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Archaeological Evidence for the Emergence of Language, Symbolism, and Music—An Alternative Multidisciplinary Perspective

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In recent years, there has been a tendency to correlate the origin of modern culture and language with that of anatomically modern humans. Here we discuss this correlation in the light of results provided by our first hand analysis of ancient and recently discovered relevant archaeological and paleontological material from Africa and Europe. We focus in particular on the evolutionary significance of lithic and bone technology, the emergence of symbolism, Neandertal behavioral patterns, the identification of early mortuary practices, the anatomical evidence for the acquisition of language, the

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development of conscious symbolic storage, the emergence of musical traditions, and the archaeological evidence for the diversification of languages during the Upper Paleolithic. This critical reappraisal contradicts the hypothesis of a symbolic revolution coinciding with the arrival of anatomically modern humans in Europe some 40,000 years ago, but also highlights inconsistencies in the anatomically–culturally modern equation and the potential contribution of anatomically "pre-modern" human populations to the emergence of these abilities. No firm evidence of conscious symbolic storage and musical traditions are found before the Upper Paleolithic. However, the oldest known European objects that testify to these practices already show a high degree of complexity and geographic variability suggestive of possible earlier, and still unrecorded, phases of development.

KEY WORDS: bone tools; symbolism; music; language; Neandertals.

INTRODUCTION

Humans are the only species capable of communicating with an articulated oral language and creating symbolic ideational cultures. Several contradictory theories of human cognitive evolution have been developed in attempts to model how, when, and amongst which hominid groups these abilities emerged. Key issues concern what environmental, social, and adaptive factors may have stimulated their adoption and facilitated their spread (e.g. Changeux, 1983; Davidson and Noble, 1989; Deacon, 1997; Donald, 1991; Eccles, 1989; Goonatilake, 1991; Knight *et al.*, 1995; Mithen, 1994, 1996a,b; Wynn, 1991, 1993). Since language and cognition do not fossilize, theorists are forced to rely on evidence from archaeology and paleoanthropology to corroborate their models. This approach becomes flawed because, unable to test their evolutionary models adequately through a direct analysis of the archaeological evidence, many of these theorists accept dominant archaeological paradigms as established facts, without first sufficiently researching the pertinent debates surrounding the interpretation of primary archaeological and anthropological data. Worse still, they may adopt archaeological scenarios that best fit their view, disregarding others.

An example of this is the chronology proposed by Ruhlen (1994, 1996) and others for the origin of modern languages. He controversially uses the methods of historical linguistics to reconstruct archetypal languages, and proposes an evolutionary model based on the assumption that all present-day languages derive from a single *proto-langue*, through a process of increasing diversification. Since historical linguistics does not allow for the calculation of a rate of language diversification over an extremely long period, nor does it provide a starting point for this process, Ruhlen uses a package of archaeological, paleoanthropological, and genetic "evidence" to estimate a date for the origin of language diversification. He proposes that this process may have started 40,000–50,000 years ago, on the basis of (1) the date for the beginning of the Upper Paleolithic in Europe, with its purported "explosion" of symbolic activities, (2) the arrival of Anatomically Modern Humans (AMH) in this region, (3) models suggesting a dramatic change in human cognition all over the world at this time (Klein, 1999; Mellars, 1996a), and (4) current hypotheses on the timing of the first colonization of Australia and New Guinea. This model also assumes that only AMHs could speak a modern language or, if this was not the case, that languages spoken, for example, by Neandertals in Europe and the Near East did not contribute to languages spoken by contemporary and more recent AMH populations.

The strongest challenges to Ruhlen's scenario (see also Greenberg, 2000) come from historical linguists who disagree with his heretical methodology, which abandons the very methodological precision that has put Indo-European linguistics on a scientific footing, distinguishing it from the work of erudite amateurs. However, few of these critics seem to be aware that the package of knowledge, external to their discipline, on which Ruhlen's scenario is based, might be better described as a mere assemblage of working hypotheses constantly challenged by contradictory counterparts and new relevant finds.

A number of recent discoveries challenge models that equate the symbolic revolution with the arrival of AMH in Europe some 37,000 years ago (Bar-Yosef, 1998; Mellars, 1996a, 1998; Stringer and Gamble, 1993). Evidence suggests that late Neandertals produced and wore a repertoire of personal ornaments (Fig. 1), interpreted as proof of symbolic thinking (d'Errico

Fig. 1. Chatelperronian ornaments from Grotte du Renne (first six from the left) and from Quinçay. Scale = 1 cm.

et al., 1998c; Granger and Levèque, 1997). An increasing number of objects found in Lower and Middle Paleolithic sites from the Near East, Europe, and in Middle Stone Age sites from Africa, together with new dating of Neandertal burials, supports the hypothesis of an origin of symbolism earlier than that of the Middle–Upper Paleolithic transition in Europe (cf. discussion in d'Errico *et al.*, 2001; d'Errico and Nowell, 2000; Henshilwood *et al.*, 2001a,b, 2002; McBrearty and Brooks, 2000). Finally, the Near East archaeological record reveals striking behavioral similarities between Neandertals and AMHs (Bar-Yosef, 1992; Shea, 2001), making it presumptuous to assume dramatic differences in their cognitive abilities.

Recent excavations at the sites of Twin Rivers in Zambia (Barham, 1998, 2000, 2002) and Kapthurin in Kenya (McBrearty, 2001) have yielded convincing proof of the symbolic use of pigments during the Acheulean–Middle Stone Age transition (ca. 200,000 years ago). These behaviors could be associated with archaic *Homo sapiens (sensu lato)*. Fieldwork at Twin Rivers led to the discovery in 1999 of 176 fragments of pigment in layers dated to between 260,000 and 400,000 years. Five different pigment colors with traces of use are recorded. Geological surveys indicate that prehistoric people must have collected these pigments several kilometers away from the settlement site. Layers dated to 200,000 years also yielded 132 pigment samples. The variety of colors denotes a more than functional use of these minerals. If pigment use is an archaeological indication of symbolic behavior, and indirectly of language, the origin of these abilities, traditionally attributed to AMH, has to be considered more ancient than commonly accepted.

At Blombos Cave (Western Cape, South Africa), careful examination of 8000 ocher pieces and an elaborate bone industry (associated with a Still Bay lithic assemblage ca. 75,000 years old) revealed ocher pieces and bone fragments engraved (Fig. 2) with abstract patterns (d'Errico *et al.*, 2001; Henshilwood *et al.*, 2001a,b, 2002; Henshilwood and Sealy, 1997). The engraved ochers associated with the remains of *Homo sapiens* constitute, at present, the most ancient irrefutable evidence for symbolic behavior.

Both functional and natural interpretations have been proposed for a number of isolated bone finds from Lower and Middle Paleolithic sites in Europe and the Near East (d'Errico and Villa, 1997). However, the shaping, marking, and use of bone was a regular activity at Blombos Cave. The techniques employed in bone modification at this site are complex (d'Errico *et al.,* 2001; Henshilwood *et al.*, 2001b) and must have been acquired through linguistic communication rather than by observation or mimicry. The multiple-stroke technique used to engrave a bone fragment at Blombos Cave (d'Errico *et al.*, 2001) is evidence of coherent behavior and technical knowledge shared and transmitted within a community. No functional interpretation of these lines can be reasonably implied, as has been suggested

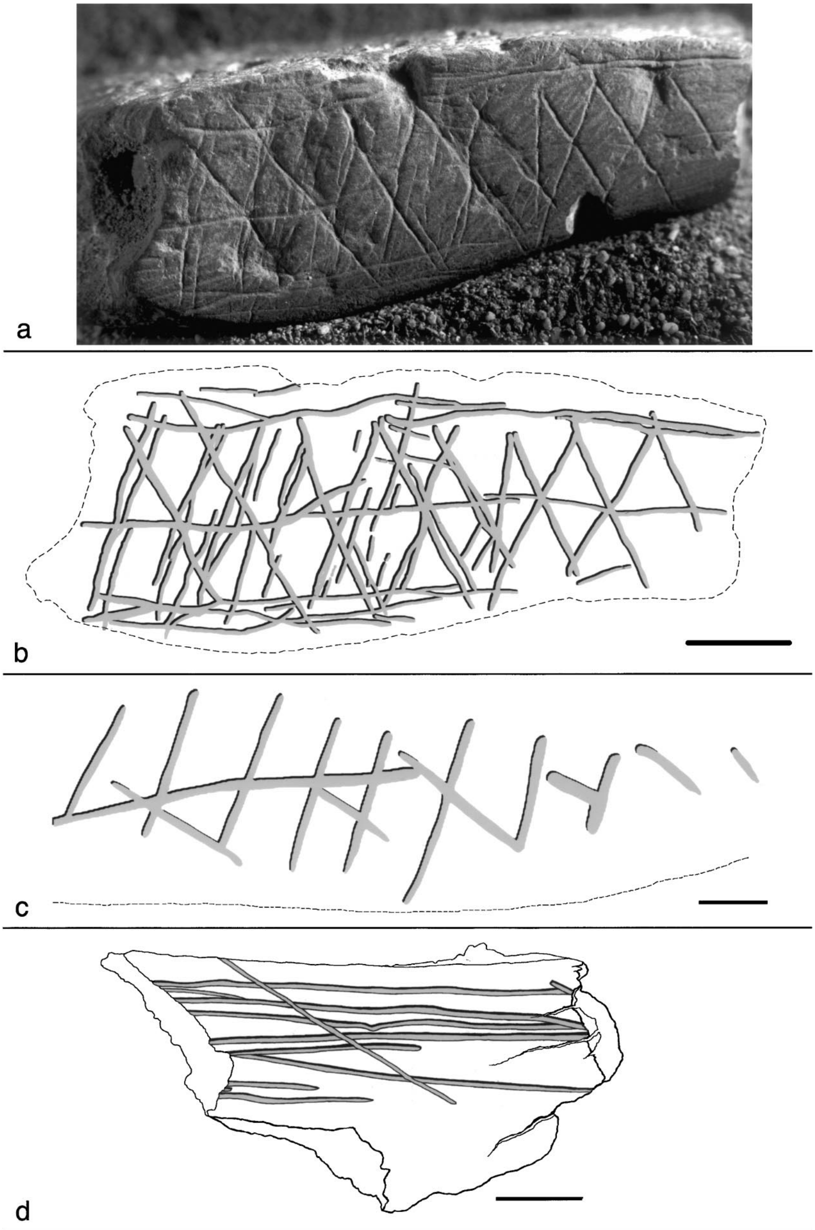

Fig. 2. Abstract engravings from Blombos MSA levels. (a–c) Photo and tracing of engraved patterns on the edge of ocher slabs; (d) tracing of an incised bone fragment. (b) Scale = 1 cm, (c) scale = 2 mm (d) scale = 5 mm.

for utilized ocher from Middle Stone Age (MSA) sites. The engraved ocher fragments also show traces of scraping and grinding similar to those recorded on the 8000 ocher fragments excavated from the same levels at Blombos Cave. The presence of a symbolic engraving on utilized pigment suggests that a solely functional use of pigments by MSA peoples is unlikely.

Linguists and scholars interested in the evolution of human cognition need to be aware of these and other discoveries, and archaeologists need to develop methods of analysis to explore the overall significance of archaeological material, thus paving the way for a solid database on which any theoretical superstructure might be built. The best transdisciplinary theories are those where the contribution of each involved discipline is apparent, each of them has independent means to test hypotheses, and untested assumptions of one are not used as pillars for another.

A MULTIDISCIPLINARY ENDEAVOR

In recent years, there has been a tendency to correlate the origin of modern culture and language with that of Anatomically Modern Humans. However, this correlation should be considered, as far as archaeology is concerned, as no more than a model that needs to be tested against empirical data.

To avoid the shortcomings inherent in directly correlating AMH with modern culture and language, we can utilize the behavioral corollary of language abilities and, in particular, its expression in material culture, to create a properly structured model on which to base their origin. It is widely accepted that a direct link exists between the highly symbolic nature of modern language (i.e. its capacity to refer to past, present and future-actual or imaginary-events) and the creation, maintenance, and transmission of the material expression of symbols within a given human culture. The only direct evidence for the first use of symbolic language amongst humans is the recognition in the archaeological record of the material products of symbolic thinking. However, the mere presence of an artifact does not indicate how it was used nor can its function be implied by supposition or simple interpretation. Useful additional evidence for language capacity is provided by the human fossil record (e.g. Arensburg *et al.,* 1990).

Therefore, we need to establish how, when, and where symbolic cultures first developed, whether they have single or multiple origins, and whether they can be assigned to specific human groups. Our joint effort involves examination of all categories of potentially symbolic material culture produced by Neandertals and early AMH (personal ornaments, decorated tools, utilized pigments, engraved bones and stones, burials, grave goods, systems of notation, musical instruments, complex bone technologies) from Europe, Africa, and the Near East. Our aim is also to tentatively trace major steps in the diversification of languages in Europe during the Upper Paleolithic through the analysis of symbolic objects functionally equivalent to language. In this paper, we present a synthesis of the research in progress, discuss its implications for the question of the origin of behavioral modernity and language, and sketch a provisional model for the emergence of these abilities. To achieve this goal we will focus on the evolutionary significance of lithic and bone technology, origin of symbolism, Neandertal behavior, early burials, paleontological evidence for language, origin of conscious symbolic storage, origin of musical tradition, and the archaeological evidence for the diversification of language during the Upper Paleolithic.

COGNITION AND LITHIC TECHNOLOGY

It has been suggested that the study of ancient technologies and, in particular, lithic artifacts provides a sound basis for the evaluation of hominid cognitive abilities (e.g. Boëda, 1991, 1997; Karlin and Julien, 1994; Pelegrin, 1990; Perlès, 1992; Roche *et al.* 1999; Schlanger, 1994, 1996; Wynn, 1979, 1985, 1991). However, while major trends of artifact evolution have been proposed (e.g. Isaac, 1986; Pigeot, 1991; Toth and Schick, 1993; Wynn, 1993, but see McPherron, 2000), the implications of these changes for the evolution of human cognition are far from clear. Binford (1979, 1989) characterized early human technology as poorly organized and "tending toward the expedient manufacture, use, and abandonment of instrumental items in the immediate context of use" (Binford, 1977, p. 34). This hypothesis, together with an interpretation of faunal remains, concludes that early humans had limited predatory abilities (Binford, 1981). It also argues that Neandertal and earlier societies were much less complex than early modern ones (Binford, 1981, 1989; White, 1982) and that there was a difference, even a clear inferiority, in the cognitive abilities of Neandertals, when compared to early AMH (Binford, 1989; Noble and Davidson, 1996; Stringer and Gamble, 1993). New research makes it clear that behaviors considered by Binford as peculiar to AMH were progressively acquired by Neandertals. This is the case for the transport, resharpening and standardization of stone tools (Callow, 1986, pp. 374–375; Conard and Adler, 1997; Geneste, 1985, 1989, 1990; Roebroeks *et al.*, 1988; Soressi 2002; Soressi and Hays, 2003), hunting strategies (Armand *et al.*, 2001; Brugal, 1999; Chase, 1987, 1989; Farizy and David, 1992; Gaudzinski and Roebroeks, 2000), and the organization of habitation sites (Farizy, 1990; Leroi-Gourhan, 1982).

Some scholars have used Piaget's theory (1947, 1976), according to which the steps in mental development of children correspond to the cognitive frontiers crossed by humanity during its evolution, to try and estimate ancient hominid cognitive capacities (Longuet-Higgins, 1996; Wynn, 1985). However, this approach has produced contradictory results. Russell (1996) states, for example, that hominids during the Middle–Upper Paleolithic transition were capable of symbolic thought. Other scholars (Gibson, 1985; Gibson and Mellars, 1996, pp. 5–6; Gowlett, 1984; Wynn, 1979) believe that Acheulean populations already possessed these capacities a few hundred thousand years earlier. This is but one example of how archaeologists reach opposing conclusions based on the same facts. A further case in point is Mithen's interpretation of the behavioral differences between the Middle and Upper Paleolithic (Mithen, 1994, 1996a,b), as a consequence of a shift from a Neandertal-specific intelligence to Modern Human generalized intelligence—the latter being the only hominids able to integrate social and natural history, technical knowledge, and cognitive thought processes. Others see the same empirical evidence as the expression of uneven cultural development with no evolutionary implications (d'Errico, in press-a,-b; Hayden, 1993; Simek, 1992). The main reason for such a striking lack of consensus is the absence of a sound analogy that establishes a firm link between a given form of stone tool technology and a degree of intelligence, whatever that may be (cf. Ingold, 1993, p. 344; Renfrew, 1996; Wynn, 1991). When stone tools produced by modern ethnographic societies or by past societies that we know were behaviorally modern, such as those of the Upper Paleolithic, are used as an analogy to characterize the more recent step of this evolutionary process, a number of features appear as valuable criteria for detecting the acquisition of modern cognitive abilities and language. Long distance exchange of raw materials and the production of stylistically distinct tool categories certainly represent robust evidence of symbolic cultures and linguistically transmitted traditions (Deacon, 1993; Deacon and Deacon, 1999; Sackett, 1982; Wynn, 1998). Fully symbolic societies using very basic lithic technologies, however, also exist (Mulvaney and Kamminga, 1999), and this seems to demonstrate that, while the occurrence of stylized stone tools suggests modern cognition, their absence cannot be assumed to indicate "archaic" adaptations.

