The Thinking Primate: Establishing a Context for the Emergence of Modern Human Cognition[1]

IAN TATTERSALL
Curator Emeritus
American Museum of Natural History

It is a great honor to have been invited to present the R. A. F. Penrose Lecture at this general meeting of the American Philosophical Society. Thinking of what I might say that would be of greatest interest to the Society's diverse membership, it occurred to me that, as human beings, we all have a stake in understanding the process by which we *Homo sapiens* became the unprecedented thinking primates we are today. Of course, even after many years of neurobiological investigation and extravagant hypothesizing, the neuroanatomical basis of our unusual cognitive style still stubbornly resists reductionist explanation; and it consequently remains true, remarkably enough, that the only reason we have for believing that an ancestor broadly equivalent cognitively to today's great apes *could* ever have given rise to a descendant that reasons as we do, is that it so self-evidently *did*. Still, recent improvements in our understanding of our fossil and archaeological records are finally lifting at least a corner of the curtain that has covered the larger context in which this radical and fateful transformation occurred, and this issue is what I would like to briefly address today.

Let me preface my consideration of the origins of human cognitive uniqueness by emphasizing that there can be no rational doubt whatever that we living *Homo sapiens* are fully integrated into the great Tree of Life that unites all living organisms on this planet. Unquestionably, we are intimately nested into the natural world. At the same time, however, it is equally obvious that we are not simply just another run-of-the mill primate. A primate we most certainly are—but there is nonetheless something qualitatively unique that sets us apart from all of our primate relatives. Physically, of course, we are strongly distinguished by our upright bipedal form of locomotion, an unusual

1 This paper, presented as the R. A. F. Penrose Lecture, was read 12 November 2015.

way of getting around that has affected our bodily structure in a host of different ways. But what makes us most truly unique and unprecedented, and certainly what makes us *feel* so different from the rest of Nature, is the way in which we process information in our minds.

The key to this difference seems to be that we human beings think symbolically (a useful metaphor for something that, quite frankly, we do not fully understand). We mentally dissect our exterior and interior worlds into a vocabulary of discrete symbols; and having done this, we can rearrange those symbols, according to rules, to imagine alternate versions of those worlds. As far as we know, no other organism in the world today manipulates information in this way. That is not, of course, to suggest that the cognitive processes of primates and other vertebrates cannot be very complex indeed. Our closest living relatives, the African apes, can, for example, readily recognize and respond to symbols. They can even use them additively, to make and understand simple statements such as "take . . . red . . . ball . . . outside." But the additive algorithm is limiting, and what apes evidently do not do is engender multiple alternatives by rearranging those symbols in the human manner. As a result, there is a narrow but hugely significant gulf between the cognitive styles of human beings and those of apes—and indeed all other organisms.

However, given our intimate position within the Tree of Life, there can be no rational doubt that our symbolic—and, equally remarkably, linguistic—species was descended from an ancestor that was neither of these things. So, at some point in our evolution that symbolic and linguistic gulf must have been bridged. But how did that transformation occur? In terms of evolutionary mechanism, there are two theoretical possibilities. One of them is embodied in the traditional neodarwinian view of evolution as a long, slow process of modification under the guiding hand of natural selection. That view sees us basically as a better version of what went before, as the result of a gradual accretion of improvements over the eons. And in the larger frame of things, there is some truth in it, at least to the extent that nothing about us today would ever have been possible in the absence of anything that had previously occurred in our evolution.

Still, it has been abundantly clear for years that the neodarwinian perspective hugely oversimplifies how evolution works: the various processes that promote evolutionary change have turned out to be largely non-continuous, and affected by a host of factors—such as short-term environmental changes—that are basically random with respect to adaptation. This backdrop to human evolution throws wide open the second possibility, namely that our unique cognitive style might have been achieved in a short-term and definable event.

The two theoretical alternatives available to us have significantly different implications for the kind of creature we are. Gradual honing by natural selection implies that we have somehow been fine-tuned by Nature to think and behave in certain ways, whereas a short-term origin of the unique human capacity might suggest that there is something adventitious, emergent, and unpredicted about us. Only empirical evidence will help us choose between these alternatives, and our options are limited. Indeed, because cognition itself is an abstract quality that does not preserve directly, and such preservable factors as brain size and external morphology have proven rather disappointing as cognitive indicators, we are left with only two potential sources of information. One of these is the overall pattern of human evolution, and the other is the archaeological record, the (rather selective) material register of ancient hominid behaviors.

