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ORIGINAL SCIENTIFIC ARTICLE

Becoming Modern *Homo sapiens*

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Abstract Human beings are unusual in many ways but perhaps most strikingly in their unique symbolic form of processing information about the world around them. Although based on a long and essential evolutionary history, the modern human cognitive style is not predicted by that history: it is emergent rather than the product of an incremental process of refinement. *Homo sapiens* is physically very distinctive and is clearly the result of a significant developmental reorganization with ramifications throughout the skeleton and presumably beyond. It is reasonable to suppose that the neural underpinnings of symbolic thought were acquired in this reorganization. However, the fossil and archeological records indicate that the first anatomically recognizable members of the species substantially predated its first members who behaved in a demonstrably symbolic manner. Thus, while the biological potential for symbolic thinking most likely arose in the morphogenetic event that gave rise to *H. sapiens* as a distinctive anatomical entity, this new capacity was evidently exaptive, in the sense that it had to await its "discovery" and release through a cultural stimulus. Plausibly, this stimulus was the invention of language. One expression of symbolic reasoning is the adoption of technological change in response to environmental challenges, contrasting with earlier responses that typically involved using existing technologies in new ways. As climates changed at the end of the last Ice Age, the new technophile proclivity was expressed in a shift toward agriculture and sedentary lifestyles: a shift that precipitated a fundamentally new (and potentially self-destructive) relationship with nature. Thus, both of what are arguably the two most radical (and certainly the most fateful) evolutionary innovations in the history of life (symbolic thinking and sedentary lifestyles) were both very recent occurrences, well within the (so far rather short) tenure of *H. sapiens*.

Keywords *Homo sapiens* · Symbolic cognition · Human origins · Upper Paleolithic · Middle Stone Age · Human uniqueness · Exaptation · Emergence

Introduction

Becoming human (as we know ourselves today) was not a sudden, one-time event. Nor was it the culmination of a slow process of fine-tuning over many thousands of generations. Instead, the transformation of our precursors, from a readily recognizable (if rather odd) variation on the primate theme to the altogether unprecedented entity we are now, was both recent in geological terms and complex in its unfolding.

Modern *Homo sapiens* is an unusual creature in many respects. Most of our many physical peculiarities are in one way or another associated with our upright posture, a feature with a long, well-documented history. Nonetheless, the acquisition that gives us our strong feeling of qualitative difference from the rest of the living world lies not among our physical attributes but in our unprecedented form of cognition. Uniquely among living things, we human beings live not solely in the world as nature presents it to us but substantially in the world as we re-create it in our heads. We are able to accomplish this trick because we are symbolic creatures: we mentally decompose the world

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around us into a vocabulary of discrete symbols, which we can combine and recombine in our minds to envisage new possibilities and ask questions such as "what if?" As far as it is possible to ascertain, no other creature does that or has ever done it.

The Fossil and Molecular Records

Interestingly, the very first hominids (members of the human zoological family; an alternative adopted sometimes is to call them hominins, distinguishing them from their closest living cousins at only the subfamily level), who looked physically identical to us, do not appear to have behaved in this distinctive fashion.

In the fossil record of the past several hundred thousand years, a variety of morphologically different hominids is known. Partly because all had respectably large brains (even if not all were quite up to the modern average), most of them (with the traditional exception of the Neanderthals) were regularly classified as "archaic *Homo sapiens*." However, paleoanthropologists are increasingly beginning to recognize that this is a meaningless and inappropriate category (see discussion by Schwartz and Tattersall 2005); and, indeed, it is remarkable how poorly foreshadowed in the known fossil record the distinctive modern *H. sapiens* morphology is. Thus, while readily recognizable close fossil relatives are known for European *Homo neanderthalensis* (see Tattersall and Schwartz 2006), nothing comparable is as yet known for *H. sapiens*, though it cannot be ruled out that this is because the African record is as yet poorly sampled.

Living *H. sapiens* is highly distinctive in its bony structure. Cranially, our species is most remarkable for its short in lenght, tall-domed, rather balloon-like braincase, beneath the front of which a very small facial skeleton is distinctly retracted. Among other very unusual details of the face are (typically very small) ridges above the orbits (eye sockets) that are bipartite, i.e., divided into lateral and central sections by a distinct groove; and a complex chin structure at the front of the lower jaw that essentially takes the shape of an inverted "T" (Schwartz and Tattersall 2000). Like the skull, our body skeleton is lightly constructed, with a slender, parallel-sided thorax matching a narrow pelvis below.

The first fossil intimations we have of this characteristic modern bony anatomy come from Africa. A fragmentary skull from the Omo basin in southern Ethiopia has recently been dated (McDougall et al. 2005) to about 195,000 years ago. As reconstructed, it is large-brained and modern in general appearance, though it does not seem to have had typically modern brows and chin. Somewhat younger, at around 160,000 years, is another Ethiopian cranium, from Herto in the Middle Awash basin (White et al. 2003). This one lacks a lower jaw and, as illustrated (it is not available for independent examination), it appears damaged above the eyes; but apart from a possible lack of division in the brow, it seems to resemble modern humans pretty closely in other observable respects.

In their possible lack of a true chin and/or bipartite brows, both Ethiopian specimens recall a small suite of younger (some very much younger) fossils from southern Africa that include the Fish Hoek, Boskop, and Border Cave 5 crania (Schwartz and Tattersall 2005). This mutual resemblance suggests that not only the South African fossils, but also Omo 1 and Herto, may well be *H. sapiens* that happen to lie just outside the documented modern envelope. At the very least, the Omo and Herto fossils demonstrate that by close to 200,000 years ago the basic modern *H. sapiens* morphology was already established. The fixation in our lineage of the new cranial (and by extension postcranial) morphology resulted very probably from a single change in DNA regulation, the developmental consequences of which positioned the new species *H. sapiens* as anatomically quite distinct from its nearest African relatives (some of which, at least, lingered on until well after 200,000 years ago).

The fossil evidence that *H. sapiens* emerged as a recognizable anatomical entity in the period immediately following 200,000 years ago is corroborated by molecular studies of modern human populations (e.g., Harpending and Rogers 2000) that converge on a common ancestry for all extant populations of *H. sapiens* within this approximate time frame. Analyses of DNA diversity among peoples from all over the globe also indicate that the ancestral human population originated in Africa, where genetic diversity is greatest (and has thus been accumulating longest). The founding population, most recently suggested to have lived in southwestern Africa (Tishkoff et al. 2009), subsequently spread out to colonize the rest of the continent and ultimately the rest of the world. A typically modern human skeleton from the Israeli site of Jebel Qafzeh, dated to 93,000 years ago, shows that anatomical moderns had spread beyond Africa proper by that time. However, molecular analyses as well as archeological considerations (see below) suggest that this occupation of the Levant was ephemeral and that the definitive human exodus that gave rise to all extant human populations came later than this, at around 85,000 years ago or less (Harpending and Rogers 2000).

Over the next ten thousand years, the descendants of these early emigrants moved eastwards along the southern coast of Asia, reaching China by about 75,000 years ago. Australia may have been colonized (necessarily using boats) by about 60,000 years ago. Warming of the climate around 50,000 years ago allowed reinvasion of the Levant and the Fertile Crescent region to its north; and by about 40,000 years ago, *H. sapiens* was entering Europe and central Asia. By 25,000 years ago, northeastern Eurasia had been occupied, all the way to the Arctic Circle. Perhaps as early as 20,000 years ago, and certainly within a few thousand years of this date, populations had entered the New World via a Bering Straits Land Bridge exposed by low glacial sea levels. Indications are that people had reached Chile by almost 15,000 years ago, possibly following the coastline in boats.

Symbolism and the Archeological Record

Significantly, the archeological associations of the earliest anatomical *H. sapiens* are almost spectacularly unimpressive. The few stone tools reported from the same sediments as the Omo 1 cranium have been described as "unremarkable" (Klein 1999), while those from the deposits yielding the Herto cranium are notably archaic, consisting of some of the latest recorded African handaxes (large, teardrop-shaped bifacial implements that had by that time been made continuously in Africa for almost 1.5 million years), plus some Middle Stone Age elements, roughly equivalent to the productions of Neanderthals (Clark et al. 2003). This lack of association between the new kind of hominid and any identifiable technological innovation actually echoes a longstanding theme that goes back to the very beginnings of archeology: the first stone tools were evidently made by "bipedal apes" that were otherwise not detectably different from their non-toolmaking predecessors; and the appearance of the first hominids to have possessed essentially modern body proportions was not accompanied by any evidence of significant technological change. Though perhaps counterintuitive, these observations actually make good practical sense; for the inventor of any new way of doing things has perforce to belong to a pre-existing species.

The technological history of Hominidae following the invention of stone tool making some 2.5 million years ago was thus much like the life of a soldier: long periods of boredom punctuated by moments of sheer terror. Sporadic innovations were followed by vast stretches of time bereft of significant novelty. Technologies did their job, and hominids simply used them to do whatever was necessary as environments fluctuated. This longstanding pattern only ever changed once, and very recently. The change is best exemplified in Europe, where the well-documented arrival of *H. sapiens* about 40,000 years ago was accompanied by a restless creative spirit that expressed itself in the constant pursuit of the new (White, 1986, 2003). The best-known manifestation of this new creative spirit was the art executed and preserved within caves such as Chauvet, Lascaux, and Altamira—art that includes some of the most powerful, deft, and closely observed ever made, and that was clearly executed in the service of highly complex systems of belief. But the creative urge went far beyond these mural images to include elaborate self-ornamentation, the almost compulsive and often ethereally beautiful decoration of everyday objects, the creation of complex musical instruments, the development of systems of notation, and a host of clever new technologies.

