Jennifer Wagner

"Motor Control, Speech and the Evolution of Human Language" by Philip Lieberman

Lieberman's article examines characteristics of human anatomy that make human speech and language possible. Using recent studies of neuroanatomy of the human brain, he attempts to explain language evolution through the framework of Darwin's natural selection and comparative method. Although ancestral reptilian brains did not fossilize and so cannot be compared to contemporary reptilian or mammalian brains, inferences can be made involving the differentiating traits between modern-day reptiles and mammals.

Lieberman refutes the idea that human language is completely unrelated to the language or communication systems of other species. Comparative studies "show that the biological bases of human linguistic ability depend both on primitive characteristics shared with many species and on certain derived anatomical and neural properties" (256). These primitive characteristics include lexical ability, which extends back to the beginning of hominid evolution, as well as syntax, which Lieberman argues that chimpanzees can understand. As a gradualist, Lieberman believes these primitive mechanisms disprove theories of sudden transitions between proto-language and full language.

Although apes can somewhat understand human language, they cannot use speech. Humans use a sequence of articulatory gestures to produce sounds through the nose and mouth, but apes do not have this capacity to alter muscle commands to produce the same sounds. Additionally, field studies show that ape vocalizations are not voluntary, and are bound to certain emotions or situations. Therefore, "speech production is a characteristic of human language" and the evolution of speech must be understood first before the evolution of syntax, which too many theoretical linguists focus on when discussing the evolution of human language.

In the next section, Lieberman provides an explanation of human speech production using articulatory and acoustic phonetics, and what role this plays in linguistic ability and language evolution. Humans are able to understand rapid speech due to the encoding of formant frequencies that change every time the supralaryngeal vocal tract changes shape. "It is impossible to isolate formant frequencies of the individual sounds that constitute the syllable" (260) so several sounds are encoded together as a unit. This perceptual mechanism is also "a primitive mechanism used by other species to gauge the size of a conspecific by listening to its vocalizations" (260).

However, the adult humans differ from all other animals in that the vocal tract has a right-angle bend at its midpoint. Additionally, adult humans cannot breathe and drink simultaneously due to the lowered larynx which prevents the air pathway from being sealed from the oral cavity. On the contrary, only adult humans can produce the vowels [i], [u] and [a] but no other animals (or human infants) can. Modern human faces are in line with the forehead, while modern apes have longer faces and tongues. Chewing is less efficient in the shorter mouths of humans, and food can become lodged in the lowered larynx. Since the functions of eating, swallowing and breathing are burdened by the human vocal tract in producing speech, "the neural capacity to produce speech must have been in place before the evolution of the modern human [vocal tract]" (262).

Lieberman next explains the neural bases of human language and states that the locationist theories of Broca's and Wernicke's areas are wrong. Functional neural systems are actually responsible for complex behaviors and they are linked throughout the brain, rather than being localized to one area. Lieberman believes "the human brain contains a 'functional language system' (FLS) that evolved to regulate the production and comprehension of spoken language" (264). He also believes the basal ganglia plays a much larger role in human linguistic ability and other aspects of human behavior.

Using experimental studies on the neural bases of language, Lieberman tries to show that damage to Broca's and Wernicke's areas do not result in permanent aphasia, but that damage to the basal ganglia does. After a brief explanation of Broca's and Wernicke's aphasia, Lieberman disagrees with the accepted belief that damage to these areas alone can cause aphasia, quoting Stuss and Benson's conclusions that damage to the basal ganglia and white matter is most likely responsible. Furthermore, Lieberman cites research on neurodegenerative disorders and states "the behavioral effects of these diseases can illuminate the role of basal ganglia" (267) in the damage to the brain.

Further studies of neurodegenerative disorders posit that "basal ganglia circuitry implicated in motor control does not radically differ from that implicated in cognition" (268). Broca's aphasics have trouble controlling the sequencing of articulators in the mouth, especially the lips and larynx in Voice Onset Time. However, formant frequency patterns are controlled by the configuration of the supralaryngeal vocal tract, and so control of these structures is not hindered in aphasics. Other studies on patients with Parkinson's disease and hypoxia produced results of "correlated deficits in sequencing manual motor movements and linguistic operations in a sentence comprehension task" (269).

In the last section, Lieberman explains the evolution of the neural bases of language and the role of the basal ganglia in the evolution of the FLS. "The FLS may derive from neural systems that produced timely motor responses in response to changing environmental challenges and opportunities" (269). Using comparative studies of animals and humans again, Lieberman points out that the cortex and basal ganglia work together. They are both involved with motor control and cognitive ability. Research on the family KE demonstrates these roles that the basal ganglia and cortex play.

Lieberman ends his article with one of the first features that distinguishes humans from apes: bipedalism. Walking upright is a learned behavior, and an inability to walk upright is caused by damage to the basal ganglia. "Perhaps Natural Selection for basal ganglia that facilitate learning and sequencing complex movements" (271) was the reason for the initial production of human speech and complex syntax.