Articles

What Paleo Voice Recognition Can Tell Us About Early Humans' Hearing

by Diana Crow

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When early hominins—the chimp-like forerunners of modern humans—moved from the forest to the savannah, they also started hearing a bit more like modern humans, according to a study in the September 25th issue of *Science Advances*.

Paleoanthropologist Rolf Quam of Binghamton University and his colleagues carefully measured the ear bones and ear holes of skeletons from two three-million-year-old hominid species, *Australopithecus africanus* and *Paranthropus robustus*, and found that these species' ear bones fell somewhere in between human and chimpanzee ear bones size-wise. However, ear bone length alone won't help you fully reconstruct our ancient relatives' auditory abilities. For that, the paleoanthropologists teamed up with a telecommunications engineer who works on voice recognition.

Manuel Rosa from the University of Acalá in Spain usually works on algorithms to make cellphone and Skype calls clearer, but on this study he helped develop a computer simulation of how the ancient ear bones would have vibrated in response to various types of sound waves. They ran trials of their simulation with 3D data from CT scans of both fossils and ear bones from modern humans and chimpanzees. Since the simulations based on modern human and chimpanzee ear bones match what humans and chimpanzees can hear, it's likely that their estimates are fairly accurate for *Australopithecus* and *Paranthropus,* Rosa says.

Modern chimpanzees are sensitive only to a relatively narrow band of low-frequency sounds in the 500-3000 hertz (cycles per second) range, which reverberate off of tree trunks and leaves. Humans, on the other hand, are sensitive to a wider range of frequencies; we can clearly distinguish sounds up to about 4000 or 4500 hertz.

Quam says that wider range of sensitivity is key for the evolution of human language,

because most consonant sounds occur in the 1000 to 4500 hertz range. Chimpanzees have no trouble hearing most vowels, but they would have a hard time telling the word "ought" apart from rhyming words like "thought" and "hot." (But they'd probably have no trouble hearing "got," because the hard "g" sound occurs at about 2000 hertz, well within chimps' range.)

Australopithecus, however, probably heard some consonants in the 2500 to 3500 hertz range that most likely elude chimpanzees but possibly had trouble hearing sounds above 4000 hertz, like the consonant sounds "th," "s," and "h."

"Aside from being symbolic and sophisticated, one of the other main distinctions between human language and virtually all other forms of animal communication is other animals almost always use vowels," Quam said. "All the utterances—the screeches, the shrieks, the grunts, the screams, all those things—are basically vowels. So the use of consonants is one of the defining features of human language that haven't been so strongly emphasized."

So would *Australopithecus* ears have been able to process modern human speech? "No. But using the model we have learned a lot about human hearing," Rosa said. His team will be able to use the information from the ear-bone simulator to improve speech processing algorithms, which can be used to filter out background noise during Skype calls.

Quam stressed that although these results suggest *Australopithecus* and *Paranthropus* were more sensitive to high frequency sounds than chimpanzees, their hearing was closer to chimps than to modern humans.

Other researchers in the field also caution against assuming that these small ear-bone changes were related to communication. "The modeling system is telling you that there was something these Australopithecines were doing that made it desirable to have more efficient hearing around 3 kilohertz [3000 hertz]," said paleoanthropologist Matt Cartmill of Boston University, who was not involved in the study. "But [the model] doesn't tell you why they needed it," he added.

The outer ears and the auditory nerves also play key roles in hearing, but since those tissues don't fossilize, many aspects of our ancient relatives' sonic landscape will remain uncertain.