

No Last Word on Language Origins

NEWS

Human beings were anatomically ready to speak more than 150,000 years ago—but clear evidence that they were doing so does not appear for 100,000 years afterward

time or space. For archaeologists eager to learn how we became human, when and how language emerged is a crucial question.

Unfortunately, “speech does not fossilize,” notes anthropologist John Shea of the State University of New York, Stony Brook. Writing appears 6000 years ago, and there is scant evidence for the existence of notation before 13,000 years ago. How long might language have been around before that? The only evidence is indirect, and it suggests two wildly different answers.

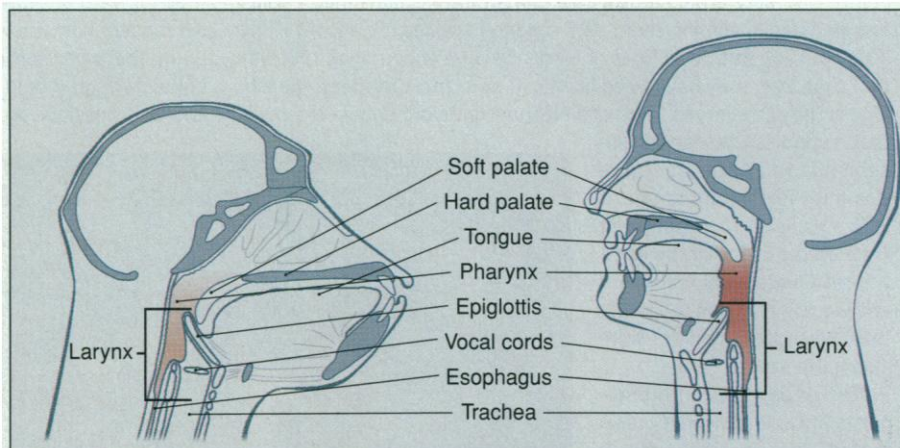
Fossils show that the raw brain capacity for complex language, along with the necessary mouth and throat anatomy, were probably in place before 150,000 years ago. But most of the behaviors thought to depend on language did not appear until 40,000 years ago—the so-called Upper Paleolithic explosion that is manifested most strikingly in Europe. That was when tools, burials, living sites, and occasional hints of art and personal adornment reveal beings capable of planning and foresight, social organization and mutual assistance, a sense of aesthetics, and a grasp of symbols. “Everybody would accept that by 40,000 years ago, language is everywhere,” says Stanford University archaeologist Richard Klein.

That leaves at least 100,000 years of wiggle room. Into this time gap fall rare hints of modern behavior—burials and glimpses of trade, art, and sophisticated tools—that have allowed some archaeologists to argue that humans were speaking, and thinking the complex thoughts that go with speech, long before they left a plentiful record of these activities. Others, however, argue that there is no unequivocal

Nothing is more human than speech. Our closest primate relatives, chimpanzees, use tools, have intricate social lives, and show signs of self-awareness. But they lack spoken language, and all the capacities it implies, from rapid and flexible manipulation of symbols to the ability to conceptualize things remote in

cal evidence for modern human behavior before about 50,000 years ago. “At one extreme there are people who think that all hominids are ‘little people’ and at the other that the really ‘human’ things about human behavior are really very late,” says Alan Walker of Pennsylvania State University in University Park.

