

LANGUAGE AND HUMAN EVOLUTION

Deborah L. Cunningham
Department of Anthropology
University of Missouri, Columbia

"It may reasonably be supposed that there is a limit to the degree of complexity of behaviour and cultural life which may be transmitted without language" (Tobias, 1991:836).

Introduction

Human language is a complex system of communication composed of distinct components, one of which is structured verbal communication. This component is unique to humans and involves a large lexicon tied together by grammar-governed sentences. These sentences contain words based on phonemes that combine to produce morphemes (Wolpoff, 1996). Wolpoff (1996) asserts that there are two basic differences between human language and non-human primate communication systems: (1) human language allows an infinite combination of phonemes into arbitrary morphemes, and (2) it also uses a hierarchical system of syntactic rules that create sentences from thoughts, allowing the listener to regenerate each sentence they hear. While non-human primates also rely on vocalizations and paralinguistic features for communication, their system is rudimentary compared to that of humans. Since both modern African apes and humans evolved from a common ancestor roughly five to eight million years ago, and spoken language is considered a derived (occurring since the ape-human split) characteristic (Noble and Davidson, 1991), it is reasonable to assume that our hominid ancestors passed through ape-like communication stages, progressing steadily toward the linguistic capabilities of modern humans.

Just when and how language came about has long been a subject of speculation and controversy. In the nineteenth century, three "ingenious but unprovable accounts" of language origins were put forth: the bowwow theory, the pooh-pooh theory, and the ding-dong theory (Salzmann, 1998:113). The bowwow theory postulates that the first words early humans uttered were an attempt to imitate animal sounds, the pooh-pooh theory contends that the first speech was in response to pain or other strong feelings, and the ding-dong theory holds that "the peculiar ring each substance in nature possesses came to be vocally represented in the first human words" (Salzmann, 1998:113). However, such hypotheses, as Salzmann noted, are untestable via the scientific method.

How is it possible to determine when hominids graduated from an ape-like communication system to true language? Theories of language evolution like the three listed above or those involving hand gestures, blending, and duality of patterning cannot be tested in the fossil record since no evidence of them can fossilize. What does fossilize are bones, and these can provide anatomical evidence for language capacity, as we shall see below.

There are two schools of thought on the timing of the origin of human language: (1) language appeared early in our evolutionary history, at least by the beginning of the Pleistocene, and (2) language appeared very late in human evolution, maybe only 40,000 years ago (Walker, 1993). Evidence cited by adherents to both schools is gathered by analyzing hominid vocal tracts, central nervous systems, brain size, brain structure and asymmetry, and also by looking at the complexity of the archaeological record, evaluating language development in children, and assessing the language capabilities of non-human primates (Walker, 1993).

In order to appraise the linguistic ability of fossil hominids, I have focused on some of the morphological evidence. During the course of this research I discovered that the literature available on the topic of "Language and Human Evolution" is vast; many books and dissertations have been written on the subject. In fact, Mellars (1996:387) writes, "it is tempting to suggest that there are almost as many views of the possible origins of language as there are linguists, psychologists and paleoanthropologists who have written on the issue." It is impossible to exhaustively deal with all of the various evidence and theories in such a brief paper. My goal is to focus on evidence for language capacity from the vocal tract, brain, and hypoglossal canal, and then to discuss this morphological evidence in the genera *Australopithecus* and *Homo*.

Language is extremely useful to humans. Lieberman (1992) writes that human speech allows the transmission of complex ideas much more rapidly than could occur through non-linguistic means. While sign language can do the same, the hands are not free for other tasks. "Vocal language represents a continuation of the hominid evolutionary trend towards freeing the hands that followed from upright bipedal locomotion" (Lieberman, 1992:134). Therefore, vocal language, once developed, became a key part of hominid evolution.