THE ORIGIN OF COMPLEX TECHNOLOGIES

Complex societies are generally characterized by varied and complex technical systems, involving production of tools made from different raw materials and the use of these tools for different technical activities. A panoply of tools and techniques implies diversified strategies for raw material acquisition, more complex cultural transmission, the possible emergence of craft specialization, and increased complexity of social roles. The evolution of toolmaking from simple to composite, and the further development of using tools to make tools, might even be seen as the archaeological reflection of the transition from a proto-language to a language with a more complex structure. It is probably for these reasons that use of composite tools, hafting, and, in particular, the production of bone and ivory tools, with techniques specifically conceived for these materials, such as scraping, grinding, grooving, and polishing, are generally considered by archaeologists to be important features characterizing modern human behavior (Ambrose, 2001; Klein, 2000; McBrearty and Brooks, 2000; Mellars, 1973).

What do we know of the emergence of these behaviors? Complex bone technologies have long been seen as an invention of AMH during their spread across Europe, ca. 35 thousand years ago (Bar-Yosef, 1992, 1998; Klein, 1999; Mellars, 1973). However, the existence of used or shaped bone and ivory points functioning as awls or with wooden hafts has also been suggested for a number of Lower and Middle Paleolithic sites from Europe (Bordes, 1984; Gaudzinski, 1999; Howell and Freeman, 1983). Shaped bone tools were also reported from a number of late Neandertal sites in France and Italy, yielding Châtelperronian and Uluzzian stone tools, but their presence in those layers was interpreted by many as resulting from a reworking of sediments, or as evidence for an acculturation of the last Neandertals by the Modern colonizers. Recent research on this topic, mostly conducted in the framework of our multidisciplinary project, presents a different picture.

Use of Bone Tools by Early Hominids

Most of the objects from Lower and Middle Paleolithic sites have been published without a validating microscopic analysis of the bone surface to show possible traces of manufacture and use. This kind of physical examination is necessary because we know that natural processes can produce pseudobone tools similar to those attributed to humans. In a number of recent papers (Backwell and d'Errico, 2001; d'Errico *et al.*, 2002; Villa and d'Errico, 2001), an integrated method has been developed on the basis of taphonomic observations, actualistic data, replicative experiments, and microscopic analysis to assess putative shaped or used bone tools from Lower and Middle Paleolithic sites. The oldest evidence for modification and use of bone points comes from the sites of Swartkrans, Sterkfontein, and Drimolen in South Africa (Brain and Shipman, 1993; Keyser *et al.*, 2000). Using the purported bone tools from Swartkrans and Sterkfontein (dated to ca. 1.8–1 million years), we reanalyzed the evidence for these being tools, and reappraised their probable function. Previous work, based on microscopic analysis of a number of specimens, led to the interpretation of these bones as tools used for digging up tubers and working skins. However, this was not supported by a comparison of the tool morphology and wear pattern with those produced by natural processes known to mimic anthropogenic modifications. Brain and Shipman (1993) did not consider alternative functional interpretations, nor did they test those experimentally using appropriate analytical methods. Other potentially relevant data that we have taken into account (species, type of bone used, fracture patterns, degree of weathering, bone flake morphometry, spatial distribution) were not collected or discussed by Brain and Shipman in the context of the site's taphonomy.

Our analysis of the wear patterns on the purported bone tools, pseudobone tools resulting from known taphonomic processes, and experimentally used bone tools confirm the anthropogenic origin of the modifications. Additionally, our analysis suggests that these tools were probably used to dig into termite mounds, rather than to dig for tubers.

We used dental impression material to make replicas of all the Swartkrans and Sterkfontein putative tools, and optical and scanning electron microscopy to identify the features that they had in common. Each specimen was found to have a rounded tip, showing individual longitudinal striations running parallel to the main axis of the bone. The orientation and dimension of the striations were recorded on a random sample of 18 fossils, using image analysis software. We then examined the faunal collection from Swartkrans for specimens with a similar wear pattern. We found 16 new pieces with equivalent wear, giving a total of 84 specimens. The wear pattern appeared to be a feature peculiar to the bone tool collection, and did not represent an extreme form of a process affecting the entire assemblage. Cave sedimentation was thus eliminated as a possible causal agent. We examined 35 reference collections of modern and fossil bones from open air and cave contexts (13,301 specimens) modified by 10 nonhuman agents (animal and geological). Of the pieces examined, 24 appeared similar to the archaeological specimens. We made resin replicas of these pseudotools and examined them as above. None had the distinctive wear pattern observed on the Swartkrans and Sterkfontein specimens. We then compared the wear pattern on these bones with that of experimentally created modern bone tools. Using antelope limb bone shaft fragments and horn cores, we dug for tubers in a range of soil types, scraped and pierced animal hides, and dug out termites from their mounds.

The wear patterns on the termite tools proved to be virtually indistinguishable from those on the archaeological specimens. This leads us to conclude that the latter were not only real tools, but that they were predominantly used to dig termites out of the numerous termite mounds found in the Swartkrans/Sterkfontein area. Alternative explanations are unlikely for two reasons. They would require the identification of a subsistence activity based on extensive digging carried out exclusively in a fine-grained, stoneless soil matrix such as that of termite mounds, a feature unlikely to occur in the deposits of the Sterkfontein Valley or inside the Swartkrans caves. Second, while limb bone shaft fragments are suitable for breaking the hard crusts of termite mounds, they appear inefficient for other digging activities when compared with the long, stout digging sticks used by modern hunter–gatherers to extract buried tubers, larvae, and small game.

Termites are a valuable source of protein and fat in the diets of primates and human foragers. Chimpanzees are known to both "fish" for termites as well as perforate and dig termite mounds in a variety of ways. By digging termites out of their nests, hominids would have made available a rich food source that was otherwise only accessible during the period when insects voluntarily leave their nests for breeding.

The Swartkrans and Sterkfontein bone tools are not formally shaped, as are those from later periods (e.g. Blombos Cave and see below). However, analysis of the breakage patterns indicates that the early hominid users selected heavily weathered bone fragments of a particular size range (13–19 cm) and shape (long, straight bone flakes, and horn cores). Metric analysis of the Swartkrans faunal collection also suggests that the bone tools are a discrete population within the assemblage, in that the lengths of the few complete worn bones fall outside the range of the lengths of the unworn long bone fragments from the site, and even the broken tools are generally longer. A similar result is obtained when the widths of the tools are compared with those of the other fragments, or the thickness of the compact bones in the two populations, suggesting that longer, wider, and more robust bone fragments were selected.

Who used these tools? The predominant numbers of robust australopithecines at Swartkrans and Drimolen (associated with 23 undescribed bone tools), and the fact that no stone tools have been found at Drimolen, might suggest that the bone tool culture belonged to *Paranthropus (Australopithecus) robustus*. It is still a matter of debate, however, whether this hominid was a stone toolmaker. The absence of these tools in southern African sites younger than 1 million years suggests that this technique was not passed on to more recent *Homo* populations. The discovery of future sites with bone tools associated with a single hominid type will certainly help clarify this issue. Another open question is why these types of tools exist only in southern Africa. Possible bone tools have been identified at Olduvai (Shipman, 1989); they mostly consist of heavy broken shaft fragments and epiphyses from very large mammals with evidence of large flake removals. Are these bone tools genuine and, if so, is this difference indicative of cultural traditions distinct from those of southern Africa? This is the question that Backwell and d'Errico are now trying to answer through the ongoing reanalysis of the Olduvai putative tools. What is the significance of these bone tools for the evolution of cognition and language origin? Studies on chimpanzees have demonstrated (Whiten *et al.*, 1999) that each group is characterized by different and rather complex cultural traditions that are subject to ecological influences. The transmission of these traditions, however, does not seem to require language competence. Relatively complex activities requiring a high degree of neuromotor control, such as nut-cracking, can be passed to offspring by imitation and gesture. In conclusion, our study shows that the use of bone as a raw material need not, in itself, imply modern cognitive abilities and should not be considered a hallmark of behavioral modernity.

Use of Bone Tools by *Homo*

A number of Lower Paleolithic sites in Europe, mostly from the Latium region of central Italy, have yielded Acheulian-type bifaces made by flaking elephant long bones, and many other Lower and Middle Paleolithic sites have produced bone fragments used to retouch stone tools. In the case of the bone bifaces, the premodern hominids applied the same techniques to bone that they used in knapping stone artifacts; in the case of retouchers, they used bone as they used stone hammers. Scholars who have a reductive view of the technological and cognitive abilities of early hominids and Neandertals often consider the transfer of percussion flaking to bone as an indication that early humans were incapable of developing sophisticated techniques, specifically designed for bone materials, based not on percussion but on shaping by cutting, scraping, grinding, and polishing. Thus, it has been argued that Mousterian and earlier technologies were essentially expedient and involved only a short series of single-stage operations, and a lower degree of conceptualization (Mithen, 1996a,b; Noble and Davidson, 1996). However, the discovery of six wooden spears, at the 400,000-year-old site of Schöningen in Germany confirms what was already known from Clacton and Lehringen—that Middle Pleistocene hominids were quite capable of designing pointed tools for the hunting by shaping wood using specific techniques, such as shaving and scraping (Keeley in Oakley *et al.*, 1977; Thieme, 1997, 2000; Thieme and Veil, 1985). The occurrence of four wooden shafts at another locus (Schöningen 12) also suggests the existence of composite tools in the middle part of the Middle Pleistocene, Oxygen Isotope Stage (OIS) 11. We also know that hafting technology was practiced in the Middle Paleolithic of Eurasia. Hafting of stone spear points is documented by direct evidence of mastic, by a point tip embedded in a vertebra, and by more indirect evidence of wear and impact scars. One convergent scraper, three Levallois flakes, and one cortical flake with traces of bitumen adhesive used for hafting have been found in Mousterian levels dated to about 60,000 years at the site of Umm El Tlel. One blade from the Hummalian levels (Middle Paleolithic) at Hummal carries similar traces. Both sites are in the El Kwom Basin, Syria. More direct evidence for stone-tipped spears also comes from Umm El Tlel, where a Levallois point has been found embedded in the third cervical vertebra of a wild ass (Boëda *et al.,* 1996, 1998a,b, 1999; cf. also Friedman *et al.,* 1994; Shea, 1988, 1997, 1998). Thus, it becomes reasonable to ask whether Neandertals and earlier hominids developed techniques specifically conceived for bone and ivory materials, and possessed an organic spear armature technology, comparable to that documented in the Upper Paleolithic/Later Stone Age.

A recent study conducted by Villa and d'Errico (2001) shows, however, that this is not the case. Their new analysis of the 37 ivory pieces from Torralba and Ambrona, interpreted as shaped and/or used as tools by Howell and Freeman (1983), and of the 19 tusks found at Ambrona in the new excavations reveals that the breakage morphology of these pieces is similar to fragments found in African game preserves that result from the accidental breakage of a tusk tip during the animal's life. The morphometric analysis shows great variability (from 1.8 to 23.2 cm in length) which seems incompatible with the functional requirements of hafting, and microscopic analysis indicates that, by comparison to the remainder of the faunal and stone tool assemblage, surface modifications interpreted as traces of manufacture or use are actually due to taphonomic processes or wear produced by the animal during its lifetime. On the basis of comparison with pseudopoints produced by a number of taphonomic agents, and on primary microscopic analyses of the archaeological specimens, Villa and d'Errico also demonstrate that a natural explanation must be favored for other bone and antler points reported from sites such as Vaufrey, Combe Grenal, Camiac, Pech de L'Azé I, and probably for a number of other sites that they were unable to study. Bone awls shaped with techniques specific to bone material were produced by late Neandertals (see below) but, apparently, not spear armatures. Why is it that Middle Paleolithic hominids with subsistence strategies that included hunting with hafted stone points did not produce bone spears? The obvious question is whether this limitation depended on Neandertal cognitive/linguistic ability or on the organizational strategy of the hunters?

Upper Paleolithic bone and stone spear tips differ from Middle Paleolithic stone points both aerodynamically and in the amount of kinetic energy expended at impact (Shea, 1997). Middle Paleolithic stone points, even when carefully and symmetrically shaped by retouch, often have a fairly large and thick base. This implies the need for a fairly large shaft, suggesting a rather heavy lance or javelin. This kind of weapon, when thrown by hand, will have a low velocity but a high penetration and stopping power at a short distance; its cutting edges can cause extensive and/or lethal wounds. Robust organic points, launched in a similar way, would be unable to penetrate deeply into the hide and flesh of large mammals because of the softer and more elastic nature of this material, and the lack of sharp edges facilitating the initial penetration of the weapon. Upper Paleolithic stone and bone points all have common features: they have thin, straight tips and are light, making them highly aerodynamic and able to travel at high speed. This makes them suitable to be cast from afar. Their morphology and speed will allow them, if not stopped by bones, to go deeper into the animal's body and injure internal organs. In general, however, javelins with organic points have less killing force than stone-tipped spears and will produce less lethal wounds in large terrestrial game (Boëda *et al.,* 1999; Ellis, 1997). It is difficult at this stage to choose between these two contrasting interpretations that have very different implications for our view of Neandertal cognitive abilities.

Blombos: Securely Dated Evidence for Early Formal Bone Tools

The oldest evidence for the production of formal bone tools, that fits Klein's definition of "formal"—"bones that were cut, carved, or polished to form points, awls, borers, and so forth" (Klein, 1999, p. 344)—comes from a group of African Middle Stone Age (MSA) sites. However, most of these findings consist either of unique pieces or small collections of objects of uncertain stratigraphic provenance and chronological attribution. Eight barbed bone points with grooved bases to facilitate hafting, similar to harpoons found in the Later Stone Age (LSA), but associated with MSA stone artifacts, have been described from the site of Katanda (eastern Zaire) dated to between ca. 80,000 and 90,000 years (Brooks *et al.,* 1995; McBrearty and Brooks, 2000; Yellen, 1998; Yellen *et al.,* 1995). Given the uniqueness of these artifacts which antedate well-documented Later Stone Age harpoons by 50,000 years or more, it is understandable that the age estimates have been challenged (Klein, 2000). A bone point and utilized ivory pieces come from the Kabwe site (Clark *et al.,* 1947), but their age and association with faunal and hominid remains are questionable (McBrearty and Brooks, 2000). A bone point, purportedly from the lowest HP levels at Klasies River (KR) dated to ca. 65,000–70 ,000 years (Miller *et al.,* 1999; Vogel, 2000) is described by Singer and Wymer (1982) as similar in color to MSA bone from the same level. Notched bone pieces come from Apollo 11, Namibia (Volman, 1984), and Klasies River (Singer and Wymer, 1982; Wurz, 2000).

Fig. 3. Bone awls from Blombos MSA levels.

Four unpointed tools made on ribs are reported from the Aterian site, Grotte d'el Mnasra in Morocco (Hajraoui, 1994). At White Paintings Shelter, Botswana, a single bone point comes from transitional MSA/LSA deposits dated to ca. 38,000–50,000 years.

The largest assemblage of formal bone tools, which has recently been studied in the framework of our multidisciplinary project (Henshilwood *et al.*, 2001b), is that found at Blombos Cave, western Cape Province. At this site, 28 bone tools (Fig. 3) were recovered from securely dated ca. 77,000-year-old Middle Stone Age levels (Henshilwood *et al.*, 2002) during 1992–2000. The key issue is whether any of the bone tools recorded in MSA layers could have derived from the <2000 B.P. LSA levels and vice versa. Given the rarity of bone tools in MSA contexts and the presence of LSA deposits in Blombos Cave, it was necessary to establish firmly the provenience of the MSA bone tools (also see Klein, 2000, p. 29). Five independent lines of evidence were considered: stratigraphic integrity, the distribution of key finds, chemical testing, the stratigraphic distribution of the tools, and the size of the LSA and MSA tools. The published results of this in-depth study clearly demonstrate that the MSA bone tools derive from the >70,000-year levels and are not intrusive (Henshilwood *et al.*, 2001b, pp. 638–642).