These new technologies were plausibly spurred by changes in environmental circumstances, to which this innovative response by the early European *H. sapiens* was altogether unprecedented. Previously, hominids had accommodated to environmental challenges by emigration or by adapting existing technologies to new uses. But the "Upper Paleolithic" Europeans were responding to external stimuli by coming up with new technologies, just as we do today. Nobody looking at the messages implicitly embedded in the succession of material cultures left by the Upper Paleolithic societies of late Ice Age Europe, either from an aesthetic or from a technological viewpoint, can doubt that these cultures were the product of beings that possessed fully modern symbolic sensibilities.

The early *H. sapiens* who invaded Europe (evicting the resident and almost certainly nonsymbolic Neanderthals in the process) evidently arrived there with their symbolic capacities fully formed. We see no process of transformation in the archeological or paleontological records. With a very few local and invariably arguable "post-contact" exceptions, the material leavings of the "Middle Paleolithic" Neanderthals in Europe were abruptly replaced by those of the *H. sapiens* who succeeded them. The symbolic ability we see embodied in the European Upper Paleolithic must have evolved elsewhere before the arrival of the newcomers.

In very instructive contrast to the European situation, the early *H. sapiens* who penetrated the Levant by around 100,000 years ago seem to have wielded Middle Paleolithic technologies identical to those of the Neanderthals who somehow shared the region with them up to about 45,000 years ago (Bar-Yosef 1993). It is not known whether the two hominid species partitioned the landscape concurrently or whether, perhaps, the Neanderthals moved in during cold times while the early *H. sapiens* predominated during warm ones; but whatever the case, there is no evidence for any behavioral or cognitive difference between the two species over this period. Indeed, it was only after the local invention of a stone toolkit equivalent to that of the European Upper Paleolithic that the Neanderthals disappeared. And although we have no direct evidence bearing on what kind of hominid invented this new toolkit or on what other behavioral changes might have been implicated in its appearance, it is a very good bet that the new technology was the product of anatomically distinctive *H. sapiens*.

Since cognitive states do not preserve directly, they have to be read from proxy evidence. And inevitably, specialists disagree as to what kinds of material indication can be viewed as satisfactory proxies for symbolic cognition. It has periodically been suggested that complex stone working technologies require language (and by extension symbolic abilities) for transmission down the generations; but experiments by Japanese researchers (Ohnuma et al. 1997) suggest that this is not the case. Indeed, there is a strong argument to be made that no aspect of Paleolithic technology can by itself be taken as prima facie evidence of symbolic capacities; for intuitive, nondeclarative, forms of intelligence can evidently accomplish formidable feats (Tattersall 2009). Only in the presence of overtly symbolic objects can we be confident that their makers were thinking symbolically.

The earliest intimations of symbolic thinking, as thus expressed, come from Africa. Researchers at the site of Blombos Cave, close to the continent's southern tip, recently reported the discovery of ochre plaques engraved with regular geometric designs (Henshilwood et al. 2003). Found in a Middle Stone Age industrial context, these objects are dated back about 77,000 years; and their interpretation as symbolic is reinforced by the subsequent finding at the same site of gastropod shells pierced for stringing (Henshilwood et al. 2004). Body ornamentation has profound symbolic implications in all modern societies, and many believe that it is not unreasonable to infer this for earlier societies too. The Blombos evidence is supported by similar "beads" found at other African Middle Stone Age sites, including the 82,000 year-old Grotte des Pigeons in Morocco (Bouzouggar et al. 2007) at the other end of the continent. Interestingly, a possible occurrence of similar kind has recently been reported just outside Africa, at the >100,000 year-old Israeli site of Skhūl (Vanhaeren et al. 2006).

Earlier than this, possible intimations of symbolism become more difficult to accept. For example, the pigment processing and shellfishing recently reported from the site of Pinnacle Point on the southern African coast at about 160,000 years (Marean et al. 2007) are arguable as markers for "modern" behavior patterns. This is especially the case given that both of these economic activities are documented for the almost certainly nonsymbolic *H. neanderthalensis* (Stringer et al. 2008). And claims for "symbolic" organization of the living space at the approximately 100,000-year sites of Klasies River Mouth in South Africa (Deacon and Deacon 1999), while interesting, are necessarily inferential.

The Transition(s)

Current evidence thus strongly suggests that the appearance of *H. sapiens* as an anatomically distinct entity, at around 200,000 years ago, considerably preceded the first unequivocal expressions of symbolic cognitive processes (under 100,000 years ago). The simplest way of explaining this disconnect (which, remember, reflects the typical pattern for biological and behavioral innovations in human evolution) is through the routine evolutionary phenomenon of exaptation, whereby existing structures are recruited to new purposes. The four limbs of tetrapods were acquired in an aquatic context long before becoming essential for terrestrial locomotion; and birds possessed feathers for many millions of years before using them for flight. Similarly, it seems reasonable to suppose that the neural substrate underpinning symbolic cognition was initially acquired in the major developmental reorganization that gave rise to the distinctive modern human anatomy and that the new potential inherent in the reorganized brain remained unexpressed until it was "discovered" through the action of what was necessarily a cultural stimulus. The best candidate we have for such a stimulus is the invention of language. Language is, after all, the ultimate symbolic activity and one that is inextricably entwined with symbolic consciousness as we experience it today. It is virtually impossible to envisage one in the absence of the other. What is more, we know that language can be contrived spontaneously by nonlinguistic modern humans, as in the recent creation of a sign language by deaf Nicaraguan schoolchildren (Kegl 2002).

The transition from a nonsymbolic, nonlinguistic cognitive state to a symbolic, linguistic condition is a virtually unimaginable one. Indeed, almost the only reason for believing that it *could* be made is that, inescapably, it *was* made. For this extraordinary switch was a qualitative leap rather than an additive refinement of a pre-existing system. Of course, it was based on an extremely long and accretionary history of vertebrate brain evolution, and it would have been impossible in the absence of any aspect of that history. But it was not predicted by anything in that history, and symbolic cognition is not just a better version of what was there before. Albeit superimposed on a pre-existing cognitive system, symbolic reasoning is a truly new method of processing information about the surrounding world; and, although many like to view it as the outcome of a long process of generation-by-generation fine-tuning, it is in fact best explained by emergence, the phenomenon whereby a chance combination of elements gives rise at once to an entirely new level of complexity (Tattersall 1998).

What is perhaps most counterintuitive of all is that this cognitive transition took place well *within* the tenure of our species *H. sapiens*. And since this momentous transition occurred, mankind's history has largely been a matter of discovering how the resulting potential could be used—a process that is abundantly observable today in our rapidly proliferating technologies and art forms. Sadly, beyond a few isolated hints, we have no evidence of what exactly transpired in between those first stirrings of the human symbolic spirit in southern Africa and the torrential outpourings of symbolic behaviors by the early modern Europeans some sixty millennia later. But we can be reasonably sure that the intervening period saw an unsteady exploration of the possibilities inherent in their new and distinctly non-fine-tuned creativity, as the tiny and scattered early *H. sapiens* populations were buffeted by major climatic and environmental vicissitudes. The most fateful of those explorations took place at the end of the last Ice Age, when a true revolution in lifestyle occurred.

The "Declaration of Independence"

Like their ancestors in an unbroken succession, the earliest *H. sapiens* were hunter-gatherers, exploiting the natural bounty of the landscape. This basic lifestyle continued essentially undisturbed right through the end of the Pleistocene, although clearly both social lives and means of exploiting the environment became more complex following the acquisition of symbolic thought. However, as the climate warmed, around 11,000 years ago, climatic stresses and environmental instability in a number of different regions of the world began to stimulate humans to start cultivating plants and domesticating animals—again, showing the typical modern human propensity to develop new technologies in response to environmental challenge. With these economic innovations came demographic change and the adoption of settled ways of life.

One of the several independent centers of plant and animal domestication worldwide, and possibly the earliest (though it is now being run very close by China), was the Fertile Crescent of the Near East, the area that arcs northward from Israel through Syria and Turkey and east and south into Iraq and Iran (see overview in Tattersall 2008). People in this region who had come to depend on gathering wild cereals found this resource diminishing at the end of the last Ice Age, as summers became longer and hotter and aridity increased. In compensation, they initiated a process of cultivation and artificial selection that necessitated a sedentary lifestyle.

This relatively recent event constituted the most radical economic, social, and demographic shift in the entire long history of mankind, and its consequences not only reverberate but continue to gather momentum today. Most importantly, for the first time humans found themselves in opposition to Nature rather than living by its rhythms. And this fundamentally changed the way in which people viewed themselves and their place in the world.

In his book *Dominion* (Eldredge 1997), the co-editor of this Journal points out that historically documented hunting-gathering peoples have tended to see themselves as integral parts of the environment that supports them: to identify with it and to feel responsibility toward it. Agriculturalists, on the other hand, find themselves in opposition to nature. Rain does not fall at their convenience, nor does the sun shine; and life inevitably becomes a struggle to modify natural processes and, if possible, to dominate them.