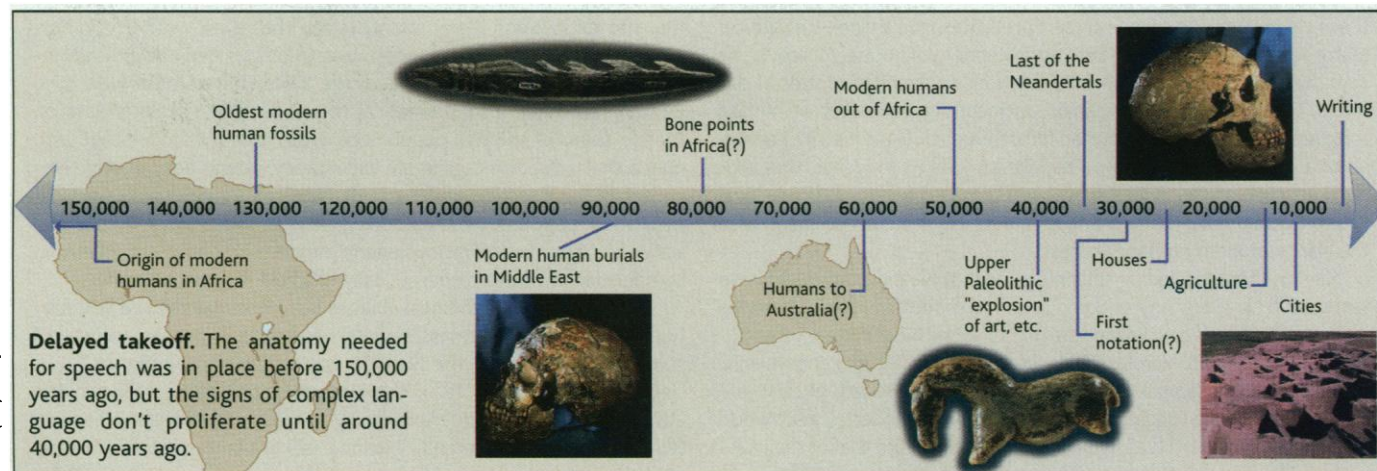
Judging from anatomy alone, speech of some sort—although not like that of modern humans—has probably been around for at least a million years, says Philip Lieberman of Brown University. Based on comparisons of modern humans with fossils and living apes, he says the hominid breathing and swallowing apparatus were even then beginning to reorganize in areas affecting the capacity for speech. Skull shape was becoming more humanlike, he says, with the distance be-



Sound systems. The human upper respiratory tract made speech possible as the high larynx seen in species like the chimp (left) dropped, creating an expanded pharynx (red).

tween spinal column and the back of the mouth decreasing, indicating a shorter mouth better adapted for speech of some kind—albeit nasalized and phonetically limited.

Meanwhile, the other precondition of modern language, a big brain, was also emerging. The chimp-sized brains of the early australopithecines almost doubled in a growth spurt starting 2 million years ago. Then a second surge, beginning around half a million years ago, increased hominid brain size by another 75%, according to Erik Trinkaus of Washington University in St. Louis, bringing it to the 1500 cubic centimeters of today. At the same time, brain organi-



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How Much Like Us Were the Neandertals?

Next to our own selves, there is no more interesting hominid than the Neandertal. Neandertals are the humans manqué, the evolutionary dead end: eerily like us, but different in major ways. And they are the subject of one of the hottest ongoing debates in anthropology.

How smart were these big-brained, stocky-bodied people, who inhabited Europe and the Middle East starting about 200,000 years ago? And what caused their relatively abrupt disappearance by 30,000 years ago? The Neandertals' reputation has oscillated over the years, and new evidence has sharpened the debate. Genetic data suggest a sizable gulf between Neandertals and modern humans, while recent discoveries hint that Neandertals had a brief technological golden age before vanishing.

Last year, DNA testing of a Neandertal bone showed that these beings probably branched off the human line a half-million years ago, perhaps qualifying them as a separate species (*Science*, 11 July 1997, p. 176). But other lines of evidence have encouraged speculation that they may have been like us in one crucial respect: speech. One is the discovery in 1989 of a Neandertal hyoid bone—the bone that supports the larynx—in Kebara cave in Israel. Because it is a lot like a human one, it indicates, says archaeologist Francesco d'Errico of the Institute of Quaternary Prehistory and Geology in Talence, France, that "Neandertal abilities were also quite similar."

Earlier this year, anthropologists at Duke University reinforced that notion with a comparative analysis of the hole that carries motor nerves to the tongue, called the hypoglossal canal, in several hominid skulls. Chimp-sized in the 2-million-year-old australopithecines, the canal is significantly larger, falling in the modern human range, in both Neandertals and an earlier, 300,000-year-old skull. This suggests that "the vocal capabilities of Neandertals were the same as those of humans today," Richard Kay and colleagues wrote in the 28 April *Proceedings of the National Academy of Sciences*.

Cognitive scientist Philip Lieberman of Brown University disputes these claims. First, he says, you can't predict tongue shape—the critical factor for modern speech—from an isolated hyoid bone. Moreover, he says the Duke team based their calculations of the relative sizes of different species' hypoglossal canals on incorrect estimates of human tongue size and shape. Lieberman himself argues, from his 1971 analysis of a Neandertal skull from Chapelle-aux-Saints in France, that proportions such as the distance between the hard palate and the spinal column would have made it impossible for Neandertals to speak with the clarity modern humans possess.