At the rear of the cave in Square E2 (1 sq. m out of 29 sq. m excavated), the sterile aeolian sand that separates the MSA and LSA levels

(BBC HIATUS) phase is thinnest (ca. 5 cm) (see Henshilwood *et al.*, 2001a,b). In this square, some fragments of well-preserved charcoal have penetrated as much as 30 cm into MSA levels. This was an unusual find as charcoals in the MSA levels at Blombos Cave are mostly poorly preserved because of the antiquity and alkaline nature of these sediments. Four charcoal samples from Square E2 are ^{14}C dated to ca. 2000 years (Henshilwood *et al.*, 2001b, p. 637). In one case, this is due to a sample from an LSA layer being mistaken for MSA because of an error with the acronyms. The three remaining dates are statistically identical to dates obtained from the lowermost LSA layer (cf. Henshilwood, 1996; Henshilwood *et al.*, 2001b, p. 637), from which they are probably derived. The most likely reason for the charcoal contamination in this area is a slumped burrow, digging stick hole or post hole. One (SAM-AA No. 8941) of the 28 bone tools recovered from MSA levels comes from Square E2 (Henshilwood *et al.*, 2001b, p. 674). One charcoal piece and five marine shell opercula (*Turbo sarmaticus*) from the same area and depth provide infinite dates of >32,000 years. There is no evidence of LSA-derived artifacts penetrating the MSA in this area (for a fuller explanation see Henshilwood *et al.*, 2001a,b).

Further evidence against migration of LSA artifacts into the MSA levels across the site is given by the recent results of an optically stimulated luminescence dating program (Jacobs *et al.*, in press). Several data-handling processes were applied to dating the sterile sand layer (BBC HIATUS) that separates the MSA and LSA levels, and all of them provided ages with similar precision. In their report, Jacobs *et al.* state that the lack of intrusive young or old grains indicates that this sand layer is not disturbed and confirms the integrity of the underlying MSA levels.

Detailed analyses show that MSA bone tool production methods follow a sequence of deliberate technical choices, starting with blank production, the use of various shaping methods, and the final finishing of the artifacts to produce "awls" and "projectile points." Tool production processes conform to generally accepted descriptions of "formal" techniques of bone tool manufacture (Klein, 1999, p. 344). Comparisons with similar bone tools from the Later Stone Age at Blombos Cave, other Cape sites, and ethnographic contexts show that although shaping methods differ, the planning and execution of bone tool manufacture in the Middle Stone Age is consistent with that in the late Holocene.

Although the majority of Blombos Cave tools are awls marginally modified by scraping, three points finished with careful polishing after being shaped by scraping are probably projectile points made for hafting. The different treatment of tools for different functions is noteworthy. It is unlikely this final polish was applied as a practical shaping technique, as it does not produce any significant change in the point morphology. This deliberate behavior has no apparent functional reason and rather seems a technique used to give a distinctive appearance or an "added value" to this category of artifacts. The differences in the manufacturing techniques between the Blombos Cave MSA projectile points, probably used for hunting, and awls used domestically, may well reflect the different social and possibly symbolic value of these activities (see Wiessner, 1983). In other words, the differences in the technical procedures are probable indices of the different social roles of the users and of clearly distinct contexts of use of the two tool categories. It is logical to believe that in order to be passed from generation to generation, this difference in tool manufacturing must have been linguistically transmitted. Only a modern language, with its corollary of symbolic implications, can transmit a finishing technique that results in almost imperceptible difference in appearance, to create meaning.

THE ORIGIN OF SYMBOLISM

Depictions or abstract representations and personal ornaments are generally accepted as archaeological expressions of modern cognitive abilities, and evidence for the acquisition of articulate oral language (Aiello, 1998; Davidson and Noble, 1989; Deacon, 1997; Mellars, 1996a,b, 1998; Noble and Davidson, 1991; Stringer and Gamble, 1993). These behaviors are commonly recorded at European sites dated to between ca. 35,000 and 10,000 years. It is a matter of debate whether convincing archaeological evidence exists for an earlier origin. Some models link these behavioral innovations to a "revolution" in AMH, taking place in Europe at around 40,000 years and coinciding with the first arrival of our species in this region (Bar-Yosef, 1998; Mellars, 1973, 1996a,b, 1999; Stringer and Gamble, 1993). Others speculate that the changes resulted from a rapid biological change that would have produced no visible change in neuroanatomy and took place, probably among African AMH, at ca. 50,000 years (Klein, 2000). Others suggest a much earlier and possibly more gradual evolution toward such "modern" behavior (Barham 1998, 2000, 2002; Henshilwood *et al.*, 2001a,b, 2002; Knight *et al.,* 1995; McBrearty and Brooks, 2000). In the last case, symbolism might have developed in Africa, in conjunction with the gradual biological evolution of our species. Yet other scholars believe that symbolism and cultural modernity may have even been independently developed or acquired at different times, and by a range of hominids, including Neandertals (d'Errico *et al.* 1998c; Zilhão and d'Errico, 1999a,b).

Research conducted in the last few years by several components of our team has, we believe, significantly contributed to gaining an insight into the emergence of behaviors generally considered as peculiar to our species. A primary problem when examining evidence for "modern" behavior is the criteria used for assessing markers interpreted as "symbolic." In particular, how is a distinction made between potentially symbolic objects deliberately crafted by humans from those produced by functional activities or natural processes? Proponents of gradualism find support in evidence such as ocher or hematite use, collection and transport of crystals and fossils, and perforated and engraved portable objects of stone and bone found in several Lower and Middle Paleolithic sites in Europe, Africa, and Asia. There is, however, no consensus on the nature and the significance of this evidence, especially from European sites. Some scholars, (Bahn, 1996; Bednarik, 1995; Marshack, 1976) have claimed that traces of symbolic behavior can be found at earlier times in Europe at sites associated with Early Neandertals and pre-Neandertal hominids. It is difficult to accept the validity of these claims because the human manufacture, intentional nature, and symbolic or functional significance of many objects are yet to be ascertained. It is then important to distinguish between objects whose anthropogenic origin is verified through detailed examination using microscopic techniques, actualistic data, replicative experiments, and those objects that remain unexamined.

In the last few years, we have examined materials considered by some to exhibit the attributes of behavioral modernity, but many of these objects must be rejected because of modification by natural processes. In a paper analyzing putative symbolic objects from Lower and Middle Paleolithic sites of Europe, d'Errico and Villa (1997) have shown that some pieces interpreted as engraved or perforated bones from sites such as Pech de l'Azé II, Stránska Skála, Kulna, Bois Roche, and Cueva Morin are not early manifestations of non-utilitarian behavior. Putative engravings are in some cases vascular grooves, while perforated pieces are partially digested bones regurgitated by hyenas. We do not refute in this paper the possibility of non-utilitarian or symbolic behavior in the Lower and Middle Paleolithic, but show that a number of pieces have been misinterpreted, and cannot be used as evidence in favor of the emergence of symbolic behavior in early times. This survey was, however, limited to only one category of possible symbolic behavior. Several stone objects, reported from Lower and Middle Paleolithic sites from Europe and the Near East (Bilzingsleben, Tata, Bacho Kiro, Temnata, Quneitra, Qafzeh) might well, on the basis of published photos, bear deliberate engravings.

In this context, the Middle Paleolithic site of Molodova I in the Ukraine is important because it is one of the sites where claims have been made for possible symbolic behavior among Neandertals (Chernysh 1982, pp. 53–65). In total, there are between 2000 and 3000 faunal fragments, mostly mammoth, from Molodova I, Level IV. This level also boasts large mammoth bone circles thought by Ukranian scholars (Chernysh, 1982) to represent the foundation of habitation structures, but alternatively interpreted as resulting from slopewash or other taphonomic processes (Hoffecker 2002, p. 107; Klein, 1999, p. 447), tent rings (Klein, 1999, p. 447), hunting blinds (Binford, 1983, p. 129), windbreaks (Hoffecker, 2002, p. 107), nest-like living areas (Stringer and Gamble, 1993, p. 207), or centrifugal living structures (Kolen, 1999, pp. 153–157).

Of the 3000 faunal remains, 300 have been identified as bearing traces of hominid activity. While d'Errico and Nowell's research on this material is ongoing, it is clear that most, if not all, of the cases of purportedly engraved and incised pieces can be attributed to natural causes such as blood vessel grooves, carnivore gnawing and scoring, and postdepositional damage, including damage incurred during excavation.

The systematic use of pigment for decoration is generally considered evidence of symbolic thinking and a hallmark of behavioral modernity. In recent years, the observed increase in the numbers of ocher pieces from African MSA sites (e.g. >8000 pieces from Blombos Cave) has been used, along with other discerned changes in hominid lifestyle, to support the hypothesis that modern cognitive abilities gradually arose in Africa, in conjunction with the biological changes that mark the origin of our species. Although pigments, mostly manganese dioxides, are reported from at least 40 Mousterian sites in Europe, little is known about pigment use by Neandertals. d'Errico and Soressi's analysis of the unpublished collection of 450 specimens of pigment found by F. Bordes at the Mousterian/Acheulean Tradition site of Pech-de-l'Azé I demonstrates that Neandertal use of black pigment does not differ significantly from that known from MSA sites (d'Errico and Soressi, 2002). The majority of these pigments clearly bear modification and use traces, namely scraping marks and, more frequently, single or multiple facets produced by rubbing against a soft material. Some pieces appear intentionally shaped into pointed crayons. Microscopic analysis of the worn tips and experimental reproduction of these traces suggest that they were used to draw linear designs. Two of the pieces bear an engraved abstract pattern produced with a stone point. In sum, early pigment use is not a feature specific to early AMH, and Neandertal production of pigment seems to contradict the popular single species model for the origin of behavioral modernity. Further, only tenuous traces of complex behavior, anticipating the Upper Paleolithic, seem to occur in Europe before OIS 3. Evidence in favor of the gradual acquisition of modern technical and cognitive abilities from the Lower Paleolithic onward remains limited. Much work remains to be done on Bilzingsleben and other material to verify the validity of claims of artistic engravings before OIS 3—that is, the end of the Middle Pleistocene and the first part of the Upper Pleistocene. On the basis of present evidence, the hypothesis of separate but converging cultural trajectories for archaic hominids in Europe and anatomically modern *Homo sapiens* before the Middle/Upper Paleolithic transition is not proven, but cannot be rejected.

The Near East Evidence

An increasing number of scholars (Ambrose, 2001; Deacon, 1993; Henshilwood *et al*., 2001a,b, 2002; Henshilwood and Sealy, 1997; McBrearty and Brooks, 2000) suggest that symbolic cultures were first developed by AMH in Africa. Thus, the appearance of these behaviors in Eurasia would be the result of the out-of-Africa dispersal of modern populations into the near East at an early time (during OIS 5), with subsequent migrations into Europe about 40 thousand years ago (during OIS 3), accompanied by extinction and total replacement of Neandertal populations.

This hypothesis appears to be supported by the widespread use of ocher in various MSA sites in sub-Saharan Africa (prior to OIS 3), such as Klasies River and Apollo 11 and by the new discovery of engraved bone and ocher pieces at Blombos Cave (d'Errico *et al*., 2001; Henshilwood *et al*., 2002). Comparable, although very limited evidence from the Near East includes the enigmatic Berekhat Ram figurine, an engraved cortex from Qafzeh (Fig. 4), and perforated and ocherd marine shells from this same site, found in deposits associated with burials of AMH. At Quneitra, a similar engraved cortex (Fig. 4) comes from a Mousterian open air site. The Berekhat Ram figurine (Goren-Inbar, 1986) is an artifact made from a basaltic lapillus tuff incorporating scoria clasts and measures 35 mm in length. As its morphology is vaguely reminiscent of a female figure, the assumption has been that a hominid incised the piece to enhance its natural "female" features, thus producing a figurine. Dated to approximately 233,000 B.P., this "figurine" would be the oldest known example of representational art and thus symbolism. Volcanic materials, however, can take on a variety of forms during the processes of eruption and cooling, thus calling the object's anthropogenic nature into question (Noble and Davidson, 1996, p. 75; Pelcin, 1994). A recent study based on optical and scanning electron microscopy and experimental reproduction of the object's grooves and abrasions demonstrates that this artifact was purposely modified by hominids (d'Errico and Nowell, 2000). Whether or not it is truly a figurine, however, remains an open question, although arguments have been made for its having a non-utilitarian purpose. Other artifacts from Israel include an engraved cortex, and perforated and ocher marine shells from the site of Qafzeh, associated with burials of AMH. They date to between 90,000 and 100,000 B.P. The Qafzeh piece is a broken Levallois core measuring 6.2 cm in maximum length, with its cortical face marked with incised lines. While the lack of patterning in these lines makes

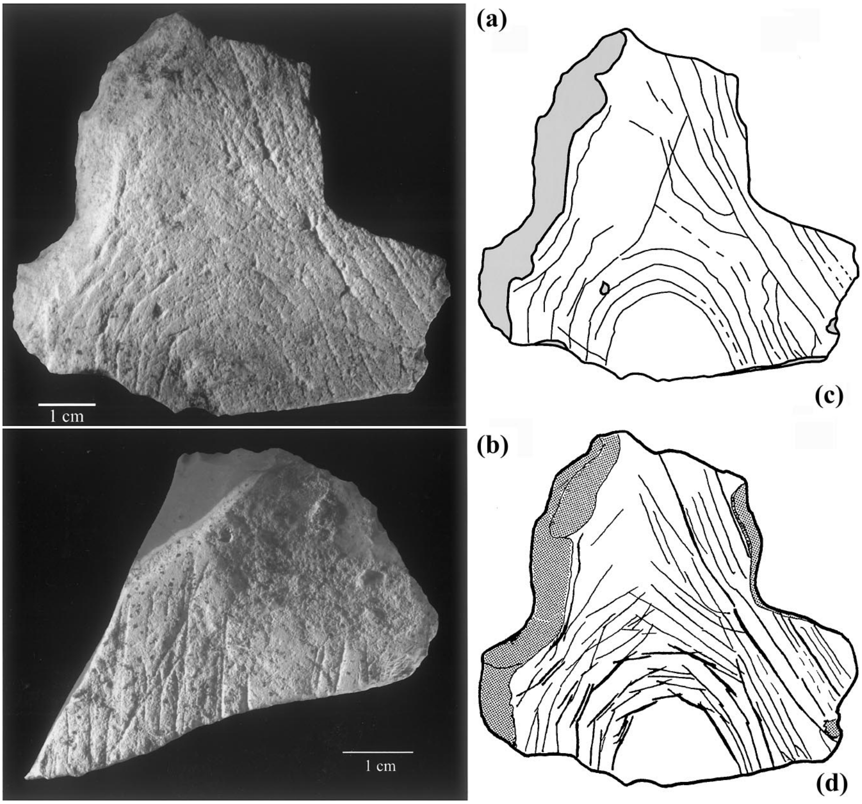

Fig. 4. Engraved cortex from Quneitra (a) and Qafzeh (b). Tracing of the engraved pattern on the Quneitra fragment as established by d'Errico and Nowell (c) and by Marschack (d).

it difficult to determine whether it can be taken as evidence of symbolic use, the lines are inconsistent with trampling and gnawing (Hovers *et al.*, 1997). Furthermore, many of the lines are shorter than one would expect. Cutmarks produced through experimental butchering and experimental work on cortices suggest that changes in the direction of tool incisions and the presence of curves are not typical of cutmarks. These observations suggest that this "artifact" may be non-utilitarian (Nowell *et al.*, 2001). A similarly engraved cortex comes from the site of Quneitra dating to 50,000 B.P. (Goren-Inbar 1990). Although a recent reanalysis of this engraving (Nowell *et al.*, 2001) suggests that the original drawing of this piece (Marshack, 1995) is flawed, it also demonstrates that it is an intentional engraving. We do not know, however, if the hominids responsible for this artifact from Quneitra were Neandertals or AMH.

The Cognitive Abilities of Neandertals and Their Putative Acculturation

Most researchers doubt that Neandertals and AMH shared sophisticated behaviors, such as symbolism or complex techniques of bone and ivory manufacture. Neandertals have long been seen as scavengers or opportunistic hunters, mired in primitive technical traditions impervious to innovation. In the last few years, however, new studies have begun to cast a different light on the intellectual abilities of these ancients and on the chronology of their contact with the first modern human groups colonizing Europe. It has generally been taken for granted that the first arrival in the far-West of Europe of AMH moving from the East took place ca. 40,000 years ago. These direct ancestors of ours, utilizing a typical lithic and bone technology called Aurignacian, would have triggered, through imitation or acculturation, the appearance of a new lithic technology, of ornaments, decorated objects, and bone tools among some late Neandertal groups—a phenomenon best exemplified by the Châtelperronian artifacts found in some French and Spanish sites. The manufacture itself of personal ornaments and bone tools by Neandertals is considered controversial. Many researchers credited the presence of such objects in the Châtelperronian layers of sites such as the Grotte du Renne, to a reworking of archaeological layers, incorporating Aurignacian artifacts, or to the collection of objects by Neandertals that were manufactured by neighboring moderns. At best, they were attributed to Neandertals trading with the latter.

