

RETHINKING THE RELATIONSHIP BETWEEN STUDIES OF ETHNOBIOLOGICAL KNOWLEDGE AND THE EVOLUTION OF HUMAN CULTURAL COGNITION

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Introduction

Recent projects reclaiming social anthropology for the study of human origins have relatively little to say about cognition of the natural world. Yet, how early humans organized their knowledge of biota must have been crucial for key adaptations at successive thresholds of evolutionary change. Drawing on a growing body of work comparing the perception, engagement and management of biotic forms among peoples living in a diversity of environmental and social contexts, this chapter offers a critical review of how it might be applied to our understanding of human evolution.

Models

Anthropologists have long reflected on the legitimacy of applying theory developed in relation to contemporary ethnography to the study of human origins. As we move backwards in time differences in

biology, behaviour, cognition and ecology make it decreasingly plausible that such theory is relevant. For peoples who preceded the historical record by a few millennia it is reasonable to assume 'continuity thinking': that these are 'people like us' (Ingold 2000). But to what extent can we be confident for human and pre-human populations at 20,000 BP, or 200 ka or 2.0 ma? When we find evidence of red ochre use at 100 ka (Watts 2014) what assumptions can we make about behaviour that accompanied it?

The big epistemological and methodological issue for evolutionary biology is different. In dealing with the earlier period of human evolution, biologists assume humans to be like other species for which the modern synthesis of genetics, palaeontology and socioecology is our best source of models and evidence. However, there are varying views as to the extent to which this approach might apply to more recent phases of human evolution, and Mithen (1996) has argued that comparison with living nonhuman primates for species closer phylogenetically to *Homo sapiens* than early African *Homo erectus* (sometimes called *H. ergaster*) is problematic. Up until the 1960s - and still in some quarters - there was a view that evolutionary theory was unhelpful because of the overarching dominance of 'culture' and the human capacity to self-consciously control the conditions of its own change. We would now want to qualify this, and note the usefulness of primate models when examining, for example, sexual signalling in descendants of *Homo heidelbergensis* in the past half-million years (Power, Sommer and Watts 2013). Indeed, the rise of human ethology, and then behavioural ecology, evolutionary psychology and most recently cultural phylogenetics (Callan, this volume), has undermined the notion that the dominance of 'culture' is always inconsistent with evolutionary explanations.

We therefore have two types of model: those from social anthropology looking from the present towards the past, and those from evolutionary biology looking forwards from the past, a distinction mirroring anthropology's uncomfortable relationship with the concepts of history and evolution. To this we might add a third type: Darwinian modelling testing hypotheses using data drawn from archaeology or ethnography. At some point in geological time, the explanatory power of evolutionary models meets that emerging from anthropological and other forms of socio-cultural theory coming in the other direction. At the meeting point there is a horizon where both might plausibly operate. Thus, depending on whether we focus on the emergence of 'symbolic culture' (learned behaviour socially transmitted through symbols) at 100 ka or earlier, on modern humans

at 200 ka, or fire and homebases at 400 ka, there are major differences in how modelling based on either might work. Archaeologists have been caught between these two kinds of theory, reliant on biological theory to understand the early parts of the human story but on comparative social anthropology and history to understand the recent past. But while biological models are at their weakest in explaining the specific present, and social anthropology at its weakest in explaining the distant past, each operates at different explanatory levels and they should not in any fundamental sense compete, both contributing to explaining behaviour that is ostensibly the same.

One argument in favour of ethnographic analogies and theory drawn from social anthropology is that while they generate models that might be wrong, at least they are explicit and testable. The same applies to behavioural ecology based on fieldwork with modern peoples. By contrast, one of the criticisms of evolutionary psychology is its underlying teleological notions about 'basal humanity', often dependent on studies from WEIRD (Western, Educated, Industrialized, Rich, Democratic) populations (Henrich, Heine and Norenzayan 2010). While apparently drawing on modern hunter-gatherer studies, evolutionary psychologists are often insufficiently explicit and selective in analogy, and disregard many findings from contemporary ethnography and comparative anthropology (e.g. Confer et al. 2010).

It is unsurprising that the study of human origins has been especially concerned with hunter-gatherers. Since Lee and DeVore (1968) more care has been taken in defining what kind of model we are talking about, and the view that the lives of the ever-dwindling number of African hunter-gatherers might tell us something about the socio-cultural contexts in which humans evolved has been reinforced by what we now know of sub-Saharan Africa as the home of 'basal humanity' through the fossil, archaeological and genetic evidence. However, the extent to which early foragers were 'hunter-gatherers' as we currently understand the term, or that 'hunter-gatherers most closely represent *natural* humanity' (Barnard 2011: 106) [my emphasis], remains controversial. If we accept that what has made humans is a capacity to diversify behaviour through cultural transmission on a scale not found among great apes and early hominins, in order to deal with the widest possible set of environmental conditions, then the African hunter-gatherer model alone is insufficient to allow us to properly understand not only later transformations but human origins as well. Given ecological differences and cultural change through geographic separation, we might expect considerable variation among palaeolithic hunting and

foraging groups. In placing so much weight on the significance of contemporary African hunter-gatherers we risk missing evidence from other hunter-gatherers, or indeed other subsistence populations, and adopting a very restricted interpretation of the relevance of social anthropology.