Eldredge finds powerful echoes of changed attitudes in the founding documents of the Judaeo-Christian religions, the work of the descendants of those earliest farmers. Indeed, he characterizes the opening words of the Book of Genesis ("God said ... be fruitful, and multiply, and replenish the earth, and subdue it; and have dominion ... over every living thing ...") as "the most ringing declaration of independence ever set down" (1997: 101). He refers, of course, to independence from the environment; and this declaration certainly summarizes the major elements that have bedeviled humanity's relationship with the ecosystems that sustain it ever since. Hunter-gatherers live in sustainable low densities, whereas agriculturalists need hands to till the fields and tend stock. But extra hands bring with them extra mouths; and the larger the population, the more vulnerable it becomes to fluctuations in agricultural productivity. These natural oscillations place populations on a sort of technological treadmill, leading to ever more intensive exploitation of environmental resources: an exploitation that in turn becomes ever harder to sustain in the face of natural climatic cycles. And, as a result, the history of mankind since the adoption of sedentary lifestyles has largely been one of local population increases, followed by economic collapse and social disintegration.

Conclusion

The history of humankind is a long one, extending back to the first "bipedal apes" some seven million years ago. Following the appearance of these unusual primates, evolutionary changes in the hominid family were highly sporadic, producing for the most part organisms or technologies that did what their predecessors had done, if a little better. The most radical subsequent innovation prior to the emergence of *H. sapiens* was the appearance of essentially modern body form and proportions, about two million years ago. This event coincided more or less with the initiation of a prolonged radiation of hominid species showing on average brain/body size ratios significantly enlarging with time. Knowing what that factor was that consistently disposed hominids to acquire metabolically expensive larger brains after the early initiation of this trend will be critical to discovering exactly what it was that eventually made us the truly unique creatures we are today. But it nonetheless remains true that the two most fateful and unprecedented innovations in hominid history—one cognitive, one economic—were remarkably recent, both appearing on Earth well *within* the lifetime of our species, *H. sapiens*.

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Concept

The Origins of Language

Why we first spoke may be more important than **when**

The origin of human speech and language is one of the most fascinating aspects of human adaptation and evolution, yet perhaps the most difficult to explain. Modern languages contain hundreds of thousands of words. We use words to convey information about every aspect of our lives. Shakespeare's vocabulary is estimated to have been 24,000 words; a newspaper reporter uses approximately 6000 words; the average person on the street has a speaking vocabulary of some 3000 words.

We have a natural interest in when and where this ability to communicate with the spoken word originated. Language did not appear suddenly at some point in the past, without antecedents; it evolved gradually from the utterances and cries of early primates to its modern forms. On the one hand, the English language today is a huge complex of vocabulary, grammar, and structure, to which many new words are added each year. On the other hand, most animals make sounds. Monkeys vocalize to express emotion but do not have voluntary control over vocalization; for one thing, they lack the vocal apparatus humans have (Figure 4.6). Chimpanzees, however, have a repertoire of 20 or more vocalizations and gestures for expressing their needs. Although these apes can manipulate symbols, they are unable to connect more than two or three concepts in a single phrase. To understand the evolution of language from gestures and cries to its complexity today, we must appreciate the path of its development.

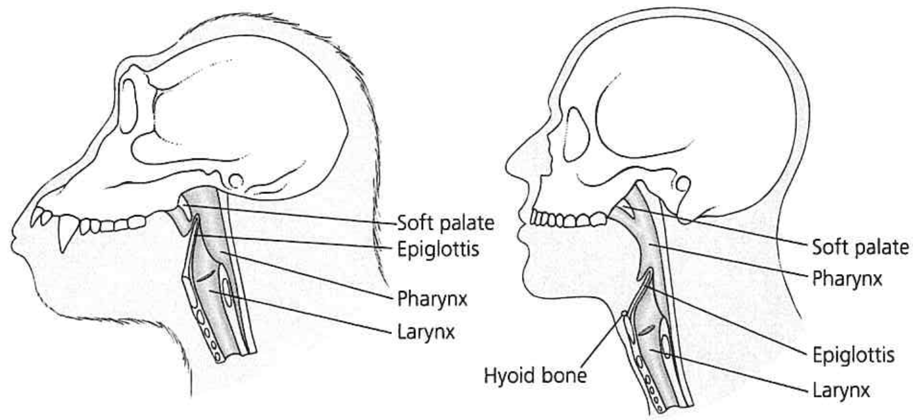


Figure 4.6 The vocal apparatus of a chimpanzee (left) compared with that of a modern human (right). Notice the more complex vocal cords in humans. The human pharynx is more curved, is deeper in the throat, and produces a great variety of sounds.

Studies of the physical remains of early humans provide substantial information about language use by early hominins. Discovery of the hyoid bone in a Neanderthal burial from Kebara Cave in Israel showed that it was no different from our own. The **hyoid bone** holds the muscles of the tongue to the throat. The similarity between the hyoid bone in Neanderthal and in modern-looking *Homo sapiens* suggests that speaking abilities would also have been similar.

Endocasts of the inside of the skull provide the only direct evidence of brain organization (Figure 4.7). The cerebrum, the upper portion of the brain, is primarily concerned with the complexities of behavior. This area is large and developed in higher primates. The size of the cerebrum, its convoluted surface, and the extent of wrinkling have increased over the course of evolution of the human species from our primate ancestors.

The organization of the cerebrum is critically important. In modern humans, the front of the brain is much larger than the back, and the sides of the brain are well developed, in contrast to the brains of chimpanzees and other apes. The two sides of our brain operate cooperatively to direct and control different aspects of our behavior and activities. This division in the organization and operation of the brain is called **lateralization.** One side of the brain controls language, and the other side regulates motor skills and perception. Lateralization is essential for language, because the processing of word

hyoid bone A delicate bone in the neck that anchors the tongue muscles in the throat.

endocast A copy or cast of the inside of a skull, reflecting the general shape and arrangement of the brain and its various parts.

lateralization The division of the human brain into two halves.

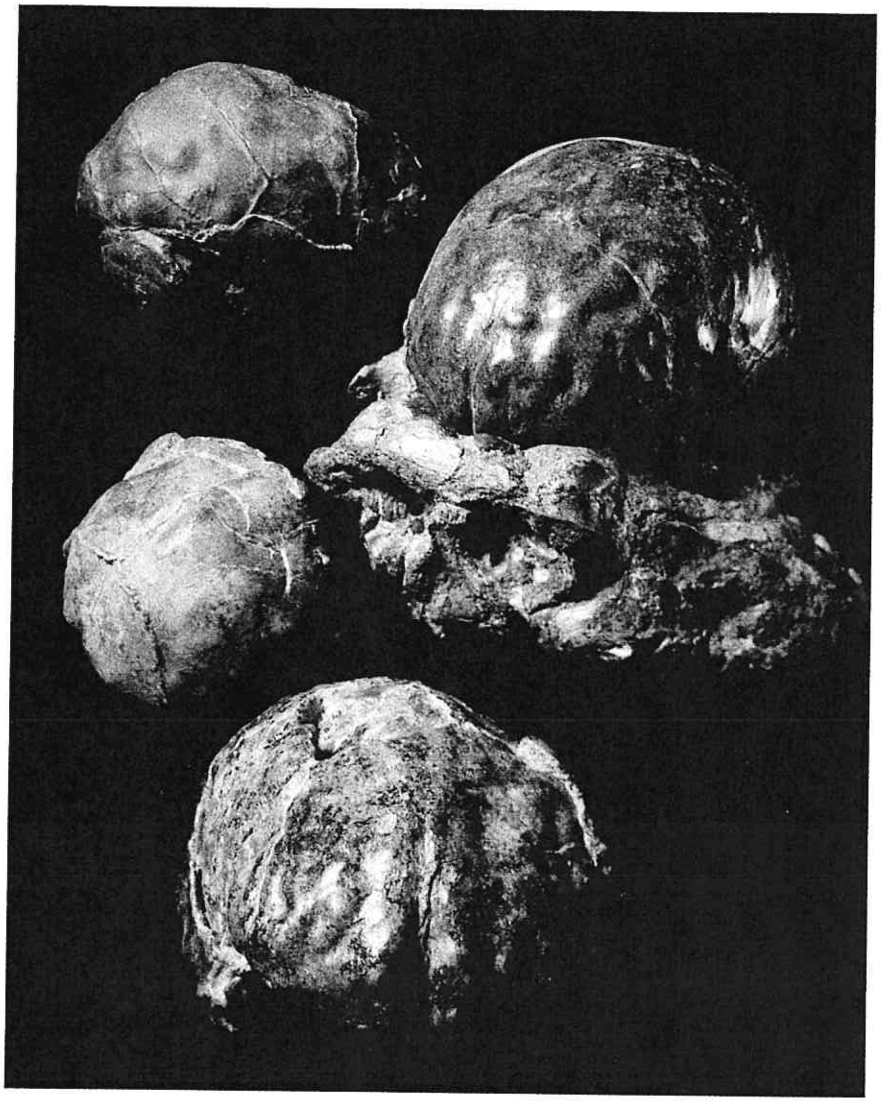


Figure 4.7 Endocasts from South African australopithecines. Notice the details of the blood vessels and other features of the brain that have been preserved in the fossil casts.

strings must occur in close proximity in the nerve cells of the brain. Individuals with speech problems are probably sequencing words and controlling speech from both sides of the brain.