The Vocal Tract and Language Capabilities

The vocal tract, which includes the pharynx, larynx, laryngopharynx, oropharynx, and nasopharynx, is not only involved in the production of sounds and speech, but is also essential to breathing and swallowing. A brief de-

scription of the linguistically relevant anatomical terms and their functions follows.

At the proximal end of the esophagus, the muscular tube which transmits food from the oral cavity (mouth) to the stomach, three anatomical regions of the vocal tract are connected: the nasal cavity (nose), the oral cavity, and the larynx (voice box) (Aiello and Dean, 1990). This connected area at the top of the esophagus is called the pharynx. The area of the pharynx that opens opposite the larynx is the laryngopharynx, the area, which opens opposite the oral cavity, is the oropharynx, and the area which opens opposite the nasal cavity is the nasopharynx. The larynx prevents food from entering the opening of the trachea (windpipe) during swallowing, and also closes during extreme muscle strain so that the thorax can act like a rigid framework, thereby easing exertion (Aiello and Dean, 1990). In addition to these important functions, the larynx contains vocal folds (cords), from which speech sounds originate. These folds vibrate as air is pushed through them. The pharynx, oral cavity, and nasal cavity modify this sound in order to produce the many sounds necessary in human speech (Aiello and Dean, 1990).

Laitman (1993) found that the position of the larynx is important in determining how an animal vocalizes, breathes, and swallows. He described two anatomical patterns in the position of the larynx: the basic mammalian pattern, and the older (over two years old) human pattern (see Figure 1). In the basic mammalian pattern, the larynx is found relatively high in the neck, approximately opposite the first, second, and third cervical vertebrae (Laitman, 1993). This position lets the larynx link with the nasopharynx, providing a direct passageway for air between the nose and the lungs. This position allows mammals, excluding older humans, to swallow liquids and breathe simultaneously; while the animal is breathing, the liquid flows around the side of the interlocked nasopharynx and larynx through the piriform sinuses to the esophagus and stomach (Laitman, 1993). Human babies are able to do this as well, as this is a necessity for successful nursing. Although this anatomical pattern allows simultaneous swallowing and breathing, it also limits the multitude of sounds that the animal, or baby, can produce. Since the larynx is so high in the throat, the space allowed for the pharynx is limited. Therefore, its ability to modify sounds produced by the vocal folds of the larynx is also limited. Because of this, most mammals rely primarily on the oral cavity and its surrounding lips to modify the laryngeal sounds (Laitman, 1993).

Once a human reaches about the second year of life, the larynx descends into the neck, reaching its final position at the fourth to seventh cervical vertebrae (Laitman, 1993). This has many implications for the human's way of breathing, swallowing, and vocalizing. This position does not allow the larynx to lock into the nasopharynx in order to separate the swallowing and

breathing passageways. Now, the trachea and esophagus cross above the larynx, increasing the possibility of choking on food lodged in the windpipe. Additionally, adult humans cannot drink and breathe at the same time without choking. However, since the larynx is so far down in the throat, the pharyngeal area above the vocal folds is expanded, allowing a greater modification of laryngeal sound (Laitman, 1993). Laitman (1993:58) writes, "the expanded pharynx is the key to our ability to produce fully articulate speech."

Laitman (1993) was able to correlate the shape of the basicranium (bottom of the skull; forms the roof of the upper respiratory tract) with the position of the larynx, thereby allowing the position of the larynx to be evaluated in fossil hominids in which the basicranium is preserved. He found two anatomical configurations: a flat basicranium and a flexed basicranium. The flat basicranium is seen in non-human mammals and is associated with a relatively high larynx. The flexed, or arched, basicranium, is seen in older (over two years old) humans and is associated with a relatively low larynx (Laitman, 1993).

