This book presents new directions in the study of cognitive archaeology. Seeking to understand the conditions that led to the development of a variety of cognitive processes during evolution, it uses evidence from empirical studies and offers theoretical speculations about the evolution of modern thinking as well. The volume draws from the fields of archaeology and neuropsychology, which traditionally have shared little in the way of theories and methods, even though both disciplines provide crucial pieces to the puzzle of the emergence and evolution of human cognition. The twelve essays, written by an international team of scholars, represent an eclectic array of interests, methods, and theories about evolutionary cognitive archaeology. Collectively, they consider whether the processes in the development of human cognition simply made use of anatomical and cerebral structures already in place at the beginning of hominization. They also consider the possibility of an active role of hominoids in their own development and query the impact of hominoid activity in the emergence of new cognitive abilities.

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CHAPTER 7

Long-term memory and Middle Pleistocene "Mysterians"

Michael J. Walker

In the long term we are all dead. Alas, dead men's skulls tell no tales about their brains. Therefore, we ignore at our peril scientific information gleaned from the living about how our brains works nowadays. Yet, they were not always thus. For the past, palaeoanthropology and Palaeolithic archaeology can inform us about hominin cognition. The matter of linguistic evolution cuts across both present and past inferences, and it complicates comparisons not only between humans and other primates, but also between ancient hominins and us. Constrained by the limitations of my allotted length in this chapter, I shall address a single question: How did evolving language impinge on the evolution of long-term memory (LTM)?

Regarding neuroimaging, it has been said that a "problem with human experiments is the potential for people to recode visuospatial stimuli verbally . . . converting an object task . . . into a verbal one" (Fletcher & Henson 2001, 859). Did inadequate verbal encoding of such stimuli hamper consideration of choices about embarking on, and engaging in, chains of activity that comprise sequential links, each of which involves behavior different from that of both the previous and subsequent link? Perhaps protolanguage was simply not up to the task. Maybe, though, verbal recoding depended on demographical density, such that verbal encoding came to act as a proxy for behavior only after a threshold level of social intercourse had been reached; until then, so to speak, there were not enough people to talk to and there was not enough to talk about. Both possibilities might have occurred at different times and places. They could provide an accommodative justification of why Palaeolithic technological evolution was slow to develop. Matters are complicated because pride of place is usually given to phonological long-term memory (LTM), which is more amenable than visuospatial LTM to neuroimaging research.

It has been inferred that an Early Quaternary hominin quite likely interacted with 100 people, given a positive correlation between group size and brain size in monkeys and apes (Aiello & Dunbar 1993). Such social groupings were probably spread widely over the landscape, but made up of several small ecological groups within which individuals spent most of their time (Dunbar 2000). Nevertheless, it does not follow that social groups must have had some primitive form of language (Martin 1998), even if their members had a "theory of mind" to facilitate social interaction.

Manual skills can be learned by silent imitation, and the role of speech and protolanguage in knapping stone artifacts (or making wooden ones) may have less to do with how knapping is performed than with what is wanted, why it should to be done, and where and when to do it – and if it should be done at all. These questions imply an ability to juggle with different matters and ideas, and attend to particular aspects of individual matters. This is made easier if they can be conceptualized separately, and broken down, or built up, in arguments that can be communicated symbolically to other people by word of mouth (cf. Deacon 1997).

Logicomathematical appreciation, formal combinativity, and visuospatial appreciation of symmetries in stone knapping

Two interrelated questions have attracted much attention, although, archaeologically speaking, they are more of a distraction. One is whether an alleged artifact form represents a "mental template" (of Palaeolithic "Mysterians"). Another, more technical, is whether there is similarity in the ways immature apes and humans acquire appreciation of combinativity during cognitive development. "No" is the short answer to both questions. The two questions underlie a third – undoubtedly of archaeological and palaeoanthropological relevance – which is this: Just what may be inferred from regular irregularities and irregular regularities in artifact form? Unfortunately, a concern with this matter by some specialists has led them in advance to presume what surely scientific inquiry ought to have established as a starting point, namely, that those aspects can only be interpreted by answering "yes" to one or both of the previous questions. This has led, needlessly, to muddle-headedness. Let us very briefly see why. Happily, the matter is less complicated than it seems to be at first sight.

