How we came to be

SOME 28,000 YEARS AGO this 60-year-old man was given an elaborate burial, rife with implications of ceremonial practices and of abstract belief. He was interred with rich grave goods and was wearing bracelets, necklaces, pendants, and a tunic on which hundreds of mammoth-ivory beads had been sewn. Along with two juvenile burials from the same site—Sungir in Russia—this is one of the earliest and most resplendent examples of human burials found in Europe.

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Book Excerpt

HUMAN

The acquisition of language and the capacity for symbolic art may lie at the very heart of the extraordinary cognitive abilities that set us apart from the rest of creation

by Ian Tattersall

When we contemplate the extraordinary abilities and accomplishments of *Homo sapiens*, it is certainly hard to avoid a first impression that there must somehow have been an element of inevitability in the process by which we came to be what we are. The product, it's easy to conclude, is so magnificent that it *must* stand as the ultimate expression of a lengthy and gradual process of amelioration and enhancement. How could we have got this way by accident? If we arrived at our exalted state through evolution, then evolution must have worked long and hard at burnishing and improving the breed, must it not? Yet that seems not to be how evolution works; for natural selection is not—it cannot be—in itself a creative process. Natural selection can only work to promote or eliminate novelties that are presented to it by the random genetic changes (influenced, of course, by what was there before) that lie behind all biological innovations. Evolution is best described as opportunistic, simply exploiting or rejecting possibilities as and when they arise, and in turn, the same possibility may be favorable or unfavorable, depending on environmental circumstances (in the broadest definition) at any given moment. There is nothing inherently directional or inevitable about this process, which can smartly reverse itself any time the fickle environment changes.

Indeed, as we'll see a little later, perhaps the most important lesson we can learn from what we know of our own origins involves the significance of what has in recent years increasingly been termed "exaptation." This is a useful name for characteristics that arise in one context before being exploited in another, or for the process by which such novelties are adopted in populations. The classic example of exaptation becoming adaptation is birds' feathers. These structures are essential nowadays to bird flight, but for millions of years before flight came along they were apparently used simply as insulators (and maybe for nothing much at all before that). For a long time, then, feathers were highly useful adaptations for maintaining body temperatures. As adjuncts to flight, on the other hand, they were simply exaptations until, much later, they began to assume an adaptive role in this new function, too. There are many other similar examples, enough that we can't ignore the possibility that maybe our vaunted cognitive capacities originated rather as feathers did: as a very much humbler feature than they became, perhaps only marginally useful, or even as a by-product of something else.

Excerpted from *The Monkey in the Mirror*, by Ian Tattersall, © 2002 by Ian Tattersall, published by Harcourt, Inc.

Let's look at this possibility a little more closely by starting at the beginning. When the first Cro-Magnons arrived in Europe some 40,000 years (kyr) ago, they evidently brought with them more or less the entire panoply of behaviors that distinguishes modern humans from every other species that has ever existed. Sculpture, engraving, painting, body ornamentation, music, notation, subtle understanding of diverse materials, elaborate burial of the dead, painstaking decoration of utilitarian objects—all these and more were an integral part of the day-to-day experience of early *Homo sapiens,* and all are dramatically documented at European sites more than 30 kyr old.

What these behavioral accomplishments most clearly have in common is that all were evidently underwritten by the acquisition of symbolic cognitive processes. There can be little doubt that it was this generalized acquisition, rather than the invention of any one of the specific behaviors I've just listed—or any other—that lay behind the introduction of "modern" behavior patterns into our lineage's repertoire. This new capacity, what's more, stands in the starkest possible contrast to the more modest achievements of the Neanderthals whom the Cro-Magnons so rapidly displaced from their homeland in Europe and western Asia. Indeed, Cro-Magnon behaviors—just like our own—evidently differed totally from those of any other kind of human that had ever previously existed. It is no denigration at all of the Neanderthals and of other now extinct human species—whose attainments were entirely admirable in their own ways—to say that with the arrival on Earth of symbol-centered, behaviorally modern *Homo sapiens,* an entirely new order of being had materialized on the scene. And explaining just how this extraordinary new phenomenon came about is at the same time both the most intriguing question and the most baffling one in all of biology.