For the Pleistocene epoch, roughly the 2 million years over which our genus *Homo* evolved, that material record is pretty straightforward. It consists for the most part of stone tools and butchered animal bones, how these are spatially disposed at occupation sites, and the ways in which those sites are scattered across the landscape. However while in the aggregate, indicators like these may be indicative of general complexities of lifestyle and ecological strategy, it is improbable that any of them can be taken as a good proxy for any specifiable cognitive condition on the part of the beings who left them behind, for none of them codes directly for how the hominids who created them were mentally processing information.

To complicate matters further, scientists in different disciplines, and even within the same one, have differed wildly in their willingness to accept potential archaeological proxies for language and symbolic thought. Thus, some have readily accepted sophisticated or even relatively simple stoneworking techniques as *prima facie* evidence of cognitive states specifically foreshadowing our own, whereas others would merely perceive in them evidence of some level of general cognitive complexity. My own take on this is that, especially in view of the fact that learning by imitation can extend to extremely complex processes, few, if any, Paleolithic stoneworking techniques can be used in isolation to infer the specifically modern human symbolic cognitive style. Witnesses to sophisticated cognitive states they certainly may be; but there are evidently ways other than the modern human one in which to be smart and insightful. And if that is the case, we are left only with explicitly symbolic artifacts as reliable proxies for the specifically modern symbolic cognitive style.

However, inevitably the complications do not end there, for opinions may legitimately differ as to what may or may not be considered a

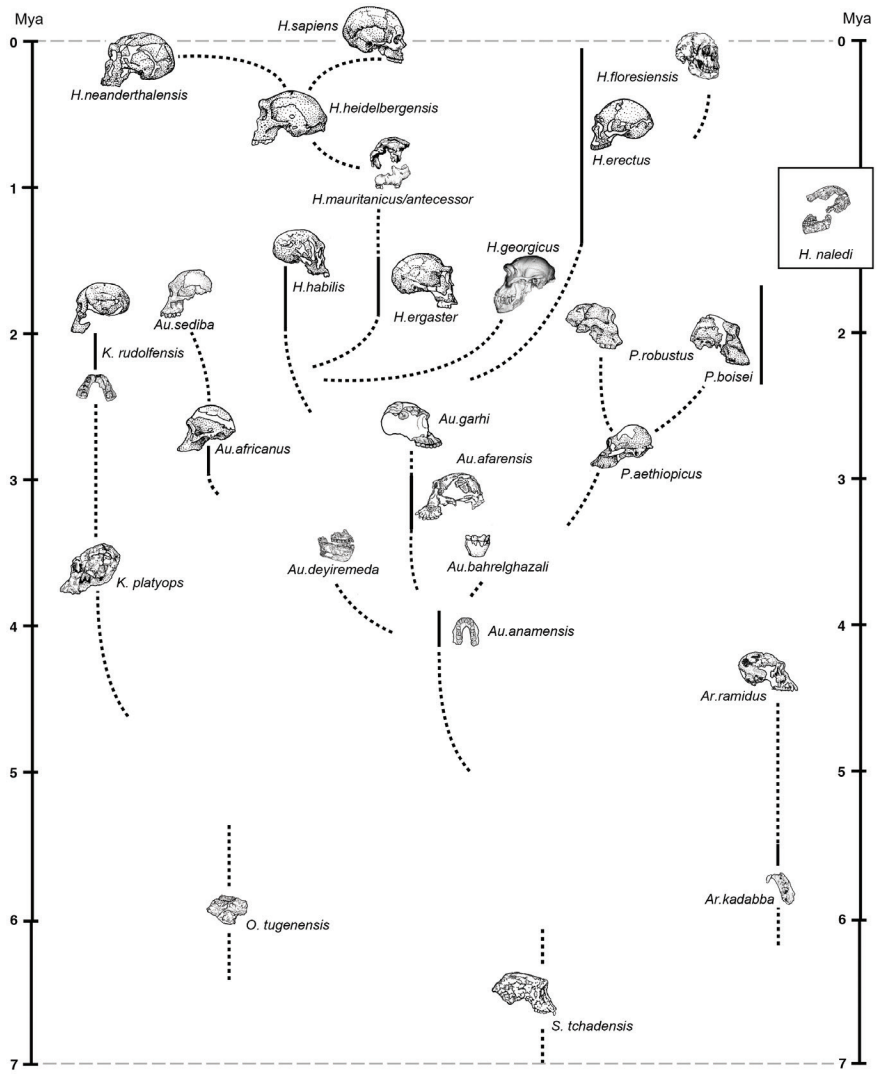

FIGURE 1. A highly provisional genealogy of the hominids, showing the family's high species-level diversity and the typical co-existence of multiple lineages throughout. Drawn by Patricia Wynne.