Cognizing the Biological World

Alan Barnard (2011) invites palaeoanthropologists to engage with 'social anthropology', meaning an intellectual tradition that had come to be recognized by 1965 as the 'British School', with its particular focus on kinship. But social (socio-cultural) anthropology in its wider sense refers to all that social anthropologists do, and increasingly this has been outside the narrowly defined canon of work. Given how social anthropology developed until the 1970s, and the main concerns of behavioural ecology and evolutionary psychology, it is understandable that there has been a primary focus on hunter-gatherer studies, and also on social cognition and kinship in seeking to apply its findings to human origins. But we cannot comprehend the evolution of sociality without attending to how early hominins and humans perceived their environment, organized the information necessary to evaluate it and used it to adapt to changing circumstances.

While it is recognized that hunting requires knowledge of animal behaviour (Barnard 2011: 100), there has been less focus on how that capacity developed. And while much of the mind has evolved to identify, harvest, process and digest biota in the widest sense, comparatively little has been published on the use of plants by early hominins and humans, as food, indicator species, tools and medicines. Many of the cognitive characteristics underpinning the sharing and transmission of this knowledge humans share with other apes, for example in regard to tool-making or nut-cracking.

There are many similarities between human and nonhuman primates in terms of categorical perception (e.g. Harnad 1987; Zentall et al. 2008). Comparative studies have demonstrated the importance of abilities to compose two or more objects into sets, and make distinctions of the kind food–non-food, same species–different species, toxic–non-toxic, male–female, predator–prey, though we have yet to find good evidence of more advanced hierarchic cognitions such as taxonomizing or synchronous notions of causality. Abstract categories seem to require the kind of training that some chimpanzees have

undergone, though some can achieve the same end using memorized images. Chimpanzees can also classify functionally, grouping, for example, pips and fruit rather than apples and pears, though it remains unclear whether these operations are routine behaviours in natural settings or simply potential evident in experimental situations. In the realm of social intelligence too, nonhuman primate studies yield evidence that individuals can group others according to their pattern of association (e.g. Premack 1986; Cheney and Seyfarth 1990: 86; Clay and Zuberbühler 2014; Pika 2014).

There is evidence for genetically encoded prototypes in nonhuman vertebrates triggering behavioural responses, such as aversion behaviour with respect to predator-like images. That these latter are strongly selected for may explain why animacy as a phenomenon and certain animal life forms (e.g. 'birds') are more perceptually salient than plants (e.g. 'vines'). However, Herrnstein (1985) has shown that pigeons exposed to pictures of all kinds of trees, as well as trees in different contexts, could differentiate these from non-trees. This has been interpreted as indicating the existence of a concept of 'treeness' as a prototype (Cheney and Seyfarth 1990: 87; Orians and Heerwagen 1992: 4559).

However we interpret the evidence, categorical thinking does not in itself separate humans from other animals (Harnad 1987), and we share many biological prompts which help make sense of the world, combined with more specific genetically encoded image-response patterns. Therefore, the tendency to categorize the world and then act on the reconfiguration is an evolved and ancient function (Tallerman and Gibson 2011), while in all apes and hominins the processes of categorization in both natural history and social intelligence are achieved through advanced neural plasticity of the prefrontal cortex.

Physical Evidence for Biological Knowledge During the Pleistocene

A problem in reconstructing the evolution of human biological knowledge capacity is lack of physical evidence. Macroscopic organization of the brain inferred from fossil crania, and the post-cranial skeleton, tell us something about the ability of early hominins (e.g. *Australopithecus*) and early humans (that is *Homo*) to perceive, interact with, and manipulate biota around them. Contextualized animal bones permit identification of butchering sites, hearths, waste areas and processed objects. For the Upper Palaeolithic the significance

of animals is apparent from artistic representations. Evidence for plant knowledge and use is, however, comparatively poor. For 10,000–27,000 BP we have data on various plants as food, psychoactive substances, poisons, cordage and textiles; and for plant processing tools (mortars and pestles, needles, awls, and loom shuttles that suggest plant fabrics) (e.g. Soffer 2004; Shepard 2005; Mercader 2009; d'Errico et al. 2012). Recent Spanish evidence (Sistiaga et al. 2014) suggests greater Neanderthal plant consumption than previously assumed, while Henry, Brooks and Piperno (2014) have shown Neanderthals and early modern humans consuming equal quantities of plant matter, including seeds and storage organs. From ~77,000 BP we have sedges and rushes from South Africa, particularly *Crypocarya woodii* for bedding and as insecticide, regularly being burned (Wadley et al. 2011). From 300 ka we have wooden artefacts (e.g. Thieme 2000), and at 790 ka burned seeds, including olives, barley and grapes from Israel (Goren-Inbar 2011).

