euresis journal

euresis
Association for the Promotion of the Scientific Endeavour

Volume 4
Winter 2013

journal homepage
www.euresisjournal.org

A possible context for the emergence of human cognitive and linguistic abilities

Ian Tattersal

Division of Anthropology, American Museum of Natural History, New York NY 10024, USA.
iant@amnh.org

Abstract

Modern human beings differ qualitatively from all other animals in their symbolic mode of cognition that permits abstract thought. Yet there can be no question that our species is descended from an ancestor that lacked this cognitive faculty. This contribution examines the context within which the almost unimaginable change in cognitive state from non-symbolic to symbolic occurred, and concludes that it did not result from the long-term influence of natural selection on the human lineage. Instead, this transition consisted of a single short-term and emergent event that took place remarkably recently: indeed, within the tenure on Earth of Homo sapiens. Plausibly the enabling biology was exaptively acquired at the origin of our osteologically highly derived species some 200 thousand years ago; but its new potential evidently did not begin to be expressed until around 100 thousand years later, when it was released by a necessarily cultural stimulus. This stimulus was most likely the invention of language, the most quinteseentially symbolic of all our behaviours. However remarkable its product might be, an exaptive event of this kind would have been entirely routine in terms of evolutionary process.

1. Introduction

Human beings are fully integrated into the great Tree of Life that embraces all living things on our planet today. The form of this Tree results from the very evident organization of living forms into an inclusive hierarchy of nested sets that is most efficiently represented by a branching diagram. Thus human beings belong to one family, Hominidae (or subfamily Homininae; it makes no difference for present purposes) of several that make up the *Order Primates*. Primates is, in turn, one of many orders that belong to the Class Mammalia, merely one of 16 classes in the Phylum Chordata, and so on. The only explanation currently available to us that actually predicts the form of this tree, as determined by the physical and genomic resemblances from which we recognize it, was neatly summarized by Charles Darwin [1] as "descent with modification." As a result, while we are vastly different in form and feature from our remotest relatives on the Tree of Life, we nonetheless share some very

fundamental features with them, most notably in the common structure of our genomes. And of course, we share the vast majority of our physical characteristics with our closest relatives in this great family tree: we are, indeed, genomically much more than 99% identical to our nearest cousins among the African great apes [2].

Still, there is nevertheless also undeniably something fundamentally different about us, different from every other living creature including the apes. At first glance it is our physical distinctions that are most apparent, most of them related to our extremely odd way of getting around: they can be traced to the upright bipedality that appears to have been the stem hominid adaptation which underpinned everything else that was to come in hominid history. But the thing that makes us truly distinctive, and certainly the one that makes us *feel* so different from other living beings, is the unique way in which we process information in our brains. What we human beings uniquely do is to disassemble our surroundings in our minds into a huge vocabulary of mental symbols [3]. We can then recombine these symbols in new ways, to produce alternative notions of the world around us. And the end result is that we human beings live significantly in the world as we reconstruct it in our heads, rather than as Nature objectively presents it to us.

This unique capacity shows in every aspect of our lives. Other species react, more or less directly, and with greater or lesser sophistication, to the stimuli that impinge on them from the outside environment. But our symbolic capacity allows us human beings to envision alternatives, and to ask ourselves questions such as "what if?" As a result, we are not just doing what other creatures do, only better. We are dealing with information in an entirely distinctive way [4]. A change of cognitive state has been accomplished at some point in our evolution.

Perhaps there is no better way to gauge this uniqueness than by looking at the cognitive style of our closest living relatives, the great apes. And while numerous observations suggest that they are very complex indeed [5], the cognitive gulf between them and us still looms. The cognitive scientist Danny Povinelli has summarized the situation this way [6]:

> *Chimpanzees rely strictly upon observable features of others to forge their social concepts... [they do] not understand that other beings are repositories of private, internal experience.*

This observation directly reflects the fundamental fact that, for all of their considerable intuitive intelligence, the apes are not symbolic creatures in the human sense. Yet there can be little rational doubt that we humans are descended from nonsymbolic ancestors that were broadly apelike in their cognitive attributes.