symbolic artifact. Can we consider as symbolic a roughly altered lump of stone that looks vaguely anthropomorphic to a modern observer, as in the case of the 250,000-year-old "Venus" from the Israeli site of Berekhat Ram? Was a 100,000-year-old gastropod shell presumptively pierced for stringing necessarily part of a symbolic ornamentation system? Does the presence of ground ochre in archaeological deposits (increasingly found at about the same time) necessarily imply its symbolic use? There are no

simple answers to any of these questions, and there will always be difficult cases like these.

On the other hand, certain early expressions were more overtly and unquestionably symbolic. The most dramatic such expressions are found in the animal art of Europe and southeast Asia, now known back to about 40,000 years ago in both places. Those images (in Europe consisting of abstract designs as well as anthropomorphic and animal representations) were the work of early *Homo sapiens* who were clearly the cognitive peers of anyone alive today. But probably even more significantly, symbolic thought allows hominids with clever hands to not only re-make their mental worlds but also shape the physical world around them in unprecedentedly complex ways, as modern humans do. This proclivity would be expected to express itself in some major visible inflection in the material record such hominids left behind—as it has so clearly done in our own case.

In the light of these considerations, it seems worthwhile to look briefly back over the archaeological record with a view to determining where in human evolution we are able to reasonably infer that hominids possessed modern symbolic behaviors, and whether those behaviors emerged gradually or suddenly. First, though, in choosing between these two latter alternatives it is instructive to look at the larger pattern of human evolution and the processes underlying it. The very provisional genealogical tree in Figure 1 clearly shows a very bushy form. Typically, multiple hominid lineages flourished in parallel over the 7 million years of hominid history, with as many as seven coexisting at one time. This diversity takes us a very long way away from the neodarwinian story of a single-minded struggle, from primitiveness to perfection, within a central lineage leading insensibly to *Homo sapiens*. Clearly, from this perspective the hominid evolutionary story was not one of gradual and continuous improvement, but instead involved the generation of biological diversity. Our zoological family tossed out numerous variants to compete on the ecological stage, exactly as would be expected of any successful and geographically widespread mammal group. Some of those variants gave rise to descendant taxa, while in the long term most did not. This repeated pattern speaks eloquently about the mechanism underlying it, which certainly was not one of gradual change and fine-tuning by natural selection.

The earliest purported hominids consist of a handful of generally poorly known and rather ill-assorted African forms, between about 7 and 4 million years old. All of them owe their hominid status largely to claims that they were upright bipeds when they moved on the ground, and, to a certain extent, also to modifications in the anterior dental apparatus. Nothing we know about them suggests that they were significantly

advanced cognitively compared to today's great apes. Much better documented are the so-called "australopiths," also exclusively African, of between about 4 and 1.5 million years ago. These relatively diminutive and short-legged human precursors were clearly bipedal on the ground, but at the same time they retained numerous features of the skeleton indicating that they were agile in the trees. Their brains were great-ape-sized and, also as among apes, their faces were large and projecting. Not for nothing have they often been described as "bipedal apes," even though from the very beginning they seem to have shown different ecological preferences, exploiting a much wider range of resources in the expanding African woodlands and bushlands.

By 3.4 million years ago, there are already suggestions that early hominids had begun to use naturally-occurring sharp stone flakes to butcher mammal carcasses, although what we have traditionally thought of as the earliest stone tools actually only show up significantly later, at about 2.5 million years ago, in Kenyan and Ethiopian sites. These simple tools, produced by hitting one fist-sized cobble with another to produce a sharp flake, are beyond the behavioral range of modern African apes and clearly show that by this point in time, hominids had moved cognitively well beyond the ape league. Still, in terms of their anatomical structure, the earliest stone tool makers seem to have been standard-issue australopiths, which gives us the first indication of another significant pattern we find throughout the hominid record—that new kinds of technology do not tend to be introduced by new kinds of hominid. As far as innovation is concerned, the archaeological and fossil records are clearly out of phase.