The shift between early hominins and early humans incorporated significant dietary change, but available physical evidence has possibly skewed our interpretations. Hunting and scavenging as practices, and meat as food, have received more attention than use and knowledge of plants. While modern hunter-gatherers (and not only hunter-gatherers) prioritize animals and meat in ritual and cosmology, apart from polar and sub-polar peoples, there is often a disconnect between the importance attached to hunting and the fact that bulk food is plant-sourced. However, even where we can demonstrate from the archaeological record levels and kinds of plant use, it is difficult to know how these impinge on the capacity for environmental perception and classification.

Controlled fire use is a crucial step in an evolving capacity for biological knowledge, as it requires collecting phytomaterials and an understanding of their properties as fuel. In Eurasia, fire control becomes general by 300–400 ka (Roebroeks and Villa 2011). In Africa, the picture remains unclear, though there is evidence from 1.0 ma at Wonderwerk (Berna et al. 2012). Fire is a pre-condition for cooking and Wrangham (2009) has suggested that the ability to cook both meat and vegetables had a major impact on subsequent human evolution, altering the apparatus of mastication, digestion and nutrition. For Wrangham, the most likely threshold is the transition to *Homo erectus* at 1.8 ma, where we find shrivelling of the gut, dental changes and other features consistent with processing food. But there are doubts concerning the early dates for cooking and the social difficulties and costliness of its use, for example the likely requirement

for homebase organization and fire-tending. Others have suggested that cooking is better associated with the appearance of *H. heidelbergensis*, between ~500 and ~300 ka (e.g. Watts 2014). In this case, cooking cannot account for the anatomical changes mentioned by Wrangham, though it doubtless made food more palatable, easier to digest, and calorifically efficient, releasing nutrients and removing toxins. Moreover, cooking requires knowledge of raw materials, their preparation and the effects of their transformation, and may have made a big difference in terms of the role of seeds and plant storage organs in the diet.

Further clues as to how biological knowledge-making evolved are found in comparative primatology. We have increasing evidence for the social transmission of plant and animal use among anthropoid apes and monkeys: for food (including nut-cracking, geophagy and the seeking out of fermented biomass), for medicines (including dewormers and insecticides), and for tool selection and nesting tree preference (e.g. Nishida et al. 1983; Badrian and Malenky 1984; Huffman 1997; Krief et al. 2006). We know that chimps think about the spatial distribution of resources, and about fruit ripening times (e.g. Wrangham 1977), but have no way of inferring the likelihood of the existence of food patches based on the generalization of knowledge. They rely on memory alone. Chimps can, however, measure distance between paired locations and make harvesting decisions on this basis (Boesch and Boesch 1984), and co-operate in hunting.

We can make a fair claim that the basal hominin diet was plant-based (Milton 1999), and that omnivory was integral to an eclectic diet and generalist feeding strategy (Teaford and Ungar 2000) in an environment where competing primate species were leaf-eating and more specialized. But although Darwinian theory goes some way in explaining how biological knowledge further evolved within human phylogeny, we need to turn to the anthropology of living human populations to find better clues as to how this happened.

The Ethnobiological Turn and Modelling Modularity

Anthropological studies of biological knowledge emerged from the Boasian ethnolinguistic tradition associated with Edward Sapir and Benjamin Lee Whorf. Initially, this was concerned with demonstrating what people knew and how they organized that knowledge at the level of individual 'cultures'. The prime exponent of this approach within ethnobiology was Harold Conklin. But by the early 1960s Brent Berlin

was showing how cross-language data could provide evidence of the way in which colour terms were added to languages (Berlin and Kay 1969), and suggesting principles that could be applied to other domains. This guided his work on ethnobiological classification, and underpinned his universalist-evolutionist approach. In the Berlin model (1970, 1972), the ontogenetic order in which ranks are acquired in the growing child mirror the order of their evolution (e.g. generics > 'higher order' taxa > sub-generic taxa > kingdom). Similar claims were later made by Brown (1984, 1986) for the order in which life forms (e.g. trees and birds before herbs and mammals) are added to language. Such mutually-reinforcing ontogeny-phylogeny models have been common in anthropology since the nineteenth century. While not accepted by all, the approach has been influential among not only ethnobiologists, but also psychologists (Rosch 1978; Medin and Atran 1999), cognitive scientists (Boden 2006), linguists and even social anthropologists (e.g. Bloch 1998). With its endorsement through the work of Atran (e.g. 1990), it has acquired the status of a new orthodoxy.