Kay says that his finding still holds, and that Neandertals might have had speech "in every way as complicated as modern humans." But others say Lieberman's conclusions are reinforced by Neandertals' other behavioral limitations. Harold Dibble of the University of Pennsylvania, Philadelphia, for example, says "the lack of art and the lack of clear evidence of symboling suggests that the nature of [Neandertal] adaptation [to their environment] was significantly different" from that of their successors. The difference shows up, for example, in their stone tools.

Neandertals could do stone-knapping with the best of them, says Stanford University archaeologist Richard Klein. But over thousands of years this practice never seemed to lead to clear differentiation in types of tools. "They didn't make tools in the [different] standardized patterns you see later," coming from the modern people who arrived in Europe about 40,000 years ago, says Klein. To him this difference suggests that the Neandertals "were only interested in a point or an edge" rather than conceptualizing a particular product.

Then there is the Neandertal hunting record. In a special Neandertal supplement of the journal *Current Anthropology* in June, for example, archaeologist John Shea of the State University of New York, Stony Brook, defends Neandertal hunting prowess. He argues that their tool assemblages show they engaged in "intercept" hunting, which would require a knowledge of animal migration routes. On the other hand, according to Erik Trinkaus of Washington University in St. Louis, the high rate of broken bones and early death among Neandertals suggests that they engaged in more close-quarter combat with large animals than did modern humans, who had figured out safer strategies.

In the past, some have claimed that Neandertals held ritual burials, which would have implied highly developed social behaviors and possibly even religion. But that belief was largely based

on a 60,000-year-old Neandertal burial at Shanidar cave in Iraq, where pollen grains were taken to imply that the body had been covered with flowers. Many scientists now believe the plant material is an incidental intrusion. In reality, "the number of claimed Neandertal burials is extremely low," and none has yielded convincing evidence for grave goods, says Dibble.

As archaeologists learned in 1996, however, the Neandertals in France and Spain showed surprising new talents at the end of their evolutionary career after 40,000 years ago. They began making more sophisticated and diverse tools, and even, at one

site, an array of beads and pendants (see p. 1451). These artifacts have led to a new surge of debate over whether Neandertals were finally expressing their symbolic potential or were just imitating their modern human neighbors.

Whatever the answer, it may have been a case of too little, too late. For shortly after that, the Neandertal record vanishes. What drove them to extinction? Many scientists say that even without a difference in brainpower, the Neandertals would have been at a disadvantage. Archaeologist Ezra Zubrow of the State University of New York, Buffalo, has made a mathematical model based on skeletal data on the life-spans of the two populations. From it he concluded that with only a slight disadvantage in life expectancy, "it was easy to drive Neandertals to extinction under a wide range of conditions" because of their small populations. Shea adds that with their heavy frames and active lifestyle, their voracious energy needs might have hurt them "in competition with more energetically efficient modern humans."

Debates about Neandertal abilities have become colored with notions of political correctness, say archaeologists. "I've been accused of being racist for saying the Neandertals couldn't speak like us," says Lieberman. Clive Gamble of the University of Southampton in the U.K., for one, doesn't understand why people need to make Neandertals something they weren't. "Neandertals are fantastic ways of realizing the alternative ways of humanness."

—C.H.



Face off. Neandertal skull from Israel (left) has a pronounced brow ridge and bulge at the back, unlike a contemporaneous modern human (right).

zation was shifting, with dramatic growth in areas implicated in speech, in the frontal and temporal lobes.

By at least 200,000 years ago, says anatomist Jeffrey Laitman of Mount Sinai Medical Center in New York City, African hominids had cranial bases "identical to [those of] modern humans." The larynx had also descended, signifying that the tongue was no longer confined to the vocal cavity but was now rooted in the throat, a development necessary for rapid and versatile vocalization. "By 100,000 to 150,000 years ago, you know you've got modern speech—there's no other reason to retain this crazy morphology," says Lieberman. He points out that the speech package is costly—not only is the big brain an energy gobbler, but a dropped larynx offers no benefits other than speech, and it raises the risks of choking.

