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# Renewing the link between cognitive archeology and cognitive science

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ABSTRACT

In cognitive archeology, theories of cognition are used to guide interpretation of archeological evidence. This process provides useful feedback on the theories themselves. The attempt to accommodate archeological data helps shape ideas about how human cognition has evolved and thus—by extension—how the modern form functions. But the implications that archeology has for cognitive science particularly relate to traditional proposals from the field involving modular decomposition, symbolic thought and the mediating role of language. There is a need to make a connection with more recent approaches, which more strongly emphasize information, probabilistic reasoning and exploitation of embodiment. Proposals from cognitive archeology, in which evolution of cognition is seen to involve a transition to symbolic thought need to be realigned with theories from cognitive science that no longer give symbolic reasoning a central role. The present paper develops an informational approach, in which the transition is understood to involve cumulative development of information-rich generalizations.



## 1. Introduction

Our commitment to the Darwinian theory of evolution means we normally hope to understand the evolution of a species in terms of well-evidenced 'survival of the fittest' events. In the case of human evolution, unfortunately, there are significant difficulties in achieving this goal. Part of the problem is the fact that, in this context, it is behavioral changes that are particularly significant. Given these may create little or no trace in the archeological record, the difficulty of inferring relevant transitions is inevitably increased.

Coming to grips with this problem, archeologists have deployed the approach of *cognitive archeology* (e.g. Plotkin, 1982; Donald, 1991; Mellars, 1991; Mellars and Gibson, 1996; Dunbar, 1996; Renfrew and Zubrow, 1993; Mithen, 1996a; Renfrew, 2007). In this approach, theories of cognitive functionality come to guide interpretation of physical evidence. The adoption of a lithic technology in a particular context, for example, might be explained by demonstrating that the cognitive skills involved are enabled by activities pursued in an immediately preceding context. Application of cognitive theory becomes a way of constraining and shaping the interpretation placed on the emergence of particular tool-use.

The approach has proved useful as a means of explaining curiosities in the evolutionary record, e.g., the fact that 'the most dramatic developments in human cognition seem to have occurred without any concomitant increase in brain size.' (Bickerton, 1996, p. 44). It has also been particularly effective for explaining the interval between emergence of anatomically modern humans around 200,000 years ago, and the emergence, somewhat later, of significant levels of characteristically modern human behavior. The earliest known artistic artifact—the incised slab of shale from the Blombos Cave—is dated to more than 70,000 years ago (Henshilwood et al., 2002). But the torrent of art, technology, ritual and symbolism that is deemed the distinctive signature of *Homo sapiens* is seen to develop momentum somewhat later, with the change being particularly dramatic at the Middle/Upper Paleolithic transition in western Europe (Henshilwood and Marean, 2003). The question is then what explains the delay? Renfrew poses it thus. 'If the genetic basis of the new species is different from that of earlier hominids, and of decisive significance, why is that new inherent genetic capacity not more rapidly visible in its effects, in what is seen in the archeological record?' (Renfrew, 2008, p. 84–85). Renfrew terms this the 'sapient paradox'.

## 2. Approaches to the sapient paradox

One way to deal with the paradox is to posit the occurrence of a mutation in human DNA, that had the effect of establishing a more sophisticated cognitive engagement with the world, but without any accompanying change in anatomy (e.g. Klein, 1999, 2001). In proposals of this type, language may be seen to play an important, mediating role (e.g. Bickerton, 1996). But such schemes remain controversial, given the relatively sparse evidence for

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symbol-oriented behavior prior to 50,000 years ago and the lack of evidence for any 'highly advantageous neurological change' after that date (Henshilwood and Marean, 2003, p. 630). Cognitive archeology is able to produce more graduated accounts, however. Rather than assuming the occurrence of some critical event which had the effect of 'switching on' modern cognition, structured processes of development can be envisaged that had the same effect over a longer period.

Taking the transition to modern cognition to entail the adoption of an increasingly *symbolizing* mode of thought (Renfrew, 2007), such accounts often explain the 'hold-up' in terms of sequential constraints. Domain integration can be the critical concept here. If development of symbolic thought facilitates (or is facilitated by) integration of domain-specific competences, it is clear the latter must precede the former. The necessity of passing through two distinct phases of development can then be used to explain why emergence of modern cognitive sophistication seems to have been delayed (Rozin and Schull, 1988).

Prominent among accounts of this type is Mithen's 'cathedral' model. In this theory (Mithen, 1993), the domain-specific entities are understood to be specialized intelligences, along the lines of (Gardner, 1993). Seeing these as broadly analogous to the chapels of a cathedral, Mithen equates general intelligence with the cathedral's nave. It is a central area through which the multiple intelligences come to be connected. The ultimate effect is a unified, cognitively fluid system of general intelligence (Mithen, 1996b, p. 72).