The Berlin–Atran consensus has fed into the archaeology of human origins through the work of Stephen Mithen. In his *Prehistory of the Mind* Mithen (1996) uses the modular model of multiple intelligences popularized by Fodor (1983) and others, distinguishing variously, mathematical, social, linguistic, technical (intuitive physics) and natural history intelligence, in addition to general intelligence. In this chapter I confine myself to natural history intelligence in relation to social cognition.

Mithen (2006) accepts the existence of a strong module of natural history intelligence, which he argues comprises the principles for organizing knowledge of plants, animals, landscapes and (perhaps we should now add) fungi. The key features of natural history intelligence are the universality of the species concept, sequential patterns of naming (mainly use of binomials implying kind-of relationships), 'taxa' based on morphological regularity, life-form recognition, an underlying principle of 'hierarchy' or ranking, and a propensity to categorize and name regardless of the usefulness of a species.

In the Mithen model the trajectory of human evolution moves from general cognitive flexibility in pre-hominins, to increasing specialization and modularization among early humans (*H. erectus*, *heidelbergensis* and *neanderthalensis*), to cognitive fluidity through inter-modular connection in modern humans. This model finds some role for a distinctive natural history intelligence in nonhuman apes. Modules for both social and natural history intelligence are predicted to have grown considerably by the time we reach early *Homo*, where a separate

technical intelligence module first appears, and is exceeded in size by social intelligence. In *Homo erectus*, social, technical and natural history modules have all grown further but are of equal size, and social intelligence appears to have propagated a new smaller and overlapping language module. The same is true of *Homo neanderthalensis*, but with a larger language module. Among modern humans, early forms are presented as merging natural history with social intelligence but without full cognitive fluidity, this being finally achieved in the Upper Palaeolithic.

I have put it this way to emphasize the reification of the idea of 'module', the proliferation of types, the difficulties of measurement and of delineating boundaries in Mithen's approach, let alone establishing a neurobiological basis. There are good reasons to be sceptical of models of 'massive modularity' (e.g. Buller 2005): the arbitrary separation of capacities, a methodology of 'reverse engineering' from the vantage of the Pleistocene that is prone to circularity, and insufficient attention to the potential of cultural cognition. Mithen's mapping of modules on to the fossil evidence is particularly unsatisfactory. I suggest here that a gradualist model, in which social intelligence co-evolves with natural history intelligence, is more consistent with current evidential and theoretical resources.

Nature-social Mutuality

Biological knowledge systems do not stand outside society, but are culturally and socially-embedded. For example, because the environments of early *Homo* were more risky than those of present-day hunter-gatherers, and food resources irregularly distributed, this likely exerted selective pressure in favour of new ways of using social links and increasing group numbers. On the basis of observed correlations between group size, neocortex size and grooming time among primates, Dunbar (1993) hypothesizes that as hominin group size increased so manual grooming alone was insufficient to maintain social relationships. The initial pressure for larger groups may have been predation risk in more open habitats, and a broad-spectrum food-getting strategy. Increased sociability and the need to handle 'social complexity', perhaps through pre-linguistic vocal-auditory signalling rather than language capacity, was a possible consequence (Freeberg et al. 2012), as were greater cognitive resources to underpin foraging strategies, including the sharing and transmission of biological knowledge. A corresponding increased capacity among

potential sharers to construct categories, mind-read and empathize would have supported this (Hrdy 2009). Dunbar (2003: 175) puts the threshold for this transition at ~500 ka. Others (e.g. Isler and van Schaik 2014) have argued that the ability to solve ecological problems correlates better with brain size, and that big brains then permitted the solving of social problems. One way of resolving this dispute would be to assume progressive mutual reinforcement between social and ecological intelligence. While great apes are equal to young children in technical matters (Herrmann et al. 2007), humans have been most selected for in terms of social skills. This would have permitted an increased role for culture in connecting domains, transmitting knowledge, and placing general intelligence into learning contexts (e.g. Tomasello 1999).

For nonhuman primates (and early hominins), Mithen implies (2006: 61–63) that natural and social intelligence work independently. However, the partial integration of social and natural intelligence must have happened before the development of full language. Since Lévi-Strauss (e.g. 1964) it has been recognized that at the core of human cognition is a necessary duality and tension whereby humans understand the natural world through their experience of social relations with other humans, and the social world through their experience of nature. This is why despite repeated attempts to counter naive dualism and challenges to the culture-nature divide, the divide keeps on re-emerging (Astuti 2001). Related to this is a proclivity to attribute and represent the inanimate world in organic terms, and to attribute inanimate objects with the properties of living things. It happens because we are bound to model our world directly on those experiences of our own body and we employ this same model as a source of labels and concepts to interpret the world outside the body. We attribute human-like minds to animals, while the lexicon of animal parts is for the most part that of human anatomy. Botanical nomenclature is less anthropomorphic, and that of inanimate objects less still, but body terms – or at least terms that appear concurrently in anatomical lexica – are still crucial (Ellen 2005: 90–116). How much of this is possible without symbolic culture is a matter for continuing debate.