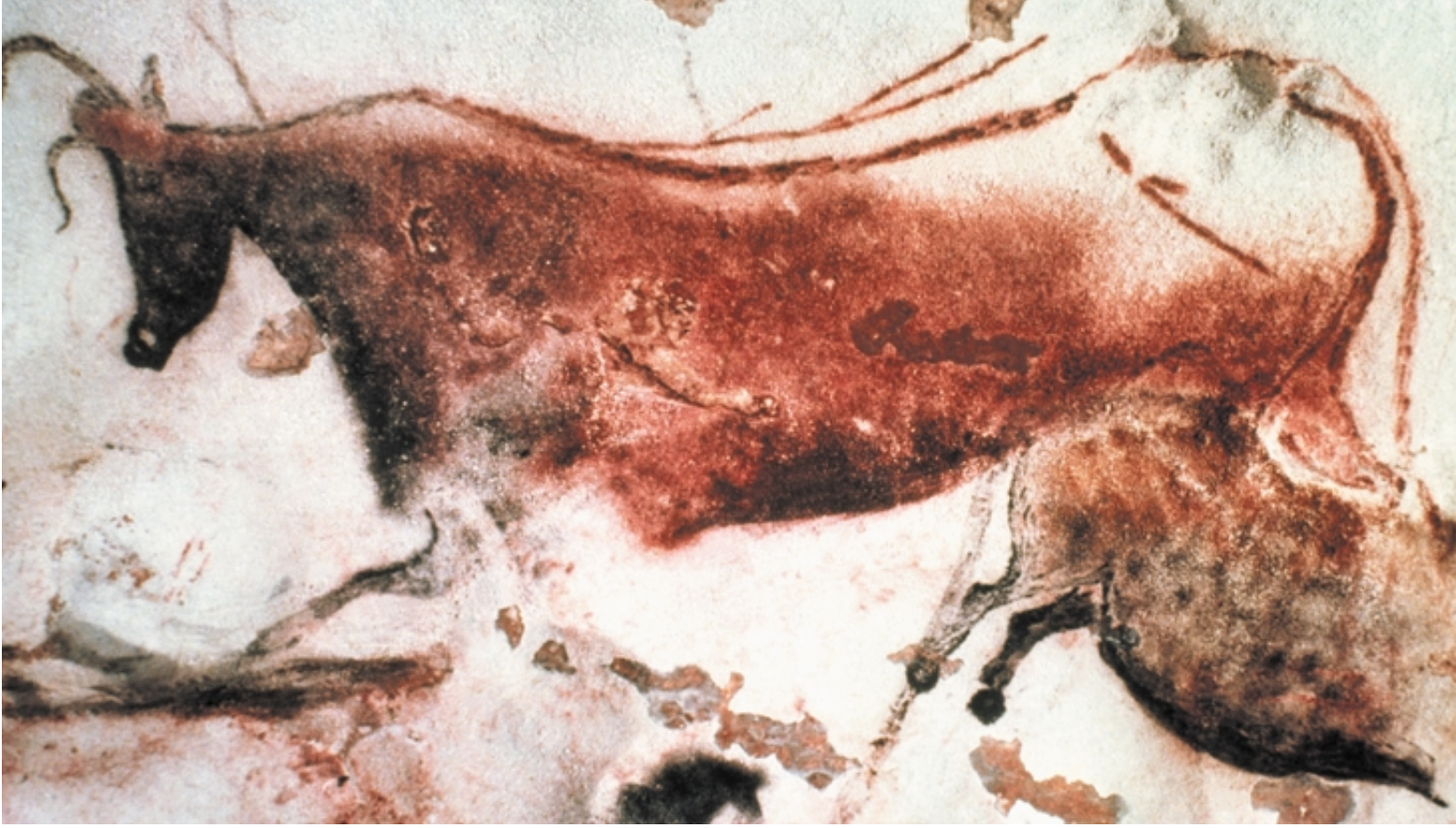
One complicating factor is that there appears to be no correlation whatever between the achievement in the human lineage of behavioral modernity and anatomical modernity. We have evidence of humans who looked exactly like us in the Levant at close to 100 kyr ago. But at the same time, in dramatic contrast to what happened in Europe, the Levantine Neanderthals persisted in the area for some 60 kyr after the anatomical moderns appeared. What's more, throughout this long period of coexistence (whatever form it took, and frankly we have no idea how the different hominids contrived to share the landscape for all those millennia), as far as we can tell from the toolkits they made and the sites they left behind, the two kinds of hominid behaved in more or less identical ways. Suggestively, it was not until right around the time that Cro-Magnon-equivalent stoneworking techniques showed up in the Levant, at about 45 kyr ago, that the Neanderthals finally yielded possession of the area. And it was almost certainly the adoption of symbolic cognitive processes that gave our kind the final—and, for the Neanderthals, fatal—edge. The conclusion thus seems ineluctable that the emergence of anatomically modern *Homo sapiens* considerably predated the arrival of behaviorally modern humans. But while this might sound rather counterintuitive (for wouldn't it be most plausible to "explain" the arrival of a new kind of behavior by that of a new kind of hominid?), it actually makes considerable sense. For where else can any behavioral innovation become established, except within a preexisting species?

