# Monkeys Hear Voices

The ability to communicate with language is one of the defining talents of the human mind. The evolution of language, of course, depends in large part on the evolution of speech, which allows us to express ourselves and understand the expressions of others. New research suggests that a brain area underlying a specific aspect of speech - namely, an area devoted to processing voices - is not as uniquely human as previously assumed.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The use of vocalizations, such as grunts, songs or barks, is extremely common throughout the animal kingdom. Nevertheless, humans are the only species in which these vocalizations have attained the sophistication and communicative effectiveness of speech. How did our ancestors become the only speaking animals, some tens of thousand years ago? Did this change happen abruptly, involving the sudden appearance of a new cerebral region or pattern of cerebral connections? Or did it happen through a more gradual evolutionary process, in which brain structures already present to some extent in other animals were put to a different and more complex use in the human brain? A recent [study](http://www.kyb.mpg.de/publications/attachments/Petkov%20-%20Voice%20Area%20-%20NatureNeuro%20-%202008_4896%5B0%5D.pdf) yields critical new information, uncovering what could constitute the "missing link" between the brain of vocalizing, non-human species and the human brain: evidence that a cerebral region specialized for processing voice, known to exist [in the human brain](http://www.nature.com/nature/journal/v403/n6767/abs/403309a0.html), has a counterpart in the brain of macaques. Neuroscientist [Chris Petkov](http://www.kyb.mpg.de/~chrisp)of the Max Planck Institute and his colleagues used functional magnetic resonance imaging (fMRI) to explore the macaque brain. They measured cerebral activity of awake macaque monkeys who were listening to different categories of natural sounds, including macaque vocalizations. They found evidence for a "voice area" in the auditory cortex of these macaques: a discrete region of the anterior temporal lobe in which brain activity was greater for macaque vocalizations than for other sound categories such as natural sounds. This region was observed in several different individuals, even under condition of total anaesthesia. Even more remarkably, the region showed repetition-induced reduction of activity--or neuronal adaptation--in response to different calls coming from a same individual. This finding suggests that this brain region is processing information about the identity of the speaker, a phenomenon that is also observed in the [human voice area](http://www.zlab.mcgill.ca/docs/Belin_and_Zatorre_2003.pdf).

**Long History of Voice?** Perhaps the most remarkable implication of this finding is that the voice area previously identified in the human brain is not uniquely human, and that it has a counterpart in the brain of non-human primates. This discovery, in turn, suggests that the voice area has a long evolutionary history and was probably already present in the common ancestor of macaques and humans some 20 million years ago. It's known that the cognitive talents underlying voice perception, such as speaker recognition, are shared with many other animal species, but the findings of Petkov et. al provide a cerebral location for these abilities. Ironically, most of the research into the evolutionary basis of language has focused so far on a single function - speech perception - which is unique to humans and thus evolutionary precursors are hard, if not impossible, to identify. The present findings suggest another, possibly more rewarding, strategy: it is perhaps rather by looking at what we have in common with other animals - that is, a rich cerebral substrate to process vocalizations and extract speaker-related information - that will allow us to understand the evolution of speech. Indeed, Petkov et al.'s finding suggests that when our ancestors began to talk, a few tens of thousands years ago, they were already equipped with sophisticated neural machinery specialized in processing voice. Another important implication of Petkov et al.'s findings concerns the functional [lateralization](http://en.wikipedia.org/wiki/Lateralization_of_brain_function) of the macaque voice area. A well-established property of the human cerebral substrate for speech (particularly speech production) is its lateralization to the left hemisphere. This well-established left-hemispheric asymmetry has led researchers to investigate whether a similar left hemispheric bias could be found in other animals, as a possible evolutionary precursor of human language. Unfortunately, this longstanding belief has possibly resulted in a strong bias in the literature, whereby studies uncovering any leftward asymmetry in non-human primates are much more likely to be published in high-impact journals.

**A Role for the Right** A counterintuitive but essential feature of Petkov et al's results, similar to the corresponding findings in the human brain, is that voice-selective activity was stronger in the right hemisphere. Furthermore, the identity-specific neuronal adaptation was only observed in the right hemisphere of the macaque brains, exactly as in the corresponding [human studies](http://www.zlab.mcgill.ca/docs/Belin_and_Zatorre_2003.pdf). This finding suggests that the right hemisphere may well have played a major role in how speech appeared in our ancestors, and that a response to the puzzle of speech evolution may not only lie in the left hemisphere. Much work lies ahead before a complete understanding of the functional role of the voice areas, in macaque as well as in humans, can be attained. Several alternative hypotheses remain to be tested: Does the voice area represent hard-wired preference for the particular acoustical structure of vocalizations from that species? Or is it more simply a "formant" detector, a structure specialized in detecting vocal features in general? One other possibility is that this voice area is really a "social" structure, interested in vocalizations because they are important cues for social interaction, and not because they share a particular acoustical structure. In conclusion, the findings by Petkov et al. provide an exciting common substrate for high-level, or complex, auditory cognition that can be studied in parallel in humans and macaques. Critical additional information will certainly be obtained in the near future by exploring the monkey voice area using more conventional electrophysiological techniques, such as recording directly from neurons, now that the location of the voice area in the macaque brain has been established. Even more important, this seminal work opens the road for comparative neuroimaging studies in which humans and other animals perform similar tasks and stimuli using similar methodologies, and the results can be analyzed using similar strategies.