TALK OF AGES

A TINY BONE REKINDLES ARGUMENTS OVER THE ROOTS OF SPEECH AND LANGUAGE

By BRUCE BOWER

In 1983, a team of French and Israeli investigators excavated a nearly complete Neanderthal skeleton from the Kebara cave site in northern Israel. The 60,000-year-old skeleton is rich in detail from the neck down, but there is no skull, except for a worn jaw fragment.

The Kebara scientists, led by anatomist Baruch Arensburg of Tel Aviv University, now report finding a small, U-shaped bone in the skeleton's neck just below the jaw. They call it an anatomical "smoking gun" that demonstrates Neanderthals could talk in much the same way as modern humans do.

With their bold assertion in the April 27 NATURE, the investigators jump headlong into a thorny anthropological debate over the origins of speech and language.

The fundamental issue, notes anthropologist David F. Armstrong of Gallaudet University in Washington, D.C., is whether language developed gradually through a series of stages beginning 2 million or more years ago, or arose relatively recently among anatomically modern humans. The argument mirrors a broader scientific dispute over whether evolutionary change typically proceeds in a step-by-step fashion or in bursts after long periods of stability.

Reconstructing the development of language is a daunting task, because the critical organs of vocal communication—the brain and the soft tissues of the vocal tract—do not fossilize. But scientists have come up with a number of indirect approaches, including the study of marks left by the brain on the inside of fossil skulls, the use of the jaw and skull base as an index of speech ability and the comparison of brain-cell circuits controlling modern human language with those orchestrating the vocal calls of monkeys.

But Arensburg and his colleagues bypass these techniques and go straight to the throat. At Kebara they uncovered a hyoid bone, which lies between the root of the tongue and the larynx, or voice box. The hyoid anchors muscles connected to the jaw, larynx and tongue.

No other hyoid bones have been found for Neanderthals or, for that matter, for any other early hominids – members of the evolutionary family that includes modern humans.

The shape and size of the Neanderthal hyoid bone and the positioning of marks left by muscle attachments closely resemble those observed in modern humans, the investigators say. In contrast, the jaw is larger and thicker than the modern version.

"This suggests evolutionary change in vocal mechanisms is conservative, although the [chewing] system has greatly changed," Arensburg says. Thus, he argues, human ancestors preceding the Neanderthals by 1 million years or more probably possessed the ability to talk much as we do today.

Some investigators, however, accuse Arensburg of making a linguistic mountain out of an anatomical molehill.

"You can't reproduce the position of the entire vocal tract [the top half of the airway linking the lungs to the atmosphere] with just a hyoid bone and a jaw fragment," says anatomist Jeffrey T. Laitman of Mount Sinai School of Medicine in New York City. No evidence exists from modern humans or apes that hyoid shape predicts the shape and position of the larynx, he adds.

Comments linguist Philip Lieberman of Brown University in Providence, R.I.: "There's no basis for comparison, since we have no hyoids from earlier hominids. At this point, the Kebara hyoid doesn't tell us anything about the evolution of speech and language."

Laitman and Lieberman contend Neanderthals possessed limited speech capabilities. They also cite evidence for rudimentary vocal communication extending back nearly 2 million years, probably to the time of the earliest known direct human ancestor, *Homo habilis*.

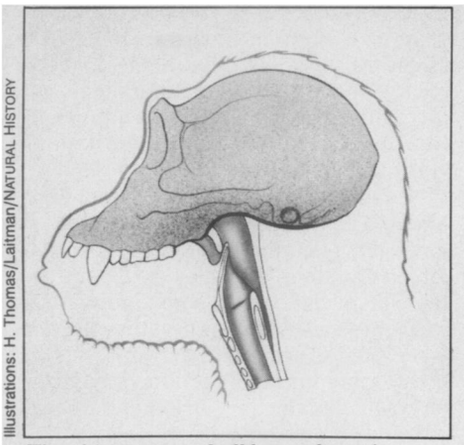
Laitman and his colleagues reconstruct hominid vocal tracts by studying the degree of bend in the bases, or basicrania, of fossil skulls. In comparative studies of mammals ranging from dolphins to apes, using dissections and X-ray movies, they find that a relatively straight, unflexed basicranium indicates a larynx positioned high in the neck. This, they maintain, is the emblem of a nonhuman vocal tract. A highly flexed basicranium, on the other hand, signifies a lower larynx and a vocal tract capable of producing the sounds of modern human speech.

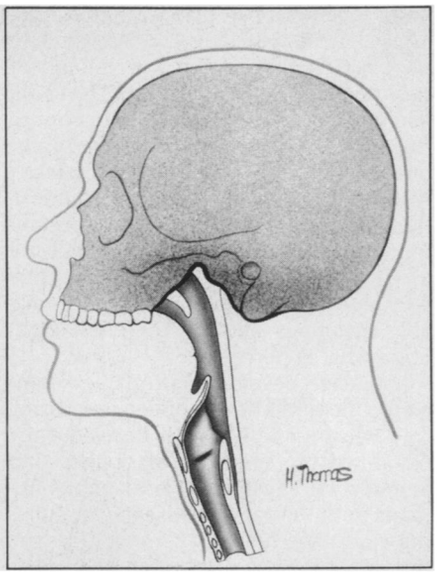
In the "basic" mammalian pattern, described by Laitman at the recent meeting of the American Association of Physical Anthropologists in San Diego, the larynx locks into the nasopharynx – the air space at the back of the nasal cavity – during breathing. This creates a direct airway from the nose to the lungs. An animal with a high larynx can drink and breathe at the same time, because liquid flows through channels on either side of the larynx and nasopharynx.