The Brain and Innovation

NOBODY WOULD DISPUTE that to understand cognitive processes in any vertebrate species, we have to look to the brain. In the case of our own family, *Homo neanderthalensis* was endowed with a brain as large as our own, albeit housed in a skull of remarkably different shape. And while we know from the very different archaeological records they left behind that Neanderthals and Cro-Magnons behaved in highly distinctive ways, specialists on human brain evolution are hard put to identify any features on the external surface of the brain (as revealed in casts of the interior of the braincase) that would by themselves suggest any major functional difference between Neanderthal and modern *sapiens* brains. The same is obviously true for the brains of those early *sapiens* whose material cultures and ways of life resembled those of the Neanderthals. Clearly, then, we cannot attribute the advent of modern cognitive capacities simply to the culmination of a slow trend in brain improvement over time. Something happened other than a final physical buffing-up of the cognitive mechanism. Of course, by the time modern-looking humans came on the scene the necessary groundwork must have been laid for the adoption of modern cognitive processes, but this is not necessarily the same as saying that a specific neural mechanism had been acquired for them.

Let's look again, for a moment, at what our knowledge of the evolutionary process suggests may have occurred. First, it's important to remember that new structures do not arise *for* anything. They simply come about spontaneously, as by-products of copying errors that routinely occur as genetic information is passed from one generation to the next. Natural selection is most certainly not a generative force that calls new structures into existence; it can only work on variations that are presented to it, whether to eliminate unfavorable variants or to promote successful ones. We like to speak in

Our VAUNTED COGNITIVE CAPACITIES may have originated rather as feathers did: as an "exaptation" that arose in one context before being exploited in another.



ICE AGE ANIMAL images, such as this aurochs—a form of wild cattle—from the French cave of Lascaux, are frequently accompanied by a wealth of abstract symbols, as we glimpse here in the markings above the neck and back and on the haunches. Lascaux is dated to about 17,000 years ago.

terms of "adaptations," since this helps us to make up stories about how and why particular innovations have arisen, or have been successful, in the course of evolution; but in reality, all new genetic variants must come into being as exaptations. The difference is that while adaptations are features that fulfill specific, identifiable functions (which they cannot do, of course, until they are in place), exaptations are simply features that have arisen and are potentially available to be coopted into some new function. This is routine stuff, for many new structures stay around for no better reason than that they just don't get in the way.

This is the general context in which we are obliged to view both the evolution of the human brain as we are familiar with it today and the appearance of modern cognitive function. There was unquestionably an increase in average hominid brain size over the past two million years, although this doesn't tell us much about the actual events of human brain evolution. But the example of the Neanderthals and, even more tellingly, of the anatomical-but-not-behavioral moderns shows us that the arrival of the modern cognitive capacity did not simply involve adding just a bit more neural material, that last little bit of extra brain size that pushed us over the brink. Still less did it involve adding any major new brain structures, for basic brain design remains remarkably uniform among all the higher primates. Instead an exapted brain, equipped since who knows when with a neglected potential for symbolic thought, was somehow put to use.

Unfortunately, exactly what it was that exapted the brain for modern cognitive purposes remains obscure. This is largely because, while we know a lot about brain structure and about which brain components are active during the performance of particular functions, we have no idea at all about how the brain converts a mass of electrical and chemical signals into what we are individually familiar with as consciousness and thought patterns. And it is this which it will be crucial to understand if we are ever to make the leap to comprehending exactly what it is that enables us to be (and I use the term advisedly) human.

