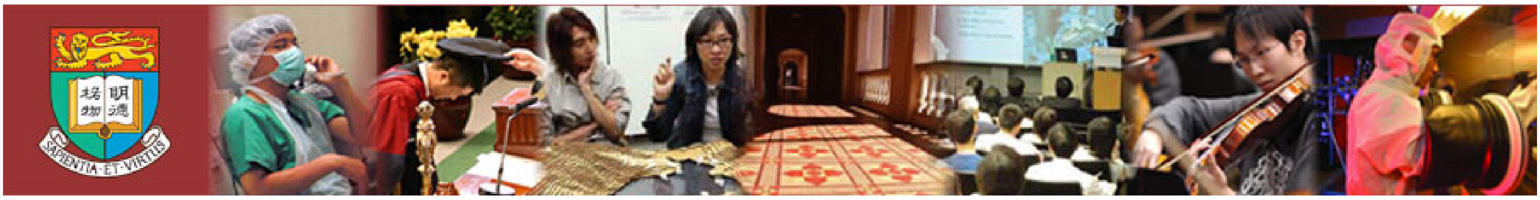

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Citation	Behavioral and Brain Sciences, 2002, v. 25 n. 3, p. 413
Issued Date	2002
URL	http://hdl.handle.net/10722/43678
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Was early man caught knapping during the cognitive (r)evolution?

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Abstract: Wynn describes a revolution in cognitive abilities some 500,000 years ago, which added new sophistication to the curiosity of early man – the ability to form hypotheses. This derivative of archaic curiosity is a fundamental feature of learning, and it is our contention that the naive hypothesis testing behavior of early man will have left a distinctive trail in the archaeological record.

Learning, along with the basic reflexive behavioral repertoires exhibited by all organisms, is a biological imperative, which provides a "powerful evolutionary advantage" – the ability to collect, collate, and develop knowledge pertinent to survival (Claxton 1997). The study of human cognition, in its many guises, has consistently signaled that two forms of knowledge are accumulated during learning. One form is tacit, implicit, or nonconscious, whereas the other is declarative, explicit, or conscious (e.g., Anderson 1987; Polanyi 1967; Reber 1993). Evolutionary psychologists argue that "sophisticated unconscious perceptual and cognitive functions" (Reber 1983, p. 86) preceded the emergence of explicit, conscious functions by some way.

Implicit unconscious learning is seen as a gradual encoding of frequency information relevant to action-outcome contingencies (Hasher & Zacks 1979). Curiosity, a characteristic of survival in most higher organisms, including early man, was likely to have been selected for because it supported implicit learning processes. By initiating exploration and aggregation of information about the environment, curiosity would have provided valuable information, for example, when the need for an escape route arose.

The shift to new environmental niches some 1.5 million years ago and the concurrent development of primitive tools provides circumstantial evidence of the innate curiosity of early man. But evidence from the archaeological record suggests that one million years on, the existing unconscious cognitive abilities were substantially augmented by the arrival of conscious manipulation of information, bringing about a revolution in learning. Production of the three-dimensional symmetry of biface tools, such as the S-twist axes found at Swanscombe (England), required a cognitive work space or desktop to "hold in mind viewpoints . . . not available at that moment" (target article, sect. 2.5.2). Epistemologically speaking, this was an evolutionarily defining moment for *Homo,* for this work space, now most commonly described as working memory (Baddeley & Hitch 1974), brought with it the potential for speech and verbalization and the storage of verbal knowledge in an explicit, consciously retrievable manner.

One consequence of this development was that a new layer was added to the process of curiosity. The ability to manipulate information about the environment meant that curiosity began to result in hypothesis testing – the intuitive judgment of how best to accomplish a task, followed by the selection and storage of the best attempts for future performance and the avoidance of failed attempts (Maxwell et al. 2001).

In particular, the evolution of the spatial abilities of *Homo erectus,* as signaled by the record of biface development, with its increased diversity of tool symmetries and advanced complexity of manufacture (e.g., a greater variety of hammering techniques, more specific location of blows, longer sequences) indicates that explicit hypothesis testing was likely. The differences between the bent cleavers of Isimila and the S-twist axes of Swanscombe may occur because they were used for different purposes; but, just as likely in our opinion, they represent the unique hypothesis testing strategies of separate groups with the same requirement of the tool, though guided perhaps by adaptations necessary for use in the different environments. It is not surprising that the record is demarcated at roughly this time by an increased sophistication of the weapons and tools crucial to survival, as the cleverest thinkers (perhaps) tested hypotheses about the effectiveness of their implements in a search for better performance. The introduction of new materials, such as bone, wood, and antler, may reflect the search for greater power, distance, or control of performance.

This conscious derivative of curiosity is mirrored in the modern day equivalent of the battle for survival. Today's archaeological record shows that hitting implements, such as tennis racquets, have become lighter and more flexible as new materials have been experimented with. The heads have become larger and the hitting area (or sweet spot) has expanded. Grips have changed from wood through leather to toweling and now suède. All of these changes have come about in response to explicit hypothesis testing behaviors as performers have searched for improved motor output in their bid for *survival* in the rankings.

The ability to produce functional implements from new materials would have required a degree of craftsmanship in early man, just as it does today. A fundamental precursor of the skilled motor output of any craftsman is, of course, learning through repeated hypothesis testing: practice. In fact, Ericsson et al. (1993) have argued that the realization of expert motor output requires a minimum of approximately ten years of deliberate practice. Wynn argues that Paleolithic stone knappers had a degree of skill and, while they may not have been experts in the Ericsson et al. sense, it seems logical that they would, nevertheless, have refined their skills through practice.

Contemporary evidence shows that novice learners leave behind characteristic products of their hypothesis testing (e.g., commission of numerous errors, aborted attempts). Novice stone knappers should have left their own characteristic products of hypothesis testing in the archaeological record.

Most obvious should be under-worked stones, discarded by the knapper if they were incorrect or unsatisfactory. Over-worked stones may be evidence of the knapper reworking the stone, refining his technique. In order to avoid wastage, at sites where materials were in short supply, a higher degree of over-working would have occurred. Plentiful materials at these sites would have been under-worked or discarded, as wastage was not a problem. These principles have their modern day cousins in the form of the unfinished canvasses in Picasso's studio. Another observation is that the differentiation between practiced and unpracticed knappers should show up in the degree of randomness in the sequence of strikes. Practiced knappers would have followed a more predictable strike path than unpracticed knappers, or adapted more easily to flaws in the materials that they worked with. Additionally, expert knappers would have exhibited transferable skills, showing few signs of under work or over work, for example, when they changed to new materials. Finally, rare nonfunctional anomalies, such as chiseled grooves (Bednarik 1995), may indicate hypothesis-testing behaviors or the practice of particular techniques that were later applied in the production of specific items.

Coincidental factors of handaxe morphology

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Abstract: Handaxe morphology is thought to be the first example of the imposition of arbitrary form. Handaxes may thus inform researchers about shared mental templates and evolving cognitive abilities. However, many factors, not related to changes in cognition (e.g., material type, function, resharpening processes), influence handaxe shape over time and space. Archaeologists must control for these factors before making inferences concerning cognition.

Wynn is without a doubt a pioneer in the study of cognitive archaeology, and his innovative approaches have inspired others to