As Povinelli himself put it [6], in all likelihood those hominid ancestors were:

> *intelligent, thinking creatures... but [they did] not reason about unobservable things: they [had] no ideas about the "mind," no notion of "causation."*

This characterization seems to be entirely reasonable, and it gives us a sort of anchor-point as we begin to explore the many developments that occurred along the way to *Homo sapiens*. But at the same time it challenges us to understand how the amazing transition to symbolic reasoning, this change of cognitive state, came about. Was it something that occurred slowly over vast stretches of time, under the guiding hand of natural selection operating on a long succession of ancestors? If this was indeed the case, we might justifiably view ourselves as being in some sense fine-tuned by evolution to be the kind of creatures we are. But might it alternatively have been a short-term event that happened at some definable point in our ancestry? If so, maybe there was some element of random chance involved in the process.

2. Hominid Evolution

The best way to approach these questions is to start with the actual form of the hominid family tree. One version is shown in Fig. 1, and it is clearly very bushy, with numerous branchings and coexistences. There is no slender central trunk; and obviously what we are looking at here is a vigorous history of diversity and evolutionary experimentation, rather than a linear grind from primitiveness to perfection. What is more, and perhaps most significantly, the figure also shows just how unusual it is for our species, *Homo sapiens*, to be the sole hominid in the world. Typically, several hominid lineages have coexisted at any one point in time, often on the very same landscape. But not today. This stark fact is actually telling us something very significant about our species, compared to every one of its predecessors. And in sorting out the history this configuration represents we have the advantage that, unlike apes, at some point in their history early hominids began leaving material traces of their behaviors. These traces come in the form of the African stone tools and living sites that make up the early phases of the archaeological record; and they allow us to pick up the general pattern of increase in hominid behavioral complexity over time.

This pattern is very revealing. Because, from the time of the first manufacture of simple stone tools, consisting of simple sharp flakes produced by bashing one rock using another, innovation was exceedingly episodic. Such sharp flakes were first made about two and a half million years ago, although naturally-occurring sharp flakes may have been used considerably earlier [7]; and they were made by small-bodied hominids of extremely archaic kind: primates that were bipedal on the ground, but that had short legs, ape-sized brains, and ape-like projecting faces. And they probably still depended on the trees for shelter as well as for sustenance. Nonetheless, by the very act of spontaneously manufacturing stone tools from suitable rock sometimes brought in from far away, they show us that they had already moved outside the ape cognitive range [8].