Studies by Ralph Holloway, of Columbia University, have shown that the pattern of lateralization in fossil endocasts goes back well into the Pleistocene and probably to australopithecines as well. Dean Falk, of the State University of New York, has also been involved in the study of endocasts, pointing out that Broca's area, a region of the brain involved in the control of language, is larger in *Homo habilis* than in their contemporaries, the australopithecines from East Africa.

Research on human use of language has recently turned to the hypoglossal nerve, which controls the movement of the tongue. This nerve is twice as thick in humans as in chimpanzees. This thick nerve began to appear around 500,000 years ago with larger-brained members of the genus *Homo*, and it may be at that point that more sophisticated language became possible. Other fossil evidence indicates that the necessary mouth and throat anatomy for a spoken language was not in place until 150,000 years ago. It is still not clear when language emerged or whether the process was gradual or sudden.

Certainly, many of the activities of our early Pleistocene ancestors would have required some form of communication. Food-sharing, social organization, and other distinctly human characteristics imply a system of verbal expression. These abilities must have evolved and expanded through time, as both brainpower permitted and need required.

One of the major unresolved issues in the development of language is the shift from a primitive language, like that of small children, to a syntactic one, with grammatical rules and structure. This development may be related in part to further changes in the human brain. Some linguists suggest that all the world's languages evolved from a common "mother tongue," and a few would even suggest a date of 100,000 years ago for this common language. Needless to say, this is highly speculative, but it does suggest that future research may provide more information on the development of human languages. One of the more striking developments in human prehistory was the "creative explosion" that occurred about 50,000 years ago, around the beginning of the Upper Paleolithic. The changes witnessed in this period may well be related to significant advances in our language abilities.

Site

The Valley of the Neanderthals

Close relatives with strange habits

In 1856, 3 years before Charles Darwin published his extraordinary treatise *On the Origin of Species,* proposing natural selection as a mechanism for evolution, pieces of an unusual skeleton were unearthed in a limestone cave in the valley of the Neander River, near Düsseldorf, Germany. Before this discovery, there had been no acceptance of human forms earlier than *Homo sapiens* and only limited awareness of a concept such as human evolution. Leading authorities first described the bones from the Neander Valley as those of a deceased Prussian soldier, a victim of Noah's flood, or a congenital idiot—but definitely not an early human ancestor. Gradually, however, more examples of these individuals came to light. In 1886, at the cave of Spy (pronounced "spee") in Belgium, two similar skeletons were discovered in association with early stone tools and the bones of extinct animals, clearly proving the antiquity of humans in Europe.

In 1913, French physical anthropologist Marcellin Boule published a study of an arthritic Neanderthal skeleton from the site of La Chapelle-aux-Saints (Figure 4.15). In this report, he described the finds from Europe as a new species, designated *Homo neanderthalensis.* Unfortunately, Boule did not acknowledge the discoveries of *Homo erectus* from Java and saw the Neanderthals as somewhere between ape and human. In Boule's own words (translated from the French), "The brutish appearance of this muscular and clumsy body, and of the heavy-jawed skull, declares the predominance of a purely vegetative or bestial kind over the functions of the mind" (1913). His work resulted in a view of Neanderthals as slow in wit, gait, and habit—an idea that continues in some quarters even today.

Gradually, however, as more *Homo erectus* and australopithecine specimens were reported and accepted into the family tree, Neanderthals came to be recognized as closer to modern humans. Today, they are usually classified as a member of our own genus but are distinguished at the species level, as *Homo neanderthalensis.*

Figure 4.15 A Neanderthal skeleton from La Chapelle-aux-Saints, France, discovered early in the twentieth century. The femur and the vertebrae are deformed by arthritis. These remains led the scientist Marcellin Boule to describe Neanderthals as brutish and slow in wit, gait, and habit.

TABLE 4.2 Major Characteristics of Neanderthals Compared with Modern Humans

Trait	Homo neanderthalensis	Homo sapiens sapiens
Forehead	Sloping	Vertical
Brow ridges	Moderate	Absent
Face	Slightly forward	Below forehead
Cranial capacity	1450 cc	1400 cc
Protrusion on back of skull	Present	Absent
Chin	Absent	Present
Appearance of skeleton	Robust	Gracile

Neanderthals were short and stocky, averaging about 1.5 m (5 ft) in height, with bowed limbs and large joints supporting a powerful physique (Figure 4.16; see also Figure 4.21). Fossil skeletons of Neanderthals are recognized today by several distinctive features in the skull and teeth (Table 4.2). The cranium is relatively low, and the face is long. Prominent **brow ridges**—bony protrusions above the eyes—and generally heavy bone structure give the skull a distinctive look (Figure 4.17). The face is large, the forehead slopes sharply backward, and the nose and the teeth sit farther forward than in any other hominin, giving the entire face an elongated appearance. This face is probably the result of a combination of factors, including adaptation to the cold. The average brain size of the Neanderthals is slightly larger than that of modern humans, probably a consequence of their heavier bone structure. A distinctive shelf or protrusion at the back of the Neanderthal skull is known as an **occipital bun.**

The front teeth are often heavily worn, even the deciduous teeth of young children, suggesting that they were used for grasping or heavy chewing. Intriguing small scratches often occur on the front teeth, usually running diagonally. These marks are thought to be the result of "stuff-and-cut" eating habits, in which a piece of meat was grasped in the teeth and a stone knife was used to cut off a bite-size piece at the lips. Occasionally the knife must have slipped and scratched the enamel of the front teeth. Most of the scratches run from upper right to lower left, although about 10% are in the opposite direction. Such evidence confirms that right- or left-handedness among humans was common by this time.

The skeleton of the Neanderthals differs somewhat from that of fully modern forms, although they had the same posture, dexterity, and mobility. Neanderthal bones are generally described as **robust;** they had heavier limb bones than fully modern humans, suggesting much greater muscular strength and a more powerful grip. This strength is also evident in the shoulder blades and neck, and on the back of the skull, where heavy muscle attachments are noticeable. Shoulder blade muscles would have provided the Neanderthals with strong, controlled downward movements for making stone tools or thrusting spears.

The robust appearance of the Neanderthals may be related to the strength and endurance required for long-distance travel over irregular terrain or to climate. Study of the Neanderthal body indicates that their stout shape is similar to that of the Eskimo, perhaps reflecting an adaptation to cold temperatures. Or perhaps Neanderthals had to be stronger to accomplish physically what fully modern humans accomplished with sophisticated tools. Neanderthal skeletons exhibit more traumatic damage, especially to the head and neck, from accident or violence than many modern populations, perhaps from close encounters with large game. The Neanderthals lived to their late thirties or mid-forties, a rather long life span in antiquity.

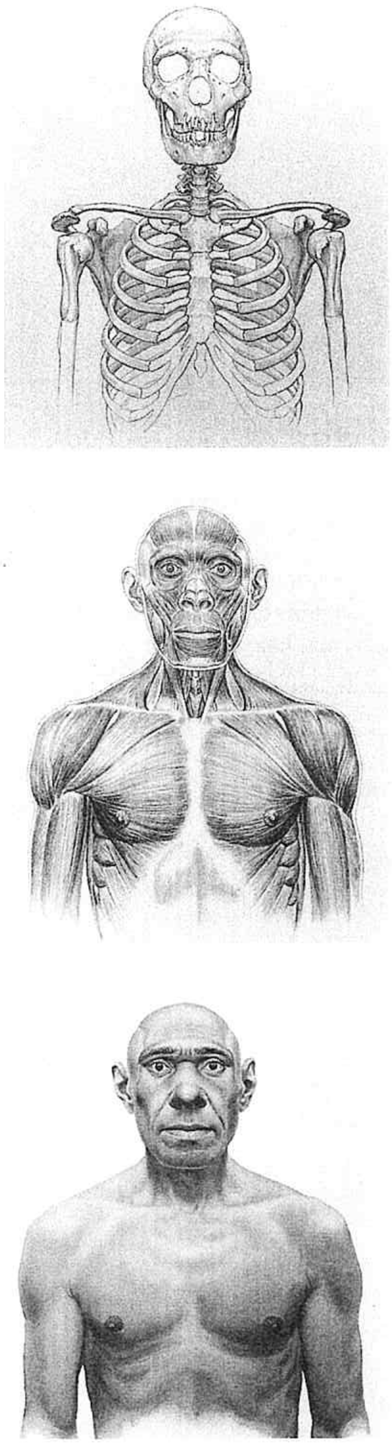


Figure 4.16 A reconstruction of the soft tissue on a Neanderthal skeleton. Forensic scientists have studied the attachment of muscle, fat, and skin to the bones of the face and skull and are able to reconstruct a likeness of a deceased individual. Such skills have been applied to a Neanderthal, with the result shown here. Body hair was intentionally not added to the reconstruction, with the exception of the eyebrows.