Words and deeds

And thereby hangs a mystery. Even though modern humans were equipped to talk up a storm, there are few definitive signs, for tens of thousands of years, of any of the behaviors anthropologists associate with language: complex tool technology and other signs of conceptualization and planning, trade, ritual, and art. Indeed, in the Middle East, where modern humans coexisted with the more archaic Neandertals for tens of thousands of years starting perhaps 90,000 years ago, the two groups behaved pretty much alike, says Klein, even though Neandertals may not have been capable of complex speech (see sidebar).

All that changes about 40,000 years ago, in the Upper Paleolithic revolution. Art and personal ornaments, which proliferate at about this time in Europe (see p. 1451), are far and away the clearest sign, says Ian Tattersall of the American Museum of Natural History in New York. "Empathy, intuitive reasoning, and future planning are possible without language," he says. So are impressive tools such as the aerodynamically crafted 400,000-year-old wooden spears reported last year to have been found in a German coal mine. But "it's difficult to conceive of art in the absence of language," says Tattersall. "Language and art reflect each other." Both involve symbols that are not just idiosyncratic but have "some kind of socially shared meaning," adds Randall White of New York University.

"Socially shared meaning" shows up around 40,000 years ago in other realms besides art—such as tools.

Harold Dibble of the University of Pennsylvania, Philadelphia, explains that until that time, the stone tools made by human ancestors don't fall into specialized types or vary much from one region to another. "The same three or four tools exist all over the Old World," he says, adding that what have been described as different types of tools are often the same things at different stages of resharpening and reduction. "There is nothing in these kinds of technologies that necessarily forces us to assume a linguistic mode of transmission," says Dibble.

But at the beginning of the Upper Paleolithic, new qualities become evident. The transition was especially abrupt in Europe, where so-called blade technology, based on standardized "blanks" that can be modified to make a wide range of tools, took over. Highly standardized tools for specific purposes, such as hunting particular kinds of animals, appear—and specialized tools, says Paul Mellars of Cambridge University, are a clue to "specialized language" on the part of their makers. Toolmakers also began exploiting new materials, namely bone and ivory, which demanded sophisticated carving skills that soon led to a proliferation of styles and designs. Once tools start to show "stylistic variability," says Dibble, we are witnessing the injection of culture into tools. And transmission of culture in any mean-

ingful way requires language.

To some researchers, these dramatic transformations imply that one more biological change, beyond the expansion of the brain and the change in throat anatomy, had taken place, making humans capable of fully modern language. Klein, for example, posits a "fortuitous mutation" some 50,000 years ago among modern humans in East Africa that "promoted the modern capacity" for rapid, flexible, and highly structured speech—along with the range of adaptive behavioral potential we think of as uniquely human. He doesn't see how anything else, such as a social or technological development, could have wrought such "sudden and fundamental" change, which modern humans then carried out of Africa and around the world.

Steven Mithen of the University of Reading in the U.K. also believes evolution did a late-stage tinkering with the brain, one that produced what he calls "fluid" human intelligence. Both apes and early humans, he believes, operate with what he calls a "Swiss army knife" model of intelligence. That is, they have technical, social, and "natural history" or environmental modules, but there's little cross talk between them. This could explain, for example, why humans were deft at shaping stones to butcher animals, but it never occurred to them to transform an animal bone into a cutting tool. At some point around the 40,000-year mark, Mithen believes the walls between these modules finally collapsed, leaving *Homo sapiens* furnished with the ability to generalize, perceive analogous phenomena, and exercise other powerful functions of the integrated human intelligence. Only then would language have been fully mature.

Others say that instead of reflecting a final step in brain evolution, language might have crystallized as part of a social change, perhaps triggered by population growth. "I don't subscribe to the cognitive model of a new bit gets added on," says Clive Gamble of Cambridge University. "I would argue it's changes in the social context"—for example, the complexity of behavior needed for large numbers of people to live together.

The revolution that wasn't?

