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Neanderthal Speech

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In the history of human adaptation there have been several important morphological changes that have had a great influence on human evolution. One of these morphological changes was the reorganization of the upper respiratory tract which allowed for the development of language. In the past twenty years, much of the research that has been done on the study of hominid vocalization has centered on the question of Neanderthal speech. The main problem with reconstructing the upper respiratory tract of hominids is the lack of fossil remains (Laumann et al., 1979). Most of the structures involved in vocalization are made of soft tissue such as muscle and cartilage and therefore are not preserved. Several bones, such as the hyoid and the styloid processes, which are key in determining the morphology of the upper respiratory tract, are rarely preserved even in modern skeletons (Arensburg et al., 1990). As a result, researchers have turned to other clues to reconstructing the upper respiratory tract of Neanderthals. Three lines of evidence have been pursued: (1) the study of newborn human morphology, (2) the study ape morphology, and (3) fossil evidence.

Lieberman, the Hyoid Bone, and Reconstruction

One of the first researchers to begin work on Neanderthal speech was Philip Lieberman. In 1971 Lieberman along with Crelin published a paper that discussed the speech abilities of Neanderthals. They approached the problem by comparing the crania of Neanderthals to those of human newborns, human adults, and apes in order to reconstruct the upper respiratory tract of Neanderthals. Then using a computer model, they analyzed the vocal abilities of the reconstructed vocal tracts. Lieberman and Crelin (1971:204) claimed that "human speech is essentially the product of the source, the larynx for vowels, and a supralaryngeal vocal tract transfer function". Based on the computer model, they found that when compared to newborn and adult humans, Neanderthal vocal abilities resembled human newborns. Therefore, they concluded that Neanderthals were incapable of producing the full range of modern (adult) human sounds. Lieberman and his colleagues argued that Neanderthals lacked the anatomy that is essential for producing (1) vowel sounds such as [i], [u], and [a], and (2) nasal versus non-nasal sound, and that the vocal abilities of Neanderthals were best suited for communication at slow speeds.

Criticism of Lieberman and Crelin's work began almost immediately and has not stopped since. Most of the criticism has been directed at their reconstruction of the Neanderthal upper respiratory tract and not the computer model; if the reconstruction is incorrect then its application in the computer model is misleading. Most researchers agree that the position of the hyoid bone, and therefore the larynx relative to the mandible and the cervical vertebrae will determine vocal ability (Houghton, 1993; Arensburg et al., 1990; Laitman, 1985; Falk, 1975; Lieberman and Crelin, 1971). The positioning of the larynx will then determine the shape of the larynx, the size of the oral cavity, and the position of the tongue. The position of the Larynx can be estimated by determining the position of the hyoid bone. In humans the hyoid bone lies below the body of the mandible, and in apes and newborn humans the body of hyoid lies above the inferior border of the mandible (Laitman, 1985; Falk, 1975). Lieberman and Crelin try to show that the position of hyoid in Neanderthals was similar to that of Newborns and apes.

Most of the morphological features in Neanderthals that Lieberman and Crelin describe as "pongid-like" or as similar to newborns have nothing to do with position of the hyoid or can be interpreted very differently (Arensburg, 1990; Falk, 1975). A review of Lieberman and Crelin's reconstruction shows that there are several problems with the newborn model. According to Lieberman and Crelin (1971), Neandertal crania and human newborn crania are similar in appearance if a Neanderthal cranium is reduced to the size of a human infant's cranium. They claim that the human infant and Neanderthal skulls are more elongated from front to back and more flattened from top to bottom than the adult human cranium and that the squamous portion of the temporal bone is similar in infant humans and Neandertals. What Lieberman and Crelin fail to mention is how these morphological similarities are associated with the ability to speak. The bony
areas that are relevant to the position of the hyoid bone are the styloid processes, the mandible, and the mastoid processes (Dickson and Maue, 1970; Kahane and Folkins, 1984). Therefore, the flattening and elongation of the cranium has no effect on vocal abilities as is evident by numerous examples of culturally modified crania. The squamous portion, the styloid process, and the mastoid process are all located on the temporal bone. However, this proximity does not necessarily imply that the squamous portion is also related to vocal ability. Rather, the squamous portion of the temporal bone is affected by the position of the zygomatic arch, the masseter muscle, and temporal muscles which are all associated with mastication (du Brul, 1977).

