Ian Tattersall

The Great Leap Forward

All other creatures we know of on Earth, even such cognitively sophisticated ones as chimpanzees, live in the world essentially as Nature presents it to them. . . . Not us . . . In a very literal sense, we human beings – and we alone – live in worlds that are at least partially of our own making.

We human beings are very peculiar creatures. For one thing, we walk upright on two legs, a very eccentric thing to do in the animal realm. We have great globular heads that balance precariously atop our curiously S-shaped vertical spines, our females conceal their ovulation, we clothe and decorate ourselves, and we make elaborate tools to accomplish tasks that other creatures use their beaks or teeth for. The list goes on and on. But most bizarre of all is the way we process information in our brains. All other creatures we know of on Earth, even such cognitively sophisticated ones as chimpanzees, live in the world essentially as Nature presents it to them. They may react to sensory stimuli in highly sophisticated ways, but they accept the world as it is. Not us. Uniquely, as far as we know, we Homo sapiens dissect all that impinging information in our minds, creating mental symbols that we can then combine and recombine to create new realities, or alternate constructions of the one we are in. In a very literal sense, we human beings – and we alone – live in worlds that are at least partially of our own making. None of us interprets what surrounds us in exactly the same way.

There is, then, a great cognitive gulf between us and all the other denizens of the planet – even our closest living relatives. We are symbolic creatures, they are not. Yet only those with an axe to grind in this matter would contest that we are descended, at some remove, from an ancestor that did not share our cognitive peculiarities – an ancestor that lay on the other side of that narrow but infinitely deep gulf. So how was the chasm crossed? Well, as long as we do not know how a mass of electrochemical signals in our brains becomes transformed into what we each individually experience as our subjective consciousness, we will never be able to answer that question mechanistically. But at
Let’s first consider the starting-point. The cognitive scientist Daniel Povinelli recently proposed that a fundamental distinction between the ways in which chimpanzees and humans view the world is that, while humans
form abstract views about other individuals and their motivations, “chimpanzees rely strictly upon observable features of others to forge their social concepts. If correct, [this] would mean that chimpanzees do not realize that there is more to others than their movements, facial expressions, and habits of behavior. They would not understand that other beings are repositories of private, internal experience” (Povinelli, 2004: 33). It would also imply that individual chimpanzees do not have such awareness of themselves, either. They experience the emotions and intuitions that arise in their own minds; and they may act on them, or suppress them, as the situation demands or permits. But they “do not reason about what others think, believe and feel – precisely because they do not form such concepts in the first place”

This is about as much as we can reasonably say about chimpanzees’ minds from our outside vantage point. Still, even though there has doubtless been a lot of evolutionary water under the bridge on both sides since human beings shared an ancestor with any ape, most authorities find it reasonable to conclude that cognition of the kind we see among chimpanzees provides us with a reasonable approximation of the cognitive point from which our ancestors started some seven million years ago. To use Povinelli’s words, one may reasonably assume that those ancestors were “intelligent, thinking creatures who deftly attend[ed] to and learn[ed] about the regularities that unfold[ed] in the world around them. But … they [did] not reason about unobservable things: they [had] no ideas about the ‘mind,’ no notion of ‘causation’” (Povinelli, 2004: 33). In the human sense, they had as yet no idea of self. This plausible yet necessarily sketchy characterization of our lineage’s starting point more or less exhausts what can usefully be said based on existing studies of comparative cognition. If we wish to know how we got here from there, we need to turn to our fossil and archaeological records.

The current best estimate is that our most recent common ancestor with any ape lived on the order of 7 to 8 million years ago. In the first half of this period a handful of mostly poorly-known African species contend to be the “earliest” hominid, among them the recently-ballyhooed and very peculiar *Ardipithecus ramidus*. All in all they make a very assorted bunch, with the clear implication that, from the very beginning, the history of the human family has been pretty unremarkable for a successful mammalian group. For right up until very recently, the Earth has routinely hosted a variety of different hominids, each doing battle in its own way for ecological space. Of course, many of us were brought up with the idea that (most unusually) human evolution involved the gradual modification of a single lineage that culminated in today’s lonely *Homo sapiens*; but this notion is flatly contradicted by the facts of a rapidly-expanding fossil record (see the family tree opposite). Indeed, as recently as 30 thousand years ago there were at least four hominid species on Earth; and our present solitary state, I am convinced, tells us something very significant about ourselves, about just how different we are from any of our precursors.

The first really well-documented hominid species is *Australopithecus afarensis*, to which the famous “Lucy” belongs. Emblematic of a whole host of species that flourished in the African woodlands between about 4 and 1.5 million years ago, the 3.2 million year-
old Lucy was a diminutive creature who would have been an adept climber in the trees even while clearly walking upright on the ground, albeit not exactly as we do today. Early hominids like Lucy are often informally known as “bipedal apes” because whatever the modifications of their hips, legs and feet, their cranial proportions were ape-like, with small braincases and large, protruding faces. There is no reason to suspect that these creatures were significantly smarter than any modern ape.