Still, it is possible to talk in general terms about the evolution of modern cognition. It has, for example, been argued that at some time between, say, 60 and 50 kyr ago, a speciation event occurred in the human lineage that gave rise to a new, symbolically expressive entity. By implication, this new species would have possessed neural modifications that permitted modern behavior patterns. It would be nice to believe this, because on one level it would certainly simplify the story. The problem is, though, that the time frame doesn't appear to permit it. For this explanation to work, a new human species, physically identical but intellectually superior to one that al-

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ready existed, would have had to appear and then to spread throughout the Old World in a remarkably short space of time, totally eliminating its predecessor species in the process. And there is no indication at all, in an admittedly imperfect record, that anything of this kind occurred. Which leaves us with only one evident alternative.

Instead of some anatomical innovation, perhaps we should be seeking some kind of cultural stimulus to our extraordinary cognition. If the modern human brain, with all its potential capacities, had been born along with modern human skull structure at some time around 150 to 100 kyr ago, it could have persisted for a substantial amount of time as exaptation, even as the neural mass continued to perform in the old ways. We have much less evidence than we would like that directly bears on the origin and spread of *Homo sapiens*. However, we do know that our species originated in this general time frame, probably in Africa. And we know as well that it quite rapidly spread Old World–wide from its center of origin, wherever that was.

Further, if at some point, say around 70 to 60 kyr ago, a cultural innovation occurred in one human population or another that activated a potential for symbolic cognitive processes that had resided in the human brain all along, we can readily explain the rapid spread of symbolic behaviors by a simple mechanism of cultural diffusion. It is much more convincing (and certainly more pleasant) to claim that the new form of behavioral expression spread rapidly among populations that already possessed the potential to absorb it, than it is to contemplate the alternative that the worldwide distribution of the unique human capacity came about through a process of wholesale population replacement. What carnage this latter would undoubtedly have involved! On the other hand, cultural interchange among human populations is a phenomenon that is widely documented throughout recorded history, and it must clearly be the preferred explanation for the rapid success of symbolically mediated human behaviors. It remains, though, to suggest what the new cultural stimulus might have been.

Cognition and Symbolism

WHEN WE SPEAK OF "symbolic processes" in the brain or in the mind, we are referring to our ability to abstract elements of our experience and to represent them with discrete mental symbols. Other species certainly possess consciousness in some sense, but as far as we know, they live in the world simply as it presents itself to them. Presumably, for them the environment seems very much like a continuum, rather than a place, like ours, that is divided into the huge number of separate elements to which we humans give individual names. By separating out its elements in this way, human beings are able constantly to re-create the world, and individual aspects of it, in their minds. And what makes this possible is the ability to form and to manipulate mental symbols that correspond to elements we perceive in the world within and beyond ourselves. Members of other species often display high levels of intuitive reasoning, reacting to stimuli from the environment in quite complex ways, but only human beings are able arbitrarily to combine and recombine mental symbols and to ask themselves questions such as "What if?" And it is the ability to do this, above everything else, that forms the foundation of our vaunted creativity.

Of course, intuitive reasoning still remains a fundamental component of our mental processes; what we have done is to add the capacity for symbolic manipulation to this basic ability. An intuitive appreciation of the relationships among objects and ideas is, for example, almost certainly as large a force in basic scientific creativity as is symbolic representation; but in the end it is the unique combination of the two that makes science—or art, or technology—possible. Certainly, intuitive reasoning can take you a long way just by itself, as I think it's justifiable to claim the example of the Neanderthals shows. The Neanderthals left behind precious few hints of symbolic abilities in the abundant record they bequeathed us of their lives, and it is clear that symbols were not generally an important factor in their existences. Still, their achievements were hardly less remarkable for that, and as far as we can tell, *Homo neanderthalensis* possessed a mastery of the natural world that had been unexceeded in all of earlier human history. Indeed, it seems fair to regard the Neanderthals as exponents of the most complex—and in many ways admirable—lifestyle that it has ever proved possible to achieve with intuitive processes alone.