Lieberman and Crelin (1971) go on to state that the mastoid process is absent in newborn humans, is absent in chimpanzees, is relatively small in gorillas, and is relatively small in Neandertals when compared to adult humans. They admit that there is a great deal of variation in the mastoid process of modern humans and that the Neanderthal specimen they used fell within the range of their collection of modern human crania. The mastoid process is the anchor for two muscles: the sternocleidomastoid which attaches with the clavicle and the sternum, and the digastric muscle which attaches with the hyoid and the mandible (Dickson and Maue, 1970). Therefore, the mastoid process can be used as a land mark to determining the position of the hyoid bone. However, the primary function of the mastoid process is an anchor for the sternocleidomastoid muscle which is a muscle that plays an important role in holding the head upright in bipeds. This function of the mastoid explains the variation in size in Lieberman and Crelin’s collection; it explains why newborns lack a mastoid process (Carlisle and Siegel, 1974); it explains why chimpanzees and gorillas either do not have mastoid processes or have very small ones (they are not fully bipedal); it explains why human females can have smaller mastoid processes and speak just as well as human males. Furthermore, the size of a the mastoid processes can be affected by mechanical stress as is evident in societies were women carry heavy loads on their heads. Therefore, it is logical to conclude that the mastoid process can be fairly important in locating the position of the hyoid (and therefore the larynx) but the size of the mastoid process does not seem to be affecting vocal abilities in any significant way (Burr, 1976).

Lieberman and Crelin discuss the similarities in the mandible of Neandertals and newborns. They state that both Neandertals and newborns lack a chin, which they describe as a "pongid characteristic". However, they do not state how this "pongid characteristic" is related to vocalization. The muscles that attach with the hyoid and the mandible are the mylohyoid muscle, the geniohyoid muscle, and the digastric muscle (Dickson and Maue, 1970; Kahane and Folkins, 1984). These muscles articulate with the mandible on the posterior and inferior portions of the mandible and not the chin. Although the obicularis oris muscle is located in the lip and chin area and plays a role in lip movement and speech, it does nothing in helping to locate the position of the hyoid or the larynx. Burr (1976:286) states, "the lack of chin [has] no relation to articular speech". The insignificance of the lack of chin in vocalization can be demonstrated by simply looking at the great deal of variation in chin size in modern humans (Carlisle and Siegel, 1974). Lieberman and Crelin go on and state that the gonial angle in Neandertals and newborns is similar in inclination, and that the mandibular foramen and mylohyoid groove of both are also similarly angled. Again Lieberman and Crelin do not state how this is significant to vocalization or how these features relate to the position of the larynx. Lieberman and Crelin do not give the gonial angle, they simply state that the Neanderthal angle is greater than their human specimens. Therefore, it is impossible to state if the angle found in the Neanderthal mandible is within the range of human variation. There are reasonable explanations for the large gonial angle and the angle of the mylohyoid groove and the mandibular foramen in the Neanderthal specimen. The Neanderthal specimen used by Lieberman and Crelin is the cranium from La Chapelle which suffered from "prolonged and intensive periodontal disease" (Carlisle and Siegel, 1974:321). As a result, the individual suffered a great deal of antemortem tooth lose and alveolar resorption which likely caused the deformation of the mandible and the exaggerated gonial angle (Carlisle and Siegel, 1974). Lieberman and Crelin also state that Neandertals and newborns have similar mandibular coronoid processes and mandibular notches. Lieberman and Crelin are vague in their descriptions; they describe the coronoid process as "broad" and the mandibular notch as "relatively shallow" in newborns and Neandertals. As du Brul (1977) states the broad coronoid process, the shallow mandibular notch, and the broad mandibular ramus are adaptations that allow for a greater force to be exerted on the occlusal surface of the teeth. Houghton (1993), also states that these morphological features have no effect on the oral cavity or the oropharynx because the pharynx commences just posterior to the alveolar portion of the mandible; Houghton bases this statement on the position of the pterygomandibular ligament and mylohyoid muscle. Therefore, these adaptations in Neandertals are clearly not vocally related (or vocally restrictive).