The Brain and Language Capabilities

Two issues in brain anatomy are frequently discussed with reference to the speech capabilities of fossil hominids: the speech cortices called Broca's and Wernicke's areas (see Figure 2), and brain lateralization. The mammalian brain is divided into two symmetrical halves: the right and left hemispheres. The left hemisphere is most involved in speech and contains Broca's and Wernicke's areas. "Wernicke's area appears to generate the basic structure of sentences, which are then encoded in Broca's area; the articulation of sounds is directed by certain motor areas of the cortex. Comprehension of speech takes place in Wernicke's area after acoustic signals are transferred there from the ear by the auditory cortex" (Salzmann, 1998:36-37). While Broca's and Wernicke's areas are traditionally thought of as the most important neural parts for speech production, Lieberman (1998) writes that deep subcortical neuroanatomical structures and pathways are also required for language production. However, since brain tissue does not fossilize, paleoanthropologists must be content to study the development of Broca's and Wernicke's areas from endocasts.

Brain lateralization is considered to be another important component in the capacity for language. Human language is lateralized; that is it is controlled by one side of the brain, usually the left. However, Lieberman (1998) writes that brain lateralization is a primitive (plesiomorphic) character, which, by itself, cannot indicate whether or not language was spoken. Other creatures that do not possess language, like birds and frogs, have lateralized

brains, indicating that this feature was present in the mammal-reptile ancestor. However, Wolpoff (1996) considers brain lateralization a significant aspect of language ability, and writes that while other primates show cerebral asymmetry, it is not on the same scale that humans do. Although Lieberman (1998) may question its use, brain lateralization is frequently assessed in the context of language capability of fossil hominids.

The Hypoglossal Canal and Language Capabilities

The hypoglossal nerve, or cranial nerve XII, is responsible for supplying nerves to the muscles of the tongue. Kay *et al.* (1998) found that the hypoglossal canal, through which this nerve runs, is absolutely and relatively smaller in African apes (chimpanzees and gorillas) than it is in humans. They infer that the human tongue has a richer supply of nerves than the non-human primate tongue, and postulate that canal size may indicate the degree to which fossil hominids had motor coordination of the tongue, and therefore, command of language.

Evidence for Speech In *Australopithecus*

The genus *Australopithecus* consists of several species known from sites in Africa. Our earliest ancestors, these creatures lived approximately 4.4 to 1 million years ago.

Laitman (1993) found that generally the basicrania of australopithecines was unflexed, and has reconstructed the position of the larynx as high in the neck. While australopithecines could most likely breathe and swallow simultaneously, they probably could not produce the sounds found in modern human speech patterns. Lieberman (1998) concurs, writing that the australopithecine basicranium does not differ significantly from that of an unflexed chimpanzee. He concludes that australopithecine speech anatomy is similar to that of chimpanzees (Lieberman, 1998).

Holloway and De La Coste-Lareymondie (1982) studied brain endocasts of forty-one fossil hominids. While they found that hominid brains are more asymmetrical than pongid brains, they write that their sample of *Australopithecus* cannot support this conclusion. They suggest that the human pattern may have emerged sometime between the time of *Australopithecus* and *Homo erectus*. However, Tobias (1983 as cited in Walker, 1993) has claimed the presence of Broca's, but not Wernicke's, area in *A. africanus*.

Kay *et al.* (1998) found that the hypoglossal canals of *Australopithecus* fall within the range of African apes, which are much smaller than modern

human canals. They conclude that the vocal capabilities of australopithecines were not significantly more developed than apes.

Lieberman (1975:159) hypothesizes that "the initial language of the australopithecines . . . may have had a phonetic level that relied on both gestural and vocal components. The system may have become more elaborate as factors such as tool use, toolmaking, and social interaction became more important". And Laitman (1993) postulates that australopithecines probably had a communication system more advanced than modern great apes. However, these hypotheses are not testable via the fossil record. It does seem, however, based on the morphological evidence, that australopithecines probably did not have human-like speech capabilities. We can only speculate about their communication system.

Evidence for Speech in *Homo*

The language capabilities of three species in the genus *Homo* will be evaluated: *Homo habilis*, *Homo erectus*, and Neandertals.