A widely held conjecture is that, before the Late Middle and Late Pleistocene, hominin cognition did not resort to fully declarative, abstract planning (for which language is assumed to be a prerequisite), even though, by the onset of the Quaternary period, there are traces of "preoperational" behavioral development (by reference to Piaget's stages of children's psychological development, in which preoperational thinking involves mental representation and language) that was more complex than that of great apes, whose rudimentary capacity for planning can nevertheless embrace strategical representation of multiple goals (cf. Parker & Milbrath 1993). However, is hominin cognitive evolution commensurable with the sequence of psychological development of modern children, let alone comparable to it? Whereas nonhuman anthropoids show very slow development of logical planning from a stage of physical responses characterized by rudimentary signaling, in human infants, physical and logical domains of cognition develop together in recursive fashion very early in life, such that second-order cognition is well established by the time the child is 2 years of age, including reversibility and substitution when the child is playfully manipulating nonrepresentational objects (Langer 1986, 2000).

This logicomathematical appreciation of combinativity is present in human infants before they can talk. Even if they can understand some things that are said to them, they are unlikely to have recoded visuospatial stimuli into silent "mentalese" verbal symbols before their responses get recorded. Far from language being a prerequisite for such appreciation, logicomathematical cognition seems likely to be a prerequisite for acquisition of language by very young children. In apes, even rudimentary attainment of logicomathematical cognition is barely reached by 5 years of age, unless there is intervention by human handlers. If it is to be argued that the evolution of a baby's attainment of logicomathematical cognition was consequent on prior evolution of speech in older individuals, then first appearance of speech has to be interpreted less in parsimonious orthodox Darwinian terms of gradual natural selection than as an evolutionary discontinuity – maybe a genetic anomaly by which a mutation gave rise to a "hopeful monster" of a new chatterbox species in Africa, namely *Homo sapiens*. Langer's notion of a logicomathematical appreciation of combinativity in young infants is perfectly compatible with notions of the part played by analogical reasoning in the development of Palaeolithic technical invention (de Beaune, this volume) and of the role of symmetries in early Palaeolithic stone knapping (Wynn 2000).

Wynn's "constellations" of knowledge, which imply reversibility, underpinned the Palaeolithic knapping undertaken to fashion blanks or remove and even modify flakes (Wynn 1993). A fuzzy view of "mental templates" looks very like these "constellations" – accurate as regards my needs and wants, rather than a precise protocol of how to attain them. Here is a modern analogy (courtesy of my philosopher friend Ian Herbertson). If I have a new suit and shirt, I may well decide that I want a new tie to go with these new clothes, but not have a clear idea of what style of tie I want. I may think about this and come to some conclusion, but I may not have a clear idea yet still know, once I am inside the tie shop, that the one I see is the one that will go with the suit and shirt. White and Thomas' (1972) observations on modern knappers and bystanders in Papua New Guinea are congruent with that fuzzy view of a mental template – accurate as regards my needs and wants, rather than a precise protocol of how to attain them. Maybe a knapping plan is more like planning a country stroll for one's family than planning a route march with military precision. If that is so, then formal Palaeolithic taxonomical categories cannot be taken, in simplemindedly reductionist fashion, as reflecting separable categories in hominin understanding, let alone as defining aspects of its evolution that are allegedly represented in ancient Quaternary assemblages.