Sharing and Knowledge Distribution

The evolutionary significance of social intelligence is that, ultimately, it improves food-getting, mating and therefore reproductive efficiency. Individual animals of many species learn to recognize different species

and utilize their properties. Similarly, repeat discovery of the same properties by ecologically separated human groups is evidence for convergent patterns of organizing biological knowledge (e.g. Moerman et al. 1999). However, what characterizes humans is how information about the natural world acquired by individuals is shared with others and transmitted inter-generationally through socially distributed storage and 'external memory' supported through language (Donald 1991). But this does raise the issue of why, if culture in the sense of socially transmitted practice is common among many species, it evolved so rarely into more elaborate patterns (Boyd and Richerson 1996). This is why data on knowledge sharing as documented in ethnobiological research is instructive. Early attempts to collect data relied heavily on aggregate figures for numbers of organism names and the omniscient speaker-hearer assumption. We now know that biological knowledge does not exist in its totality in any one place or individual (despite cases of individual encyclopedism: e.g. Berlin 2003), that it is much more distributed, while its movement between individuals is rarely regulated by what we would normally understand as exchange, though exchange relations may improve access to resources.

But for sharing of biological material and knowledge to be routinized and dependable required the recognition of individuals as intentional agents, and arising from this the development of those norms of trust that we now accept were crucial to the evolution of sociality itself, and which are now such an issue in the study of great apes, and critical for understanding the emergence of symbolic culture and language. The concept of 'sociality' is further addressed by James (this volume). Where knowledge is shared there is always a tension between literal acceptance and distrust, as in those social relations more generally that are the context for material transactions and knowledge exchange. Among hunter-gatherers, as in most acephalous societies, there are fewer robust social means for establishing authority and for standardizing what is known and adjudicating in disputes than in complex centralized systems (Sillitoe 2002).

In understanding how distributed and shared cognition evolved, other parts of the body in addition to the brain were integral (see Low, this volume). Category mechanisms work through mapping, involving our whole bodies and personal histories. The evolution of the hand in particular, and with it the tool, brought about a transformation in the relationship between hominins and their own body, a greater level of physical self-awareness and sense of self, arising from use of the hands in communication, as sensory organs, and through recognition of their manipulative capacity. The development of physical motor skills

also improved the potential utility of biota and therefore encouraged selection for more sophisticated classification skills. Similarly, transmission was not simply the passing of information from one brain to another but required complex interactive rediscovery (Ellen and Fischer 2013).

Episodic and Mimetic Memory

Key to understanding the growth in human sharing is the relationship between episodic and mimetic memory: memory based on remembering occasions in the past when significant events occurred, and remembering general principles distilled from what may have occurred on one or more occasions. It is sometimes supposed that there was a shift from cultural accumulation and transmission based predominantly on the first to one predominantly based on the second (Donald 1991, following Tulving). But the assumption that nonhuman animals have episodic recall in the sense described has been challenged, and the term 'episodic-like' may be preferable (Crystal 2010). Whether or not nonhuman animals have temporal processing or can recall 'events', they are able to associate particular contexts with experiences. In terms of plant knowledge, 'episodic-like' memory provides a basis for distinguishing predator from non-predator, toxic from non-toxic, fermented from non-fermented matter, for storing plant foods and for distinguishing medicinals. But only mimetic memory would have permitted the more abstract grouping of plants and animals necessary for sharing large numbers of types of biota among larger numbers of individuals.

The shift from episodic-like to mimetic also reflects a shift from recognition of broad use categories and similarity judgments to something resembling what Berlin, Atran and others call 'natural classification', and an ability to infer properties of one type of organism on the basis of physical similarity to another. In other words, classification reduces the 'thought load', expedites new learning and allows inference. For example, if plant (A) has property (a), and if plant (A) is similar to (B) then it is also likely to share property (a), e.g. be edible, toxic, useful in some other way, and so on. Similarity judgments can be based on morphological similarity or ecological similarity (Atran and Medin 2008), thus if (X) is in flower then (Y) will be in fruit. The same kind of reasoning is found in both folk biology and social cognition. Storing knowledge as causal hypotheses is efficient because humans do not have sufficient memory to make the right responses by

induction alone, especially where they are relying on oral culture and limited division of labour (e.g. Johnson-Laird 1982).