In a recent reassessment of the evidence (d'Errico *et al.*, 1998c; Zilhão, 2001; Zilhão and d'Errico, 1999a,b), we have shown that Châtelperronian Neandertals *were* the makers of a wealth of personal ornaments and bone tools found at Grotte du Renne, as demonstrated by the presence, in the same layers, of items that could be refitted and the by-products of the manufacture of these objects. Neandertal authorship is also demonstrated at other French sites such as Quinçay (Charente region) where late Neandertals perforated teeth using techniques different from those used by Aurignacian AMH. This study is now further supported by bone awls found in the Châtelperronian and Aurignacian levels of the Grotte du Renne (d'Errico *et al.*, in press). The studied assemblage consists of 50 Châtelperronian and nine Aurignacian awls, all well preserved (Fig. 5). If the bone tools in the Châtelperronian layers had originated in the overlying Aurignacian level, we would expect to see their number decline with depth, but the opposite is true. The lowest of the three Châtelperronian layers yielded four times the number of awls found in the Aurignacian horizons of the site. The tools from the two cultural horizons show a different spatial distribution that is, in turn, similar to that observed for diagnostic Châtelperronian and Aurignacian finds in the two horizons. In the Châtelperronian layers, most of the bone tools are

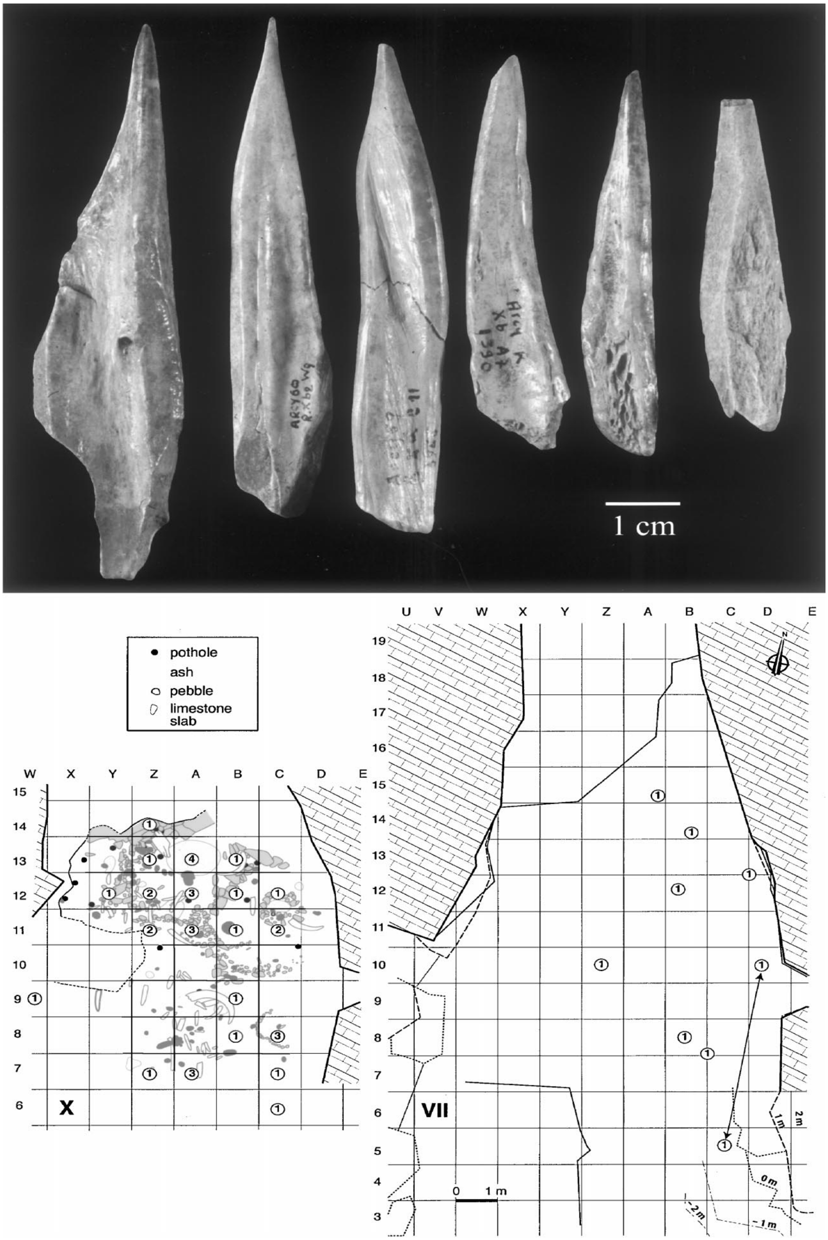

Fig. 5. Top: Bone awls from the Chatelperronian levels of Grotte du Renne, Arcy-sur-Cure. Bottom: density per square metre of awls from the richest Chatelperronian level (left) and the Aurignacian level (right).

concentrated inside a circle of stone located in the northwest of the excavated area, while the few Aurignacian awls were found in the southeast of the excavated area (Fig. 5). This contradicts the hypothesis that the presence of bone tools in the Châtelperronian levels is the result of a reworking of sediments. These tools also differ in the technology of their production and in the type of decoration from those found in the Aurignacian levels. Awls, in both assemblages, are made from horse-, reindeer-, and carnivore-limb bones. Common features in the choice of blanks includes the use of naturally pointed bone, such as horse metapodials, shaft fragments from the breaking of long bones for marrow extraction, and elongated proximal fragments, probably obtained by longitudinally splitting metapodials and radii. However, the Châtelperronian awls show a more varied repertoire of blank types (e.g. use of carnivore-fibulae and massive epiphyseal fragments obtained through fracture), methods of blank production, and degrees of shaping.

Nine Châtelperronian tools are marked with up to four sets of notches or sets of V-shaped incisions, while only one Aurignacian piece bears a decoration consisting of a set of crosses. Comparative microscopic analysis of archaeological and experimental tools indicates that the Châtelperronian awls were intensively used to perform hundreds, if not thousands, of perforations on a variety of soft materials, such as different types of skins. Worn tools were resharpened using a unique technique that consisted of rubbing the point on a grinding stone to produce a tiny awl fragment that could be reused until worn out. The fragility of some tips suggests the piercing of thin skins and furs to produce clothes. This seems to indicate that the production and use of bone tools by late Neandertals was not random, but rather represents an integral aspect of their technological knowledge. Results of this study also suggest that the bone tools reflect time-consuming and planned indoor activity. The presence of deliberate decoration suggests that symbolism played a role in all aspects, even the more domestic aspects of group life, rather than being restricted to a few objects obtained through exchange.

The hypothesis that these innovations are the product of imitation precipitated by cultural contact with newly-arrived AMH is challenged by a recent reanalysis of the evidence (Zilhão and d'Errico, 1999a,b, in press). On the basis of new knapping techniques and tool types, late Neandertal technologies from different European regions show no apparent affinities with those introduced into Europe by AMH. Rather, these technologies appear to be the result of an autonomous development of local traditions. The chronological precedence of the Aurignacian over these regional Neandertal entities, which has been interpreted as the outcome of prolonged contact, is also called into question. Reanalysis of archaeological sequences where these cultures are represented reveals that, apart from a few debatable instances of interstratification between Aurignacian and Châtelperronian, wherever archaeological layers of both cultures are represented at the same site, the Châtelperronian always underlies the Aurignacian, thus suggesting an earlier date for this industry. Similarly, consideration of all the radiometric dates (around 2500) available for this period in Europe and the Near East shows that wherever the dated sample context is well established, the earliest occurrences of the Aurignacian date to no earlier than ca. 37,000 BP—a period during which Neandertals were already developing their own transition to modernity. In others words, there is no doubt that the Châtelperronian, as with other late Neandertal cultures, emerged, at least in western Europe, before any AMH became established in the same or neighboring areas. This autonomous development may have included the manufacture and use of symbolic objects, created for ornamental display on the body and reflecting, as is often observed in traditional societies, different social roles. The alternative hypothesis that we have proposed (d'Errico *et al,*. 1998c) is that it was precisely the new conditions resulting from contact between very different peoples, and the consequent problems of personal, social, and biological identity, that may have ignited an explosion in the production of symbolic objects in both groups.

Burials

A reappraisal of the oldest known funerary practices is crucial for proposing a reliable scenario for the origin of symbolism and language. Primary burials are regarded by many researchers to be proof of symbolism. However, the intentional character and symbolic significance of burials prior to 30,000 years, especially those of Neandertals, has been the subject of intense debate over the past decades (Davidson and Noble, 1989; Gargett, 1989, 1999; Noble and Davidson, 1996; Stringer and Gamble, 1993). To establish the intentional character of the oldest known burials, new analyses of the available original excavation records, direct studies of the hominid remains and the grave goods, as well as comparison with more recent burials (see Belfer-Cohen and Hovers, 1992; Tillier 1995), in particular those from the Upper Paleolithic, are needed.

Methods based on taphonomic field observations (called in France *l'anthropologie de terrain*) have been developed (Duday, 1978, 1995; Duday *et al.*, 1990) to reach a better understanding of inhumation practices and postdepositional processes affecting skeletal remains. These methods also provide a means for assessing the deliberate nature of burials. Unpublished and largely unexplored data on the archaeological context of Middle Paleolithic burials do exist and may be used to verify old, or to propose new interpretations of possible burials excavated in the past (e.g. Maureille and Van Peer, 1998; Tillier *et al.*, 1991). Burial of the dead is in all traditional societies a complex symbolic activity (GVEP, 1995). It is difficult to imagine that a human group could excavate a grave, position the corpse in the pit, and offer funerary goods with no form of verbal exchange. Language in such situations helps organize the rituals, transmit custom, and express emotion.

We believe that there is enough evidence to suggest a well organized and very ancient funerary tradition among Near Eastern and European Neandertals. Careful reading of Peyrony's publications (1921, 1930, 1934) and notes indicate that several individuals were buried at La Ferrassie rock-shelter, including a foetus. This last skeleton was found in a pit, with three flint flakes, possibly a gift, at the surface of the pit. The fact that they took care of such a young individual seems indicative of human emotion, and certainly a high degree of social discourse, which is difficult to conceive without the existence of a complex language. It is notable that, in modern human societies, with our complex and diversified systems of communication, we do not always bury foetuses. At La Ferrassie a piece of rock lay in grave 6, which contained the remains of a 3-year-old child without its skull. On the side of the rock facing the soil surface, the excavators discovered approximately 20 small pits. A recent study shows that these pits were made by a stone tool (Lorblanchet, 1999). While the meaning of these objects remains unknown; such behavior suggests symbolic action. The interest of the reappraisal of old evidence has been recently demonstrated by the rediscovery of the Moustier 2 Neandertal neonate (Fig. 6), found by Peyrony in 1914 (Maureille, 2002a). Since two bones of this individual were erroneously associated to La Ferrassie LF4 burial, this rediscovery eliminates from the

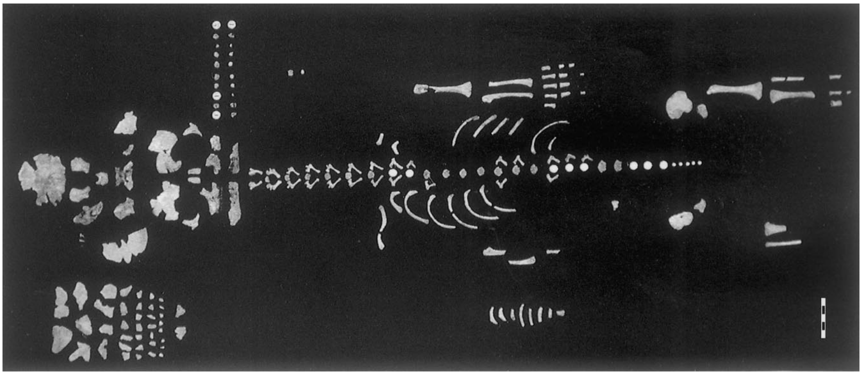

Fig. 6. The neonatal skeleton Le Moustier 2. The fragment representing the lateral part of the right clavicle is in fact the sternal extremity of the left first rib (photo Ph. Jugie, collection and copyright Musée National de Préhistoire, Les Eyzies-de-Tayac).

literature the only known example of a Neandertal double burial (Maureille, 2002a,b). Considering that mortuary practices involving inhumations of single individuals are widespread among modern and ethnographic societies, this observation cannot be used to deny the symbolic character of Neandertal burials.

Dating of anciently discovered burials also provides results relevant to this debate. TL dating of Tabun layer C at 170,000 years (Mercier *et al.*, 2000) seems to indicate that the Neandertal burial found in this layer by Garrod predates the oldest known early AMH burial found at Qafzeh, or is, at least (Grün and Stringer, 2000; McDermott, *et al.*, 1993), contemporaneous with the latter. If this skeleton is indeed associated with level C and not the still undated level B, as recently envisaged by Bar-Yosef and Callander (1999), the new TL dates would clearly contradict the interpretation of the Near East Neandertal burials as the result of acculturation by neighbouring AMH. If we discard this evidence and adopt a conservative view, the oldest known AMH primary burials are dated to ca. 100,000 years and found in the Near East; the oldest Neandertal burials are dated in Europe and in the Near East to ca. 70,000 years. This, however, does not mean that we know which human type first buried their dead and when this happened since, as demonstrated by the Tabun debate, chronological attributions may fluctuate considerably according to dating methods and new discoveries. And our knowledge on burial practices after these putative chronological hallmarks is still quite incomplete. Apart from the burials from Nazlet Khater (Vermeersch *et al.*, 1984) and, perhaps, Qena, Egypt (Vermeersch *et al.*, 1998), no burials of AMH are known that date between 90,000 and ca. 30,000 years. Little is known about funerary practices during the Middle–Upper Paleolithic transition. Available data on the concentration of human remains from Saint-Césaire is insufficient to support the hypothesis of a deliberate burial (Vandermeersch, 1993, 1995). Also few primary burials are known for the very beginning of the Upper Paleolithic and none is dated before 32,000 BP (Gambier, 1989, 1990, 1997, 2000; Gambier *et al.*, 2000; Henry-Gambier, 2002; Pettitt and Trinkaus, 2000; Richards *et al.*, 2001).

Language Capacities and Neandertal Skeletal Morphology

The capacity for complex language has often been linked to modern human origins. As stated by Cavalli-Sforza and colleagues (1988, p. 6006), " . . . it also makes it easier to understand the rapid disappearance of Neandertals, if they were biologically capable of speech of a more modest quality than modern humans." Neandertal skull morphology and, in particular, the shape of the basicranium have been long used to suggest that Neandertals did have limited linguistic capacities (Laitman *et al.*, 1975). The angle of the styloid processes, an adduced basicranial flatness, the shortness of the neck and the lack of cervical lordosis, the anteroposterior distance between the cervical vertebral column and the mandible, and mandibular anatomy (presence of a geni fossa) are among the features used to argue for the lack of fully modern development in the Neandertal vocal tract.

Most of the anatomical arguments used in favor of Neandertal limited linguistic abilities have been questioned by authors who observed, amongst other things, the imperfection of the neck reconstruction of La Chapelle-aux-Saints Neandertals (Arambourg, 1955; Stewart, 1962; Strauss and Cave, 1957), the irrelevance of basicranial shape in vocal tract reconstruction (Fitch, 2000), and the lack of fossil evidence to support the notion of a differing neural development between Neandertals and early modern humans (Holloway, 1983, 1985).

Authors who argue for the limited linguistic capabilities of Neandertals, vis à vis AMH, base their data on the incorrect reconstruction of the Neandertal neck, as well as basicranial flatness (Laitman and Reidenberg, 1988; Lieberman and Crelin, 1973). According to these authors, the larynx in Neandertals was in a high position, similar to that of nonhuman primates or that of human children before the age of full vocalization. The discovery of the Kebara 2 skeleton in Israel provided new evidence pertaining to the evolution of speech, as it allowed the reconstruction of the vocal tract with certainty (Arensburg *et al.*, 1989, 1990, 1992; Houghton, 1993). The hyoid bone (Fig. 7) was found to be metrically and morphologically within the range of variation of all recent humans. The muscular imprints indicative of the position of the hyoid bone in relation to the mandible (e.g. mylohyoid, geniohyoid, digastric muscles) permitted the placement of the Kebara bones in their natural physiological position, and this showed that the inferior border of the mandible and the body of the hyoid were at the level of the fourth cervical vertebra. The height of the mandibular ramus and that of all the cervical vertebral bodies in Kebara 2, together with a normal cervical lordosis, corroborate the low position of the laryngeal vocal tract. The interpretation of this discovery provoked intense disagreement among scholars who contended that Middle Paleolithic hominids, including Neandertals, were limited in their speech capabilities (Davidson and Noble, 1989; Laitman *et al.,* 1992; Lieberman, 1990; Noble and Davidson, 1991) and those who considered that this group possessed full linguistic faculties (Arensburg, 1994; Arensburg *et al.*, 1990; Bresson, 1992; Schepartz 1993; Tillier and Arensburg, 2000). Interestingly, observations made by those who supported Neandertal linguistic capacity have been reevaluated and confirmed by recent studies (Lieberman and McCarthy, 1999).