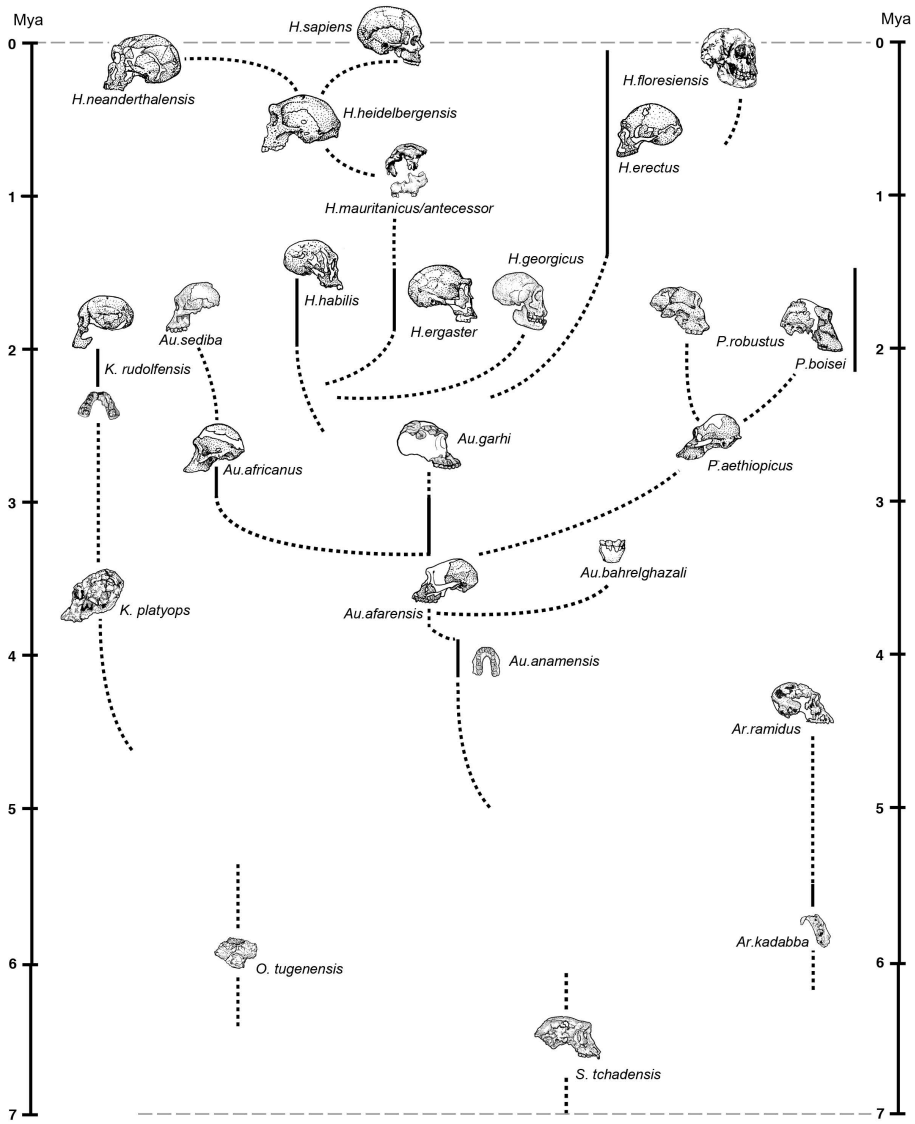

Figure 1: *Highly tentative phylogeny of the hominid family, showing the diversity of species currently known within the group over time, and indicating some possible lines of descent. Drawn by Jennifer Steffey. Copyright Ian Tattersall.*

Significantly, though, even when a much more modern-looking kind of hominid finally appeared, a little under two million years ago, stone tools of the old kind continued to be made. Which marks a striking pattern we observe among hominids: namely, that new kinds of tool do not tend to be associated with new kinds of hominid [4]. Still, the body form of the new hominid, usually known as *Homo ergaster*, tells us that, for the first time, hominids had completely emancipated themselves from the trees. This was a primate committed to the open savanna, with all of its attendant hazards for biologically defenseless and relatively slow-moving hominids like these: it was an environment that teemed with voracious predators, even as the hominids themselves were beginning to assume a predatory way of life. And it was at this point that hominid brains started to significantly expand, doubtless spurred by the new environmental stimuli. This expansion must have been underwritten by a higher-quality diet, most plausibly supplied by the carcasses of scavenged and hunted animals. It

has even been argued that the control of fire would have been necessary both to make the nutrition in this new diet available and to provide protection [9], although there is no good evidence for fire use by hominids until significantly later in time [10]. Yet, for all the cognitive and social change implied by the new lifestyle, we do not find a significant innovation in stone tool technology in regular use until about 1.5 million years ago [11]. This innovation was the so-called "handaxe," a stone tool symmetrically shaped on both sides to a standardized form that must have been held in the mind of the toolmaker before stone-working started.

This new implement was a dramatic departure from the simple sharp edge which was all that the first stone tool makers required, and clearly we are looking here at evidence of a cognitive leap of some kind. But we do not know what the other sequelae of this leap may have been; and although it was significant, we cannot read any suggestion of symbolism into the evidence we have. Sophisticated intuition was required in the manufacture of handaxes, but probably no more than that. The same is even true of the next major innovation in stone tool making, the "prepared-core" tool, whereby a stone core was shaped with multiple strikes until a final blow would detach what was effectively a finished implement. This innovation occurred some three hundred thousand years ago, again within the tenure of a more advanced-looking member of the genus *Homo*. This new hominid was *Homo heidelbergensis*, which showed up around 600 thousand years ago [12] and had a brain within the size range of modern humans – though much below the modern average. Yet although the earliest known artificial shelters were built [13] and the first compound implements were made [14] during the tenure of *Homo heidelbergensis*, the archaeological record this species bequeathed us contains nothing to suggest that these hominids had manipulated information in the unique modern symbolic manner. Complex as their behaviors were, there is no reason to believe that they anticipated our unusual modern way of processing information; rather, they appear to have been incremental improvements on earlier intuitive modes of cognition.

Even *Homo neanderthalensis*, the best-known of all extinct human relatives, can be described in the same terms. Neanderthals were the culmination of an endemic European lineage that separated from our African antecedents well over half a million years ago. And they had brains as big as ours, albeit enclosed in skulls of distinctively different shape. Again, though, despite a large archaeological legacy and recurrent claims to the contrary, there is no unequivocal evidence that the Neanderthals were mentally processing information in a symbolic manner. These hominids were hardy and resourceful, there is no doubt about that. They were wonderful craftsmen, making beautiful stone tools, if rather monotonously. But they evidently did not remake the world in their minds as we do [3]. And perhaps even more amazingly, this appears to have been equally true of the very earliest anatomically-recognizable *Homo sapiens*, which showed up in Africa at around 200 thousand years ago [15].

