

In contrast to the widespread view that language functions are lateralized to the left, dominant hemisphere, cognitive research has revealed that both hemispheres support semantic processing of symbolic stimuli. As Taylor et al. (2002) point out, ‘right hemisphere language processing has been characterized by a widespread, or coarse, as opposed to a focused activation of semantic concepts, ... the appreciation of metaphorical or connotative as opposed to literal or denotative aspects of language, ... and a preference for remote as opposed to close associations’ (Taylor et al. 2002, p. 251; Taylor et al. 1999).

In addition to this style of open, connotative semantic processing, Brugger proposes that right hemisphere processing predominates in the detection of meaningful patterns in what would otherwise be perceived as random stimuli. Brugger uses Conrad’s term ‘apophenia’ to describe this cognitive mode of pattern detection, defined as ‘unmotivated seeing of connections’ accompanied by ‘a specific experience of abnormal meaningfulness’ (Brugger 2001). Brugger argues that the apophenic ‘denial of chance’ (Brugger 2001, quoting Glatzel’s phrase) is not merely characteristic of psychosis (for example, in interpreting unrelated events as forming part of a conspiracy), but also in artistic and scientific creativity.

Brugger proposes that this apophenic thinking style reflects a disinhibition of associative processes, which in the case of psychosis-in-schizophrenia is characterized by a dysregulated bias towards right hemispheric processing, resulting in the detection of unreal connections between events (paranoia), and/or a breakdown of normal constraints on association of ideas (thought disorder) (Brugger 2001). In this regard he cites Ramachandran’s proposal that in normal cognition left hemisphere processing is specialized for ‘the suppression of anomalies and the preservation of the status quo’, while the right hemisphere has a complementary function ‘as an “anomaly detector” whose main task is to shift a currently accepted paradigm’ (Brugger 2001; Ramachandran 1998).

Ramachandran proposes that jokes engage the looser semantic associative mode of the right hemisphere so that their meaning can be worked out; ‘getting’ a joke requires a sudden paradigmatic shift, in which an indirectly related meaning or association is suddenly tapped. This suggests that a disinhibition of semantic associations is not merely permitted in certain cultural contexts, but *required* to make sense of what is going on.

Our hypothesis is that imagistic rituals deploy salient but referentially open, implicitly meaningful stimuli that require increased engagement of analogical/right hemispherical semantic processing to make sense of their perplexing but suggestive prompting, evoking loosely associative, emotive semantic processing full of connotation, metaphor, pattern recognition, and – where the limits to comprehension are reached – ‘salient mystery’ (Boyer 2003). The otherworldly beings and events evoked in the ritual setting evoke analogical interpretation precisely because they contradict the assumptions of routine, domain-based reasoning, and hence cannot both be regarded as *real* and be interpreted as meaningful without a more creative, loose, connotative sampling of available semantic representations. The evocation of this loosely associative, salient thinking results in the modification of existing semantic networks (for example, incorporating new lexical labels and background information about the beings and events alluded to in the ritual setting), as well as reinforcing or creating new connective strengths between semantic representations (for example, in the case of *Nkang’a*, forming semantic associations between percepts and ideas such as the Milk Tree, marriage, sexuality, motherhood, matrilineal relationships, amongst other potential analogical associations implicitly and/or explicitly linked in the ritual). In Mithen’s terms, the analogical mode of salient, loosely associative thinking is the mode of ‘cognitive fluidity’, ‘mapping across domains’, and ‘representational re-description’ (Mithen 2000).

The right hemisphere is predominantly involved in emotion processing as well as remote, indirect semantic processing (Davidson & Irwin 1999). This raises the question as to whether increased activation of the right hemisphere by one of the two functional modes (i.e. analogical semantic processing *or* emotional arousal) facilitates the activation of the other. It is interesting to note that cultural forms that engage analogical semantic processing – for example, poetry, music, theatre, art, religious ritual, visual arts, jokes, play – are also associated with accentuated emotion, significance, meaning (pattern recognition), and reverie (i.e. fluency of emotive mental associations). We suggest that the evocation of heightened emotion by either a sensory-affective or cognitive-symbolic route is associated with increased activation of the mesolimbic dopamine system, contributing to the sense of the heightened reality of ritual experience.

An emerging perspective: a social neurocognitive theory of religion and ritual

The aim of this paper has been to provide a social neurocognitive account of each of the components of Geertz’s definition of religion, and the relations between them. The capacity to invent, communicate and comprehend symbols depends on a suite of specialized cognitive abilities, such as dual reference, abstract representation, offline representation, amongst others. In general terms, the coordination of these cognitive functions in symbolic processing depends on associative transformations of sensory information in unimodal sensory and transmodal association cortices. These brain systems evolved under specific socio-ecological conditions which favoured selection for the efficient signal perception and abstract relational processing on which symbolic cognition and communication depend.