This inevitably brings up the question about the Neanderthals that everyone wants answered: Could they talk? Many people, especially looking at the spectacularly beautiful stone tools that the Neanderthals made with such skill, find it hard to believe that they couldn't. How, other than through the use of language, could such remarkable skills have been passed down over the generations? Well, not long ago a group of Japanese researchers made a preliminary stab at addressing this problem. They divided a group of undergraduates in two and taught one half how to make a typical Neanderthal stone tool by using elaborate verbal explanations along with practical demonstrations. The other half they taught by silent example alone. One thing this experiment dramatically revealed was

Humans had a vocal tract that could produce the **SOUNDS OF ARTICULATE SPEECH** over half a million years before we have evidence our forebears used language.

just how tough it is to make stone tools; some of the undergraduates never became proficient. But more remarkable still was that the two groups showed essentially no difference either in the speed at which they acquired toolmaking skills or in the efficiency with which they did so. Apparently learning by silent example is just fine for passing along even sophisticated stone tool–making techniques.

Although this experiment involved modern humans, not Neanderthals, it does show quite forcefully that, once again, we are making a fundamental mistake by assuming that our way is the only way of doing business in the world. None of this is to suggest, of course, that the Neanderthals did not have some form of vocal communication, even quite sophisticated vocal communication. After all, such communication is common among all mammals. And there can be little doubt that Neanderthals spoke, in some general sense. What they almost certainly did not possess, however, is language as we are familiar with it.

CARVED from mammoth ivory over 32,000 years ago, this tiny (less than five centimeters) sculpture is perhaps the earliest work of art known. Its elegant lines express the essence of the horse rather than rendering exactly the stocky proportions of horses of this period. Found at Vogelherd, Germany.

Language and the Emergence of Human Cognition

IF THERE IS ONE single aspect of human mental function that is more closely tied up with symbolic processes than any other, it is surely our use of language. Language is, indeed, the ultimate symbolic mental function, and it is virtually impossible to conceive of thought as we know it in its absence. For words, it is fair to say, function as the units of human thought, at least as we are aware of it. They are certainly the medium by which we explain our thoughts to one another and, as incomparably social creatures, seek to influence what is going on in one another's brains. Thus, if we are seeking a single cultural releasing factor that opened the way to symbolic cognition, the invention of language is the most obvious candidate. Indeed, it is perhaps the only plausible one that it has so far proved possible to identify. What might have happened? Here we have to return to notions of exaptation, for language is a unique aptitude that doesn't seem to have emerged from apelike "protolanguage" and certainly did not do so directly. Still, it has been argued that since the general ability to acquire language appears to be deeply and universally embedded in the human psyche, this ability must be hardwired into every healthy human brain, where it resides as a result of "normal" Darwinian processes of adaptation by natural selection.

It is certainly true that language is not reinvented in every generation but is rather re-expressed, as every child learns his native tongue(s) as an ordinary, if astonishing, part of the process of growing up. There is, in other words, no denying the existence in the human mind of a "language instinct." What we need to explain, however, is not only how that innate instinct was acquired but also how it made such a rapid and unprecedented appearance.

As we've seen, natural selection is not a creative force and can propel nothing into existence by itself. Rather it can only capitalize on what is already there. In a sense, this makes things easier for us since, as far as we can tell, in the emergence of

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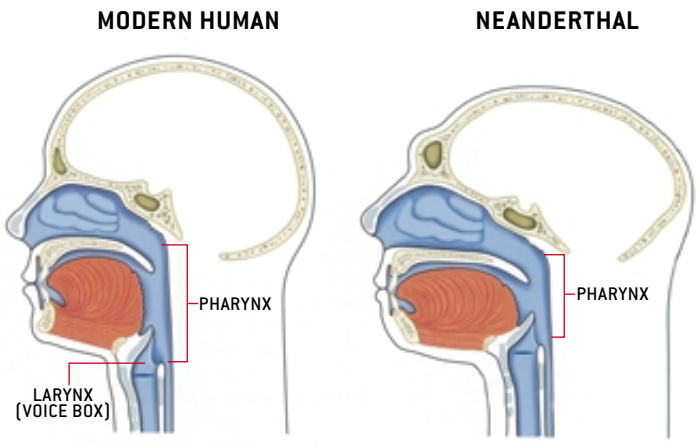
symbolic thought there is no evidence of the kind of slow trend that would be expected under Darwinian selection. What must have happened, instead, is that after a long—and poorly understood—period of erratic brain expansion and reorganization in the human lineage, something occurred that set the stage for language acquisition. This innovation would have depended on the phenomenon of emergence, whereby a chance combination of preexisting elements results in something totally unexpected. The classic example of an emergent quality is water, most of whose remarkable characteristics are entirely unpredicted by those of its constituents, hydrogen and oxygen. Nonetheless, the combination of these ingredients gives rise to something entirely new, and expected only in hindsight. Together with exaptation, emergence provides a powerful mechanism in the evolutionary process, and it truly is a driving force, propelling innovation in new directions.