A central element of mimetic thinking as applied to natural history knowledge is a universal concept of basic category or essence applied to all biological types (e.g. 'dog', 'cat', 'willow', 'oak'). This is often described as a 'species' concept, though confusingly it maps mainly on to what Berlin calls 'folk genera'. The notion of basic biological category was early identified in both anthropology (Lévi-Strauss 1966; Bulmer 1970) and psychology (Rosch 1978), based on a cognitive simplification through which living objects of sufficient similarity were recognized as being the same 'natural kind'. It is difficult to imagine the concept of shared basic category except when linked to proto-linguistic 'mental representations' and proto-names comprising arbitrary tokens standing for something else (Penn et al. 2008; Bickerton 2011) or perhaps onomatopoeia.

Experience of their own bodies enabled early humans to model the world around them and to understand inferentially how the bodies of other organisms worked. The hands in particular served not merely as sensory and motor organs, but as a strong model for binary strategies in dividing up the natural world through incipient naming. The introduction of proto-names for categories meant that while cognitive prototypes might still serve as the main way by which members of a category were identified, the act of sharing through language meant that boundaries around categories needed to be agreed, and this had to be based on a rudimentary scheme of distinctive features (e.g. colour, shape, size, smell, taste).

Language, Naming and Symbolic Culture

It is now widely accepted that language (primarily speech-based and using words in a structured and conventional way) evolved primarily to enhance sociality rather than technical communication (Barnard 2011; Dor, Knight and Lewis 2014), and co-evolved with symbolic culture more generally. By symbolic culture I understand sharing and transmission mediated through the use of symbols: concepts or things standing for each other, often in an arbitrary relationship. Using a system of social categories, for example, this allowed for kin connections and extended social links beyond the immediate present, even when relevant individuals were physically absent. However, the evidence of macro-anatomy indicates that symbolic capacity evolved before any archaeological evidence is found in early *Homo* to support

it. This suggests that it did not immediately translate into symbolic culture. The mimetic culture that developed during this period would have likely been sufficient to support proto-language capacity that involved categorization and proto-naming of the natural world in the way I have already outlined (c.f. Mithen 2006: 66–67).

While sharing practices and cognitive skills can improve without language, progressive language skills improve both. Language depends upon and fosters the ability to imagine what is in other people's minds, to make assumptions as to how they will cognize shared data. This is achieved through treating shared fictions as objective facts, using names that can stand for generalized abstract entities in an environment and mean sufficiently the same for both parties in a conversation. Some simple names may well have been onomatopoeic, and onomatopoeia is still strongly represented for certain groups of animals (e.g. birds and frogs), but the process of agreeing shared meanings in itself can lead to lexemes becoming arbitrary. In some cases, as Berlin (2006) has shown, the non-arbitrariness of the relation of sounds to animals they represent can be remarkably consistent. But it is not only names for things that are required for this process to work, but descriptions of attributes of things, for example taste in the case of plants and animals used for food, as distinctive features become increasingly important for enforcing category boundaries.

Agreeing names and thereafter a consistent semantic association between names and generalizations about entities in an environment requires shared acceptance of a set of rules for making meaning. Most ethnobiological data is collected by asking informants what they call things. Although there are methodological dangers here, names are a reasonable proxy for knowledge. And in recognizing this we identify the reasons why names were introduced in the first place, not only to increase the reliability of sharing knowledge, but as better triggers for inference. While it is possible to imagine the collective imposition of rules without language (e.g. Searle 1996: 60–61), rules are more effectively recognized (and enforced) with a language that facilitates sharing knowledge, generalizing it, agreeing on notions of right and wrong and encoding this into a moral framework. Thus, one-way rule behaviour is embedded by introducing an emotional charge to our interpretation of what is embedded in long-term memory. By making something 'right', shared rules of recognition and behaviour are reinforced: authority is established. There is, therefore, a link between enculturation of the mind, classification and social morality.

Speech acts concerning aspects of the biological world occur not only in particular physical contexts that reinforce the meaning of

names, but in the context of different kinds of social relations. In some cases there is a mutual exchange of words, but sometimes it is deliberately instructional. Pedagogy, therefore, becomes an increasingly efficient form of cultural transmission with the development of language and higher orders of intentionality, but not at the expense of self-learning.

Symbolic language also makes possible environmental narrativity, the ability to recall events and processes, and tell stories about plants, animals and their maturation in particular places, both in the specific and in the general. This has an obvious positive effect on harvesting efficiency. The idea of narrativity as an essential component of symbolic culture was first introduced by Michael Carrithers (1990), but has been elaborated by Alan Barnard (2013) in what he calls his 'second theory'. What is interesting about narrativity in terms of the evolution of biocognition is that it involves a significant role for episodic memory in the organization of resource and spatial knowledge, but in the context of a linguistic capacity that allows for generalization about particular kinds of environment, and an ability to infer what kinds of resources might be found in what kind of habitat. It also permits abstract narratives that combine biological and social knowledge in imaginative ways of the kind we call myths. Such narratives can only work by using names to generalize about species and habitats, but it is notable that with ethno-ecological categories we do not find the same kinds of complex lexically embedded classifications that we find for the separate domains of plants and animals. Instead, we find that knowledge of physical landscape is culturally embedded by using narratives of particular places and myth that enhance memorability and provides moral reinforcement. Moreover, this integration of culture and environment is all the more powerful because even before the Holocene human groups were self-evidently making their environment physically cultural, for example by creating resource rich patches through inadvertent dropping of seed, selective extraction, and camp and trail-making (Ichikawa 1996; Ellen 2007). Non-linguistic episodic memory is thus transformed through language into more effective edited accounts that can be better shared.