The large size of the bones of the mouth, mandible, and palate of the Neandertals has been used as an argument against the possibility of

Fig. 7. Hyoid bone from the Kebara Neandertal burial. Scale = 1 cm.

articulated speech (Lieberman *et al.*, 1972). A number of AMH from Qafzeh and Skhul, however, have mouths similar or larger in size than most Neandertals (Maureille, 1994), but no scholar has denied them the ability of speech on these grounds. When indices rather than measurements are used to account for bone morphology (e.g. the ratio of breadth/height of the palate), no significant differences between Neandertals and AMH are observed. (Maureille, 1994).

Another morphological issue that has implications for the language debate is that of the evolution of the speech organs. Kay *et al.* (1998) have measured the size of the hypoglossal nerve groove, the main nerve controlling the tongue, and found that the size of that groove in the Neandertal cranium was comparable to AMH, and concluded that the movements of the tongue were the same (i.e. numerous, varied and fast). Since this study, however, another team from Berkeley (De Gusta *et al.*, 1999) has carried out a comparative study of the same groove in great apes as well as living and extinct hominids, and reached the conclusion that the size of the groove is not related to the size of the hypoglossal nerve itself.

In sum, we can now consider it a fact, and not a hypothesis, that the Neandertal larynx was situated low in the throat, as in *Homo sapiens sapiens*. This has two important consequences: (1) the Neandertal tongue was able to make a wide range of movements, because its base is located deep in the neck (this is a normal consequence of a bipedal stance—unlike all the other great apes), and (2) the Neandertal soft palate was sufficiently separated from the epiglottis to allow laryngeal air into the buccal cavity. This implies that the bony anatomy of the Neandertals did not prevent them from producing phonemes for articulate speech and there is, at present, no anatomical support for the hypothesis that there was a significant change in language abilities with the emergence of Anatomically Modern Humans.

We may even wonder whether anatomical differences, if detected, may really tell us anything about differences in speech abilities. Considering the phylogenetic position of the Neandertals in the human lineage, it is highly likely that their vocal tract was able to produce a wide range of phonemes. However, it is the articulation of these phonemes, rather than phonation itself, which is probably the crucial issue. Phonation is not peculiar to humans. It consists of producing an amplified sound when the breath crosses the larynx and the pharynx, which act as resonators. Study of the phonation capacities of fossil species in fact provides information on the pitch and quality of the sound rather than on speech. In contrast, the articulation of phonemes is a uniquely human capacity. It is the ability to utilize different phonemes that are easy to differentiate from each other, and to combine them to produce comprehensible sentences that communicate specific meaning.

Phoneme articulation in a linguistic fashion is fully related to the organization of the brain and the nervous system. Unfortunately, information on the morphology and physiology of these organs in fossil populations is scant. We have few natural casts of human fossil brains (e.g. that of Ganocve for the Neandertals) with which to study imprints of cerebral vessels (arteries, veins), nerves, and cerebral lobes on the cranial vault (Bookstein *et al.*, 1999; Semendeferi and Damasio, 2000). The study of aphasia (Jakobson, 1980a,b) helped locate the main brain areas involved in language production. Because the destruction of Broca's and Wernicke's areas of the cortex, both located in the left hemisphere, produces aphasia, it was concluded that speech involves only the left hemisphere. We know now that the asymmetry of the two hemispheres is related both to language and to the preferential use of the right or the left hand. This asymmetry is already present in fossils of early *Homo* (Aiello and Dean, 1990; Deacon, 1992; Tobias, 1987), and common in Neandertals. The endocranial cast of the Amud 1 Neandertal, for example, shows a markedly enlarged Broca's area on the left side of the brain (Ogawa *et al.*, 1970), typical of modern right-handed people (Broca, 1888; Falk, 1987). Thus, the presence of Broca's and Wernicke's areas on a fossil skull is not sufficient evidence to argue for the existence of articulate speech. One might even speculate that structures morphologically similar to these areas might have existed in the past but were used by the brain for quite different functions. We also know that a complex neurological circuit connects numerous motor, receptor, and associative areas of the two hemispheres. In conclusion, while the presence of Broca's and Wernicke's areas supports the existence of articulate speech, a lack of fossil evidence will continue to hinder definitive answers on this subject.

This is evident when taking into account the range of sounds required for speech. Phonemes are the result of the different transformations undergone by the breath when crossing the vocal apparatus. Phonemes are discrete; that is, they are defined as distinct from others of a given language. In different languages, the same phoneme may be uttered using different movements of the organs of the vocal apparatus. Known languages combine between 10 and 100 phonemes to produce all their words. The number of syllables made by combining phonemes also dramatically differs from language to language. There are 162 in the Hawaiian language, and 23,000 in Thai. A large degree of variability does not affect the number of words produced by these languages or the complexity of the meaning that they are able to transmit. In light of this observation, it is difficult to argue that Neandertal language was less complex or less sophisticated than modern language, even if reconstruction of their vocal apparatus and auditory systems permit the identification of features that demonstrate a functional inability to produce some of the sounds that AMH can produce.

The Origin of Conscious Symbolic Storage

A fundamental turning point in the evolution of human cognitive abilities and cultural transmission was when humans were first able to store concepts with the aid of material symbols and to anchor or even locate memory outside the individual brain. The abstract patterns engraved on pieces of ocher found at Blombos Cave, that we have already mentioned, are indeed among the earliest manifestations of this ability, on which all human cultures are based. The next and equally important step was when humans developed physical devices specifically designed to record, store, and recover information. It is widely accepted that many of these devices were used before the advent of writing as well as after it. Relatively little is known, however, about their origins and early stages of development or about the role played by different types of retrieval systems in human neurological and cultural evolution. The production of such systems clearly demonstrates the use of modern language, because modern language is the only communication system with a 'built-in' metalanguage that allows for the creation of symbolic codes. The oldest possible examples of artificial memory systems consist of objects in bone, antler, and ivory engraved with sequences of marks produced using different techniques. Although most of these objects come from Upper

Paleolithic sites in Europe, this interpretation has also recently been proposed for objects found in African MSA sites, as is the case for the Ishango bones (d'Errico and Vanhaeren, 2000).

It is commonly held that these systems played an important role in the evolution of human cognitive abilities. They denoted, for Leroi-Gourhan (1964–1965), the final expansion of memory when individual brains became incapable of storing and handling all the information required for a functioning society. Changeux (1983) sees an appropriate metaphor for the evolution of the human brain in the initial stages of the development of writing, and considers it to be a turning point in the evolution of humankind—the moment in which images and concepts became more stable than neurons and synapses. For Goonatilake (1991), the use of 'external information systems' represents a major step in the sophistication of information dissemination. In Donald's view (1991), what he terms 'external symbolic storage' represents, from the very beginning, a major factor in human intellectual endeavor upon which the present level of conceptual development referred to as theoretical development is based. For Mithen (1996b) the conscious use of material culture to store information is a fundamental feature of any specialized (domain specific) intelligence. External memory devices demonstrate the emergence of a 'cognitively fluid mind' able to develop powerful metaphors and analogies which, following Kuhn (1979), form the basis of modern scientific thought.

Since the discovery, over a hundred years ago, of sequentially marked bones from the French Upper Paleolithic, archaeologists have proposed a number of hypotheses to explain these markings. They have been interpreted as *marques de chasse* (marks recording the number of prey killed), devices to keep track of songs, or the number of people attending a ceremony, or other notational/calculation systems. Another hypothesis is provided by Alexander Marshack who over the past four decades has examined a number of Paleolithic marked objects. He has interpreted many of these marks as notation systems based on lunar phases (e.g. Marshack, 1964, 1970, 1972a,b,c, 1988, 1991). These interpretations, however, have been repeatedly challenged (Rosenfeld 1972; see also comments in d'Errico, 1989, 1995, 1996; Marshack, 1972a; Robinson, 1992; White, 1982). Marshack has stated that morphological differences between incisions produced by burins were the result of the engraver using different tools at different times. White (1982), however, demonstrated that these morphological differences could alternatively be the result of changes in tool orientation. D'Errico (1989, 1995, 1996) has stressed that Marshack's analytical approach suffers from a lack of objectivity as no attempt is made to base interpretation on experimentally established criteria, and has shown that some technological reconstructions proposed by this author were probably erroneous. Robinson (1992) has rightly argued that Marshack's systematic interpretation of marked objects as observational calendars, produced by adding new marks in order to acquire knowledge of the lunar month, is inconsistent with his other postulation that these devices were the result of a continuous tradition throughout the Upper Paleolithic. Surely, after a pioneering stage, a tradition would be more plausibly expressed by notations created in advance, for which there would have been no need to add marks at different times.

In three recent papers, d'Errico (1995, 1998a, 2002) proposed a theoretical model to describe the variability of artificial memory systems known ethnographically. He has also suggested that a technological analysis of Paleolithic marked objects is essential for discussing their possible interpretation as memory devices, and has experimentally identified a number of clues relevant to these analyses. Initial attempts to apply this composite framework to the study of a selected sample of Upper Paleolithic sequentially marked objects (Fig. 8) led d'Errico to the conclusion that the interpretation of some of them as artificial memory systems was indeed the more plausible (d'Errico, 1991a, 1995, 1998a; d'Errico and Cacho, 1994). These studies have also shown that memory devices using different types of codes were used since the beginning of the Upper Paleolithic and that a continuity exists in the chosen raw material, in the marking techniques, and in the technical skills involved in shaping and marking the objects. The main evolutionary trend observed during this period concerns the amount of stored information and the miniaturization of the marks used to store it. Only at the end of the Upper Paleolithic do we find objects such as those from La Marche, Tossal de la Roca, Taï, Ferrovia, Öküzini, Zigeunerhöhle, on which hundreds of tiny marks are engraved on small surfaces. Microscopic analysis of some of these objects suggest that this is also the moment when complex codes are systematically adopted, based on the hierarchical organization of information, and using formally differentiated marks.

ORIGIN OF MUSICAL TRADITIONS

Musical and quasi-musical behaviors are universal features of our species today. There can be few documented societies, indeed few individuals, for whom musical expression of one kind or another does not play, consciously or unwittingly, a significant role. While in both the developing and the developed worlds, music and dance may take on some of the superficial character of "entertainment," most often it serves either a deeper spiritual purpose, or some more practical or social function: for example, in ceremonies and rituals. The ethnomusicological literature is vast and a general review is

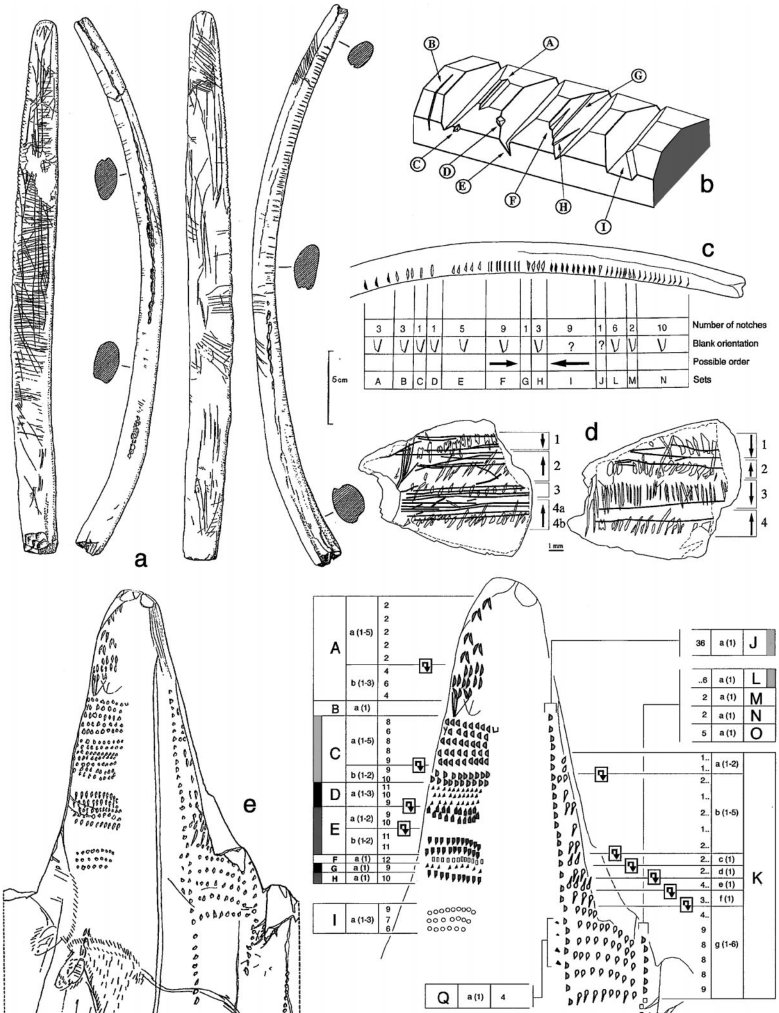

Fig. 8. (a) Engraved rhinoceros rib from the Solutrean levels of Solutré site bearing a sequence of 53 notches. Microscopic analysis of this sequence, based on experimentally established criteria, (b) indicates the presence of 13 sets of notches (c) made by different tools; (d) schematic rendition of the broken pendant from the Epipaleolithic levels of Tossal de la Roca, Valencia, carrying on both sides four sequences of incisions made by different tools; (e) tracing of the marks and of two horses on the Magdalenian antler from La Marche shelter; (f) schematic rendition of the marks. Capital letters indicate groups of marks carved by the same point. Arrows indicate the turning of the object between sub-sets of marks made by the same tool.

beyond the scope of this paper. Nevertheless, music of one kind or another is ubiquitous in the modern world, and exhibits enormous diversity and complexity. These characteristics are amply attested to historically, in both documentary and archaeological records from Late Medieval to Roman and Classical Greek times. This, in itself, seems sufficient encouragement to consider music to be somehow central to earlier human societies. Indeed, even when we look back into protohistorical and still earlier epochs, musical hardware continues to appear both varied in form and at times sophisticated. And wherever such evidence is physically capable of survival it seems to do so, often carrying within it an implication of still more remote antecedence. When stringed instruments—harps and lyres—first appear in Iraq around 5000 years ago, they already possess a sophisticated structure and are in no sense 'primitive' or newly developed. Although students of music's historical archaeology are identifying within such diversity many individual traditions, the nature of tradition per se has so far been assumed rather than explored. Little attention has yet been paid to its wider implications, or to isolating criteria for its detection elsewhere within the archaeological record. Yet it has a considerable bearing on our understanding of connections within and between our most ancient Upper Paleolithic assemblages. Consequently, it has become one of the purposes of this project to identify appropriate criteria from all relevant epochs, and to consider what their application to that earliest material can tell us about the origin of musical traditions: in other words, to identify the earliest connections between design choices, between operational traces in the artifacts themselves, and to establish what continuities of purpose, if any, these may reflect. Determining the origins of music remains a long-standing goal of scholars.

Historical musicologists, culture-historians and anthropologists have, from time to time, attempted to employ various elements of the surviving prehistoric assemblage, in order to support ethnographically based ideas as to where music may have come from, and how it was produced (Sachs, 1929; Schneider, 1957, pp. 5–8). Recently, such speculation has witnessed a revival, stimulated partly by a convergence of interest on the part of cognitive psychologists exploring the evolutionary implications of musical and quasi-musical aptitudes in human ontogeny (Cross, 1999, in press) and partly by the publicity surrounding the Divje Babe "flute" (Turk, 1997; Turk *et al.*, 1995). Although not all contributions to the debate have been fully scientific, the rigorous psychoacoustical approach of Cross (1999, in press) has been productive, yielding potentially testable theoretical models. Most important, in our view, is the suggestion explicit in some of these models (Cross, 1999) of the key role played by ancestral quasi-musical aptitudes in the acquisition by hominids of speech and language, and even deeper aspects of cognitive organization.

Neandertal Musical Traditions?