Although Wynn's constellations of knowledge say little about Palaeolithic language, he pointed out (Wynn 1993) that this does not necessarily imply that stone products could never have been regarded as signifying an indexical relationship in some contexts (cf. Deacon 1997). Plausibly, some circumscribed assemblages of ancient Palaeolithic artifacts were products of one or very few individuals, or, in other cases, were products of populations (societies or communities) with particular traditions or tendencies of stone knapping. Some exercises in complex statistical analysis of so-called Acheulian bifaces have pointed toward such possibilities (among many publications, the following are a representative sample of a wide range: Roe 1968; Wynn & Tierson 1990; Crompton & Gowlett 1993; White 1998b; Ashton & White 2003; Gowlett & Hounsell 2004). Interpretation of results has invoked, variously, differences in tradition, raw material, function, or extent of reduction.

Cognition versus recognition

The variety of Palaeolithic techniques, recognized in the East African Early Pleistocene, implies an element of thinking ahead, comparable with that involved in the Levallois technology of Middle Pleistocene Europe, according to Roe (personal communication, 2006). Inferences have been drawn about hominin cognition from the coexistence in the later Oldowan of both chopping tools and bifacial tools (Gowlett 1986). Even if Oldowan chopping tools barely exceeded the cognitive capability of great apes (Wynn & McGrew 1989), it has been argued that symmetrical handaxes imply "spatiotemporal substitution and symmetry operations" that are more complex, cognitively speaking, than are "the spatial concepts necessary to manufacture blades" (Wynn 1979, 385). They involve envisaging shapes and volumes from alternative perspectives, rotated in the mind, while paying attention to congruence (Wynn 2000). These aspects seem to be congruent with some considerations about the nature and development of human consciousness, and, in particular, Antonio Damasio's somatic marker hypothesis as a substrate for the evolutionary development of subjective self-awareness – and quite likely a theory of mind – even before language speeded up recursive spiraling of human culture (for a popular account, see Damasio 1994).

It could well be argued that such a model is by no means incompatible with differently based proposals about what loosely might be called the virtual reality of human thought experiences (cf. Dennett 1991; Deacon 1997; Pinker 1997), for which fully fledged language need not have been a precondition. The matter of self-awareness in Quaternary hominins will be mentioned again in subsequent text, both with regard to knapping and also to making choices between alternative chains of behavior. Thomas Wynn regards handaxes, in particular, as exemplifying evolution of constellations of behavioral plans of action that involve feature correspondence as well as the complex cognitive skill of reversibility, which, nevertheless, could well have been learned and communicated by simply observing and copying, without need for symbolical linguistic assistance, while not excluding a possibility of an indexical role for some artifacts (Wynn 1993, 1995).

A sceptical rejection of cognitive implications drawn from handaxes dismisses them as a "finished artifact fallacy," self-servingly reflecting archaeologists' predetermined categories – such as handaxes, Levallois blanks, and the like – for defining those objects considered worthy of interest to study (Davidson & Noble 1993; Noble & Davidson 1996). However, the force of this rejection rests, insecurely, on just how far individual hominins "intended," or not, to produce mainly (or only) those particular by-products of behavior that coincide with only (or mainly) those artifacts on which archaeologists confer distinctive typological names. Two separate matters have become unnecessarily intertwined here: Namely, the analytical classificatory recognition of taxonomists on the one hand, and whether that might or might not reflect intentional cognition in Palaeolithic behavior on the other.

Taxonomy uses an eliminatory analytical methodology to separate and recognize nonidentical things in an exclusive fashion. This does not imply that somehow carbon-14 with atomic weight 14 is somehow less carbon-like than is carbon of atomic weight 12, or that *Pan paniscus* is somehow less chimpanzee-like than is *Pan troglodytes*. The reason is simple. It is because analytical taxonomy can order nonidentical things only in terms of only those similarities or differences for which a particular eliminatory methodology was designed. Atomic numbers separate carbon from silicon, and chromosomal numbers separate chimpanzees from human beings.

Taxonomies help us to order nonidentical things and to infer possible structural relations between them. However, these inferences may differ, depending on the methodology used – and also on the choice of nonidentical things to study: this latter aspect is relevant here. Fifty years ago, specific separation of *Pan paniscus* from *Pan troglodytes* was regarded more as a conjectural possibility than as being a well-defined scientific working hypothesis that had withstood attempts to falsify it. But, let us beware. Molecular genetics suggests that the two species separated not much before the onset of the Quaternary period. Evolution is a dynamic concept about nonidentity (descent with modification by means of natural selection), not a static one. Would we really have recognized what seems quite likely to have evolved, were we to have gone on regarding them all, in undifferentiated fashion, as "just chimps," no more and no less?

