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Do birdsong and human speech share biological roots?

November 22 2017

Two zebra finches. Credit: Raina Fan

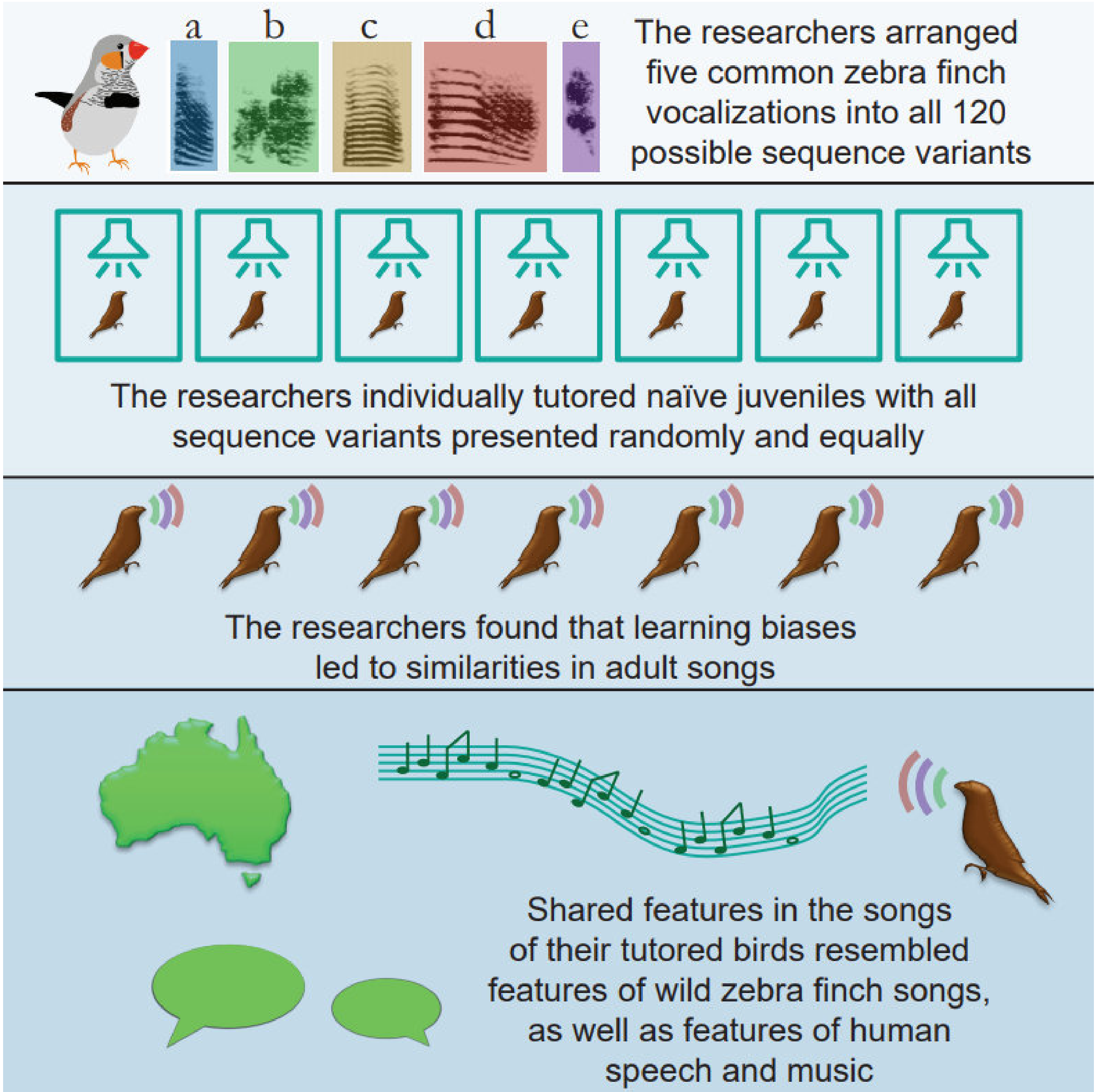
Do songbirds and humans have common biological hardwiring that shapes how they produce and perceive sounds?

Scientists who study birdsong have been intrigued for some time by the possibility that human speech and music may be rooted in biological processes shared across a variety of animals. Now, research by McGill University biologists provides new evidence to support this idea.