This arrangement also limits the array of sounds an animal can produce, Laitman says. A high larynx leaves less space for the pharynx, an air cavity that is part of the food pathway and shapes sounds generated by the vocal cords.

Laitman and his co-workers also find that human infants up to about 1½ years of age have an elevated larynx positioned much like that of any other mammal. They can breathe while nursing – an invaluable asset for ravenous babies—but emit a narrow repertoire of sounds.

Shortly after 18 months, an infant's larynx begins to descend in the neck. The larynx no longer locks into the back of the nasal cavity, so the breathing and swallowing pathways cross above it. On the plus side, the pharynx expands and can create a broader range of sounds; on the minus side, food can lodge in the larynx, blocking the airway and causing





Illustrations: H. Thomas/Laitman/NATURAL HISTORY

The chimpanzee skull base above is relatively nonflexed and the larynx is high in the neck. The human skull base at right is arched and the larynx is positioned much lower.

suffocation.

Basicrania of the earliest known hominids—the australopithecines that lived in Africa between about 4 million and 1.5 million years ago—are flat and ape-like, signaling a larynx positioned high in the neck, Laitman says. "*H. habilis* is a big question mark," he adds, because scientists have no well-preserved remains of its skull base. But *H. erectus*, which lived from around 1.6 million to 300,000 years ago, displays bending and flexing of the basicranium comparable to that of a 6-year-old child.

"*H. erectus* probably crossed some type of anatomical rubicon," Laitman contends. "Its vocal abilities were somewhere between those of apes and modern humans."

Fully flexed adult basicrania first appear on *H. sapiens* specimens dating to 300,000 to 400,000 years ago, he says.

The basicrania of European Neanderthals are straighter and less flexed than those of modern humans, and Neanderthal palates are considerably longer, Lieberman says. On the basis of a computer model of a Neanderthal vocal tract, presented in his book *The Biology and Evolution of Language* (Harvard University Press, 1984), Lieberman argues that Neanderthals could not produce sounds for the vowels "i" or "u." Sounds they were capable of making would have been highly nasal and subject to significantly more errors in pronunciation than those made by modern humans, he adds.

Other investigators, such as anthropologist Dean Falk of the State University of New York at Albany, say Lieberman's computer model miscalculates Neanderthal vocal capabilities. Falk's reconstruction of the larynx and hyoid position in the same specimen analyzed by Lieberman, described in the July 1975 AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY, indicates Neanderthals could produce the full range of speech sounds. But Falk considers Neanderthals a side issue in the search for the origins of language.

"Paleoneurologists [who study brain evolution] seem to agree that language originated early in hominid evolution," Falk says.

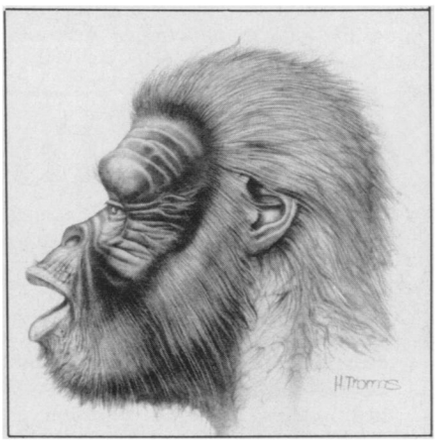
For instance, a cast of the cranium's inner surface—known as an endocast—taken from the brain case of a 2-million-year-old *H. habilis* specimen contains a groove in the left frontal lobe that resembles Broca's area, a region critical for speech production and the comprehension of complex grammatical phrases by modern humans. In separate studies conducted several years ago, Falk and Phillip V. Tobias of the University of the Witwatersrand in Johannesburg, South Africa, suggest this marking on the *H. habilis* endocast represents the beginnings of spoken language.

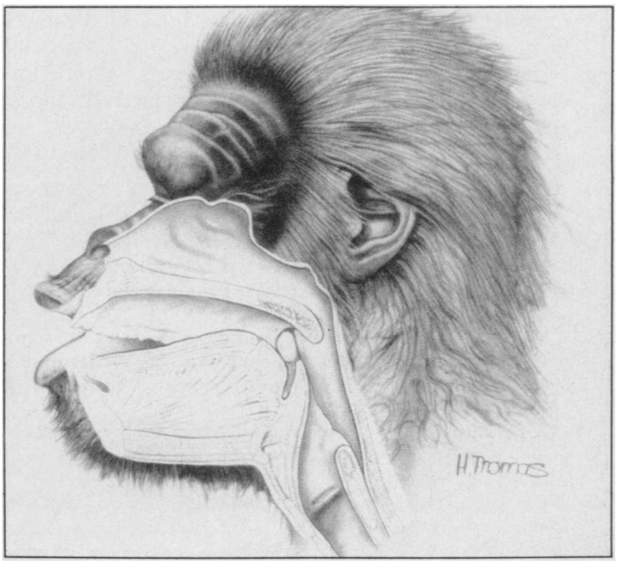
Language was the driving evolutionary force behind the rapid increase in brain size that began with *H. habilis*, according to Falk.