Or maybe there was no linguistic watershed 40,000 years ago after all. Alison Brooks of George Washington University in Washington, D.C., and Sally McBrearty of the University of Connecticut, Storrs,

have called the Upper Paleolithic revolution "the revolution that wasn't," arguing that at least in Africa, the modern behaviors thought to go hand in hand with language emerged gradually, well before 40,000 years ago. Their case rests in part on a set of barbed bone spear points that Brooks and her colleagues found at Katanda, in the Democratic Republic of Congo (*Science*, 28 April 1995, pp. 495, 548, 553). Bone technology is associated with the Upper Paleolithic in Europe, says Brooks—and yet these bone points have been dated to between 80,000 and 90,000 years ago. And stone points designed to tip spears or arrows, although very rare in Europe at this time, show up in various places in Africa more than 100,000 years ago, she says.

The Katanda site also showed other signs of sophistication: "seasonal scheduling" of freshwater fishing, says Brooks, as revealed by the remains of large catfish—and no sign of juveniles—suggesting they were caught at spawning time. Elsewhere in Africa, there is evidence of a large "trading network" as early as 130,000 years ago, say Brooks and McBrearty. Two sites in Tanzania have yielded pieces of obsidian, used to make points, found 300 kilometers away from their origin in Kenya's Central Rift Valley. Brooks also cites "a tremendous elaboration in pigment use" in the form of red ochre, presum-



Something to talk about?

Barbed spear point made from an animal rib was found in the southern Congo. It could be as much as 90,000 years old and an early sign of complex culture including language.

ably used for decoration and body adornment, notably at a 77,000-year-old site in Botswana.

Brooks believes all these lines of evidence spell the existence of language. All the signs are in the record, she says, including "complicated exchanges ... planning depth, and capacity for innovation." As for "stylistic variability" in tools, Brooks says there's plenty in 80,000-year-old African stone points. "You can pick up a stone point ... and in eight cases out of 10 say what region it came from," she says.

Brooks and McBrearty's case for the early emergence of modern behavior and language is controversial, especially as it rests heavily on the presumed antiquity of the bone points, whose age was gauged by dating of surrounding sediments and nearby hippo teeth. Scientists have reservations about the dating techniques (*Science*, 10 October 1997, p. 220). Among the skeptics is Klein, who does excavations in South Africa. Of the bone points, he says, "I don't think those things are even remotely likely to be" 90,000 years old—especially because "the next oldest occurrence" of similar points is dated at 12,000 years ago. He also discounts the ochre data, saying "red ochre is all over the place" at early sites, including Neandertal ones, and could well have been used for some purpose other than decoration. Mellars is also skeptical, saying about the obsidian trade: "Human beings move around quite a lot. Even if there was some deliberate exchange, I don't see that necessarily as an index of anything exciting cognitively."

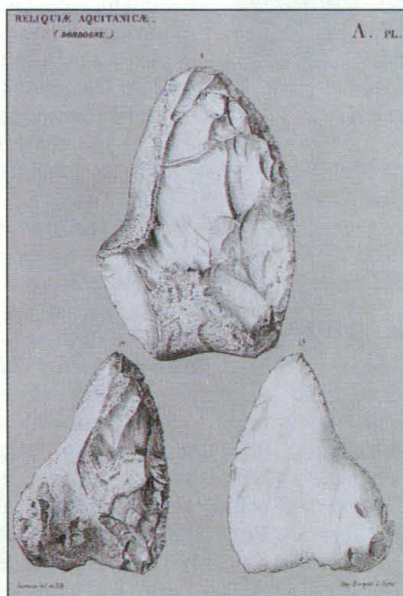
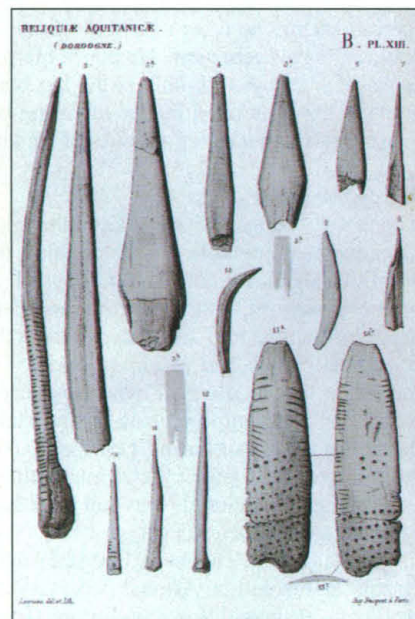
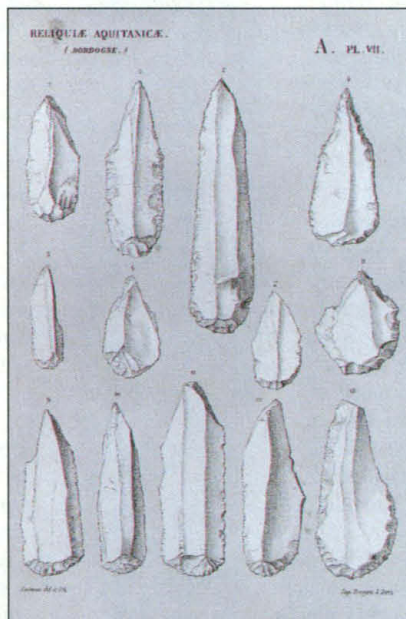
The hints of early language use don't end there, however. Two 90,000-year-old burials in Israel containing anatomically modern humans—from a time when the Middle East was ecologically an extension of Africa—unequivocally show ritual behavior and the use of language that implies, says John Shea. One burial, at a site called Qafzeh, held a child buried with a deer antler. At the other, Skhul, the skeleton was found clasping the jawbone of a wild boar to its chest. Although any deliberate burial represents going "beyond the minimal necessary action for body disposal," says Shea, the inclusion of grave goods casts the action into another realm of meaning—the socially shared meaning of arbitrarily assigned symbols that is at the heart of language.