Significantly, those very early anatomically modern human fossils are found in archaic archaeological contexts that were broadly comparable to those of Neanderthals [11]. And we have

to wait for around a hundred thousand years to start picking up any evidence of symbolic thinking – again, in Africa. Probably the best such evidence is the smoothed and geometrically engraved ochre plaque from Blombos cave in South Africa [16], almost 80 thousand years old, but there are many other symbolic straws in the African wind at about this time, summarized in [3]. By some 40 thousand years ago, we find the symbolic behavioral revolution fully expressed, with the amazing cave art of the Franco-Cantabrian region, and evidence of carving, engraving, music, notation and other symbolic pursuits from numerous sites all across Europe [3, 11].

3. Modern human cognition

Before the first stirrings of the symbolic spirit in Africa, around 100 thousand years ago, both technological and anatomical innovation in human evolution had been highly sporadic. But the emergence of behaviorally modern *Homo sapiens* witnessed a restless, and totally unprecedented, appetite for change. And to understand the qualities of this new phenomenon, it is important to remember that cognitively modern *Homo sapiens* is not simply an extrapolation of earlier trends. The archaeological record makes it clear that we are not doing what our predecessors did, but a little better. By mentally re-creating the world we truly are doing something entirely new and different in our heads. And, since this radical innovation represents a total break with the past, the state change to which I have referred, we cannot explain it away by classic natural selection, which is not a creative process. So how did it come about?

We already know from the big-brained but evidently non-symbolic Neanderthals that our unique style of processing information is not simply a passive product of increasing brain mass. The difference is clearly due to something structural in the brain. And until we know just how numerous simultaneous electrochemical discharges in our brains become resolved into what we subjectively experience as our consciousness, we will never completely understand what that something is. But the general outlines of the historical framework within which the transition from non-symbolic to symbolic consciousness occurred are already becoming clear [3, 4].

The human brain has a long and accretionary history. It is an untidy but effective structure that has evolved, over hundreds of millions of years of vertebrate evolution, by the addition of new components and by changes in old ones. And its ability to produce symbolic cognition occurred very late in its history. Indeed, this new way of using the brain seems to have originated significantly after the origin of *Homo sapiens* as an anatomically distinctive entity, and hence after the acquisition of the anatomically modern brain. This is not actually very surprising because, as we have seen, behavioral and presumed cognitive innovations have always been expressed within the tenure of existing hominid species. And it seems reasonable to conclude from this that the critical neural innovation was acquired as a byproduct of the major developmental reorganization that gave rise to *Homo sapiens* as a physically

distinctive entity. In other words, this crucial acquisition was initially an *exaptation* rather than an *adaptation*.

What is more, while it provided the biological substrate for symbolic cognition, the new potential evidently lay fallow until it became expressed through the action of what had to have been a cultural stimulus. The best candidate for such a stimulus is the invention of language: the ultimate symbolic activity. Like our unique style of thought, language involves forming and manipulating symbols in the mind, and our capacity for symbolic reasoning is almost inconceivable in its absence. Imagination and creativity are part of the same process, for only once we have created mental symbols can we combine them in new ways and ask those key "what if?" questions that allow us to pose abstract questions and envision abstract entities. What is more, if language came after *Homo sapiens* anatomy had been acquired, then the first linguistic people obviously already possessed the vocal apparatus needed to express language – having initially attained it in an entirely exaptive context. In evolutionary terms such an event would have been entirely routine, comparable to the possession of feathers by birds many millions of years before these novel structures were used for flying.

Finally, unlike other putative drivers of symbolic thought processes, language is an externalized attribute, highly likely to spread rapidly within a population already biologically enabled for it. This remains true even if the most important function of language is as an interior conduit to symbolic thought. In any event, it seems above all to have been symbolic thought, the ability to intellectually form alternative worlds, that made *Homo sapiens* an insuperable competitor at some time in the period following 100 thousand years ago, leading to the rapid disappearance of all the more cognitively archaic hominid competition. The production of symbolic material objects also coincided with a radical alteration in the pattern of technological change. From vast periods of stasis punctuated by only an occasional major innovation, technology set out on a course of constant change and refinement: perhaps the most eloquent testimony of all to a radical modification of human cognitive style.