This finding certainly holds true for the earliest well-characterized members of our genus *Homo*, whose fossils first occur at African sites a little under 2 million years old in association with flake tools more or less identical to those their archaically proportioned predecessors had already been making for half a million years. Still, in other ways, these so-called *Homo ergaster* were radically new creatures. They were tall, slender, and long-legged and had brains that were already significantly expanded beyond ape volumes. Physically, they were suited for life in the expanding African savannas, far from the shelter of the forest; and for energetic reasons, it is reasonable to conclude that they had already assumed an at least partly predatory way of life. However, once again, it took a while before hominids of this kind started to make a new kind of implement—the large and bifacially-flaked "handaxe" that was made to a predetermined form. Such axes began to be regularly manufactured, sometimes in astounding quantities, at about 1.5 million years ago; and once more, although several kinds of *Homo* apparently came and went in the intervening period, it was not until more than a million

years later that a conceptually new kind of stone tool began to be regularly used—the so-called "prepared-core" tool, in which a stone nucleus was elaborately worked on both sides until a final blow or blows would detach a more or less finished implement.

Once more, these conceptually more complex tools appeared well within the tenure of an existing species, in this case the world's first cosmopolitan hominid, *Homo heidelbergensis*. This showed up in both Africa and Europe at about 600 thousand years ago, and its fossils are found as far afield as China. *Homo heidelbergensis* boasted a brain that was within the low end of the (very large) size range of *Homo sapiens*; and within its tenure several other radical technological innovations were also introduced, including the hafting of stone tools into handles, the fabrication of the earliest shelters, and the production of the first finely shaped wooden throwing spears. But significantly, just as before, nothing produced in this period is incontestably symbolic. Quite evidently, it was possible to be resourceful, smart, behaviorally flexible, and technologically sophisticated in the absence of symbolic reasoning, or at least of any deeply embedded inclination to express this proclivity.

The same thing can even be said for *Homo neanderthalensis*, which evolved from indigenous European predecessors at about 200 thousand years ago. The Neanderthals had brains as big as ours, were wonderful craftsmen in stone, and left us an incomparable record of very complex lives. They flourished in an age of difficult climates; they hunted some fearsomely large animals; and, at least occasionally, they buried their dead. Nonetheless, despite some equivocal and disputed expressions in very late times, the Neanderthals bequeathed us little convincing evidence of any consistent tradition of symbolic activity; and in a record as geographically, temporally, and materially expansive as theirs, if the Neanderthals *had* been symbolic thinkers, they would surely have left us more convincing indications of this fact. Of course, saying this is not to disparage the Neanderthals in any way. Clearly, they were cognitively extremely complex beings, and they were clever exploiters of their environments. But it is still hard to avoid the impression that they interacted with their world differently from the way we interact with ours.

The very same thing, remarkably enough, also appears to have been true of the earliest fossil representatives of our anatomically distinctive species *Homo sapiens*. Fossils showing substantially modern morphologies have been found at eastern African sites dating between about 200 and 160 thousand years ago. Yet for all of their anatomical modernity, these early *Homo sapiens* are associated with some notably archaic toolkits, including the last handaxes ever produced in Africa. And although

members of our species eventually began to reason symbolically—or we wouldn't be discussing the subject today—it is not until significantly later in time, around 100 thousand years ago, that we start finding the first plausible indications of this unprecedented cognitive activity.

Once again, those indications first show up in Africa and nearby. At about the 100-thousand-year mark, pierced marine shell beads and ochre deposits start to be found at sites around the Mediterranean and in South Africa. Such items may on their own be arguable as indicators of modern cognition, but they are soon supplemented by more direct evidence, most notably from occupation strata at Blombos Cave. On the southern African coast, layers dated to about 77 thousand years ago have yielded two smoothed ochre plaques, of slightly different ages, that bear basically the same engraved geometric design. A fairly similar engraved geometrical pattern, found slightly later at another site, supports the conclusion that all such motifs were symbolic devices that encoded social meaning. In addition, at around 72 thousand years ago (or perhaps significantly more), the caves of Pinnacle Point, not far from Blombos, have provided evidence of a complex multistage heating technology. Used to convert the soil-derivative silcrete from a poor tool-making material into a superior one, this technology is, in my view, perhaps the only one from the African Pleistocene that is sufficiently elaborate to allow us to view it as necessarily the product of symbolic minds.

Hominid fossils are sparse at African sites in this time frame, but the evidence we have overwhelmingly suggests that these early expressions of behavioral modernity in South Africa were the work of members of our own anatomically distinctive species *Homo sapiens*. As a result of this evidence, a scenario of modern human origins and geographical dispersion is beginning to emerge. What seems to have happened is that *Homo sapiens* appeared as a distinctive anatomical entity in Africa at about 200 thousand years ago. At first, members of this new species behaved much as their predecessors had done and their hominid contemporaries were still doing; but, at around the 100-thousand-year mark, they began to express unprecedented new behavioral proclivities, including the production of symbolic objects. Very soon after that, populations descended from those first symbolic humans exited Africa and rapidly took over the world.