To some people, such as Brooks, these burials strengthen the case that modern behavior was well under way before the Upper Paleolithic revolution. Mithen sees them as a sign that the transition from Swiss army knife minds to "cognitive fluidity" was under way. Klein, on the other hand, is still dubious about the putative grave goods, saying it is extremely difficult to "distinguish what was an intentional act and a situation where something was accidentally incorporated."

There's one accomplishment that everyone agrees would qualify humans as fully modern, language-using people: getting to Australia. Even in the recent ice age, when sea level was lower, at least 100 kilometers of open water separated Australia from the nearest part of Asia. To reach Australia, humans had to build and provision sturdy boats—a sign not only of technological advancement and navigational skill but also of high levels of planning and cooperation, says Gamble.

Some archaeologists believe there is persuasive evidence that people managed to do all this by 60,000 years ago, based on dating at two stone tool sites in Northern Australia. But on this as on so many other hints of modern behavior, consensus is elusive. The dating was done by thermoluminescence, a technique that has not always proven reliable. Gamble says that the more reliable technique of radiocarbon dating, although capable of going back at least 40,000 years, has never identified an archaeological site in Australia older than 35,000.

Even if the uncertainties about artifacts and dates can be resolved,



Technological revolution. Scrapers from Europe's Middle Paleolithic (below left) are crude in comparison with the specialized stone (top left) and bone (top right) tools from the Upper Paleolithic after 40,000 years ago, taken as a sign of complex language. The tools shown here include awls and scrapers.

the question of whether fully modern language emerged in a sudden biological or cultural step 40,000 years ago or gradually, over the preceding tens of thousands of years, won't be settled. "The fundamental problem here is there is only one species on the planet who has language," says Duke University anthropologist Matt Cartmill. "We have one data point. With so many things unique to humans, we don't know what language is necessary for or what is necessary for language."

And there will still be plenty of room to argue that the scarcity of evidence for symbolic behavior before 40,000 years ago doesn't prove it wasn't happening. Leslie Aiello of University College London, for example, says the evidence might have all perished—after all, she notes, it would be very difficult to pick up signs of symbolic abilities from the archaeological record of the historical California Indians, who had a complex culture but produced very few artifacts in durable materials like stone.

Shea agrees, noting that an archaeologist "is like the drunk in the old joke who looks where the light is good" for his lost keys. Future finds could alter the hominid story: Although there are more than 100 excavated sites in southwestern France alone, Brooks notes, all of East Africa, the likely birthplace of modern humans, has just a dozen; and in Asia the record is mostly a big question mark. Thus paleoanthropology is a game for philosophers as well as scientists, and there is plenty of room for free play of the romantic imagination.

—CONSTANCE HOLDEN

CREDIT: FROM LARTET AND CHRISTY 1865-75; PL. 5A AND 7A, IN EXPEDITION 34 (3), 17 (1992)