Lieberman and Crelin attempt to draw
similarities between the size and shape of palatine bone, the palatine process of the maxilla, and the dental arch in Neandertals and newborn humans. They state that in Neandertals and newborn humans, the distance between the anterior portion of the palatine process of the maxilla (incisive foramen) to the posterior part of the palatine bone is equal to the distance between the posterior part of the palatine bone to the anterior border of the foramen magnum along the sagittal section. As Carlisle and Siegel (1974) point out all of these so call morphological differences exhibited by the Neandertals are within the range of modern human variation. Furthermore, the base of the cranium of the La Chapelle fossil is one of the areas that was missing and needed reconstruction, and Lieberman and Crelin did most of their work on a cast of the original cranium. Burr (1976) writes that the original La Chapelle cranium was missing the sphenoid, had only part of the vomer, and had a gap of nine millimetres between the reconstructed sphenoid and the vomer. Burr adds that in the cast used by Lieberman and Crelin, the sphenoid and the occipital "meet at the synchondrosis in a perfectly shaped shallow arch" (1976:286). Therefore, any measurements of the base of the skull can not be accurate and the conclusion of Lieberman and Crelin that the nasopharyngeal arch of the Neandertals was shallow is also questionable.

Lieberman and Crelin base a great deal of their reconstruction on the angle of the styloid process. The cranium from La Chapelle has the bases of the styloid processes still intact. Lieberman and Crelin (1971:207) claim that "there are sufficient fossil remains of the Neanderthal's left styloid process to determine accurately its original approximate size and inclination". Not all researchers disagree with Lieberman and Crelin on this point, but some researchers have discovered several flaws with Lieberman and Crelin's approach. Based on Lieberman and Crelin's (1971) diagrams, Falk (1975) estimates the angle of inclination of the styloid process to be approximately 46'. When Falk measured the angle of inclination of the styloid process on an accurate photograph of the original La Chapelle cranium, he found that the angle of inclination was 67'. Also, as previously mention, the bottom of the La Chapelle cranium was fragmentary or missing and as Burr (1976:287) points out, the crushed base of the cranial vault would cause the angle of the styloid process to "decrease with respect to the cranial base". As a result of the distorted positioning of the styloid process, Lieberman and Crelin incorrectly position the hyoid bone, the larynx and the tongue. When swallowing, the hyoid bone has no place to move to when swallowing.