Put another way, by picking away at differences, sometimes it may just be possible to propose their separation in terms of spatiotemporal chains – but only, of course, as a working hypothesis open to refutation. That refutation may involve showing that bonobos and common chimps are but one species, or that handaxes and Levallois blanks are all much of a muchness in a more general context of nondescript flake production or mere rock smashing; we shall return to this aspect later on. It is worth remarking that formal taxonomy need bear no relationship to the cognition of participants. Thus, at some places in the New Guinea Highlands, neither knappers nor other members of their community invariably agree on how to name knapped stone artifacts, and those names by no means always correspond to exclusive taxonomical categories, as defined in terms of the formal characteristics of the artifacts knapped (White & Thomas 1972): This shows that formal taxonomy need not imply a strong correlation between a knapper's intention with regard either to future use of artifacts or their form, nor yet how bystanders choose to name and use them (much less, that taxonomical names have to be scientifically descriptive: *Pan troglodytes* is clearly not, nor are words such as *Acheulian*, *Levalloisian*, or *Mousterian* – which is an exemplary reason for using them).

This does not mean, though, that the taxonomy of Palaeolithic artifacts is unable to point toward matters of interest, taking due precautions, at the much coarser-grained Pleistocene spatiotemporal level. Of course, different or alternative classificatory systems can be constructed, depending on the questions to be addressed. Questions about Palaeolithic cognition have as yet to form the basis of a workable Palaeolithic taxonomical system.

It is quite plausible that those artifacts that particularly have aroused the "interest" of archaeologists were outcomes of chains of activities, involving often more than one actor, from searching for and retrieving raw materials (whether close to hand or further afield), to knapping processes that went beyond a single knapper's *chaîne opératoire* and extended to use (edge-damage microscars), and refashioning at a later time (patinated flakes were reworked sometimes at Cueva Negra del Estrecho del Río Quípar, as at many Pleistocene sites). Maybe, therefore, intentionality should be interpreted less in terms of a single individual's fully self-aware intentions and more, by reference to evolutionary biology, as results and by-products of deterministic chains of complex activities that afforded tried-and-tested adaptive value to evolving hominin populations (societies or communities? – perhaps these words imply more than we have a right to infer) that as yet possessed only an emergent cognitive capability that was unspoken and unconscious, not yet self-aware or spoken aloud, although perhaps this itself might have been an exaptation that reflected the co-opting of brain circuitry, which similarly may well have enabled dispersal of social groups of Plio-Pleistocene hominins (cf. Gamble 1993, 99, 111).

As Wynn (1995, 21) put it, "it would be difficult to overemphasize just how strange the handaxe is . . . it does not fit easily into our understanding of what tools are, and its makers do not fit easily into our understanding of what humans are." It is also worth bearing the matter in mind when considering Levallois cores; thus, Noble and Davidson (1996, 200) remarked that whereas the "standard interpretation is that a core was prepared in such a way that a flake of predetermined shape could be removed . . . it does not seem likely that such cores represented a novelty in planning beginning at the time the Levalloisian technique is said to appear. Rather, such cores had been used for producing flakes almost from the very beginning, and continued to be so used even after knappers began to strike large flakes from them."

Cognogenesis and alternative behavioral chains: When did language become relevant?

Advances in rigorous multivariate statistical methodology applied to numerical taxonomy and spatial analysis have led to a reconsideration of findings that had been deployed in support of some interpretations (McPherron 1999, 2000) – although it seems quite possible that there is no single, one-size-fits-all interpretation of handaxes. This is not the place for yet another review of a very wide-ranging topic, both because some matters are still unresolved and, what is more important, because several of them refer to finer-grained aspects of the hominin record than the coarse-grained matter in hand – the alternative behavioral choices that were made by some hominins during the Early-to-Middle Palaeolithic transition in Western Europe. How did these arise? What do they imply for cognogenesis and the evolution of hominin consciousness in the Middle Pleistocene? Did most Middle Pleistocene hominins in Africa and Europe possess similar capabilities?