Our acquisition of the symbolic capacity has had effects extending far beyond the technological realm. Indeed, it changed the human condition forever, allowing us to transcend the material limitations of the world in our imaginations and to envisage new versions of the world, that we can then strive to achieve. What is more, to understand the kind of creatures we have become as a result of this extraordinary and amazingly recent transformation, we need to understand that cognitively modern *Homo sapiens* was not driven into existence by the gradual workings of natural selection. Our new kind of information processing resulted from a short-term and entirely emergent event. In practical terms, this means that we human beings have not been fine-tuned by Nature for anything.

4. Acknowledgements

I wish to thank Professors Marco Bersanelli, Tommaso Bellini and Carlo Soave for kindly inviting me to the stimulating San Marino meeting at which these thoughts were expressed, and the Editors of this Journal, Drs. Ulisses Barres de Almeida and Juan Rojo, for their help and facilitation.

References

1 Darwin, C. R. 1859, *On the Origin of Species by Natural Selection* (John Murray: London).

2 The Chimpanzee Sequencing and Analysis Consortium 2005, "Initial sequence of the chimpanzee genome and comparison with the human genome", *Nature*, 437, pp. 69-87.

3 Tattersall, I. 2012, *Masters of the Planet: The Search for Our Human Origins* (Palgrave Macmillan: New York).

4 Tattersall, I. 2008, "An evolutionary framework for the acquisition of symbolic cognition by Homo sapiens", *Comp. Cognition & Behavior Rev.*, 3, pp. 99-114.

5 Cohen, J. 2010, *Almost Chimpanzee: Searching for What Makes Us Human in Rainforests, Labs, Sanctuaries, and Zoos* (Times Books: New York).

6 Povinelli, D. J. 2004, "Behind the ape's appearance: Escaping anthropocentrism in the study of other minds," *Daedalus* 133 (1), pp. 29-41.

7 McPherron, S., Z. Alemseged, C. W. Marean, J. G. Wynne, D. Reed, D. Geraads, R. Bobe and H. A. Béarat 2010, "Evidence for stone-tool-assisted consumption of animal tissues before 3.39 million years ago at Dikika, Ethiopia," *Nature*, 466, pp. 857-860.

8 Schick, K. D. and N. Toth 1993, *Making Silent Stones Speak: Human Evolution and the Dawn of Technology* (Simon and Schuster: New York).

9 Wrangham, R. 2010, *Catching Fire: How Cooking Made Us Human* (Basic Books: New York).

10 Berna, F., P. Goldberg, L. K. Horwitz, J. Brink, S. Holt, M. Bamford and M. Chazan 2012, "Microstratigraphic evidence of in situ fire in the Acheulean strata of Wonderwerk Cave, Northern Cape Province, South Africa," *Proc. Nat. Acad. Sci USA*, 109, pp. 1215-20.

11 Klein, R. L. 2009, *The Human Career*, 3rd ed. (Univ. Chicago Press: Chicago).

12 Wagner, G. A., M. Krbetschek, D. Degering, J.-J. Bahain, Q. Shao, C. Falguéres, P. Voinchet, J.M. Dolo, T. Garcia and G. P. Rightmire 2010, "Radiometric dating of the type-site for *Homo heidelbergensis* at Mauer, Germany", *Proc. Nat. Acad. Sci. USA* 107, pp. 19726-30.

13 de Lumley, H. and Y. Boone 1976, *"Les structures d'habitat au Paléolithique inférieur,* in: H. de Lumley (ed), *La Préhistoire française vol. 1* (Paris, CNRS) pp 635-643.

14 Thieme, H. 1997, "Lower Palaeolithic hunting spears from Germany", *Nature*, 385: 807-810.

15 McDougall, I., F. H. Brown and J. G. Fleagle 2005, "Stratigraphic placement and age of modern humans from Kibish, Ethiopia," *Nature*, 433: 733-736.

16 Henshilwood, C., F. d'Errico, R. Yates, Z. Jacobs, C. Tribolo, G. A. T. Duller, N. Mercier N et al. 2002, "Emergence of modern human behavior: Middle Stone Age engravings from South Africa," *Science*, 295: 1278-1280.

Volume 4
Winter 2013

euresis
Association for the Promotion of the Scientific Endeavour