Houghton (1993) points out another major flaw in Lieberman and Crelin's (1971) reconstruction. The cervical vertebrae on the Lieberman and Crelin reconstruction are not curved; they show no vertical lordosis. Also, Houghton points out that the Neanderthal cranium has been incorrectly placed on the Frankfurt plane and therefore the cranium is "looking upwards." When oriented horizontally, the Frankfurt plane is "a reasonable indication of normal human head posture" (Houghton, 1993:139). Houghton (1993:140) states that when the skull is reoriented to align with the horizontal Frankfurt plane, "the cervical spine is given a reasonably human lordosis". Houghton states that essentially the same morphology of the vertebrae is maintained except that the cervical lordosis requires that the intervertebral discs be incorporated into the reconstruction. These intervertebral discs account for a 25% increase in overall length of the cervical spine and their presence is entirely responsible for the lordosis. Houghton states that this correction of the orientation of the Neanderthal skull will alter the orientation of the styloid processes and the pterygoid processes so that these processes will resemble human morphology more and will resemble ape and newborn morphology less. There are some problems with Houghton's interpretations. The cervical lordosis does orient the styloid processes and the pterygoid processes in a more vertical plane but it does nothing to reorient these processes with respect the Frankfurt plane; the absolute angle between the styloid processes and the Frankfurt plane does not change by reorienting the entire skull. However, Houghton does make several important points regarding the cervical lordosis and the position of the tongue. Lieberman (1989), tries to show that a tongue that is human in shape and size could not possibly fit in the reconstructed oral cavity of Neandertals. Lieberman claimed that if the human tongue was placed in the Neanderthal reconstruction, it would yield "an impossible creature" with its larynx in its chest. Houghton (1993) suggests that Lieberman has incorrectly interpreted the landmarks that determine the position of the tongue: the genial tubercles, the mylohyoid line, the length of the palate, the anterior margin of the mandibular ramus, and the distance between the posterior aspect of the mandibular symphysis and the anterior aspect of the cervical column. As a result, Houghton states that Lieberman has positioned the tongue too low in the reconstruction. When these landmarks are taken into consideration and when
the reconstruction takes into account the cervical lordosis, Houghton is able to place the human-sized tongue in the reconstruction and still be able to position the larynx at the four-fifth intervertebral disc were it is located in modern humans (Arensburg, 1989).

**Laitman and Cranial Measurements**

The lack of preservation of the styloid processes and the hyoid bone has forced researchers to explore other ways of reconstructing the upper respiratory tract of fossil hominids. In a series of papers (e.g. Laitman 1985; Laitman et al., 1979; Laitman et al., 1978), Laitman and colleagues have explored how the basicranium of humans, apes, and monkeys relates to the position of their hyoid bone, the larynx, and the epiglottis. Laitman determined the amount of flexion by a series of nine linear measurements taken between points on the external surface of the base of the skull. Laitman suggests that a flat or non-flexed basicranium corresponds with a larynx that is positioned high in the neck and this pattern was found to exist in all the mammals Laitman examined except for humans. In humans, the basicranium was found to be "markedly" arched or flexed and corresponded to a larynx position low in the neck. Laitman points out that this pattern found in humans occurs only "after the early years of life" (1985:284). Laitman applied these patterns to the fossil record as a tool in determining the position of the larynx and therefore the vocal abilities of the fossils. He was trying to develop a method that could apply to all fossil hominids, but in regards to Neandertals Laitman et al. (1979:31) write that 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." However, Laitman takes a less extreme stance and states,

> the first instances of full basicranial flexion similar to that of modern humans does not appear until the arrival of Homo sapiens some 300,000 to 400,000 years ago. It may have been at this time that hominids with upper respiratory tracts similar to ours first appeared. (1985:286)

Several researchers have been critical of the basicranial method. Houghton (1993) questions the value of such measurements. He states that the name "basicranial" is misleading since it includes points such as the prosthion and the staphyion which are not considered to be on the cranial base. Instead, Houghton proposes that the cranial base angle (nasion-epiphion-basion or nasion-sella-basion measured radiologically) be used to compare the flexion of the base of the skull. When compared this way Houghton found that the Neanderthal cranial base angle was within modern human range. However, Houghton's proposal is as useful as Laitman's since he fails to state how either measurement relates to the position of the hyoid, the larynx, and phonetic capabilities (Arensburg et al., 1990). Houghton (1993) does uncover other problems with Laitman's method. Houghton points out that Laitman is using the middle of sphenoidal synchondroses in his measurements and with the fusion of this joint this position must be estimated. This problem is further compounded when the base of the cranium is fragmentary. Laitman states that "osteo-metric land marks were occasionally missing... and these points were reconstructed... using those landmarks that were present".