It is known that a number of natural processes can produce modifications on bone which mimic human manufacture and use. Some of these phenomena (chemical alteration, mechanical abrasion, digestion or gnawing by carnivores and rodents, attack by insects) create perforations (d'Errico and Villa, 1997) or sets of grooves which may be erroneously interpreted as human-made and attributed to the manufacture of musical instruments. As musical traditions often play a major role in symbolic cultures, the assessment of claims for Lower and Middle Paleolithic musical instruments is relevant to the debate on the emergence of modern human cognitive abilities. Numerous perforated animal phalanges, often interpreted as whistles, have been reported from Middle Paleolithic sites (e.g. La Quina, Combe Grenal, Bocksteinschmiede, Prolom II). Chase (1990), however, has convincingly shown, using modern reference data, that these perforations should be interpreted as carnivore punctures, a hypothesis previously put forward by Martin (1907–1910) for the majority of perforated phalanges at La Quina. A long bone shaft with a single perforation, found in the Middle Paleolithic levels of the Haua Fteah, Libya, was published as a broken whistle by McBurney (1967). One of the shaft's broken edges is concave and has been interpreted as the remnant of a second hole, aligned with the first. The complete hole is interpreted as a carnivore puncture by Davidson (1991), who points out the absence of stone tool marks and the morphology of the hole walls, which exhibit depressed margins, a common feature of carnivore punctures. Similarly, the parallel grooves on a mammoth long bone fragment from a Belgian Middle Paleolithic site, interpreted as evidence of use as a skiffle (Huyge, 1990), have been reinterpreted as the result of carnivore damage (d'Errico, 1991b).

A well-known example of a controversial musical instrument is that of the so-called Neandertal flute from Divje Babe Cave in Slovenia, found in the Middle Paleolithic layers of the cave and described by the finders as possibly the oldest musical instrument in the world (Fink, 1996; Turk, 1997; Turk *et al.*, 1995). It has been demonstrated (d'Errico *et al.*, 1998a,b) that holes of the same size, shape, and number as those present on the Divje Babe femur occur on cave bear limb bones from cave bear bone accumulations with no human occupation, and that a number of features described as human-made by the discoverers should more likely be interpreted as the result of carnivore damage (Chase and Nowell, 1998). A further study (d'Errico, 1998b, 2000) involved detailed analysis of the putative flute and of 77 other perforated bones from different levels of Divje Babe and from four other Slovenian cave bear sites. Among these sites, Krizna Jama is of particular interest as it contains a natural cave bear bone assemblage with no traces of human occupation. A number of variables were recorded. The flute and several others bones were submitted to microscopic analysis. The new study confirms the interpretation of the holes as the result of carnivore damage. In 70% of the cases, the holes on perforated bones are associated with damage characteristic of carnivore action, such as pitting and scoring, and in 20% of the cases, bones show counterbite marks in the form of opposing perforations, or perforations opposite to impressions produced by tooth pressure. Seventy-three percent of the perforated bones belong to young bears, as is the case for the putative flute. Holes occur in almost all bones, but they are particularly abundant on limb bones and among them, on femora, the bone on which the purported flute was carved. The presence of two or possibly three perforations on the suggested flute cannot therefore be considered as evidence of human manufacture, as this is a common feature in the studied sample. In the same way, the relatively large size of the holes does not indicate anthropic carving. In fact, the maximum and minimum diameters of the holes on the putative flute are close to the mean value of those of the comparative faunal sample. Moreover, the correlation between the maximum and minimum diameter in this sample indicates a clear tendency towards slightly elongated holes, the same pattern that we observe when measuring the two complete holes of the suggested flute. In the Slovenian sample, 28% of the holes occur in compact bone. The majority of these have only one hole, but bones with two or more holes are also present. Another femur of a young cave bear from the same site shows two holes very similar in size and shape to those on the supposed flute, recorded on the same face and in the same anatomical position. Nonetheless, this object could never have been "playable," as its epiphyses were not completely opened. Microscopic analysis of the putative flute itself confirms the natural origin of the holes. Many traces typical of carnivore action, such as scoring and pitting, were found near the holes and the ends of the bone (Fig. 9). Clear tooth impressions are also present on the face opposite the holes. The distribution of different types of carnivore damage on the bone surface is consistent with the interpretation of the two holes as resulting from carnivore action. A large deep impression found on the anterior face near the proximal end, indicating strong pressure exerted by carnivore teeth, can reasonably be interpreted as the counterbite of the anterior hole. The presence of pitting near the two holes suggests that carnivore teeth touched this area repeatedly. The presence of scoring and pitting at both ends, associated with other traces produced by carnivores, confirms that the bone was heavily damaged by carnivores. In sum, all the evidence suggests that the perforations on the so called Divje Babe "flute," like other damage on the same bone, were produced by nonhuman agents. The most probable agent would appear to be the cave bears themselves; the frequency distribution of the hole diameters recorded in the Slovenian

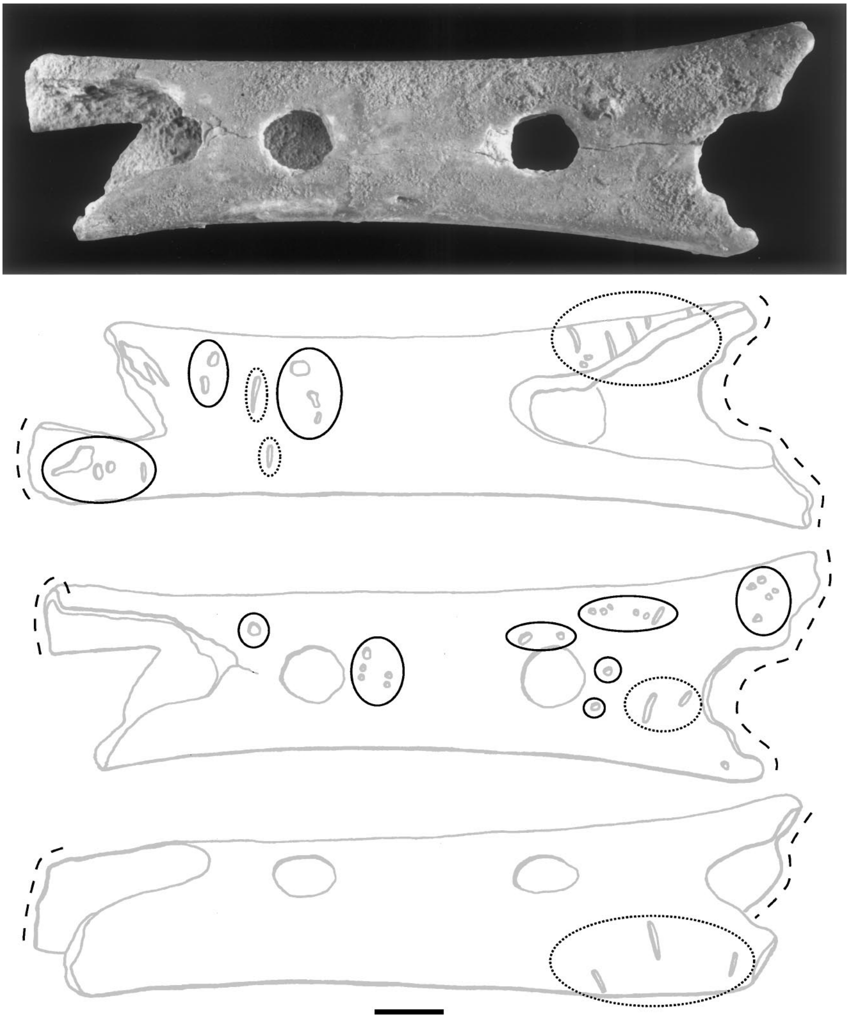

Fig. 9. Femur of a juvenile cave bear from the Mousterian levels of Divje Babe site, interpreted by a number of authors as a musical instrument. Tracings indicate the location of carnivore damage. Plain circles = pitting; dotted circles = scoring; interrupted lines = crenulated morphology and smoothing typical of carnivore gnawing. Scale = 1 cm.

sample is very similar to that observed on sites where cave bear is the only species represented, and we have tangible proof that a cave bear *could* produce large holes in bones with its teeth. Of course, this does not mean that Neandertals were unable to manufacture and play musical instruments. It simply means that we cannot use *this* object to support that hypothesis and that a taphonomic analysis of putative ancient musical instruments is an essential prerequisite to any discussion of their significance for the origin of musical tradition and the evolution of human cognitive abilities.

Upper Paleolithic Pipes

Isturitz Pipes: Form and Function

The Upper Paleolithic is associated with the first unequivocal material evidence for human musical behaviors. Foremost amongst Upper Paleolithic finds are two assemblages of bird-bone pipes from Geissenklösterle, Germany, and Isturitz, France. While the former have recently been dated to ca. 36,000 years, through their association with AMS-dated faunal remains, the latter includes by far the larger sample—more than 20 separate specimens—ranging widely in date from the Aurignacian to the Magdalenian. The Isturitz pipes have, moreover, been the subject of a recent provisional reexamination by Buisson (1990, 1994), who has reunited previously unmatched fragments to reconstruct two nearly complete specimens. They have, therefore, been chosen to be the first to be subjected to detailed examination in a recent study (Lawson and d'Errico, in press).

Since the first pipe 77142(a) [DB 4.1] came to light in Isturitz in 1921, the site has become a frequent port-of-call for archaeologists and historians interested in music, and continues to attract the attention of specialist organologists (Brade, 1975, 1982; Megaw, 1960, p. 8, 1968, p. 335) even when attention has periodically shifted towards other putative sound-related behaviors elsewhere in the archaeological record (Bibikov, 1976, 1981; Lawson *et al.,* 1997; Reznikoff, 1995; Reznikoff and Dauvois, 1988). The aim of our initial investigation was therefore to survey the remains afresh, documenting their surfaces and morphologies using optical microscopic and photometric methods. Special attention was paid to three (Fig. 10 and 11) of the best-preserved and oldest pieces: Buisson's complete four-hole pipe 83888(a)/75252-A3 [DB 2], his near-complete four-hole specimen 86757(a) [DB 5.1] and Isturitz's earliest Aurignacian piece 77142(a) [DB 4.1]. In the Aurignacian piece, the substantial surviving portion includes one finished end and three finger-holes. From the outset we were struck by the pipe's sophistication. Although archaeologists have sometimes been tempted to classify these things as "simple," even "primitive" instruments, close inspection revealed some intriguing musical choices and functional asymmetries. Bearing in mind how very ancient they are, with a date-range currently estimated, for most of them, at between ca. 20,000 and 35,000 years, these seemed remarkably advanced, and clearly justified careful reevaluation. Technical

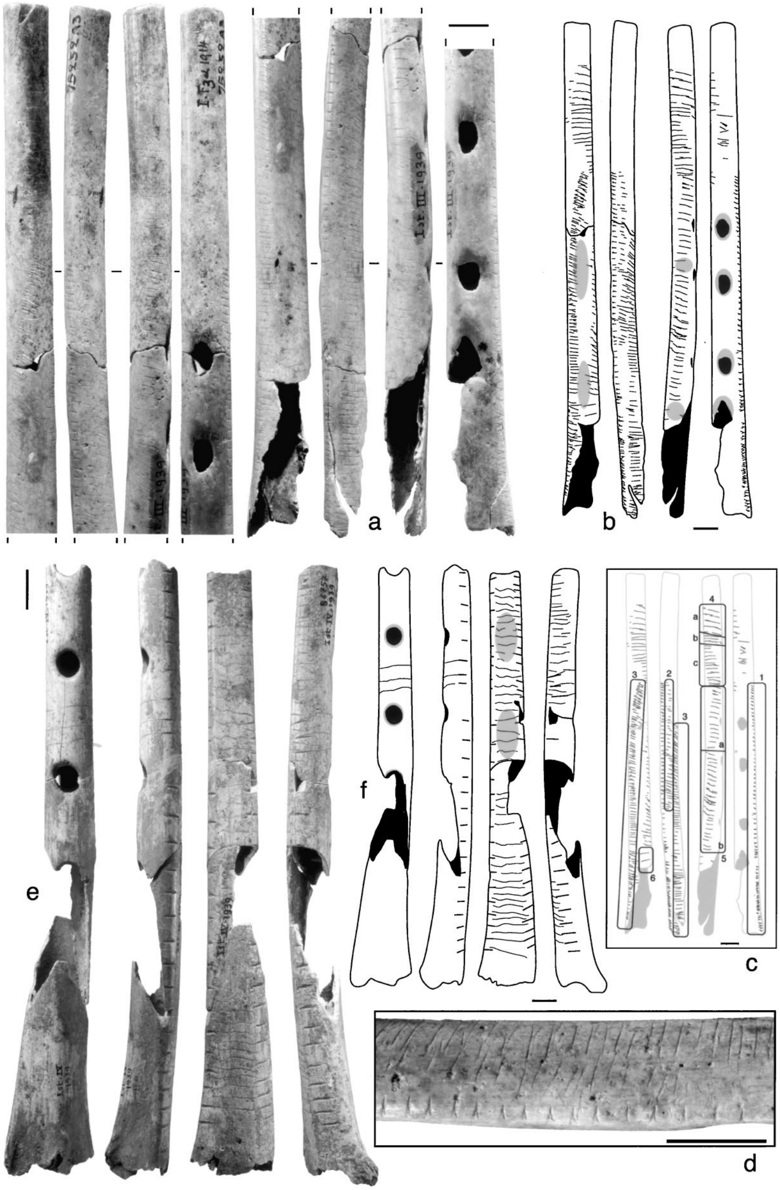

Fig. 10. (a, b, e, f) Photo and tracing of the two most complete pipes from the Gravettian levels of Isturitz Cave. Grey areas around the finger holes and at the rear of the pipe indicate concentrations of polish interpreted as use wear; (c) sketch identifying sets of marks made by different tools; (d) close-up view of sets 1–3. Scale = 1 cm.

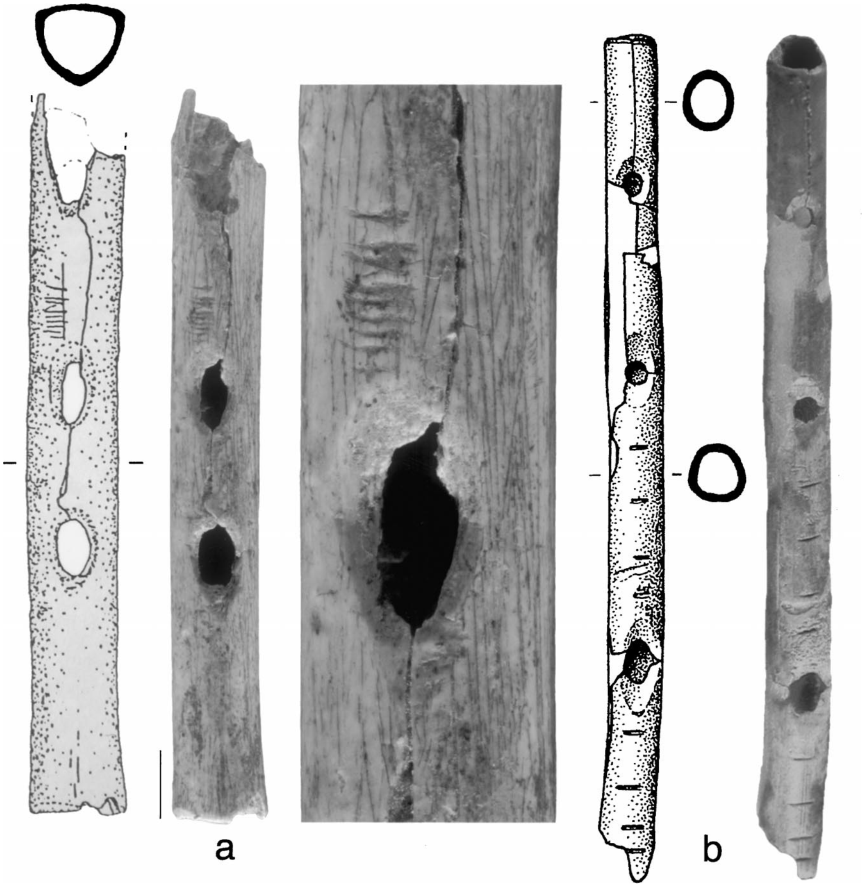

Fig. 11. (a) Bone pipe from Isturitz attributed to the Aurignacian bearing a set of marks close to a finger hole (drawing modified after Buisson, 1990; photos modified after Lawson and d'Errico, in press); (b) bone pipe from the Aurignacian level of Geissenklösterle (drawing after Conard and Bolus, 2003, photo courtesy of Tübingen Institut für Ur- und Frügeschichte). Scale = 1 cm.

inspection revealed, for example, that although they are frequently labeled "flutes" or "whistles" in the literature, this may have been a misnomer, serving only to obscure their true musical character. Instead, they appear rather to be reed- or trumpet-voiced: altogether richer-sounding and with quite different acoustical implications. Moreover, they seem designed to be played two-handed, and in a subtly off-centre playing-position.