Earlier, non-symbolic *Homo sapiens* had forayed into the Levant without displacing the Neanderthals who were resident there, or even gaining a lasting foothold. But the later symbolic emigrants from Africa clearly differed from them in possessing a cognitive edge that allowed them to rapidly displace the hominid competition throughout Eurasia. From *Homo erectus* in the far east of the continent, to *Homo*

neanderthalensis in the far west, all other hominid species promptly disappeared; and the archaeological record began to change dramatically. In the best-documented case of early behaviorally modern penetration of remote Eurasian regions, the dazzling tradition of European cave decoration was already underway by around 40 thousand years ago, accompanied by an amazing record of musical instruments, notation, portable art, and so forth. What's more, a clearly recognizable painted image of a babirusa from Sulawesi, in Indonesia, was recently dated to 40 thousand years ago, suggesting that the tradition of early representational art now seen in both Europe and Asia had originated earlier yet, most plausibly in the parent continent of Africa.

Of course, human beings are complex creatures descended from complex precursors; and from time to time we do find unusual expressions in the record those precursors left. The earliest such expression is a half-million-year-old pattern of incisions made on a mollusk shell at Trinil in Java, in putative association with *Homo erectus*. Neanderthals at the site of Krapina, in Croatia, may have deliberately removed the talons from eagle carcasses for use in decorative necklaces some 130 thousand years ago; and very late Neanderthals apparently engraved a large hash mark into the floor of a cave in Gibraltar. However, one swallow doesn't make a summer; and these items, while intriguing, are floating points—individual manifestations that were not embedded in any identifiable symbolic social traditions—whereas in huge contrast, the entire tenor of human life was clearly and dramatically changing among those early African *Homo sapiens*. In the period between 100 and 40 thousand years ago, a fundamental behavioral transformation in *Homo sapiens* was sparking a revolution in the way our species did business in the world. Previously, hominids had apparently met environmental challenges by adapting old technologies to new purposes rather than inventing new ones—hence the typical stasis in stone tool kits. However, with the emergence of behaviorally modern *Homo sapiens*, a totally unprecedented new entity was on the scene: one that clearly possessed the same restless appetite for change that increasingly dominates our own lives today.

So, how do we explain the recent and rapid emergence of this extraordinary and essentially unprecedented new phenomenon? Well, long-term natural selection is clearly no answer in the case of a dramatically short-term event that clearly took place within the tenure of an existing species—as, indeed, it had to have done because the neural structures that permit modern humans to make the complex associations involved in symbolic thought must necessarily have been in place before the new cognitive proclivity could be expressed. Furthermore, there was only one obvious event in which this fateful neural acquisition could

have been made—namely, the radical developmental reorganization that resulted, some 200 thousand years ago, in the highly derived and distinctive skeletal anatomy of the new species *Homo sapiens*.

The genetic innovation involved was plausibly a rather minor one at the molecular level, involving changes in gene regulation or expression rather than in the structural genome itself. However, it evidently had cascading developmental consequences throughout the body; and there is no reason to believe that those consequences should necessarily have been confined to the skeletal and dental systems, which are all that the fossil record preserves. They could well have affected the internal organization of the brain, creating or allowing the formation of the physical pathways that permit the complex mental associations that are the hallmark of humankind today.

However, the new cognitive potential evidently then lay fallow for a short but significant lapse of time, during which humans with the new anatomical structure continued to behave and presumably reason in the old manner, accounting for the unremarkable archaeological record associated with the earliest *Homo sapiens*. Eventually, at around 100 thousand years ago, something happened to stimulate the recruitment of the new potential, much as ancestral birds rather tardily discovered that they could use their feathers to fly. That stimulus was necessarily a purely cultural one, and the most plausible candidate we have for it was the invention of language. Several factors combine to make language particularly attractive as the cultural releaser of symbolic thought. First, language is the ultimate symbolic activity. Indeed, from our modern perspective it is virtually impossible to imagine thought in isolation from language. For example, the linguist Wolfram Hinzen (2012) has recently recalled that the "close connection between grammar and thought" was a consistent theme in early studies of generative grammar, and he has provided persuasive arguments for reviving the view that language and thought are "not two independent domains of inquiry." In other words, among modern humans, language and thought are so closely intertwined that they appear to be functionally, if not conceptually, inseparable.