Other problems with Laitman's basicranial method is the classification of crania in age groups. Laitman et al. (1979:16) arbitrarily divided the specimens that they were working on into five age groups according to dental eruption:

- **stage 1:** prior to eruption of the deciduous dentition.
- **stage 2:** from the eruption of the first central incisor to eruption to complete deciduous dentition,
- **stage 3:** eruption of the first permanent molar,
- **stage 4:** eruption of the second permanent molar,
- **stage 5:** eruption of the third permanent molar.

Laitman stress that newborn humans aged from one and one-half to two years have a larynx that is positioned high on the neck and that these infants have upper oropharyngeal morphology that is similar to apes and monkeys. Yet in the age classification of the specimens this critical age of about two years old is lumped between the eruption of the first deciduous incisor and the eruption of the first permanent molar which covers the ages from about six months to six years old (Ubelaker, 1992). The Classification of Laitman et al. (1979) of the La Chapelle cranium as having a stage 2 Homo flexion can mean that Neandertals could have the vocal abilities of 6 month old infant or a 6 year old child. Furthermore, Laitman et al. (1979) state that several specimens such as the Predmost 4, and the Cro-Magnon skulls could be assigned to stage 2 Homo, stage 4 Homo, or stage 5 Homo, and that the Neanderthal skulls from La Ferrassie, Monte Circeo, and Saccopastore can be assigned to stage 2 Homo or stage 3 Homo. This shows two things: that Neanderthal variation overlaps with Homo sapiens variation and that the classification system used by Laitman et al. is somehow lacking if several crania can be classified in more than one stage.
Archaeological Evidence: the Kebara Cave Hyoid

In 1983, a multidisciplinary team of researchers working in Kebara Cave, Israel, made an extraordinary find (Bar-Yosef et al., 1986). In Unit 12, dated to about 60,000 years BP (Valladas et al., 1987), a well preserved skeleton was found that had (1) a nearly complete hyoid bone and (2) all the cervical vertebrae in anatomical position. The complete mandible was found with all its teeth, and most of the post-cranial skeleton was found except for the right leg. The skull was missing except for the upper right third molar (Bar-Yosef et al., 1986). The hyoid from Kebara was not complete; the distal tip of the left greater horn and the two lesser horns were missing, and the greater horns were not fused to the body (Arensburg, 1989). However, Arensburg (1989) states that the articular facets for the greater horns are very well marked on the lateral borders of the body, and the ligamentous attachments for the thyroid cartilage are very clear on the right greater horn. Arensburg also states that the point of attachment for various muscles such as the geniohyoid, and omohyoid are visible. In their study Arensburg et al. (1990) compared the hyoid bone from Kebara to a collection of modern hyoid bones. Arensburg et al. (1990) found that "the attachment areas for the infrahyoid muscles on the ventral surface of the body [of the hyoid] are identical to those of modern humans, as are the attachments for the hyoglossus muscles". The infrahyoid muscles are (1) the sternohyoids that attach with the body of hyoid, and with the superior portion of the manubrium and the medial end of the clavicle, and (2) the omohyoids that attach with the greater horns of hyoid and with the superior border of the scapula. The hyoglossus muscle articulates with the greater horn of the hyoid and supports the styloglossus muscle and the tongue (Dickson and Maue, 1970). These muscles hold the hyoid and the tongue in an inferior and somewhat posterior position in humans (Dickson and Maue, 1970). Arensburg et al. (1990; and Arensburg, 1989) state that even though the mandible from Kebara is massive, the size and shape of the hyoid is essentially human and not like the box shaped hyoid found in great apes. Although the cranium was not preserved, the Kebara hyoid bone, mandible and complete cervical vertebral column reveal a great deal about this individual's upper respiratory tract and vocal abilities. Based on the muscle marks, the shape of the hyoid, the size of the hyoid bone, and the hyoid bone's relation to the cervical vertebrae, this individual likely had his hyoid, and therefore larynx, in the same position as modern humans. This evidence supports Houghton's (1993) reconstruction of the Neanderthal upper respiratory tract.