With the ability to convey and store messages about abstract 'natural kinds', it becomes in principle possible to construct categories of increasing inclusiveness (through aggregation) or decreasing abstraction (through segregation). Berlin (1972) showed that classification, in terms of shared named basic categories, evolves from the middle outwards, both ontogenetically and historically. This core, as Berlin (1992: 96–101 has also shown, comprises around 500–600

'generic' categories in all recorded ethnobiological classification systems, with the total number of taxa altogether reaching approximately 2000. The process depends on notions of ranking and taxonomy that may have evolved independently of biocognition, as a means of contrasting and grouping various kinds of entity, and as a response to the difficulties of recalling large numbers of similar items (Miller 1956). Such procedures are enabled by a syntax that can repeatedly embed adjectives and phrases, and a recursiveness that gives form to more complex classificatory structures.

The convergence of language, social-natural mutuality, imagination and abstraction permitted plants and animals to be spoken of in multi-referential ways as parts of networks of meaning. This reinforced knowledge about them but also increased their symbolic functionality in other social contexts: through analogical reasoning (e.g. use of male/female), genealogical metaphors ('families', 'brothers', 'mother of'), the very notion of 'hierarchy', animation and the personification of biological types.

Naming and the Influence of Environment and Subsistence

What constitutes a name? Conklin and Berlin showed in the 1960s that though we can treat some names as semantically 'unanalysable' or primary (e.g. 'oak', 'cat'), many are secondary (e.g. 'turkey oak', 'house sparrow'), have obvious histories, and allude to other domains (colour, social, places, other animals and plants, human anatomy). Secondary names take on a kind-of or part-of relationship, and are a feature of all known languages, a nomenclatural consequence of marking behaviour: 'A : not A', where 'not A' is the marked term.

Systematic binomialism, however, is rare in the nomenclatures of hunter-gatherers compared to farmers (Morris 1976; Ellen 1999). Binomials only become predominant with domestication, where it is necessary to (firstly) distinguish cultivated from non-cultivated forms, and thereafter numerous cultivars (varietals). In contexts of proto-domestication the basic categories that are marked are those for the cultivated form of the same natural kind found outside of cultivation (Nabhan and Rea 1987). For populations where cultivation is the default mode, as among the Nuauulu, adjectival qualifiers that mark non-cultivated habitats tend to predominate e.g. 'forest', 'mountain' rather than 'garden', 'village' or 'house' (e.g. *munu wesie* ['forest *munu*'], the fish poison *Derris trifoliata*). The more humans managed their

environment the more distinctions below the species level became important. Thus, among Nuaulu plant terms, cultivar segregates (e.g. for sago, yams and taro) represent the largest group of binomials.

One problem of the Berlin–Atran scheme of taxonomic biocognition as a default universal model is that we have poor accounts of the ethnobiological classification of contemporary hunter-gatherers, and what we do have challenge this consensus (Morris 1976, 1984; Brown 1986). For example, there are fewer names reported for hunter-gatherers compared with farmers. This is counter-intuitive, given claims that hunter-gatherers have more sophisticated biological knowledge systems than farmers. They also use fewer sequential naming practices, resort less to hierarchies and ranks, have fewer more inclusive categories (e.g. life-forms), rely more on use categories, and are more flexible (e.g. Heinz and Maguire 1974; Terashima and Ichikawa 2003; Bownern et al. 2014). This is also the case for hunter-gatherers whom we often place in a separate category, such as the peoples of the northwest coast of America (e.g. Turner 1974). Because these groups are subject to similar constraints – social, demographic and environmental – we can account for some of the characteristics through small population size and density, widespread distribution, and foraging strategies that tend to be more individual and less social, and that rely on direct experience less easily communicated and encoded in language, or not requiring lexical elaboration. Indeed, hunter-gatherer biological knowledge is more ‘substantive’ than lexical (Ellen 1999), with wayfinding for example being less about linguistic competence and the application of self-consciously encoded knowledge than about how the body learns to move through familiar landscapes. Complex names (serving as proxies for connected knowledge about specific taxa that cannot easily be expressed lexically) are important once it becomes useful to encode large numbers of differences and share with larger numbers of people, as in farming.