Homo habilis

The species *Homo habilis* has traditionally inspired controversy among paleoanthropologists, mostly over whether specimens conventionally attributed to *H. habilis* comprise one species or two. This paper will not address that discussion, and will not differentiate between the larger and smaller morphs of *H. habilis*. *H. habilis* is known from East and South Africa, and first appears in the fossil record 2.4 million years ago (Jurmain *et al.*, 1997).

Unfortunately, only a single specimen of *H. habilis* (OH 24) preserves the basicranial area. Tobias (1991) writes that, while Laitman and Heimbuch (1982) assert that OH 24's basicranium displays flexion consistent with the degree seen in orangutans, the specimen is distorted making their measurements unreliable. Therefore, basicranial flexion cannot be properly evaluated in this species.

Tobias (1991) described the endocranial casts of *H. habilis* as possessing prominences corresponding to well developed Broca's and Wernicke's areas. Since these "are the two most important neural bases for language abilities in the human brain . . . it is reasonable to accept that the occurrence of these well-developed prominences on the endocasts testifies to the presence of the neurological basis of articulate language in the brain of *H. habilis*" (Tobias, 1991:836). Tobias (1991) also found that both the frontal and parietal lobes of the brain of *H. habilis* exhibit asymmetry and concludes that "the occurrence of both a strong inferior parietal lobule and a prominent motor speech

area of Broca in the endocasts of *H. habilis* represents the first time in the history of the early hominids that the two most important neural bases for language abilities appear in the paleoneurological record” (Tobias, 1991:730)

Kay *et al.* (1998) analyzed hypoglossal canal size from probable *H. habilis* specimens and found that they are much smaller than those of modern humans are. They conclude that the speech capacity of *H. habilis* would not have differed from that of African apes.

Tobias (1991) contends that *H. habilis* had the capacity for speech, and also had a complex culture. “This culture was of an order of complexity and reflected a level of intelligence that virtually demanded spoken language for the transmission of the culture to the young” (Tobias, 1991:839). However, the basicranial and hypoglossal canal evidence contradicts Tobias’s (1991) assertion.

Homo erectus

Homo erectus, the predecessor of modern humans on the hominid evolutionary tree, was a widely distributed species known from sites in Africa, China, Europe, and Indonesia. The latest dates suggest that this species first appeared approximately 1.8 million years ago, and lasted for at least one million years (Jurmain *et al.*, 1997).

Laitman (1993) analyzed the basicrania of various *H. erectus* specimens and writes that some of the skulls show incipient basicranial flexion, indicating that the larynx might have started its descent down the throat in this species. Lieberman (1992) concurs, writing that it was with *H. erectus* where the human-like supralaryngeal vocal tract started evolving. However, Walker (1993) contends that there is no direct support from reconstructing the upper respiratory tract for the presence of speech 1.5 million years ago, during the time of *H. erectus*.

Begun and Walker (1993) analyzed the brain of the famous “Nariokotome boy” (KNM-WT 15000), a near complete *H. erectus* skeleton discovered in 1984 in Kenya. The brain endocast of this specimen indicates that Broca’s area was present and the asymmetry between the lobes is pronounced. However, the authors treat this evidence with caution, and point to the fact that Broca’s area is also involved in non-linguistic activities such as motor programming. They conclude “that enlargement of Broca’s cap, or of the area in its immediate vicinity, should occur at the same time that stone tool assemblages with complex typologies appear in large numbers is suggestive of some sort of causal linkage” (Begun and Walker, 1993:357), thereby giving Broca’s area credit for increased cultural complexity. Asserting that the cause

of this complexity lies more with hand control and other fine movements rather than language ability.

Kay *et al.* (1998) also examined the Nariokotome *H. erectus* boy, and concludes that he had a small hypoglossal canal out of the human range. However, they concede that this could be because the boy was young when he died.