The near east is a unique area during the Middle Palaeolithic; both Neandertals and Homo sapiens were present at the same time. The majority of the differences between Neandertals and Homo sapiens are found in the cranial morphology (Nelson and Jurmain, 1991). Therefore, it is not absolutely certain if this skeleton from Kebara Cave is Neanderthal or not. Arensburg (1989:338) states that the find has implication for the "Mousterian peoples of this site" and he does not explicitly state that skeleton is Neanderthal. Arensburg et al. (1990) in their study of the hyoid bone from this skeleton were reluctant to explicitly state that this was Neanderthal, rather they stated that they were investigating "Middle Palaeolithic" speech abilities. Other researchers are less ambiguous: Bar-Yosef et al. (1986:64), the excavators of the Kebara skeleton, state "the characteristics of the skeleton indicate affinities with the Tabun, Amud, and Shanidar [Neanderthal] group rather than with the Qafzeh-Skhul one", and Valladas et al. (1987:159), also participants in the excavation of the site, state "unit XII [at Kebara] yielded a well-organized, almost complete burial of an adult Neanderthal". Since this find is very likely a Neanderthal, Lieberman's reconstruction and Laitman's approach are even less likely. Arensburg et al. (1990) addresses the work of both researchers; they state that Lieberman's reconstruction which places the hyoid at the height of the body of the mandible and not bellow is not in accordance with the new find.

Apart from the practical problems with Lieberman and Laitman's work, there are several theoretical problems. One theoretical problem with the approach of some researchers is their inability to show how the morphology of the upper respiratory tract is affected by respiration, mastication, and vocalization. All three are functions that influence the morphology of this area; determining which traits are a result of which function is essential. Another theoretical problem with Lieberman and others, especially those that propose ape models, is that they do not account for morphological variation due to locomotion. Falk (1975:131) states some characteristics of the human upper respiratory tract such as the separation of the epiglottis from the soft palate are "correlated with the evolution of erect posture". Laitman discusses in some detail how newborns and other mammals are able to swallow liquids and breath almost simultaneously. However, he does not state how the morphology of the basicranium is directly affected by these functions. Laitman does not present any evidence that shows that the flexion of the basicranium is related to vocalization and not mastication, respiration or locomotion. Lieberman does not address these issues at all; he does not take into account that the shape of the Neanderthal mandible may not directly relate with vocalization but rather is an adaption to diet or using the mouth.
as a tool.

There has been a great deal of debate over the range of vocal abilities of Neandertals. There is no clear evidence that suggests that the upper respiratory tract of Neandertals was any different from that of modern humans. However, there is evidence that strongly suggests that the morphology of the Neandertal upper respiratory tract is within the range of variation found in modern (adult) human populations. The ultimate goal of most of the researchers is to use the upper respiratory tract reconstructions as another tool in determining hominid phylogeny (LaUman, 1985; Laitman et al., 1979; Laitman et al., 1978, Lieberman and Crelin, 1971). Although the ability to speak can not be used alone to determine how Neandertals are related to other hominids, reconstruction of the upper respiratory tract is another line of evidence that can be pursued while researchers attempt to solve the "Neanderthal Problem" (Valladas et al., 1987). Research done by Lieberman, Laitman, and others has forced physical anthropologist to take a closer look at what enables humans to communicate through spoken language. There are still many unanswered questions surrounding the upper respiratory tract of fossil hominids. Arensburg et al. (1990) explicitly state that although the hyoid bone from Kebara strongly suggests that Middle Palaeolithic hominids had an essentially modern larynx, the find is an isolated one. Once the debate over Neanderthal speech is fully resolved, the techniques that have been used and tested on the Neanderthal case can then be applied to other fossil hominid with a greater degree of confidence.

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