Wynn (2000, 138) remarked on a paradox: "by 300,000 years ago spatial perceptual-cognitive thinking was modern. The ability to conceive and execute regular three-dimensional congruent symmetries in flaked stone was in place.... Despite having a repertoire of modern spatial abilities, these hominids did not produce modern culture."

Perhaps there should be less emphasis on the cognition and skill of individual hominin stone knappers. An alternative is to consider the archaeological record as showing that hominins made choices – spoken or unspoken – that required decisions – spoken or unspoken – to be taken about embarking on, and engaging in, chains of activity that comprise sequential links, each of which involves behavior different from that of both the previous and subsequent link – sometimes involving different actors, perhaps separated in time by many generations.

At Cueva Negra del Estrecho del Río Quípar, *Homo heidelbergensis* by 0.5 million years ago was able to choose between different ways of modifying stone (Walker et al. 2006). Although most of the behavior may have been silent and imitative, protolanguage may have been required for making and taking choices – which chain to take part in, what is wanted, why it should be done, and where and when to do it – and if it should be done at all.

Did the Cueva Negra hominins, so to speak, enjoy an edge over Nature in a singular microenvironment? Is it too much to wonder whether that slight edge provided beneficial circumstances within which alternative Palaeolithic working edges came to be knapped? Can this be inferred from the flexibility with which hominins were able to execute the very different chains of behavioral activities involved in the bifacial fashioning of a limestone cobble into a handaxe on the one hand, and the Levalloisian knapping of flakes from prepared chert blanks on the other?

Perhaps the plan-like principles that set out those different practical objectives, which must have been held in mind as separate and alternative possibilities, while at the same time letting the knapper monitor the chosen work in hand so as to allow its transformation in a fluid yet structured configuration of possibilities according to the initial choice of objective, imply that working memory was not held in an iron grip by a single expert aptitude in procedural LTM but, instead, could pick and choose from very different alternatives stored in LTM. Did these choices mean that alternative patterns of behavior had sometimes to be explained verbally to bystanders? Did they come back with, "What if you were to have chosen to make a handaxe instead of a Levalloisian flake?"

The facilitative part that language could have played raises a question of whether fluency might have increased as human populations increased. Selection pressure for fluency could have been an outcome of exponentially increasing interactions between growing numbers of people. In those Palaeolithic communities that experienced the greatest demographical abundance, an acceleration in rate and frequency of interpersonal discourse could have led to positive feedback, in nonlinear fashion, with cascade effects. The outcome was modern culture.

Maybe labeling some assemblages as "Mousterian" reflects growing demographical abundance and density of knappers from later Middle Pleistocene time onward. Perhaps one that would be followed was a growing tendency toward debitage assemblages, and toward their production governed by secant-plane techniques, perception of which could have gone hand in hand with neuroanatomical exaptations in brain circuitry favoring nonlinear evolution, in self-organizing manner, in larger-brained, later Middle and Early Late Pleistocene hominins. If natural selection came into play at both biological and behavioral levels, advantages accruing from debitage assemblages such as those of the Mousterian and African Middle Stone Age could have permitted growing demographical abundance and density of hominin communities in Africa, Southwestern Asia, and Europe.

The likelihood that the Middle Pleistocene record affords empirical evidence that hominins participated in self-determining or self-constraining chains of sequential behavioral activities, which permitted alternatives open to freedom of choice and thus enabled second-order cognitions, is a working hypothesis about a peculiarly palaeoanthropological approach to cognitive evolution. The very limitations of the approach endow the hypothesis with the advantage that it is open to the possibility of refutation (falsification) by future research into the material record to which it is addressed.