Summary

The problem is: how can we map changes in hominin and human capacity to organize and use biological knowledge on to chronological frameworks, and what theories of cognitive and language evolution most satisfactorily support them? In terms of the first, I rely here on Shulz et al. (2012), which conveniently brings together key data, arguing for punctuated changes in hominin brain evolution at approximately 1.8 ma, 1 ma and 100 ka, plus gradual changes within

H. erectus and *H. sapiens*. In terms of the second, I follow Donald (1991), in distinguishing three major cognitive transitions: (1) 'episodic' to mimetic (involving sharing and social storage); (2) mimetic to 'mythic' (meaning broadly symbolic culture); and (3) external symbolic storage (graphic symbols and pictures). This may oversimplify the picture, especially in relation to language origins, but the diversity of opinion here is considerable, and it has seemed to me wise to engage only in so far as it is necessary to explain key features of the linguistic encoding of natural history knowledge.

Transition 1 is linked to the appearance of *Homo habilis*, and *H. erectus* with a wider geographic distribution (extending to the trans-Caucasus and into Asia). The beginning point corresponds to the appearance of Acheulean tools in Africa from 1.76 ma, apparently associated with a step-change in encephalization. The evidence suggests an ability to hunt large animals, greater performance of social tasks, more dependent young, an extended juvenile learning phase, with more opportunities for improving problem-solving capabilities, and with consequent changes in group structure, foraging behaviour and range use. This would likely correspond with a shift from 'episodic-like' to mimetic thought between 2.0 and 0.5 ma, completed with the arrival of modern humans. This phase is associated with improved (functional) categorization and basic naming skills linked to proto-language.

Transition 2 is associated with *H. heidelbergensis* and *neanderthalensis* after 500 ka, and the need to adapt to a wide range of new species and environments as humans moved both within and out of Africa into Eurasia between 400 and 100 ka. In other words, life-world concepts and natural history knowledge diversified in response to habitat change and a diversity of environments. Indeed, much of what we regard as the essential features of the modern package of ethnobiological classification are probably a consequence of developments arising as humans moved into varied new environments that they were thus able to manage with increased effectiveness, through greater sharing and management of social relations, as reflected – for example – in effective fire control. The important cognitive breakthrough here (as suggested by Mithen) was a predictive model of natural history, emerging through a self-learning process in which as the lexicon grows and proto-sentences are used, categorization of experience leads to more complex proto-syntax (Bickerton 2011). In turn, engagement between ecological diversity, local population histories and ethnobiological classification itself fuelled further cultural diversity (Mithen 2006: 65).

Transition 3 begins with the appearance of the first modern humans in Africa after 200 ka, having evolved a fully modern life-history strategy but with no clear corresponding changes in archaeology. However, a ‘cascade of consequences’ accompanied increasing evidence of symbolic behaviour after 60 ka as modern humans spread from Africa: cultural variation reflected in technological specialization, art and decoration, and the rapid facilitation of full-language capabilities at 50 ka, involving lexical (rather than phonological) syntax (Knight et al. 2000; Tallerman 2011: 442). Syntactical language made classifying much easier, by enforcing arbitrariness (e.g. category boundaries) through shared rules. It permitted relational similarity, intentionality competences (e.g. number of embedded clauses), metaphor (including ‘totemic thinking’), analogy, higher order spatial relations, transitive inference, and hierarchical and causal relations. Words could be introduced for non-basic categories as required in different eco-cultural contexts through a process of progressive aggregation and segregation, finally denoting ‘unique beginners’ at a kingdom level. The adaptiveness of this system stemmed from the multiplicity of ways in which it could re-organize perceptual data, and from the redundancy built into the process. The classifications that resulted were fluid and negotiable, produced as well as reproduced.

Conclusion

The origins of kinship and religion are big and important issues, but are not the only issues that socio-cultural anthropologists are equipped to explain. I have tried in this chapter to focus more on the role of natural history knowledge in accounts of human evolution, and to pay more attention to plants in particular. In his *Prehistory of the Mind*, Steven Mithen offers us a powerful model based on theories of modularity, and builds his model of natural history intelligence on the basis of the findings of Berlin and Atran. I have suggested that there are difficulties with his appeal to modularity. There are problems in defining the boundaries of modules, and a likelihood of much more continuous interconnection between the elements of different modules, such that we might wish to question the exclusiveness of separate natural history intelligence. On the other hand, the strong evidence for nature–social mutuality implies two cognitive sub-systems that are constantly reinforcing each other. Similarly, what is grouped together in the Berlin–Atran model might be better envisaged

as a collection of different cognitive and cultural elements that arose separately, at different evolutionary phases. We need to recognize the difference between semantic domains that we can infer from patterns of linguistic and cultural practice, and neurobiological modules that we can only infer with more circumspection.

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