Mithen's account particularly invokes Tooby and Cosmides' evolutionary model, in which specialized cognitive modules are analogized with the tools of a Swiss army knife (Tooby and Cosmides, 1989, 1992). It also references Fodor's (1983) 'Modularity of Mind'. This proposal envisages mental architecture to comprise a large number of informationally-encapsulated 'input systems' under the management of an integrative reasoning system. Fodor commits to this medium being an inner, compositional language—the so-called 'language of thought'. Mithen is more agnostic on this point, although stressing the degree to which integration must involve processes of analogy and metaphor (Mithen, 2006).

A key advantage of Mithen's account is its ability to address the sapient paradox. It becomes possible to see why a critical development in the evolution of modern human cognition might have involved no gross change in anatomy. The transition can be seen to have been more a change in 'software' than 'hardware'. Delays in cognitive emergence are then more easily comprehended. Indeed, by developing more structured accounts of the changes involved, it is possible to reach a point where the time allowed seems almost too short.

In Donald's (1991) account, for example, the evolution of modern cognition is understood to involve a progression through four distinct *cultures* of representation. The initial culture is *episodic* representation. The main entity here is a kind of situational snapshot; reliance on it significantly limits possibilities for engaging with temporally-extended and otherwise relational phenomena. Episodic representations are then seen to be superceded by *mimetic* representations. These are language-like generalizations, but mediated by non-linguistic forms of expression such as mime and body language. Exploitation of temporal and relational phenomena becomes a possibility.

In the subsequent culture of *mythic* representation, we see emergence of language itself, with expression in mythical entities and traditions. The final phase in the sequence is then characterized by use of external symbol storage (e.g., written representation) and *theoretic/scientific* culture. Mapping these four cultures onto the archeological record then addresses the sapient paradox in a more fine-grained way. The effect is accounted for in terms of the progression through mimetic and mythic stages of representation, within an overarching journey from episodic to theoretic/scientific culture.

It is an important advantage of these cognitively-informed theories that they make it easier to understand why there may have been a delay between appearance of modern human anatomy and modern cognitive sophistication. But they are not without their problems. Allowing cognitive evolution to proceed in a way that is largely disconnected from anatomical change deals with the sapient paradox; but it also tends to eliminate constraints on absolute timing. The question arises of how long we should expect such progressions to take. Cognitive science's reliance on computer simulation means it is not well equipped to give an answer (Boden, 2006). Indeed, the time-scale of most simulation work allows that Donald's four-stage progression might be accomplished in a relatively modest number of generations. Mithen's might even be completed in a single lifetime. A question mark remains hanging over the issue of timing, therefore.

From the present point of view, the more pressing problem with these accounts relates to their terms of reference. Evolution of modern cognition is seen to be a process through which domain-specific functionalities come to be integrated through the operations of a centralized system. This is understood to be either dependent on, or somehow constituent of processes of symbolic reasoning. Development of this style of reasoning is generally assumed to interact closely with evolution of language. But the connection is difficult to discern, partly because language seems somewhat overpowered with regard to its initial application (Dunbar, 1996), and partly because it is extremely hard to disentangle cause and effect (Hauser et al., 2002).

As McBrearty and Brooks note, 'Abstract and symbolic behaviors imply language, but it is doubtful that the point at which they can first be detected coincides with the birth of language' (McBrearty and Brooks, 2000, p. 486). Henshilwood and Marean suggest the latter is likely to have come first, noting the 'capacity for language probably existed in humans well before it was manifested in material culture' (Henshilwood and Marean, 2003, p. 635). But the degree of integration between evolution of symbolic reasoning and evolution of language is not presently of concern. It is the implication of symbolic reasoning being *fundamental* in modern cognition that is more significant.

The difficulty is that this way of conceiving cognition is increasingly out of step with developments in cognitive science. The field has changed significantly in the last two decades. Commitments from earlier years that have recently been revised (and in some cases overturned) include some of those that particularly inform proposals from cognitive archeology. Where cognitive science once emphasized factors of modular decomposition (e.g. Newell and Simon, 1972; Johnson-Laird, 1983; Fodor, 1983; Haugeland, 1985), it now more strongly stresses efficient coding and information use (e.g. Eliasmith, 2007; Griffiths, 2009; Friston, 2010). Where it once emphasized the importance of representational multiplicity and centralized integration (e.g. Anderson, 1983; Gregory, 1984) it now gives as much weight to exploitation of scaffolding and embodiment (e.g. Wheeler, 1994; Beer, 2000). And where it once committed to symbolic reasoning being the medium of high-level integration (e.g. Marr, 1977; Boden, 1977; Winston, 1984) it increasingly recognizes the greater potential (and neural plausibility) of probabilistic forms (e.g. Doya et al., 2007; Chater and Oaksford, 2009; Clark, 2008).

Conceptions of cognition in which symbolic reasoning takes charge are increasingly questioned (Thelen and Smith, 1993; Ballard, 1991). Indeed, they are often seen to be philosophically flawed (Wheeler, 2005). The essence of the charge is that they are