In a series of experiments, the researchers found that young zebra finches - a species often used to study birdsong - are intrinsically biased to learn to produce particular kinds of sound patterns over others. "In addition, these sound patterns resembled patterns that are frequently observed across human languages and in music," says Jon Sakata, Associate Professor of Biology at McGill and senior author of a paper published online in *Current Biology* on Nov. 22.

On the shoulders of Chomsky

The idea for the experiments was inspired by current hypotheses on human language and music. Linguists have long found that the world's languages share many common features, termed "universals." These features encompass the syntactic structure of languages (e.g., word order) as well as finer acoustic patterns of speech, such as the timing, pitch, and stress of utterances. Some theorists, including Noam Chomsky, have postulated that these patterns reflect a "universal grammar" built on innate brain mechanisms that promote and bias language learning. Researchers continue to debate the extent of these innate brain mechanisms, in part because of the potential for cultural propagation to account for universals.



Credit: McGill University

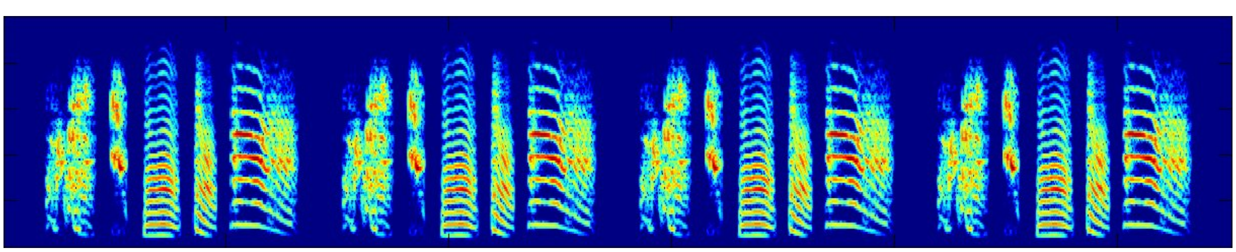
At the same time, vast surveys of zebra finch songs have documented a variety of acoustic patterns found universally across populations. "Because the nature of these universals bears similarity to those in humans and because songbirds learn their vocalizations much in the same way that humans acquire speech and language, we were motivated to test biological predisposition in vocal learning in songbirds," says Logan James, a PhD student in Sakata's lab and co-author of the new study.

A buffet of birdsong

In order to isolate biological predispositions, James and Sakata individually tutored young zebra finches with songs consisting of five acoustic elements arranged in every possible sequence. The birds were exposed to each sequence permutation in equal proportion and in a random order. Each finch therefore had to individually "choose" which sequences to produce from this buffet of birdsong.

In the end, the patterns that the laboratory-raised birds preferred to produce were highly similar to those observed in natural populations of birds. For example, like wild zebra finches, birds tutored with randomized sequences often placed a "distance call" - a long, low-pitched vocalization - at the end of their song.

Other sounds were much more likely to appear in the beginning or middle of the song; for example, short and high-pitched vocalizations were more likely to be produced in the middle of song than at the beginning or end of song. This matches patterns observed across diverse languages and in music, in which sounds at the end of phrases tend to be longer and lower in pitch than sounds in the middle.



Credit: McGill University

Future research avenues

"These findings have important contributions for our understanding of human speech and music," says Caroline Palmer, a Professor of Psychology at McGill who was not involved in the study. "The research, which controls the birds' learning environment in ways that are not possible with young children, suggests that statistical learning alone—the degree to which one is exposed to specific acoustic patterns—cannot account for song (or speech) preferences. Other principles, such as universal grammars and perceptual organization, are more likely to account for why human infants as well as juvenile birds are predisposed to prefer some auditory patterns."

Sakata, who is also a member of the Centre for Research on Brain, Language and Music (CRBLM), says the study opens up many avenues of future work for his team with speech, language, and music researchers. "In the immediate future," he says, "we want to reveal how auditory processing mechanisms in the brain, as well as aspects of motor learning and control, underlie these learning biases."

Denise Klein, Director of the CRBLM and neuroscientist at the Montreal Neurological Institute, says James' and Sakata's study "provides insights on universals of vocal communication, helping to advance our understanding of the neurobiological bases of speech and music."

More information: "Learning Biases Underlie 'Universals' in Avian Vocal Sequencing," Logan S. James and Jon T. Sakata, *Current Biology*,

published online Nov. 22, 2017. www.cell.com/current-biology/f … 0960-9822(17)31322-2 , DOI: 10.1016/j.cub.2017.10.019

Provided by McGill University

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