The dimples and bumps on endocasts are often ambiguous, however. In a long-running dispute, Falk asserts that australopithecine endocasts look essentially ape-like, while anthropologist Ralph L. Holloway of Columbia University in New York City argues that the same casts show a more human pattern suggesting the presence of a primitive form of language 2.5 million to 3.5 million years ago.

However australopithecine brains were arranged, evidence now suggests that the right and left brain hemispheres in monkeys have specialized functions somewhat analogous to those observed in humans (SN: 1/7/89, p.10). Falk and others say this implies that the neurological underpinnings of the left hemisphere's important role in human speech and language emerged early in primate evolution, tens of millions of years ago.

Harvard University neuroanatomist Terrence W. Deacon contends that the left-hemisphere region linking the hoots and coos of monkeys to human utterances is not Broca's area but a patch of tissue just in front of it called the prefrontal area. At the physical anthropology meeting, Deacon cited evidence that similar neuronal connections exist in the





A reconstruction of an australopithecine vocalizing (top) and a cross section of its vocal tract (right) are based on findings from fossil basicrania. The volume of the throat above the larynx is much smaller than in modern adult humans. Space for the pharynx is too limited to modify sounds produced by the vocal cords to the extent required for modern speech.

prefrontal areas of both monkeys and humans.

He says his studies reveal that a large number of nerve cells in monkey prefrontal tissue connect to deep-brain structures responsible for automatic behaviors such as breathing. Although researchers are just beginning to explore the function of the prefrontal area, Deacon says it apparently programs and organizes brain messages, which are then sent to motor areas that produce various types of primate calls.

Brain imaging studies and electrical stimulation of precise spots on the brains of anesthetized humans (SN: 4/30/88, p.281) indicate the prefrontal area is crucially involved in word perception, silent and oral reading, verbal reports of memories and grammatical analysis of complex sequences of spoken words.

Deacon suggests that the array of prefrontal neurons involved in primate calls expanded during hominid evolution, while their connections to the automatic controls of the inner brain weakened. In his opinion, the evolutionary push toward a brain capable of consciously controlling speech began at least 2 million years ago and concluded with the appearance of early *H. sapiens* around 300,000 years ago.

"In some ways, primate calls have been reborn in human speech and incorporated into a larger network of prefrontal neurons," he contends.

Among those disputing the argument that language has ancient roots and a long development period are anthropologist Iain Davidson and psychologist William Noble, both of the University of New England in Armidale, Australia. In the April CURRENT ANTHROPOLOGY, they argue that modern humans transformed vocal forms of communication into language sometime around 50,000 years ago. They define language as a system of widely recognizable meanings allowing one to reflect upon what is perceived.

Language developed after the expansion of hominid brains ended, according to Davidson and Noble. It derived, they say, from the mimicry of objects and animals with gestures. For example, humans initially may have used an undulating wave of the hand to represent a bison's hump. Mimicry, say the researchers, was a precursor of the sophisticated tools and symbolic artwork, such as cave paintings and carved figurines, that abruptly appeared in the archaeological record about 32,000 years ago.

With the mental facility for symbolism, humans developed the shared meanings that make up language, Davidson and Noble say.

Their argument dovetails with that of anthropologists Philip G. Chase and Harold L. Dibble, both of the University of Pennsylvania in Philadelphia. Tools and other remains left by Neanderthals—who lived between about 130,000 and 35,000 years ago—show no indication that these creatures possessed the intellectual capacity for symbolic thought or language, the Philadelphia researchers report in the June 1987 JOURNAL OF ANTHROPOLOGICAL ARCHAEOLOGY.

Neanderthals and their hominid contemporaries were probably capable of foresight, planning and strong affection for one another, and they evidently extended special care to some individuals with physical handicaps. But they did not leave behind symbolic artwork or stylistic variations in tool production linked to language later on, Chase and Dibble conclude.

Researchers base their inferences about the origins of language and culture on "fragile and indirect lines of reasoning," says neuropsychologist John C. Marshall of Radcliffe Infirmary in Oxford, England. In his opinion, the Kebara hyoid bone lends credence to the notion that Neanderthals were capable of modern speech. Nevertheless, he adds, "the argument about their language capacity will undoubtedly run and run until we discover a deep-frozen Neanderthal who is susceptible to resuscitation."

In that unlikely event, the thawed-out Neanderthal will face perhaps the ultimate linguistic challenge of the technological age – enduring the endless questions of scientists, talk-show hosts and science writers. □