In the case of linguistic potential, with its innate presence among all humans today, we have to suppose that initially a neural change occurred in some population of the human lineage. This change was presumably rather minor in genetic terms and probably had nothing whatever to do with adaptation in the classical sense. Since during early childhood development the brain rewires itself through the creation of specific pathways from undifferentiated masses of neuronal connections, it is even possible that this event was an epigenetic rather than a genetic one, dependent on developmental stimuli. Whatever the case, it certainly seems to have made no mark on the fossil record, although ultimately its impact on the archaeological traces of the Cro-Magnons and their successors was enormous. Just as the keystone of an arch is a trivial part of the structure, yet is essential to the integrity of the whole, this innovation (whatever it may have been, and we are very far from understanding that) was the final physical element that needed to be in place to make possible language and symbolic thought—and all that has flowed from them, with such fateful consequences for the world. Once it was there, of course, the potential it embodied could lie fallow, simply doing no harm, until released by a cultural stimulus in one particular population. Almost certainly, though it's hard to prove, this stimulus was the invention of language. Everyone today has language, which by itself suggests that it was a highly advantageous acquisition. And if it is as advantageous as we would wish to believe, it is hardly surprising that language, and its associated symbolic behavioral patterns, were subsequently able to spread rapidly among human populations worldwide.

Among the numerous possibilities for how **LANGUAGE MAY HAVE BEEN INVENTED** is that an initial form was created not by adults but **BY CHILDREN**.

So much for the spread of language from its center of origin. Exactly how this fateful novelty may have been invented is a separate question, upon which it is beyond my expertise to speculate. But with the substrate for language in place, the possibilities are numerous. My favorite among them is that an initial form of language may have been invented not by adults but by children. Given the fact that the brain is not a static structure like a rubber ball but is rather a dynamic entity that reorganizes itself during development (and indeed, given the right stimuli, throughout life), it is not implausible that a rudimentary precursor of language as it is familiar today initially arose in a group of children, in the context of play. Such prelanguage might have involved words—sounds—strung together with additive meaning. It is hard to imagine that once this invention had been made, society as a whole would not have eventually adopted it. On a Japanese island, macaque monkeys living along the beach were fed by researchers with sweet potatoes. These delicacies became covered with beach grit, and pretty soon, young macaques started washing them in the sea to remove the sand. It took a while for the adults to catch on: first the females, and only last the dominant males. Doubtless, some of the older and most dominant males never deigned to indulge in this behavior, preferring a familiar life of grit. But a good idea is a good idea—and it is difficult to believe that, in the case of language, once the notion of associating words with objects and ideas had developed, it would not have spread quite rapidly throughout society.

Still, the transition from a nonlinguistic lifestyle to a linguistic one as we are familiar with it involved a huge cognitive and practical leap. It seems probable that the addition of



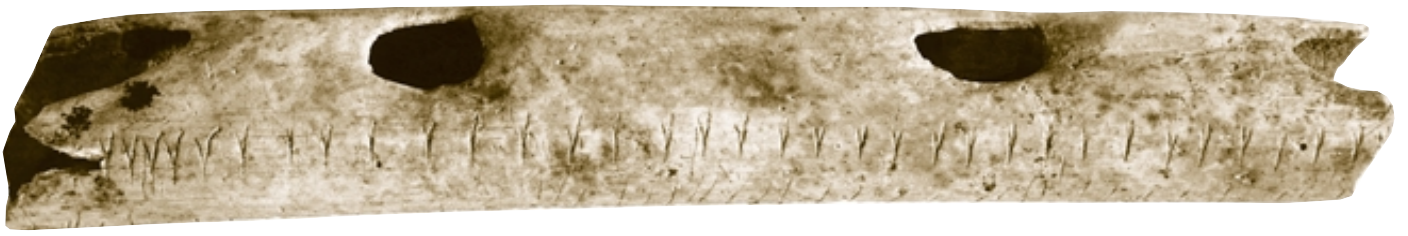
COMPARISON of the head and neck of a modern human and a (reconstructed) Neanderthal shows the differences in the structure of the vocal tract. The much longer pharynx in the modern human is what makes possible the full range of sounds demanded by articulate speech.