It seems, based on the available evidence that support for speech in *H. erectus* is lacking. The brain evidence may point to the capacity for speech, depending on how much credit one is willing to give to Broca's area, but the respiratory tract reconstruction seems to preclude the possibility for articulate spoken language as we know it in *H. erectus*. The hypoglossal canal evidence is inconclusive.

Neandertals

Neandertals are well represented in the fossil record. These hominids lived in Europe and the Near East from 130,000 to 35,000 years ago (Jurmain *et al.*, 1997). Whether or not they are ancestors to modern humans is a topic hotly debated among paleoanthropologists.

Laitman *et al.* (1979) analyzed the basicranial flexion of some Neandertal specimens, discovering that the upper respiratory structures of three specimens were similar to a subadult human. While the larynx was not as low in the throat as in modern humans, it was low enough to allow for some pharyngeal expansion. They write that this differed greatly from the primitive australopithecine condition. However, another Neandertal specimen, La Chapelle-aux-Saints, was significantly different from the other specimens. It had upper respiratory structures more like a two to four year old human child, with a much higher larynx than the other specimens (Laitman *et al.*, 1979). It seems that the Neandertal upper respiratory tract presents a mosaic of conditions, perhaps in transition. They conclude that "classic Neandertals had the potential for greater sound modification than australopithecines, [and] they probably had a more restricted vocal range than that of modern adult or subadult humans. . . What we emphasize here is that Neandertals probably had a different, narrower, range of vocalization available to them than do modern humans" (Laitman *et al.*, 1979:31).

Lieberman (1998) also discounts the possibility that Neandertals could have had a human-like vocal tract. He writes that the length of the Neandertal mouth, which can be measured between the incisors and basion, was too long for them to have a long pharynx without placing their larynges in their chests (see Figure 3). He concludes that the Neandertals had less efficient speech communication than modern humans, and that "they represent an in-

intermediate stage in the evolution of human speech” (Lieberman, 1998:95). He contends that the classic Neandertals of Europe were the last to retain the non-human supralaryngeal vocal tract (Lieberman, 1992).

However, in 1983 a partial skeleton of a Neandertal was uncovered at Kebara Cave. The remains include a hyoid bone, a bone in the anterior portion of the throat, which provides muscle attachments for muscles involved in swallowing and speaking. The Kebara hyoid is morphologically identical to that of a modern hyoid, and Arensburg (1989) writes that this bone indicates that it and the larynx were relatively low in the throat. He concludes that the Kebara Neandertal was just as capable of speech as modern people (Arensburg, 1989).

Holloway and De La Coste-Lareymondie (1982) found that Neandertal brains showed the same asymmetry that modern human brains do. However, they stop short of inferring that Neandertals were capable of speech, and contend that the asymmetrical patterns present in the brain endocasts cannot prove the existence of language in any pre-human hominid group.

Kay *et al.* (1998) found that the hypoglossal canals of Neandertals are significantly larger than those of African apes and are within the range of those of modern humans. They believe that the vocal capabilities of Neandertals were modern by 600,000 years ago.

Mellars (1996:390) sums it up nicely when he writes that “no one would seriously question that Neanderthals, as well as much earlier hominids, must have possessed a reasonably effective form of vocal communication. . . the question is simply whether Neanderthal language was of essentially modern form, or, . . . fundamentally simpler in its basic grammatical and syntactical structure”. The morphological evidence seems to indicate a transitional condition in the Neandertals. While exact human-like speech probably was beyond their capabilities, they likely had a complex communication system that heavily relied on the spoken word.

Language Origins and Cultural Complexity

While this paper has focused on the anatomical capabilities of our hominid predecessors to articulate spoken language, Noble and Davidson (1991) assert that morphological evidence by itself is not sufficient to support the contention that the hominids analyzed used language. Since language is a behavior, and behavior does not fossilize, it cannot be directly inferred from a human skeleton (Noble and Davidson, 1991). These authors recommend investigating the origins of language from the perspective of the archaeological record, from which they claim modern human behavior, such as language, can be inferred. They maintain that since language is the symbolic use of

signs, evidence of symbol usage in the archaeological record is the evidence that must be looked for. They find no such symbolic evidence before 32,000 years ago (Noble and Davidson, 1991).