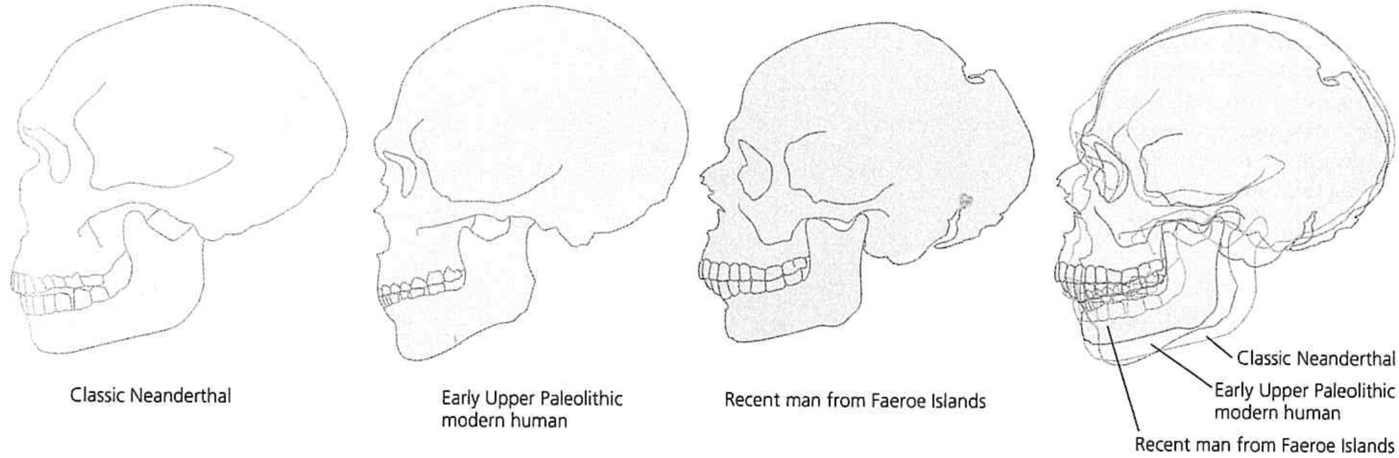


Figure 4.17 Differences between the skulls of a Neanderthal (La Ferrassie A), an early fully modern individual from the Upper Paleolithic (Predmosti 3), and a recently deceased male *Homo sapiens sapiens* from northern Europe. The bulging forehead, the presence of a chin, reduced brow ridges, and the absence of a large protrusion on the back of the skull, known as an occipital bun, characterize modern humans.

(From *Athena Review*, Vol. 3, No. 2, p. 54, 2002. Image courtesy of Athena Review and C. Loring Brace.)

Neanderthal populations are generally associated with the manufacture of a variety of flake tools in groups of artifacts termed **Mousterian** (moose-TEER-e-an) assemblages, after the site of Le Moustier in France. The Mousterian belongs to the Middle Paleolithic, dating to approximately 120,000–40,000 years ago in Europe. Although handaxes continued to be made, large retouched flakes and **Levallois** pieces, from a technique for making thin flakes with a lot of cutting edge, are the major hallmarks of the period. Flakes were shaped into a variety of tools for more special purposes (Figure 4.18).

Neanderthal fossils and/or Mousterian assemblages are found primarily in Europe and southwestern Asia (Figure 4.19). The Neanderthals were large-game hunters. Isotopic studies of Neanderthal bones document a carnivorous diet. Their prey varied across Europe; reindeer were hunted primarily in the west, and mammoths were hunted in eastern regions. Neanderthals were apparently an indigenous adaptation in Europe, well adapted to the cold conditions of the Pleistocene. However, an extremely cold period around 75,000 years ago may have pushed some Neanderthal populations southeast into Southwest Asia and eastward into western Asia (see "The Fate of the Neanderthals," p. 121). The easternmost Mousterian sites are known from the Altai Mountains, around Lake Baikal and into western Mongolia.

Cultural innovations during this period include the first intentional

The fact that Neanderthals buried their dead is surprising to many people. What do you think this practice may have meant?

The past is a foreign country; they do things differently there.

—L. P. Hartley

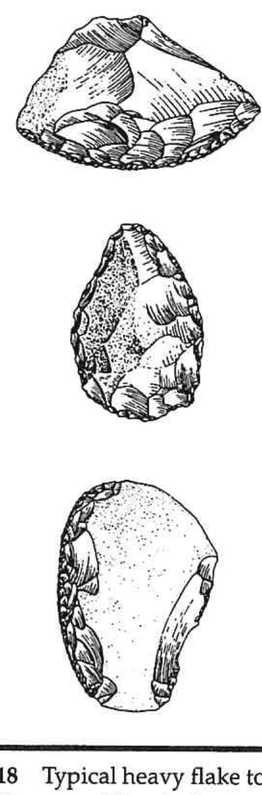


Figure 4.18 Typical heavy flake tools from the European Mousterian.

brow ridge That part of the skull above the eye orbits.

occipital bun A distinctive shelf or protrusion at the base of the skull; a feature usually associated with Neanderthals.

robust "Big-boned," heavy, thick-walled skeletal tissue. Robust early hominins had very large teeth.

Mousterian A term describing the stone tool assemblages of the Neanderthals during the Middle Paleolithic, named after the site of Le Moustier in France.

Levallois A technique for manufacturing large, thin flakes or points from a carefully prepared core.

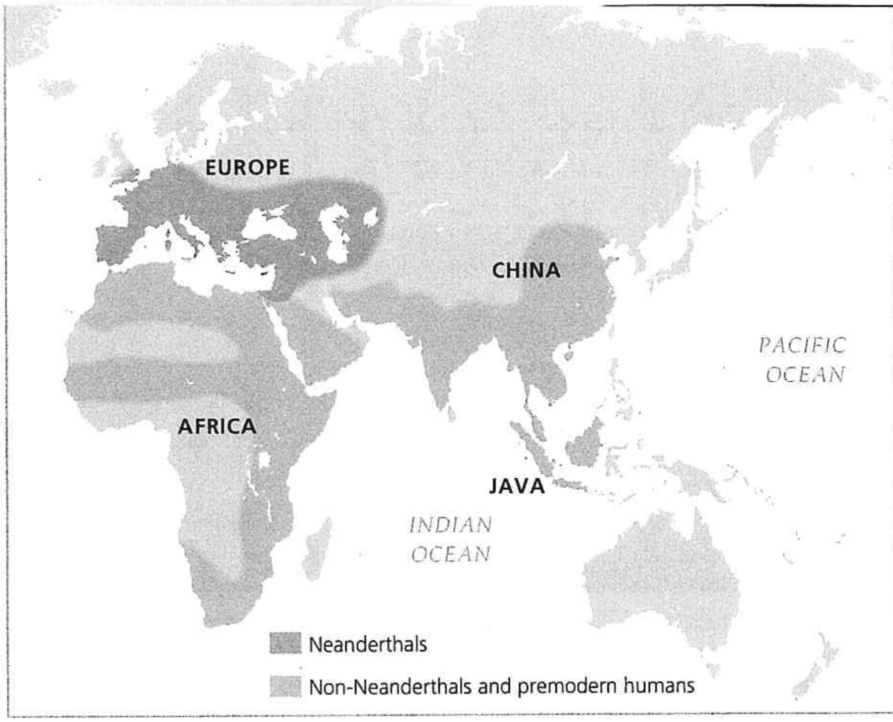


Figure 4.19 The distribution of *Homo neanderthalensis* and Mousterian sites in Europe and the Near East. *Homo sapiens sapiens* were living in most of the rest of Asia and Africa during this time.

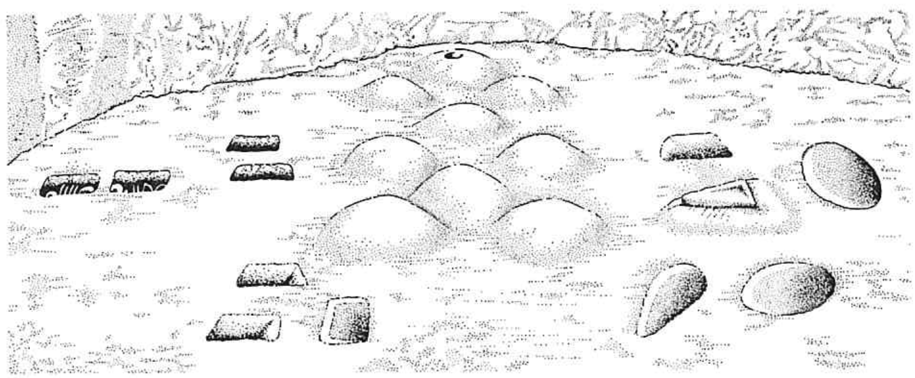


Figure 4.20 An artist's speculative reconstruction of the Neanderthal burial ground at La Ferrassie, France. The graves of several infants and adults were uncovered here during the 1800s.

Figure 4.21 An artist's reconstruction of a Neanderthal female.

burial of the dead in graves (Figure 4.20), sometimes accompanied by flowers, tools, or food. The presence of these materials in graves certainly implies concepts of death as sleep or of life after death.

More exotic practices emerge as well, difficult to understand or explain from our modern perspective. Several examples of broken and burned human bones have been found among the remains of other animals in deposits belonging to the Middle Paleolithic period. At the cave of Krapina in Croatia, the bones of at least 13 human individuals were found, along with those of various herbivores and other animals. The human bones had been burned, split to extract marrow, and treated like the bones of the animals that had provided meals for the occupants of this site. At the Grotte de l'Hortus in southwestern France, similar evidence of cannibalism was found. Heavily fragmented Neanderthal bones from at least 20 people were scattered among the numerous bones of small wild goats. Most of the human bones are skull and jaw fragments, and many of the individuals were over age 50. Whether such practices were rituals of consecration of the dead, or the bones were simply individuals from enemy groups that were added to the larder, is not known. It has also been argued that the bones may have been accidentally burned and broken by later inhabitants at the site.