Close inspection of the complete pipe, 83888(a)/75252-A3 [DB 2], immediately revealed the first of these curious details. The smooth, rounded form of the rim of the narrow end, representing the distal end of the bone, but probably the proximal (player's mouth) end of the instrument, bore no obvious adaptation to being played as a "flute," which is to say to being voiced by means of a blown jet of air. In particular, it offered no sharp edge to blow against, but suggested instead insertion into the player's mouth, perhaps with the addition of a vibrating reed. The most important result of any such reidentification is twofold. Firstly, it means that, for this reason alone, such pipes could be more sophisticated than we thought, albeit with an important part (the reed itself) absent. Secondly, and unfortunately, it also means that the tuning implications of the finger-hole placements cannot be precisely determined, for in such systems (unlike true flutes) the form and tensile strength of the reed (or lips)—which are unknowable—strongly affect the frequency of each output sound. However, finger-hole placement—at least half of the tuning equation—*is* preserved and from this and other details we may draw some comparisons. Careful examination of the outer finger-hole margins of both Gravettian objects reveals further evidence of adaptation beyond any notional base-level condition. Every hole, for example, has been chamfered (beveled) so as to present a smooth, slightly concave plateau to the fingertip. This is more than just an artifact of the technique used to pierce the hole. It is a device which is very familiar amongst later bone-pipe traditions (indeed, amongst those of bird ulna), including those made using metal blades, where it serves to improve the pneumatic efficiency of the fingertip seal. Such a seal is acoustically essential for the pipe to operate: even a minor leak can cause a major change in the frequency and tone of the output sound.

However, adaptation does not stop at the morphology of the holes; it extends to their precise orientation. All other things being equal, one might expect them to lie (within limits) perpendicular to the pipe's axis. Here instead, each has been given a subtle, yet repeatedly oblique alignment. It could be an unintentional by-product of handedness in manufacture, of course, but if so, it is remarkably consistent, all being rotated clockwise by between about 5° and 15°. Again, such obliquity is very common—and quite deliberate—amongst a variety of later musical traditions, where it is especially associated with high-pressure embouchure and may therefore relate to our proposal, already discussed, of reed- or lip-reed voicing. In such systems, the player's facial muscles must work (and are thus trained) very hard in order to maintain and control an unsupported central embouchure, as any modern student of the oboe can affirm. By positioning the instrument towards the corner of the mouth, instead of at the centre, the player's lips can maintain their pressure-seal with considerably less effort.

Isturitz Pipes: The Markings

Technical analysis of markings on the pipe 83888(a)/75252-A3 reveals that what appears at first to be scratched decoration is in reality an accumulation of sets of marks engraved in different ways, with different tools, motions, spacing and orientation, and with variable accuracy in their alignment (Fig. 10(c)). They involve single-stroke lines made with a point; single- and multiple-stroke notches; complex morphologies obtained by superimposing marks, made using different techniques. Experiments in engraving indicate that the observable changes of tool are not the result of technical need arising from, for example, breakage or the resharpening of its point. Yet, technically speaking, the engraver could have made all the incisions with just one technique, and in one session, producing a more regular and symmetrical pattern. The fact that he or she (or they) did not rather suggests that the sets were engraved at different times, even though the exact time-scale of events remains unclear. Apparently, too, there was no interest in achieving any symmetry in the disposition of sets of marks lying within the same aspect of the bone, or even in their visibility. Some sets are almost invisible to the naked eye. It is also interesting to observe how the engraver seems to pay little attention to keeping the marks equidistant. A clear example of this is Set 1, in which marks are spaced quite evenly in the middle of the bone, but very close to each other near one end, as if the engraver, faced with diminishing space, nevertheless anticipated and attached importance to the completion of a number (or at any rate an accumulation) to be put there. It is clear that these marks cannot simply be interpreted as decoration, created to communicate visually a recognizable, somehow meaningful, symbolic pattern. Rather, they seem to form an accumulation of marks having another quite different purpose. Their variations in placement can hardly be dismissed as a mere symptom of a clumsy motion of technical incompetence, for Isturitz has yielded the best and most numerous collections of Upper Paleolithic art objects. Any hypothesis that they could have been applied to facilitate the handling of the instrument seems contradicted by the fact that the maker has increased the number of marks in an area where there is no obvious need to put a finger. So, could such sequences have served another more elaborate symbolic purpose? Ethnographical examples suggest that they may have. In these examples, when repeated isomorphic markings are made deliberately on objects to create a single unit of meaning (that is, a single sign), rather than use a single mark to represent complex information, this is achieved through the overall appearance of the complete engraving, carefully manipulating the symmetry of the pattern relative to the object's shape and to other groups of marks nearby. Consistency or variation in spacing and orientation of the marks can also contribute to meaning in the pattern achieved, either using the same marking technique and the same tool within a unique session, or by adopting techniques and motions compatible with the execution of the planned design, i.e., techniques that will avoid visual distinction between technical and gestural changes when reading the whole design. In contrast, markings used to store and recover information through time, which is to say artificial memory systems, are not directly intended or required to produce such meaningful patterns, so their marks can vary in distribution, spacing, orientation and dimension, rather more than if they had been created to communicate by these means. If the number of items to be recorded by an artificial memory system is not, or only roughly known at the beginning of an accumulation, spacing cannot be established in order to precisely fill up the available space. Thus, it is possible that by the end of the process marking will occupy only part of this space, that it will have to be continued in a space not originally intended for this purpose, or even that spacing will have to be compressed at one point or another to include all the marks in the space meant for them. If marking is carried out over an extended period it is also conceivable that the object may be lost or damaged before achieving completion (a phenomenon familiar in the manufacture of folk-musical instruments). Both of these latter cases should result in sequences of marks recognizable for a diagnostic lack of uniformity and symmetry in relation to the overall shape of the object or surface. The complete Isturitz pipe 83888(a)/75252-A3 in particular, cannot easily be interpreted as a form of decoration intended to convey a visual message, because of the lack of symmetry (or, indeed, of any obvious internal organization) in its engraved sequences, and because of the clear utilization of different tools. On the other hand, several sets of marks, engraved on both flutes, are difficult at present to distinguish and count individually. In an ideal artificial memory system, of which the code is socially shared (i.e. used by a number of people), and of which each mark records a discrete element of information, it is essential that no ambiguity should exist between the marks. They must be individually recognizable. This is clearly not true of the marks on the Isturitz pipes. Artificial memory system codes must have a certain degree of morphological recognizability to be learned and used without creating ambiguity (as is the case with writing), which is to say without loss of information in the recorded message. Even if these marks were more visible when the instruments were still being used, it is clear that we cannot consider the sets on these two pipes as the expression of a code. However, in a hunter–gatherer society, things may not always be so clear-cut. Thus, codes may have been used in a limited way, possibly only by some members of the group, and so did not need to achieve the level of recognizability as those used for a specific purpose by a large number of people. We may also have in these societies markings which symbolically record or recover certain information attributed to its morpohology, rather than by the actual use of the marks to store a particular piece of information. In such a context, if musical instruments were used by initiates, the act of repeatedly marking the instrument might form part of the actions which distinguished the instrument, its owner or consecutive owners, for example in order to facilitate a particular goal in ceremonies, such as the achievement of a state of trance. In this case, the marking might have both a social and a personal use: its general function may be understood quite differently by noninitiates, who know why its "decoration" is not symmetrical, but who may not have insight into what each set actually means, and by the initiated user who may symbolically link the marking with the use he or she makes of the instrument. In this respect, the clear relationship that we have identified between the marks and the positioning of the finger holes appears relevant.

If the act of symbolically marking the instrument was in some way related to the manner or circumstances in which the instrument was played, then it is conceivable that it could embody some form of limited musical notation: not a note-for-note notation of pitch or rhythm in the conventional musical sense, but nevertheless a representation of some feature of the music which the notator(s) felt moved to record. Such systems are attested in modern and historical folk-musical contexts.

Isturitz Pipes: Connections and Tradition

Preserved in the forms of the instruments themselves are suggestions of a long-term consistency in subtleties of design, which, considering the vast timescales involved is difficult to explain in terms of a solely oral connection, or by imitating some preserved prototype, or indeed by independent invention. We have already noted the special features shared by Isturitz's two best-preserved Gravettian pipes—their finely-worked finger-holes, equal in size, numbering four and arranged not randomly, or equally, but precisely in two pairs—to which may be added their choice of precisely the same material: vulture ulna. All this suggests a surprising agreement of purpose, for two pipes that could be separated in time by hundreds or even thousands of years (^{14}C dates for the Gravettian indicate that this technocomplex spans 27,000–20,000 years). Use of large bird ulnae (albeit usually other than vulture) is of course something that recurs throughout music's archaeological and ethnographical record: it is a suitable bone to use, its long, empty cavity providing an ideal raw material for acoustic exploitation. However, the shared finger-hole layout has no obvious parallel with bone pipes of later pre- and protohistoric music cultures, and seems to contrast distinctly even with those remaining from Isturitz's own late Upper Paleolithic (Magdalenian) levels. So it is all the more remarkable to find suggestions of such continuity, not with later but with earlier, Aurignacian practices. Isturitz's Aurignacian pipe, indeed, resembles the Gravettian in several ways: firstly, in choice of bone and competence of manufacture; secondly, exhibiting as many as three, probably more, well-formed finger-holes with obliquely angled finger-orientations; thirdly, in their embodiment of two different spacings, the wider space (between holes 2 and 3) bearing divisional incisions; and finally, perhaps even the same plain, polished terminal, if the surviving end is indeed the player's proximal end.

It is not yet evident from the miscellany of remains previously found at other sites whether this Aurignacian–Gravettian continuity may have resonances beyond the immediate confines of Isturitz, but it appears increasingly possible. The recent finds from Geissenklösterle, near Ulm, discussed by Hahn and Münzel (Hahn and Münzel, 1995; Hein, 1998) offer a tantalising glimpse, fragmentary, but nonethelesss valuable for their association with assemblages firmly attributed to the Aurignacian. Here, we again see both competent workmanship and complexity of form: we see similar preferences for wing-bones of large birds, albeit involving a slightly different bone and species (identified in the more complete specimen as a swan radius); here too are similar linear series of notation-like scratches; and, most remarkably, at least three well-formed finger-holes, with closely comparable platformed margins, spaced unequally in such a way that the larger gap again falls between holes 2 and 3, and again displays "three-scratch" divisional markers. Given the disparity in repertoire of other, especially later, Upper Paleolithic instrument forms, this is a very close match.

Isturitz and Geissenklösterle: Estimating Music's Antiquity

Such long-term consistenc in musical instruments may have implications far beyond the Upper Paleolithic. The sophistication of the pipes' various design elements (technological and ergonomic), both at Isturitz and Geissenklösterle (Fig. 11), suggests that such instruments must, even at around 35,000 years, be several conceptual stages removed from the earliest origins, even of instrumental musical expression, to say nothing of those universal vocal, manual-percussive and dance forms which must have existed independently of—and before—any need for such tools. While the Aurignacian pieces may indeed be the earliest yet found, they cannot represent humankind's first attempts at piping, any more than the earliest known harps and lyres of Sumerian civilisation around 5000 years can have been the first—or even close to the first—stringed instruments. Ian Cross (1999, in press) argues persuasively that our musical and quasi-musical skills are, contrary to previous psychological opinion, highly adaptive. Intimately involved in the acquisition of speech and language by individuals during early infancy, proto-musical aptitudes especially might have played a key role in the evolving structure of conscious thought, the way we interpret the world around us, and the way we interact with others. In terms of *H. sapiens*, acquisition of these skills must indeed have been remote. So what kind of archaeological time-scale might we be looking at? That is, of course, very difficult to establish in the absence so far of any clear material evidence with which to calibrate it. However, unless early and pre-Aurignacian developments occurred abruptly or at a significantly rapid pace, the already advanced level of our earliest Isturitz pipe could imply a very lengthy antecedence for such toolmaking and tool-using behaviors—even one which we might previously have thought wildly optimistic. At any rate, it is increasingly difficult to feel confident that their origins could still rest solely within the so-called Upper Palaeolithic cultural explosion. But if their development was really such a long gradual process, how is it that the Middle Palaeolithic has so far failed to yield any convincing evidence of it? One possible explanation may be that scholars have been mistaken, especially recently at Divje Babe, in hoping to find traces of pipes with finger holes—in other words, instruments which employ the finger-hole principle for the generation of their different musical pitches.

We must not be misled by what, to our modern eyes, is the simple "penny-whistle"-like appearance of the Aurignacian and Gravettian instruments; their designs embody advanced concepts. Looked at more closely, their economy of form quickly begins to seem born almost as much of elegance as of primitiveness: indeed, in order for the "cultural explosion" model to apply, it would require us to compress into an uncomfortably short period major conceptual advances. Perhaps the most crucial is the very adoption of the finger-hole principle. This is far from the most obvious, most "primitive" solution to the problem of obtaining a series of pitches. Assuming as a reasonable hypothetical starting-position, a custom of producing single, plain bone tubes, perhaps to serve as imitative hunting lures, it would surely be remarkable if the first logical advance in pitch-organization was not simply through organic accretion, physically combining two or more such pipes in ranks or bundles. This was later to characterize the evolution of stringed and percussion instruments, we believe, commencing with ranks of "open" (i.e. unstopped) strings and arrays of individual chimes, and only subsequently evolving more economic forms where manual dexterity or adaptations such as finger-boards might elicit from one single string or one chime a whole series of discrete pitches. Moreover, among pipes such compound configuration is not only simple to engineer-but musically effective as well. Such compound pipes exist today and were widespread throughout virtually the whole of the ancient world during late pre- and proto-historical times, including the pre-Columbian Americas; these are the so-called Pan-pipes of ancient Greece, Bronze Age Europe, early historic China, the Romans and Vikings, the Maya in Mesoamerica, and the Moche and Nazca cultures of Peru. The majority of them are flute-voiced, but reed-voiced and lip-reed multiples have also been excavated, such as the numerous finds of ancient Chinese bamboo *sheng* mouth organs. The ubiquity alone of these composites may be suggestive of extreme antiquity. That they are absent—so far—from Palaeolithic assemblages may be because their identification is too easily hampered by their paucity of distinguishing features, especially when separated. It is no doubt compounded also (as in later periods) by the inevitable failure of other, more easily worked organics than bone, to survive.

If we consider such composite forms to have been an inevitable step towards achieving what we might call "single-player melodic capability," of which the Isturitz finger-hole pipes can now be seen as an advanced expression, the very need for such multiplication and differentiation of pitches would itself rather presuppose an already extant, noninstrumental (probably vocal) pitch-organizing behavior of some kind; and so even those putative simple ancestral tube-sets, however extreme their antiquity, would themselves hardly constitute music's starting-point. That in turn requires a yet more remote chronology for any noninstrumental exploitation of sound, and of course movement, which may have accompanied—perhaps even enabled—the emergence of articulated speech and song.

In conclusion, Upper Paleolithic musical instruments form a distinct category of object which certainly represents one very tangible element of a complex sound-communication behavior. Recent studies of the oldest known examples (Lawson and d'Errico, in press) show the sophistication of the pipes' various design elements, technological and ergonomic, at sites such as Isturitz and Geissenklösterle, by ca. 35,000–30,000 years. If such instruments are, even at that stage, already far removed from the ultimate origins of simple sound-tools, they are presumably even further removed from those of ancestral behaviors of noninstrumental kind. Amongst these behaviors, proto-musical aptitudes might have played a key role not just in speech but in the evolving structure of conscious thought: the way we interpret for ourselves the world around us, and the way we interact with others. The acquisition of these aptitudes may have begun very early in our prehistory.

THE DIVERSIFICATION OF LANGUAGES DURING THE UPPER PALEOLITHIC

Most historical linguists (e.g. Campbell, 1998; Joseph and Salomon, 1998; Matisoff, 1990) are skeptical that any language from the Upper Paleolithic could be reconstructed, and even the more convinced proponents of the Nostratic hypothesis, and of a monogenetic theory for language origin (Bomhard and Kerns, 1994; Dolgopolsky, 1999; Greenberg, 2000; Ruhlen, 1994, 1996) admit that they have little to contribute about the languages spoken in Europe before 12,000 years ago (see Renfrew, 2000 for a discussion).