Yet at some point something happened. At around 2.5 million years ago, early African hominids started making stone tools. No doubt wooden and other tools were already used by hominids long before, as they are by apes today; but those early stone tools preserved well, and marked a major (and fateful) step ahead in hominid behavior and cognition. For even with intensive coaching, no living ape has been able to grasp the idea of hitting one carefully-selected rock with another, at precisely the angle required to detach a sharp flake. What’s more, those carefully-selected stones were often carried long distances before being made into tools as required, implying an impressive degree of foresight on the part of the toolmakers. Without any doubt, with the first stone tools we have the earliest good evidence that our ancestors had advanced cognitively far beyond the ape league.

We do not know exactly who those first stone tool makers were. But there is good circumstantial evidence that they were creatures who we would almost certainly classify physically as “bipedal apes.” Which means that, yet again, we have early evidence of a pattern that would hold throughout the rest of human evolution: the arrival of new ways of doing things is never explained by the evolution of a new kind of hominin. Technological innovations are always made by members of pre-existing species.

So it should come as no surprise that, when a totally new kind of hominid came on the African scene at some time after about 2 million years ago, it did not bring with it a new tool kit. At the beginning Homo ergaster, the first hominid species to have effectively modern body proportions, made simple flake tools more or less exactly like those its archaically-bodied predecessors had been making for a million years before. Establishing a routine practice for hominids, it adapted the old tools to new ways, which would have included a life out on the expanding African savannas, away from the shelter of the trees. Adapted like us not merely to uprightness, but to a striding locomotion over open ground, these hominids would have had a lifestyle that emphasized stamina and endurance, a hallmark of hominids ever since.

Once the modern body type was established, hominids spread rapidly beyond Africa: they were in the Caucasus by about 1.8 million years ago, and in Indonesia not much later. By 1.4 million years ago they had already penetrated the harsher climes of Europe. Interestingly, this initial spread was achieved in the absence of radically larger brains or improved technologies. Still, back in Africa, and a bit later elsewhere, we do see the inauguration of a trend among hominids towards increasing brain size. This trend seems to have been expressed independently in several hominid lineages in different parts of the world, so that there is evidently something about the genus Homo that has historically predisposed it to increasing brain sizes. Brain is met-
abolically expensive tissue that takes a lot of energy to maintain, and it will be very important to understand just what it is that underwrote this trend if we are ever going to fully unravel the story of the evolution of human cognition. But right now what that underpinning element was remains unclear, although it must almost certainly have had in some way to do with a feedback between human lifeways and a form or forms of “intelligence” that we cannot yet specify.

Again in Africa, a radically new type of tool was invented about 1.5 million years ago, still during the tenure of *Homo ergaster*. This was the “handaxe,” a largish tool made by carefully shaping a stone “core” on both sides to flat, teardrop shape. The earliest stone tools were no more than simple flakes with a sharp cutting edge, the only feature desired. It didn’t matter what shape the tool was. But handaxe-makers were fashioning tools to a specific pattern that existed in the toolmaker’s mind before production started. This was clearly a conceptual advance, but alas we do not know to what extent it may have reflected more complex cognitive processes on the part of the hominids concerned.

The same can be said of the next major conceptual advance in stone tool making, the “prepared-core” tool, whereby a stone core was carefully shaped on both sides until a single blow would detach a more or less finished tool with a cutting surface all around its periphery. Invented at some time after about 300 thousand years ago, following a long period of stasis in stone tool production, prepared-core tools were introduced during the tenure of *Homo heidelbergensis*. This, the first cosmopolitan hominid species, appeared in Africa.
about 600 thousand years ago, and rapidly spread to Europe and eventually as far afield as China.

Members of *Homo heidelbergensis* had brains that lay within the lower limit of the modern size range, but at the beginning they were associated with archaic tool types in Africa, and in Europe they started making handaxes fairly late. The earliest evidence for the sustained control of fire in hearths goes back to about 800 thousand years ago, before we have any evidence of *Homo heidelbergensis*, but the routine use of fire in this way dates only to about 400 thousand years ago, well within the tenure of this species. Also of about this age are the first constructed shelters and the first-known wooden throwing spears, both equally significant technological innovations. Clearly, something was astir cognitively at around this time; but again we are frustratingly unable to tie it in to the way *Homo heidelbergensis* actually experienced the world around it. Still, it is almost certainly significant that no symbolic artifacts are associated with *Homo heidelbergensis*.

Quite probably the most sophisticated practitioners ever of the prepared-core technique were the Neanderthals, *Homo neanderthalensis*, who flourished in Europe and western Asia between about 200 thousand and 30 thousand years ago. These hominids had brains as large as ours, albeit housed in skulls of rather different aspect and differing from us in various aspects of body structure (see the figure). At least occasionally, and very simply, they buried their dead; and there is evidence that they looked after disadvantaged members of the social group. They were excellent craftsmen, though apparently rather unimaginative: their beautiful products always look remarkably similar, wherever they come from. It was these hominids who were apparently abruptly displaced by the first *Homo sapiens* to enter Europe, about 40 thousand years ago – whether by direct conflict or by indirect economic competition is not known.