In terms of interpreting the material archaeological record, one can of course object that although all human beings are symbolic, they do not all necessarily leave traces of this distinctive proclivity in objects that might be preserved. However, over the long haul, and over the entire expanse of its distribution, any species that processed information in the modern human manner would surely be expected to have left some consistent material indication of its unusual cognitive status, just as modern humans have already left huge scars all over our planet. And this we simply do not find, even in the case of the big-brained and

exhaustively-documented Neanderthals, who experienced broadly similar environmental stimuli.

From the linguistic perspective, there is no compelling reason to believe that the invention of language by a biologically predisposed hominid could not have been a more or less instantaneous event, and that property of suddenness not only makes language a particularly credible driver of symbolic reasoning but also distinguishes it from such rival stimulants of symbolic thought as theory of mind. Further, unlike theory of mind, language is an externalized attribute that would have been poised to spread rapidly within a species that was already biologically enabled for it.

In this scenario of modern cognitive origins, language and symbolic thought are inextricably entwined and were more or less simultaneously acquired by *Homo sapiens* in a single, short-term feedback event that was recent, emergent, and exaptive. Exaptation is the routine evolutionary process whereby novelties arise in contexts entirely other than the ones in which they will eventually be co-opted, much as bony limbs were initially acquired by the marine ancestors of the terrestrial tetrapods. This same evolutionary mechanism also neatly explains how the highly derived modern vocal tract was in place at precisely the point when it was needed for the expression of language. The proportions of the upper vocal tract that permit articulate speech are very different from those of more primitive hominids, such as the Neanderthals; but they may, in fact, be no more than incidental by-products of the retraction of the face beneath the braincase that is the most fundamental cranial specialization of *Homo sapiens*. If that is true, the long-running argument over the condition of the larynx and other structures of the upper vocal tract in various fossil hominids is actually irrelevant to the precise point in human history at which language was acquired. The modern vocal tract was there first, as it had to be.

All this notwithstanding, we unquestionably have vastly more similarities with our closest extinct relatives, such as the Neanderthals, than we show differences; and, for all its peculiarities, our unique cognitive style is clearly built upon a long and complex series of acquisitions over 400 million years of vertebrate brain evolution. However, that style itself was clearly acquired recently, in an abrupt event that was entirely random with respect to adaptation, thus strongly suggesting that we human beings have not been programmed by eons of evolution to behave in specific ways, as some scientists suggest. Furthermore, I would suggest that knowing this fundamental fact is incredibly important in understanding the kind of creature we are; for the absence of long-term fine tuning of our cognitive systems in our evolutionary past helps to explain why our decision-making processes are typically

so messy, and sheds light on why, for all of our amazing rational powers, our behaviors are so frequently irrational, self-destructive, and short-termist. However, there is another side to the coin, as it also reminds us that, cognitively speaking, we have not been formed by Nature to be creatures of a specific kind. The good news here is that, at least biologically speaking, we human beings really do have a substantial measure of free will. Less welcome news, perhaps, is that this knowledge endows us with special responsibility for our actions, both individually and as a species.

Acknowledgments

My appreciation goes to Keith Thomson for inviting me to speak in this distinguished lecture series. Keith was the very first person to introduce me, many decades ago, to the wide world of paleontology beyond the confines of the primates, and I have always been grateful for the perspective I acquired at that time. Annie Westcott facilitated my attendance at the 2015 general meeting of the APS, and Samantha Andreacchi shepherded this text through publication. Thank you both. The thoughts expressed here have been a long time in gestation and have been aired, in various guises, in several recent publications. These include Bolhuis et al. (2014) and Tattersall (2012, 2014a, 2014b). Unlike this lecture, all of those publications are fully referenced.

Literature Cited

Bolhuis, J. J., I. Tattersall, N. Chomsky, and R. C. Berwick. 2014. "How Could Language Have Evolved? *PLoS Biology* 12 (8): e1001934.

Hinzen, W. 2012. "The Philosophical Significance of Universal Grammar." *Language Sciences* 34: 635–49.

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

Tattersall, I. 2014a. "An Evolutionary Context for the Emergence of Language." *Language Sciences* 46: 199–206.

Tattersall, I. 2014b. "Language as a Critical Factor in the Emergence of Human Cognition." *Humana.Mente Journal of Philosophical Studies* 27: 185–99.