In addition to literal referential language, symbolic culture requires a capacity for mentalizing and analogical thought. The latter ability is particularly involved in the creation of symbol systems that comprise the structured worlds of meaningful stimuli and social relations that human beings inhabit. This world of public symbolism forms the basis for the internalization of cognitive schemata that underpin individual understandings of and dispositions towards a social group's 'conceptions of a general order of existence'. There is evidence for species-typical constraints on concept formation and memorization, which contribute to a transmission advantage for 'counterintuitive' concepts. Nevertheless, cultural familiarity with certain kinds of violation of conceptual templates reduces the salience of related concepts, suggesting that cultural learning also constrains the 'intuitiveness', salience and memorability of concepts.

Neo-associationist models of learning and a neurocognitive model of moral socialization form the basis for new proposals about enculturation. A combination of social referencing, mentalizing, and emotion perception enables enculturation to occur by attention to stable, repetitive conjunctions of meanings and emotions in the social environment, promoting the formation of semantic memories and emotional and motivational dispositions. In addition to informal enculturation in routine social interaction, cultural systems such as religions organize and protect transmission of valued knowledge. Religious rituals are culturally invented symbolic displays that transmit conceptions of the world and imbue them with emotional and motivational significance. Two kinds of ritual are distinguished: high frequency, low arousal rituals belonging to a 'doctrinal' religious mode, and low frequency, high arousal rituals belonging to an 'imagistic' religious mode (Whitehouse 2000). 'Doctrinal' rituals allow the extraction of semantic memories and associated emotions through repeated participation and exposure. 'Imagistic' rituals are particularly associated with intense emotion, and the formation of episodic memories and strongly felt social ties.

New hypotheses are introduced to account for the efficacy of ritual: religious rituals, and especially imagistic rituals, employ two major strategies to convey conceptions of the world and invest them with a heightened sense of reality and emotion: (1) a 'sensory' route evokes salient thought and experience by orchestrating multiple reinforcing social-emotional signals and other stimuli (e.g. motoric stimulation through dance), engaging attention, emotion, and arousal; (2) a 'semantic' route, in which the presentation of enigmatic but suggestive verbal and non-verbal symbols engages an analogical/right hemispheric processing strategy to make sense of what is authoritatively presented as *real* but incompletely understood. Both routes are hypothesized to synergically interact, activating the mesolimbic dopamine system amongst other components of cognitive-emotion processing, so that the 'moods and motivations' evoked by the ritual performance seem 'uniquely realistic' (Geertz 1993 [1966], p. 90; see also Laughlin *et al.* 1990 for an alternative two-route model). These social, cognitive, and neural processes constitute ways in which religious ideas are turned into convictions.

Implications, limitations, and future directions

This approach to enculturation in general, and the acquisition of religious beliefs in particular, has drawn on general principles of cognitive and neural functioning to

outline mechanisms of enculturation. Nevertheless, identifying species-typical constraints on cognition and brain function does not imply a pan-human uniformity of experience and behaviour. In fact, the aim of the approaches reviewed and developed in this paper is to identify processes that enable distinctive networks of cognitive-affective schemata to become widespread in a population, contributing to the group-level differences we call 'culture'.

The explanatory focus of this paper has been on what Hinde would term 'the study of immediate causation' – in other words, the social, cognitive, and neural causal mechanisms by which religious ideas are acquired and turned into beliefs (Hinde 1999). Explanations relating to the evolution, development, and function or significance of these behaviours have not been addressed in any detail (for evolution, see Barrett *et al.* 2002; Deacon 1997; Dunbar *et al.* 1999; Durham 1991; Mithen 1996; Sperber 1996; for development, see DeLoache 2004; for debates about the social significance and/or functions of ritual, see Bell 1993; Douglas 2000; Hinde 1999; Lambek 2002; Valeri 2000).

A religious sceptic might take the arguments here as a form of eliminative reductionism, which account for religious belief in naturalistic terms without a need to invoke the existence of the objects of religious belief. By contrast, I suggest that the programme here can be understood as a social neuro-cognitive extension of the sociology of knowledge, in which the existence of all beliefs is taken as equally problematic (in the sense of equally requiring explanation). The focus of inquiry is the Kantian question of 'what cognitive capacities are presupposed by, and necessary for, the existence of beliefs'? This question can be asked of any beliefs, including those of scientists. The sociology of knowledge does not obviate the need to determine the conditions under which, and senses in which, a given belief or web of beliefs can be judged to be true or false (Bowker 1987).

The perspective presented here draws on two very different research traditions: social anthropology, which attempts to describe and explain complex social reality through participant observation; and the experimental approach of the cognitive sciences, which typically uses simplified cognitive or sensory stimuli in controlled experiments, to allow inferences about a variable or variables of interest. Progress in a cognitive science of culture will require increasing the ecological validity of the experimental approach, in order to understand how cognitive and neural processes allow human beings to meaningfully participate in diverse social worlds (Sperber & Hirschfeld 2001). Engaging with social anthropology, religious studies, and other humanities will be a vital part of this process.

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