The contrast between the Neanderthals and the invading “Cro-Magnons” was extreme, principally because the latter had lives that were quite overtly pervaded by symbol. By 35 thousand years ago they were carving exquisite figurines, and painting powerful animal images on cave walls; soon they were decorating everyday objects, making elegant pictorial and geometric engravings, and developing systems of notation. On the economic front they were occupying the landscape in far greater density than their predecessors, and exploiting its resources with greater efficiency and perception. In short, the Cro-Magnons were *us*, while the nonsymbolic Neanderthals remained emblematic of all the other hominids that had preceded them: clever for their times, certainly, but lacking the creative spark that makes us who we are.

---

In short, the Cro-Magnons were us, while the non-symbolic Neanderthals remained emblematic of all the other hominids that had preceded them: clever for their times, certainly, but lacking the creative spark that makes us who we are.
That spark was not acquired by *Homo sapiens* in Europe. Instead it was brought in with them by the invaders, from a place of origin that almost certainly lay in Africa where our species itself evolved. Fossils from Ethiopia show that, as an anatomically-recognizable entity, *Homo sapiens* had emerged by about 200-160 thousand years ago. But those early *Homo sapiens* are not associated with archaeological remnants that suggest they were symbolic. Instead, they did as their predecessors had done and adapted to changing environmental conditions by using traditional technologies in new ways. This is also true of the earliest *Homo sapiens* who penetrated beyond Africa, into the Levant at the eastern end of the Mediterranean. There the newcomers, documented by about 93 thousand years ago, did not immediately displace the resident Neanderthals, who persisted for another 50 thousand years; and they also made virtually identical stone tool kits. There is no reason to suspect any cognitive difference between *Homo sapiens* and *Homo neanderthalensis* at that time and place.

The first stirrings of symbolic behavior are found in southern Africa, and although not associated with human fossils, they are almost certainly attributable to early *Homo sapiens*. Overly symbolic objects include a couple of 77 thousand year-old ochre plaques engraved with geometric motifs, from Blombos cave on the southern African coast, and shells pierced for stringing (hence for bodily decoration) come from that and other sites of similar age. Complex heat-treatment of silcrete from the nearby Pinnacle Point, dated to more than 70 thousand years ago, also seems to indicate very complex sequential thought processes.

Observations like this suggest that full modern humanity was achieved in two stages. First, the very distinctive modern human anatomy was acquired, plausibly as a result of a change in gene expression that had cascading developmental consequences throughout the body. If that change, minor in structural genetic terms, involved neural circuits as well as the structures visible in the fossilized skeleton, it would have created a new cognitive potential. Evidently, though, that potential was not immediately expressed. This would be nothing unusual: changes involving cognition in hominid history had, after all, always been backwardly compatible; new hominids had routinely continued with the technological habits of their predecessors before discovering new ways of doing things. Still, the new potential nonetheless had to be discovered by its possessor; and that had to have happened through a *cultural* stimulus (the biology was, after all, already there). It was this act of behavioral discovery that announced the second stage of becoming fully human, some tens of thousands of years after anatomical modernity had been achieved. My favorite candidate for the stimulus involved is the invention of language – which, depending as it does on the creation of mental symbols for its very existence, is the ultimate symbolic activity. What is more, language is a supremely communal attribute that, once adopted, would have very easily spread through a population with the biological predisposition to absorb it.

This puts the origin of the extraordinary and radically unique human cognitive capacity in the context of emergence, whereby something entirely new is created from a novel combination of elements. After some 400 million years
of accretionary vertebrate, mammal and primate brain evolution, the human brain had evolved to a point at which a small addition was able (somewhat like the keystone of an arch) to create a structure with an entirely novel potential: in this case, for a radically new way of processing information about the world, and about its own internal state. Many commentators, including Alfred Russel Wallace, co-inventor of the idea of evolution by natural selection, have had difficulty imagining how selection could have driven human consciousness into existence. The substitution of emergence for selection now places that fateful event in an entirely routine evolutionary context: one that requires no special explanation. And it focuses scientific attention where it ought to be: on the precise identity of the alteration to the brain that enabled human beings to become the extraordinary creatures they are.

Raised in East Africa, educated at Cambridge and Yale, and Curator Emeritus at the American Museum of Natural History, Ian Tattersall is a paleoanthropologist and primatologist whose recent research centers on the origin of *Homo sapiens*. He has conducted fieldwork in places as diverse as Madagascar, Yemen, Vietnam, Mauritius and Surinam, and is a prominent interpreter of science to the public through exhibitions and books. His most recent titles include: *Paleontology: A Brief History of Life* (2010); *The Fossil Trail: How We Know What We Think We Know About Human Evolution* (2nd Ed., 2009); *Human Origins: What Bones and Genomes Tell Us About Ourselves* (with Rob DeSalle, 2008); and *The World From Beginnings to 4000 BCE* (2008). He lives with his wife in Greenwich Village.

**Work Cited**

Povinelli, Daniel J. “Behind the ape’s appearance: escaping anthropocentrism in the study of other minds.” *Daedalus* 133 (1), 2004: 29-41.