ILLUSTRATION BY DIANA SALLES, AFTER SKETCHES BY JEFFREY LAITMAN, © IAN TATTERSALL

syntax may have been a separate, and later, event, though perhaps one made inevitable by the arrival of word-object associations. A single-stage progression from inarticulacy to articulate language as we know it seems more than a little implausible, and a multiple-stage process would certainly better mirror the way in which infants acquire language, with the vocabulary beginning to develop (very rapidly) first, and syntax and (later) sentence structuring following after the age of about two years. The history of the emergence of language is undoubtedly complex—indeed, this emergence only seems even possible from our perspective because we *know* it must have occurred. Subsequent to its origin, of course, language quite obviously changed, complexified and diversified hugely, as it became ever more widely adopted among human populations. But its common structure everywhere today, independent of culture, is surely due to the fact that the underlying basis was already there in everyone, long before language itself came along.

But there still remains one other factor to be explained. To speak, you need a brain that will tell your vocal tract what to do, but you also need a vocal tract that will respond appropriately to the brain's instructions. And the primitive primate vocal tract cannot respond in this way. In fact, adult human beings are the only creatures, apes included (though some birds can mimic speech), that can physically make the sounds that are essential to articulate speech. And this ability comes at a price. The principal structures that make up the vocal tract are the larynx, the structure in the neck that houses the vocal cords; the pharynx, a tube that rises above it and opens into the oral and nasal cavities; and the tongue and its associated apparatus. Basic sounds are generated at the vocal cords, and then there is further modulation of those sounds in the pharynx and allied airways above. Among typical mammals, including the apes—and newborn humans—the larynx is positioned high in the neck, and the pharynx is consequently short, limiting what can be done to modulate vocal sounds. In adult humans, in contrast, the larynx lies low in the neck, lengthening the pharynx and increasing the potential for sound modulation. The price I've mentioned is that while the human arrangement makes a vast array of sounds possible, it also prevents simultaneous breathing and swallowing—thereby introducing the unpleasant possibility of choking to death.

This alone suggests that there must be some powerful countervailing advantage in the human conformation of the vocal tract, but the ability to speak, unfortunately, is not it. We know this because the roof of the vocal tract is also the base of the skull. Thus, where this region is preserved in fossils, we can reconstruct in general terms what the vocal tract had looked like in life. The low larynx–high pharynx combination betrays itself in a flexion of the bones of the skull base. We begin to see some evidence of such flexion in *Homo ergaster,* almost 2 myr ago, and a skull of *Homo heidelbergensis* from Ethiopia shows that it had reached virtually its modern degree by about 600 kyr ago. A vocal tract capable of producing the sounds of articulate speech had thus been achieved among humans well over half a million years before we have any independent evidence that our forebears were using language or speaking.



MUSICAL INSTRUMENTS, such as this bone flute from a French site, date back at least 32,000 years. They are some of the most striking indicators of a new sensibility in early humans.

Clearly, then, the adult human vocal tract cannot in origin have been an adaptation "for" modern speech—though it might have conferred some advantage in the context of a "prelinguistic" form of vocal communication. So what, then, *is* it "for"? Inevitably we have to come back to exaptation. Despite its disadvantages, basicranial flexion appeared, and it then persisted for a very long time before being capitalized upon for its linguistic qualities. Maybe over that long period it did indeed bestow certain advantages in the production of more archaic forms of speech—forms that we are hardly in a position to characterize. Or maybe it conferred some kind of benefit in terms of respiration, which is an issue that is still very poorly understood among extinct hominids. Still, whatever the case, we have to conclude that the appearance of language and its anatomical correlates was not driven by natural selection, however beneficial these innovations may appear in hindsight to have been.

At present, then, there is no way we can come up with any even modestly convincing scenario of what happened in the origination of the extraordinary creature we are, without invoking the humble process of exaptation. Clearly, we are not the result of a constant and careful fine-tuning process over the millennia, and much of our history has been a matter of chance and hazard. Nature never "intended" us to occupy the position of dominance in the living world that, for whatever reasons, we find ourselves in. To a remarkable extent, we are accidental tourists as we cruise through Nature in our bizarre ways. But, of course, we are nonetheless remarkable for that. And still less are we free of responsibility. SA

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