Concept

The Fate of the Neanderthals

A peaceful or violent end?

Between approximately 45,000 and 25,000 years ago, Neanderthals became extinct and were replaced by fully modern humans in Europe and western Asia. The fate of the Neanderthals is open to question: Were they completely replaced by fully modern humans, perhaps violently, or did they interbreed and simply disappear in the mix? The evidence on this transition is quite different in Southwest Asia and in Europe.

Current evidence from newly dated sites in Southwest Asia suggests that the first fully modern humans appeared in this area as much as 100,000 years ago (Figure 4.22). At Qafzeh Cave and the site of Skhul in Israel (Figure 4.23), and elsewhere in Southwest Asia, the bones of *Homo sapiens sapiens* are found in layers with Mousterian tools, dating to 90,000 years ago. At other sites, such as Shanidar and Kebara, Neanderthal skeletons have been found dating to between 75,000 and 45,000 years ago. It is entirely possible that the Neanderthals found in Southwest Asia moved there from Europe during a period of intense cold. It appears that fully modern humans coexisted with Neanderthals in Southwest Asia until around 45,000 years ago. The earliest evidence for Upper Paleolithic technology comes from East Africa more than 50,000 years ago and includes bone tools and pendants, along with a standardized set of artifacts.

In Europe, the transition is less clear, and evidence for the first fully modern humans shows them appearing later. Neanderthals are first known in Europe by approximately 250,000 years ago, yet the earliest bones of fully modern humans do not appear in this area until after 40,000 years ago.

Recent evidence from new, calibrated AMS radiocarbon dates (see "Radiocarbon Dating," p. 145) has shown that the expansion of fully modern humans was faster than previously thought and that the period of their coexistence with Neanderthals was considerably shorter. Thus, *Homo sapiens sapiens* arrived in southeastern Europe from the Near East around 46,000 years ago and reached western Europe within 4000–5000 years. The Neanderthals may have been largely gone from Europe by 40,000 years ago, perhaps coinciding with the onset of one of the coldest periods of the Pleistocene, as well as the arrival of fully modern humans. Although there appear to have been some surviving populations of Neanderthals in some parts of Europe, for the most part

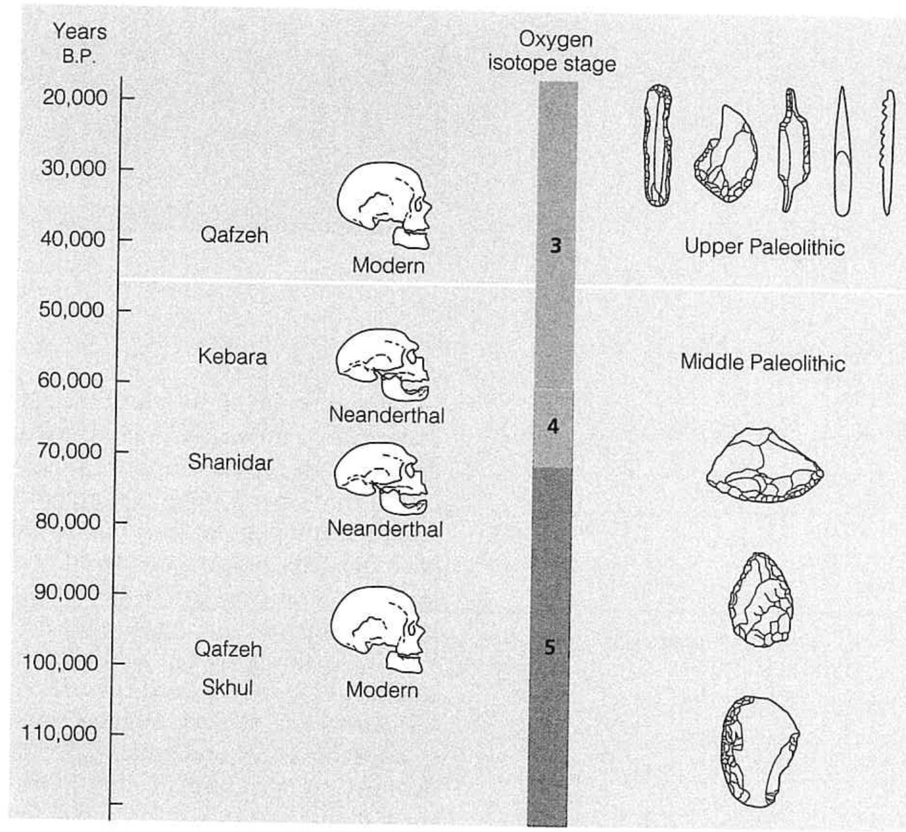


Figure 4.22 The sequence of hominins from major sites in the Near East. This important evidence indicates that fully modern humans were present in this area by 100,000 years ago, before the Neanderthals. Neanderthals were probably forced out of Europe and into western Asia during an extreme period of cold. The Neanderthals in the Near Eastern sites date to between 70,000 and 45,000 years ago. Technological changes from Middle to Upper Paleolithic took place around 50,000 years ago and were not related to the human subspecies present.

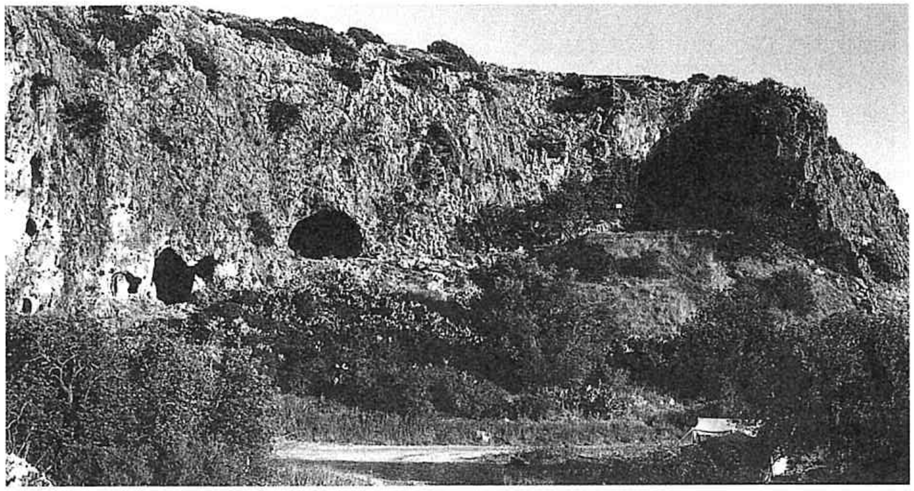


Figure 4.23 A view of the caves at Mount Carmel, Israel. The caves of Tabun and el-Wad are in the center of the photo. The site of Skhul is out of view to the left. Many of the Paleolithic sites in the Near East are found in similar caves that formed in the limestone geology of the region.

Homo sapiens replaced *Homo neanderthalensis* very quickly.

The question of the fate of the Neanderthals remains unsolved. Why did they disappear? Several possibilities have been suggested in both scientific and popular literature. Were Neanderthals simply conquered and slain by advancing groups of technologically superior *Homo sapiens sapiens*? Was it a major period of cold climate in Europe? Two recent discoveries of human skeletal remains suggest some interbreeding of Neanderthals. The oldest fully modern human skull in Europe, dating to 35,000 years ago at the cave of Oase in Romania, combines characteristics of modern humans and Neanderthals. A child burial at the cave of Lagar Velho in Portugal, dating to 24,500 years ago, has been described as the product of Neanderthal and modern mating. The long span of time between these two dates also suggests a very long period of contact between the two subspecies.

On the other hand, there is genetic evidence to the contrary. Did Neanderthals disappear into the gene pool of modern-looking humans as smaller numbers of Neanderthals interbred with larger numbers of *Homo sapiens sapiens*? Ancient DNA extracted from a newly excavated 40,000-year-old Neanderthal bone from Feldhofer Cave, Germany, and DNA from bones at several other places in Europe and western Asia suggests that there was little genetic relationship, and thus no mating, between the Neanderthals and the fully modern humans who replaced them (Figure 4.24). From this evidence, the end of the Neanderthals may have been more violent than romantic, or perhaps a combination of cold conditions and aggressive new neighbors. The jury is still out in this scientific trial.

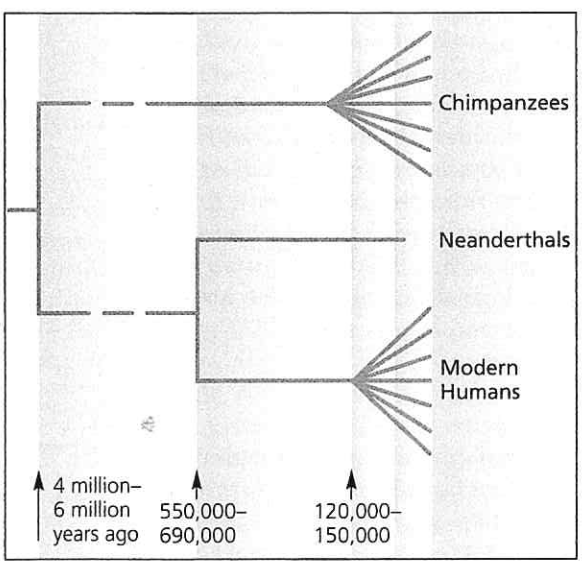


Figure 4.24 A dendrogram of the genetic relationship between modern humans, Neanderthals, and chimpanzees, based on the study of ancient DNA in several European Neanderthals.