However, Tobias (1991) believes firmly that *H. habilis*, at 2.4 million years ago, was not only capable of speech, but actually had much to talk about. He asserts that the complex culture associated with this species "reflected a level of intelligence that virtually demanded spoken language for the transmission of the culture to the young" (Tobias, 1991:839). He argues that the culture of *H. habilis* exceeded that of the australopithecines in its "lithicultural" achievements, and that the manufacture of these stone tools required intelligent behavior. To sum up his argument, he contends that *H. habilis* not only had the anatomy necessary for the production of verbal language, but also possessed an advanced culture which needed spoken language in order to transmit it to the next generation. This occurred over hundreds of thousands of years via social transmission, the most effective means of which is spoken language (Tobias, 1991).

Although *H. habilis* is the evolutionary predecessor of *H. erectus*, Begun and Walker (1993) and Walker (1993) do not readily assign language to *H. erectus* as assuredly as Tobias (1991) does to *H. habilis*. Walker (1993) seems to concur with Noble and Davidson (1991) that the earliest signs of language can be uncovered in the archaeological record, and that there is no substantial evidence for an early origin of human language. He writes that Tobias's (1991) idea that *H. habilis* required language for cultural transmission is testable, and suggests an experiment in which people are asked to make stone tools either by following verbal instructions, or by following an example. He believes that the example would be easier (Walker, 1993).

Mellars (1996) contends that the Neandertal archaeological record called the Mousterian or Middle Paleolithic, lacks evidence for symbolic behavior or expression. This is based on

a lack of well documented decorative or artistic items in Mousterian contexts; a lack of any obvious symbolic component in most Middle Paleolithic tools, and a lack of convincing evidence for ceremonial burials. . . No one would question, however, that elaborate symbolic thought and expression is one of the defining hallmarks of all fully developed languages. The virtual lack of convincing evidence for symbolism in Mousterian contexts is at least consistent with the lack of highly developed language in Neandertal communities, even if it cannot be taken as concrete proof of this (Mellars, 1996:389).

He goes on to allege that it is at the Middle to Upper Paleolithic transition where modern human language appeared, and ties this to cultural advances

which occurred in the Upper Paleolithic. These include an elaborate toolkit and a shift in economic planning strategies which, he writes, would demand a structured and relatively advanced spoken language (Mellars, 1996).

Conclusion

The anatomical evidence seems to indicate that it was *H. erectus* who began the morphological transition from an ape-like communication system to a modern one. The evidence for speech prior to the time of this species is equivocal. The Neandertals present a variety of morphologies, indicating that they too were in transition, but were likely less removed from modern capabilities than the earlier members of the genus *Homo*.

However, as Noble and Davidson (1991) maintain, morphological evidence is insufficient to confidently assess the linguistic capabilities of early hominids. They claim that symbolism in material artifacts, meaning something that conveyed a meaning, is not seen until 32,000 years ago. In Germany such signs are manifested as the repetition of arbitrary signs and iconic sculptures, and in France, similar clusters of iconic and non-iconic figures were discovered. Noble and Davidson (1991) support archaeologists who have claimed a revolution in cultural complexity beginning in the Upper Paleolithic, roughly 40,000 years ago.

It seems that we can confidently state that while early hominids likely possessed a more advanced communication system than non-human primates, the morphological and archaeological evidence for modern language is not incontestable until fully modern members of our species, *Homo sapiens*, came into the evolutionary picture. Even though Tobias (1991) asserts that *H. habilis* spoke, I tend to concur with Walker's (1993) assessment that the cultural complexity of this species could be transmitted via example and did not require spoken language. Modern human language seems to have appeared roughly 40,000 years ago.

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