It has been suggested that one possible exception to this rule might be the Basque. The hypothesis that a genetic, cultural, and linguistic continuity exists between the modern Basque population and the Upper Paleolithic inhabitants of the northeastern Iberia was first proposed by Barandiaran (1937) on archaeological, ethnological, and anthropological grounds. The skulls found at the Urtiaga cave, in particular, were considered by him and his followers (e.g. Altuna, 1975) as indisputable proof that Basque racial characters were already present in the region by the end of the last glaciation. This hypothesis was further reinforced by geneticists (Cavalli-Sforza and Cavalli-Sforza, 1995; but see MacClancy, 1993) who showed that the geographic dispersion of the Basque language loosely coincides with a gradient in the occurrence of Rh-(Rhesus negative) blood.

A number of recent studies temper these conclusions. Direct C14 dating of the Urtiga skulls has shown that these human remains are much younger than assumed by the continuity hypothesis (Altuna and de la Rua, 1989). A new phylogeny of the European population (Semino *et al.*, 2000; see also Wells *et al.,* 2001), derived from 22 binary markers of the nonrecombining Y chromosome, has proposed that, contrary to what was assumed by the Ammerman and Cavalli-Sforza scenario (1984), a substantial portion of the European gene pool, and not only that of the Basque, appears to be of Upper Paleolithic origin. This interpretation in now challenged by a new study supporting the Neolithic demic diffusion model (Chikhi *et al.*, 2002).

Historical linguistics provides little evidence that Basque is a straight descendant of the language spoken by the Paleolithic hunter gatherers. The study conducted by Mitxelena (1964, 1985) using traditional comparative methods demonstrates that a proto-Basque may be traced back to the beginning of the Christian era and that the so called "common Basque" has been spoken since the fifth or sixth century A.D. A more recent study identifies roots which may well go back to the first millennium B.C. (Lakarra, 1995a,b). Attempts to establish a link between the Basque and a number of putative linguistic macrofamilies have been made using glottochronology

(Tovar 1961; Trask, 1997) and macrocomparativism (e.g. Schuhmacher and Seto, 1993). However, close scrutiny of these results reveals that the hypotheses they have generated must be taken at best as viable scenarios, at worst as mere speculations (Lakarra, 1997a,b).

Paleolithic Archaeology and the Diversification of Languages

Thus, it is becoming increasingly clear that only the identification of reliable archaeological proxies for languages, combined with studies of paleodemography, might permit researchers to trace, to some extent, the process of language diversification in earlier periods. We can assume that the more reliable proxies are those related to behaviors which need to be transmitted from generation to generation, through language. Symbolic behaviors such as artistic activities, mortuary practices, decoration of utilitarian and non-utilitarian objects, are the elements of material culture to which we should turn.

In particular, ethnography suggests that among traditional societies, personal ornaments may be representative of ethnolinguistic diversity (Faris, 1972; Hodder, 1979; Ray, 1975; Strathern and Strathern, 1971; Wiessner, 1983). Extensive use of body ornaments is one of the most remarkable innovations introduced by AMH into Europe some 35,000 years ago. These objects (perforated animal teeth, marine shell beads, bone and stone pendants) have always fascinated archaeologists, but their potential for reconstructing language barriers has not yet been fully addressed. The potential of the approach has already been demonstrated by a group of researchers who have created a model based on ethnographic data from 256 Native American groups, and subsequently applied it to European Mesolithic (10,000–4000 years) ornaments. This has allowed them to propose a tentative ethnolinguistic geography of Europe for the Holocene (Newell *et al.*, 1990). The large number and wide geographical and chronological distribution of Upper Paleolithic ornaments make them especially suitable for characterizing Paleolithic groups. The advantage of abundance may become a handicap once an attempt is made to interpret the variability of the technical and symbolic behaviors displayed during the production and use of these objects. The main question, of course, is how to integrate these data in a reliable framework of inferences to guide our interpretation, i.e. what kind of analogy should we adopt to progress from the study of beads, to individuals, and perhaps to their society and language (White, 1992). Difficulties are associated with the nature of the archaeological record and with the polysemic function of ornaments in traditional societies. Personal ornaments are seen variously as objects used to beautify the body, as "love letters," amulets, exchange media, expressions of individual and group identity, markers of age, class, gender, wealth, or social status. Studies in ethnicity (Jones, 1997) reveal that ornaments may have one or more of these functions, and to isolate them is difficult, even in the case of living people. Ethnography also shows that these functions change in time and that, to express self and group identity, the same members of a group may wear different types of personal ornaments, according to the social context of use (for example war, feast, ritual, funeral, aggregation events). However, identifying these contexts in the archaeological record may be difficult. Ethnographic data also indicate that individual beads, the most common occurrence in excavations, rarely convey meaning. It is the combination and arrangement of numbers of beads, and their positioning on the body that is important (for example in the hair, on bonnets, chokers, necklaces, pendants, bracelets, belts, anklets, garment decoration). Clearly, before interpreting synchronous variations in number, association, type, decoration, size, manufacture and suspension techniques of personal ornaments, in terms of linguistic boundaries and diachronic changes in bead use, as trends in language evolution, other possible reasons determining this variation need to be addressed. Since ethnoarchaeology has so far failed to provide a general interpretive model applicable to such beads, we have recently argued (d'Errico and Vanhaeren, 2000, 2002; Vanhaeren and d'Errico, 2001, 2003, in press) that, to counter these problems, it is necessary to study appropriate archaeological contexts. The required resolution seems available through the study of purposeful deposits such as pit contents, occasionally lost complete ornamental displays, primary human burials and animal teeth, which we know were perforated by the same craftsmen. Primary burials, in particular, offer the advantage of being intentional, virtually instantaneous-deposits that often preserve the spatial arrangement of beads. Thus, complex ornaments, composed of a large number of beads can be isolated and compared with others found on the same skeleton, and we can investigate associations with anatomy, gender, and age. Primary burials also guarantee that the associated types of beads (raw material, color, species, shape, size etc.) found there, and the techniques used to manufacture these objects, were all part of the material culture of the mourners. Combinations of data on the choice, source, production, assembly, manner of wearing, and degree of use of beads from one burial and from contemporary burials in the same or different sites, may suggest the predominant functions of personal ornaments in a given society. These contexts allow the study of variability in the behavior of a single bead-maker, and, as a consequence, assist in differentiating between individual and group technical variability in bead production. Any variation exceeding individual and intragroup variability might be the index of ethnolinguistic diversity. Analysis of ornament variability in cemeteries that we can confidently assume were used by the same human group provides an approach to the problem of group variability. This may allow discovery of features that are common to all members of the group, and those that identify gender and age classes. Comparison of contemporaneous cemeteries from different regions may reveal features peculiar to each group that are likely to represent cultural identity markers. These studies provide an analogy to guide the interpretation of individual ornaments found at habitation sites. Integration of these two records may help gain an insight into the geography of Upper Paleolithic ethnic groups and follow cultural changes during OIS 3-2.

With this aim in mind, we recently analysed grave-goods variability in two Epi-Paleolithic–Early Mesolithic cemeteries in southern Europe—La Vergne in western France and Arene Candide in northern Italy (d'Errico and Vanhaeren, 2000). Dated around 11,700 and 9,000 BP respectively, each cemetery included approximately 10 individuals with associated ornaments and grave goods. In each site, some categories of ornaments are common to all, or almost all, of the deceased, and equally associated with adults and children, irrespective of sex. However, the most abundant types of beads are different in each site. The deceased at La Vergne share ornaments made from shells of *Dentalium* and *Nassa* and the canines of red deer and fox, whilst at Arene Candide fragments of *Lamellibranchia* and shells of *Patella* and *Cyclope* fulfill this role. This led us to conclude that the materials used in the main personal ornament categories project aspects of group identity. Integration of this interpretation with a detailed analysis of grave goods associated with the 10,210 ± 80 years old (OxA 5682) Aven des Iboussières burial site in the southeast of France, further refined the model. Our study made it clear that not only the type and source of ornaments, but also the manufacturing techniques, size choices, forms of decoration, as well as modes of suspension and wearing of the ornaments, are relevant in conveying the cultural identity.

The study of the personal ornaments (Fig. 12) associated with the Lagar Velho child burial (ca. 24,000 BP) has allowed us to address linguistic issues more directly (Vanhaeren and d'Errico, 2003). The comparison of the grave goods associated with this child, interpreted as a possible mosaic of Neandertal and early modern human-characteristics (Duarte *et al.*, 1999), with those found in 71 other burials has revealed a clear and previously unnoticed difference between the Gravettian burials from the Italian peninsula, and those from northeastern Europe. The Italian burials have in common the widespread use of shells as personal ornaments. Twenty different species of gastropods and bivalves were found in these burials and two of them (*Cyclope* sp. and *Cyprea* sp.) are associated with, respectively, 13 and 7 of the 20 inhumations from this region. In contrast, perforated shells are rarely associated with Early Upper Paleolithic burials from northeastern Europe, and in the few cases where they do occur we see species unknown in the

Fig. 12. Red deer canines and *Littorina obtusata* shells associated with the Lagar Velho child burial dated to ca. 24,000 B.P. Scale = 1 cm.

southern sample, such as *Dentalium* sp. at Brno II and *Littorina obtusata* at Paviland. Another dissimilarity appears in the choice of tooth pendants. Fifteen of the 20 southern interments have yielded red deer canines, absent in northeastern burials. The latter shows, instead, the frequent use of fox canines, none of which was discovered in the Italian sample. Stone pendants and perforated discs are another feature specific to northern burials. The Italian interments are instead characterized by an abundance of flint tools, rare among burials of the other group. In sum, differences in the grave goods suggest that a cultural boundary existed between the south and the north-east of Europe during the early Upper Paleolithic. If confirmed by future comprehensive analysis of the personal ornaments found at habitation sites (Vanhaeren and d'Errico, 2002; Vanhaeren, 2002) these differences may be interpreted as reflecting a frontier between two cultural entities and language families. Diversification of languages and cultural change during the Upper Paleolithic were certainly influenced by climatic events and related cyclical depopulation in some regions. Correlating cultural and climatic changes as established by continental and marine proxies will allow us (see d'Errico and Sanchez Goñi, 2003 for an attempt concerning the OIS 3) to produce an informed evaluation of population density between ca. 60 and 10 Kyr and compare the results from our analysis of personal ornaments with the hypotheses put forward by linguists and geneticists (Richards *et al.*, 1996; Torroni *et al.*, 1998) on the diversification of languages and the peopling of Europe during this period.

CONCLUSION

The first conclusion of our ongoing collaborative research is that the emergence of behavioral modernity is a complex matter that needs to be tackled from a global perspective and be grounded in primary archaeological and anthropological evidence. Creating models that account for the origin of human cognition, language, music, symbolism, and religion has become a popular undertaking among scientists from diverse backgrounds, and it seems that collecting supporting evidence for a new model is within the reach of any scholar able to read a few textbooks and web sites on prehistoric archaeology and human evolution. The challenge, however, is to combine theory and practice to produce evolutionary models by investigating new, or reappraising old fossil evidence, in order to challenge our own and others' wishful thinking. This dialectic requires at once knowledge of the general questions we wish to answer, and the creation of frameworks of inferences that can establish a link between the primary archaeological evidence and its wider implications. We argue that establishing this link is a challenge for archaeologists or physical anthropologists, yet must become a necessary everyday practice for all those scientists (linguists, psychologists, computer scientists, neurobiologists, geneticists) who wish to tackle the question from their own perspective. Turning to previously unexplored fields of study may be beneficial as it is precisely as a result of contact and exchange with neighbouring disciplines that flaws in established research traditions and longstanding paradigms appear. In this way, research methods are adapted to new goals. It may be argued that the same call should be made by the above scientists to archaeologists.

However, the development of comprehensive hypotheses to trace and explain the origins of language is still at an early stage, and any assessments must therefore be provisional. We have chosen to highlight below features we believe cogent to the argument. Yet these are not intended as a trait-list to distinguish modern from non-modern. Rather, they should be viewed as a collection of features suggesting the direction of future research endeavors.

In the search for the archaeological counterpart of language, lithic technology does not seem the best evidence for suggesting the presence or absence of linguistic ability. AMH and Neandertals living in the Levant at ca. 90,000 years ago were producing similar stone tools. If language is linked to lithic technology it suggests a number of plausible scenarios: both groups were unable to speak like us, or both had a modern language, or, as is commonly proposed, just one human type possessed this ability. At present, we have no means by which to choose between these models. In spite of more than a century of research devoted to lithic technology and typology, we are forced to admit that we are still unable to separate, when examining lithic assemblages, functional needs and features related to ethnicity, social status, and active style. The only thing we can say is that the existence of a regional lithic variability is documented after 70,000 years ago, within the Middle Paleolithic of Europe (e.g., Soressi, 2002) as well as within the Middle Stone Age of Africa (McBrearty and Brooks, 2000). This regional variability may reflect linguistic borders.

Diversification in the raw material used to produce tools, wood and bone, also fails to provide any firm indication that the user or maker of these tools was capable of syntactical language. Bone and wooden tools were certainly used and shaped by early hominids and *Homo* populations as part of their material cultures, but they are not clear proxies of behavioral modernity. The production of tools made from nonlithic raw materials may in some instances reflect the use of symbolic language. At Blombos Cave, bone manufacturing techniques reflect social values rather than utilitarian functions. If manufacturing techniques materialize as a consequence of the social roles of the makers/users, and no obvious link exists between one particular technique and the meaning attributed to it, this action represents symbolic behavior. Language then becomes a prerequisite for the maintenance of that tradition in a given society.

This leads us to archaeological evidence which, more than any other, implies the previous acquisition of modern language: the production of a symbolic material culture. How can we recognize early traces of symbolism in the archaeological record? Can early symbolic societies have left unambiguous traces of their being symbolic? Without the two engraved ocher pieces from Blombos Cave, a merely functional interpretation for the use of ocher in the South African Still Bay could be applied. However, at Blombos Cave symbolic behavior can be inferred, as the engravings are almost certainly the final outcome of the engravers' intention. In contrast, the utilized ochers from this and other MSA sites, and the used manganese pieces from Mousterian sites of Europe, do not, in themselves, signify symbolic behaviour. They only represent a step in the production of a residue which may or may not result in the production of symbolic representations. If this is the case, then what interpretation should be attributed to this material and would this result only in biased answers?

The Blombos Cave engraved ochers show that in some cases, particularly when dealing with the earlier periods, dramatic changes in our understanding of the production of symbols may rest largely on the occasional discovery of very few artifacts. This conclusion invites us to conceptualize flexible models, designed to guide the interpretation of new findings, rather than to establish rigid boundaries between periods, regions, or human types. Burial is also a case in point. Simply denying the existence of Neandertal burials is counterproductive in building alternative scenarios for the origins of symbolism. Rather, a detailed reappraisal of available Neandertal burial evidence will inform about Neandertal funerary practices, and possibly highlight that treatment of the dead was significantly different from that of contemporary and more recent AMH groups. In the light of recent evidence, we should rather conclude that Neandertals did practice intentional burial, with the corollary that Neandertals may not have buried their dead following the same traditions as AMH. However, we propose that the basic purpose behind the act was the same—namely, that of interment with symbolic intent.

Little has been done to produce a global scenario for what took place once all of these modern behavioral innovations were acquired, and to trace back how more-or-less abrupt changes in technical systems and a varied repertoire of symbolic behaviors may be related to demography, climatic shifts, and the influence they had on cultural identity and language diversification. Archaeologists face severe problems in tracing, recognizing, and interpreting many aspects of complex symbolic societies. Although this is essential if we wish to fully evaluate systems of belief in a society, many symbolic activities (rituals, dance, songs, music) leave little or no visible trace in the archaeological record. However, objects displaying notation, musical instruments, and personal ornaments may allow interesting insights into the more hidden aspects of these cultural systems. Notation allows information to be stored on artifacts that is available as required. Prior to the availability of notational systems, symbolic traditions could only be conveyed orally. The introduction of notational devices provided valuable additional potential for transmitting complex traditions across space and between generations.

The few available Upper Paleolithic musical instruments provide a series of glimpses between 30,000 and 10,000 years ago of musical tradition and related activities. Continuities and changes in the techniques of instrument manufacture and in the way they were played probably reflect variation in the tradition of sound production and associated practices. These changes certainly reflect patterns of diversification of languages, spatially and temporally.

Personal ornaments are a more direct proxy for language diversity. Since ornaments tend to be ubiquitous at Upper Paleolithic sites, they provide the potential for the future identification of ethnolinguistic boundaries and even social group and personal identity.

Multidisciplinary archaeological research has the potential to increase our understanding of modern human behavior. Although language does not fossilize, the origin and diversification of languages are closely linked to behavioral innovations preserved in the archaeological record. We believe that continued research in this field will provide important keys necessary for unlocking our understanding of the origins of language.

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