Concept

The Upper Paleolithic

The arrival of Homo sapiens sapiens

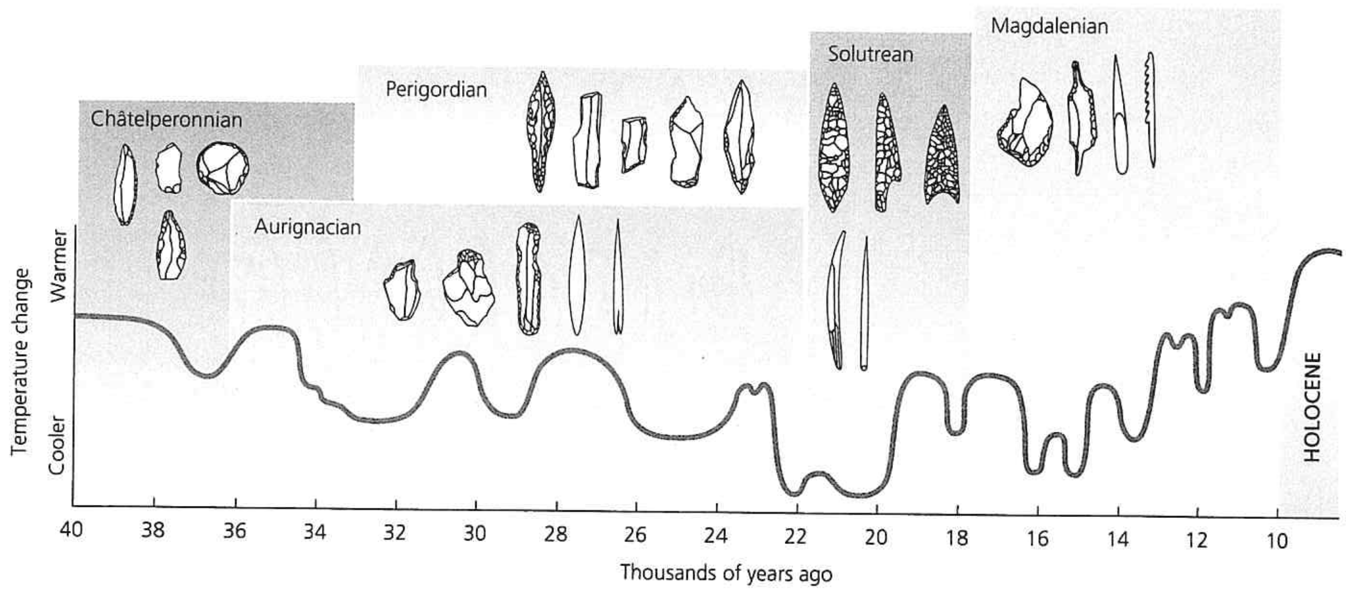


Figure 4.25 A chart of the chronology, climatic changes, major cultural periods, and typical artifacts of the Upper Paleolithic. The differences between these European cultures were much greater during the Upper Paleolithic than during the Middle Paleolithic.

The Upper Paleolithic is characterized by a variety of innovations that developed over the last 40,000 years or so of the Pleistocene. These include the arrival of anatomically modern humans in Europe; the extensive use of stone blades; the widespread manufacture of a variety of objects from bone, antler, ivory, and wood; the invention of new equipment, such as the spearthrower and the bow and arrow; the domestication of the dog; and the appearance of art and decoration.

The Upper Paleolithic also represents an important phase in the geographic expansion of the human species. There were more sites in more places than ever before. Virtually all the earth's diverse environments, from tropical rain forest to arctic tundra, were inhabited during this period. Africa, Europe, and Asia were filled with groups of hunter-gatherers, and Australia and North and South America were colonized for the first time.

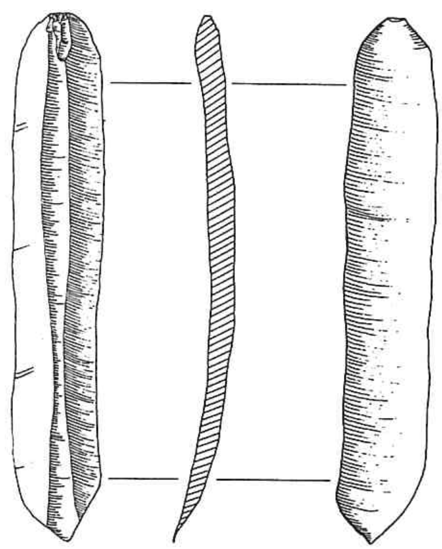


Figure 4.26 Three views of a blade: a flake with a length at least twice its width.

What forces were at work making us more human? How did evolution select for more creative individuals?

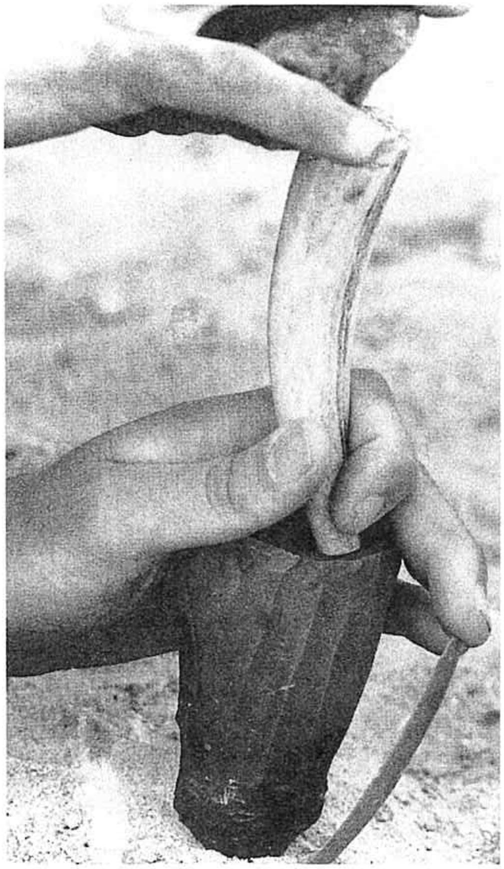


Figure 4.27 Upper Paleolithic manufacture of blades and blade tools. Blade manufacture is a kind of mass production of many elongated flakes. A pointed piece of bone or antler is struck with a hammerstone to remove the blade from the core using the indirect percussion technique.

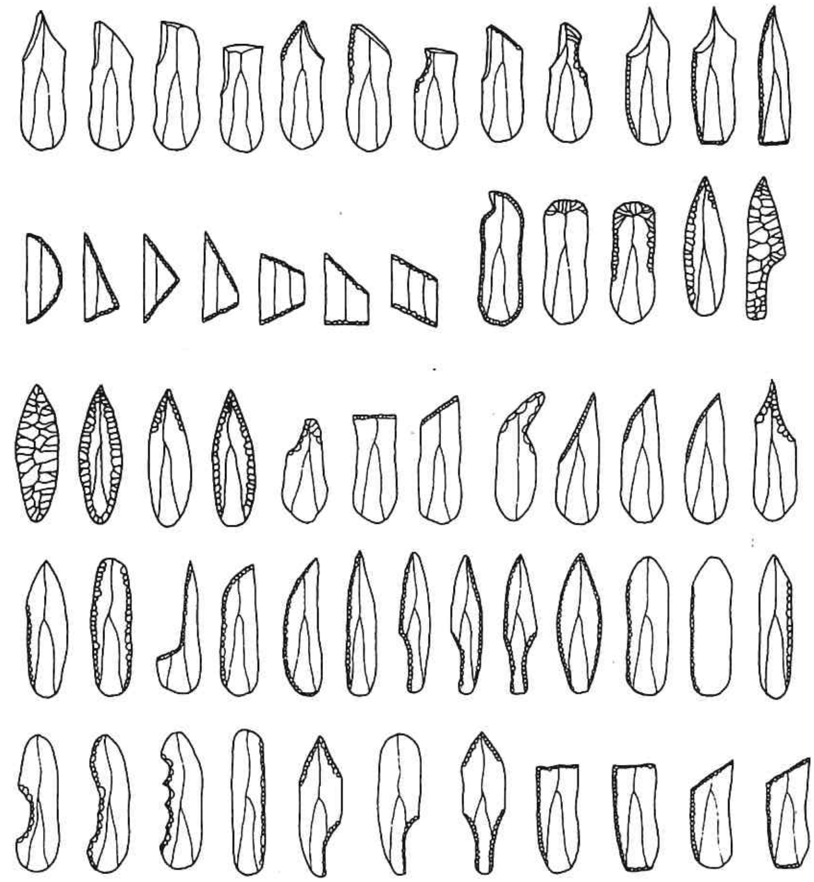


Figure 4.28 Blades as forms, or **blanks,** for making other tools. Increasing specialization in the function of tools was an important trend during the Paleolithic. This illustration shows some of the many types of tools that were made from blades.

Figure 4.29 Solutrean laurel leaf point produced by retouching and thinning the surface of the artifact.

The archaeological materials of this period are best known from Europe, especially from southwestern France, an important hub of archaeological activities during the twentieth century. In Europe, the Upper Paleolithic replaced the Middle Paleolithic after 40,000 years ago. Excavations over the past 100 years in the deep deposits of caves and rockshelters in this area have exposed layer upon layer of materials from the last part of the Pleistocene. These excavations and studies of the contents of the layers resulted in the recognition of a sequence of Upper Paleolithic subperiods, known as the Châtelperonnian, Aurignacian, Perigordian, Solutrean, and Magdalenian (Figure 4.25). In central and eastern Europe, the Upper Paleolithic remains are designated the Gravettian, roughly equivalent to the Perigordian in the west.

The earliest skeletal remains of *Homo sapiens sapiens* found in western Europe date to 42,000 years ago, following the appearance of blade tools and other distinctively Upper Paleolithic artifacts. These anatomically modern individuals were originally called Cro-Magnon, after the place in France where they were first discovered. In spite of this distinctive name, they were indistinguishable from fully modern humans. Lacking the robust frame, heavy brow ridges, and protruding jaw of the Neanderthals, the *H. sapiens sapiens* face sits almost directly under a bulging forehead. A chin reinforces the smaller, weaker jaw and its smaller teeth. Cranial capacity is fully modern, and there is no reason to assume that Cro-Magnons were intellectually different from us.

The material remains left by these Upper Paleolithic societies reinforce the idea that by this time our species had indeed arrived as creative creatures. Blade-manufacturing techniques and blade tools characterize the Upper Paleolithic. Stone **blades** are a special form of elongated flake, with a length at least twice its width and sharp, parallel cutting edges on both sides (Figure 4.26). Blades can be mass-produced in large quantities from a single nodule of flint, removed from a core in a fashion akin to peeling a carrot (Figure 4.27). Blades also provide a form, or **blank,** that can be shaped (retouched) into a number of different tools. Projectile points, burins, knives, drills, and scraping tools can all be made from a basic blade form (Figure 4.28).

Another distinctive aspect of Upper Paleolithic stone tool manufacture is the appearance of special flaking techniques during the Solutrean period, to make thin, beautiful, leaf-shaped points in several sizes (Figure 4.29). Some of these points were used for spears and some perhaps for arrows, while others may have served as knives. These tools are among the finest examples of the flintknapper's skill from the entire Paleolithic. At the end of the Solutrean, however, these flaking techniques largely disappeared from the craft of stone tool manufacture, not to be used again for thousands of years.

Many new kinds of tools—made of materials such as bone, wood, ivory, and antler—also distinguish the Upper Paleolithic. Spearthrowers, bows and arrows, eyed needles, harpoons, ropes, nets, oil lamps, torches, and many other things have been found. Hafting and composite tools, incorporating several different materials, were also introduced during the Upper Paleolithic. Resin and other adhesives, for example, were used to hold stone tools in bone or antler handles.

Spearthrowers provide an extension of the arm, enabling hunters to fling their darts with greater force and accuracy (Figure 4.30). A hunter with a spearthrower can kill a large animal such as a deer from a distance of 15 m (50 ft). Spearthrowers of bone, wood, or antler usually had three components: a handle, a balance weight, and a hook to hold the end of the spear. These spearthrowers were often elaborately decorated, with the carved figures of animals used for the weight (Figure 4.31). By the end of the Upper Paleolithic, the spearthrower was replaced by the bow and arrow as the primary hunting weapon. The bow provided an even more accurate means of delivering a long-distance, lethal blow to an animal.

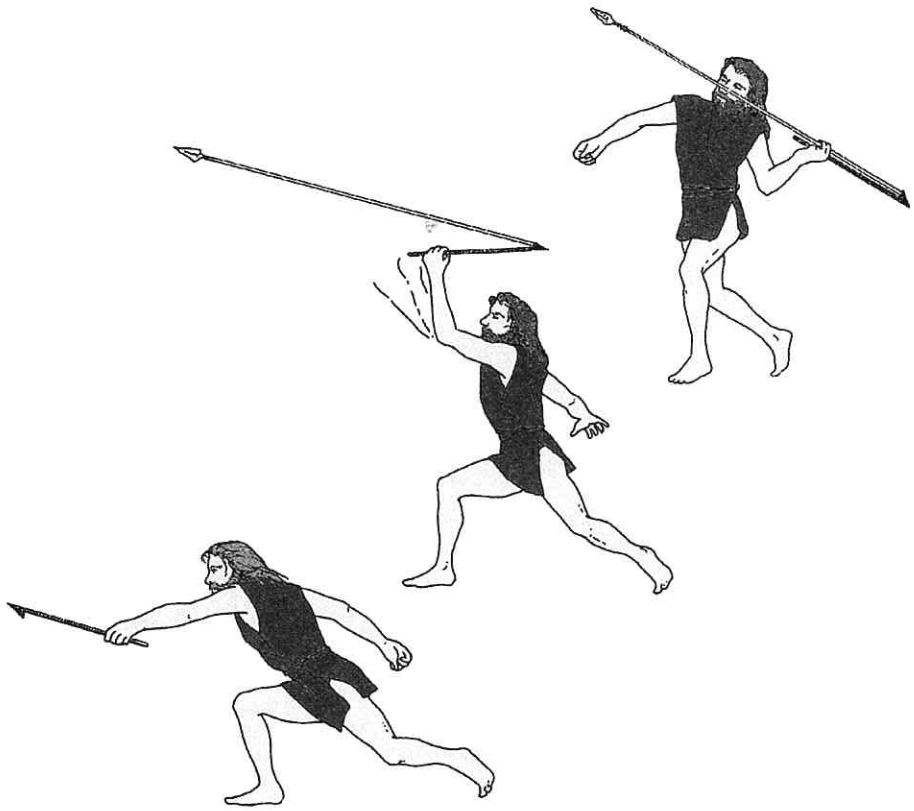


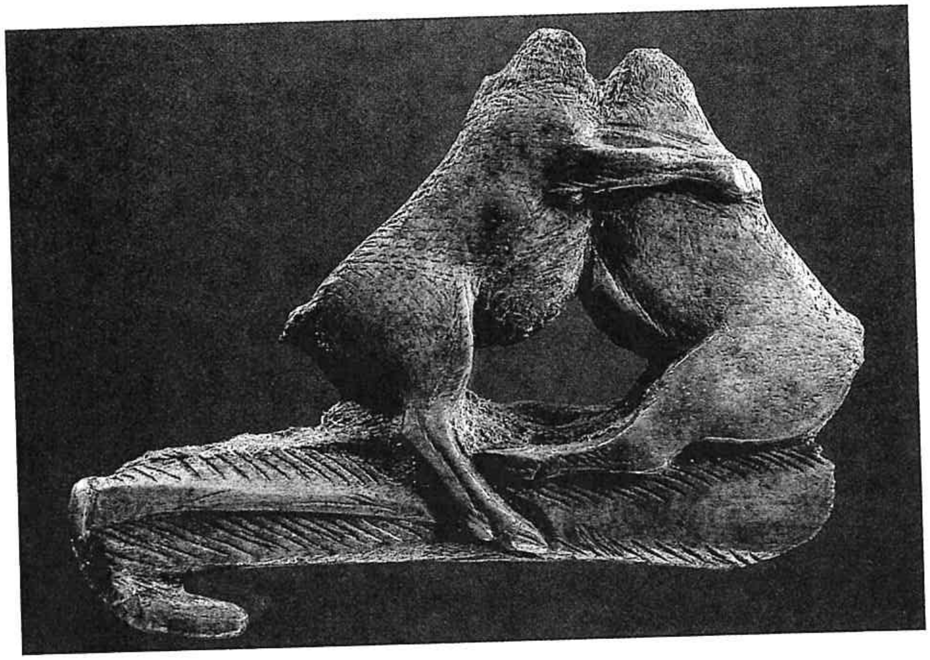
Figure 4.30 An artist's reconstruction of a spearthrower in action.

Dogs were domesticated during the Upper Paleolithic, probably for the purpose of hunting. As temperatures warmed at the end of the Pleistocene and the European forests spread back across the continent, woodland species of animals became more common but less visible to the hunter. A strong sense of smell, lacking in a human hunter, to locate prey was well developed in his faithful canine companion.

blade A special kind of elongated flake with two parallel sides and a length at least twice the width of the piece.

blank A basic form or preform from which various kinds of tools can be shaped.

Figure 4.31 One end of a decorated spearthrower from the Upper Paleolithic in France. A carving of two embracing elks provides the balance weight.



Fine bone needles with small eyes document the manufacture of sewn clothing and other equipment from animal skins. Several categories of carved artifacts—buttons, gaming pieces, pendants, necklaces, and the like—marked a new concern with personal appearance, an expression of self, and the aesthetic embellishment of everyday objects. This development was closely related to the appearance of decorative art. Figurines, cave paintings, engravings, and myriad decorations of other objects reflect the creative explosion that characterized Upper Paleolithic achievement. There is also compelling evidence for a celebration of the seasons and an awareness of time in the archaeological remains from the Upper Paleolithic. Finally, the suggestion of counting systems and the beginning of a calendar of sorts—or at least a recording of the phases of the moon—may have appeared at this time (see "Symbols and Notation," p. 140).