Scientists question the utility of mice to explore the foundations of vocal learning

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Mice lacking the cerebral cortex develop normal song. Credit: Kurt Hammerschmidt

The human language is unique in that we can refer to objects, events and ideas. The combination of syllables and words enables humans to generate an infinite number of expressions. An important prerequisite for language is the ability to imitate sounds, i.e. to store acquired acoustic information and to use this for one's own vocal production. Cortical structures in the brain play a crucial role in this. While songbirds and certain marine mammals are capable of such vocal learning, there is very little evidence for vocal learning in terrestrial mammals – not even in our closest living relatives, the chimpanzees. Nonhuman primate vocal production is largely restricted to an innate repertoire of sounds.

In order to explain the foundations of vocal learning, mice attracted

increasing attention in recent years. They are more closely related to humans than birds or dolphins, vocalize frequently, and there are numerous so-called "mouse models", where certain genes can deliberately be manipulated. Besides, there was some evidence that to a certain extent mice could be capable of vocal learning. In their recently published study, Julia Fischer and Kurt Hammerschmidt of the German Primate Center (DPZ) in Goettingen together with colleagues from the Max Planck Institute for Biophysical Chemistry have shown that mice are less suited to study the foundations of vocal learning than previously assumed. Animals that do not have a cerebral cortex due to a genetic defect do not differ from healthy mice in their vocalization ("song"). Their vocalizations are thus controlled in evolutionarily older brain areas and are not dependent on cortical processing (Published in *Scientific Reports*).

One of the most pressing questions in human evolution is the emergence of language. We have the ability to imitate words and learn how to use them in certain appropriate situations. Both for higher-order processing of sounds as well as for the planning of vocalizations, the cerebral cortex is essential. There are numerous studies of songbirds, bats, and increasingly of mice that deal with the fundamentals of vocal learning. However, the studies in mice are currently contradictory: It was previously disputed as to whether mice are able to change their vocalization due to imitation or learning. Together with Gregor Eichele and Gabriela Whelan of the Max Planck Institute for Biophysical Chemistry, Julia Fischer and Kurt Hammerschmidt of the German Primate Center examined the ultrasonic sounds of mice that did not have a cerebral cortex due to a genetic defect and compared these with the sounds of their siblings with a normal brain.

The researchers focused on two characteristic vocalizations of the mice. First, they examined so-called isolation calls that occur when young mice are separated from the mother. Since nine-day-old mice that were still

incapable of hearing made these calls, Fischer and her colleagues were not surprised that the calls of the mice without a cerebral cortex did not differ from those of control mice. Second, they studied the "song" of adult males, which is used to attract females. The fact that there was no difference in neither the occurrence of calling nor the acoustic quality of the songs uttered by males with and without cerebral cortex, was a rather unexpected findings for the scientists.

"Apparently, the vocalization of mice is controlled by evolutionarily older areas of the brain," says Julia Fischer, Head of Cognitive Ethology Laboratory at the German Primate Center. Other than in humans, the cerebral cortex is not as important in the vocal communication of mice. "Mice are therefore less suitable for the study of the mechanisms that support vocal learning", she concluded. "Nevertheless, we believe that they are valuable models for the study of the genetic fundamentals of social behavior", she added.

More information: Hammerschmidt, K., Whelan, G., Eichele, G. & Fischer, J. "Mice lacking the cerebral cortex develop normal song: Insights into the foundations of vocal learning." *Sci. Rep.* 5, 8808, DOI: 10.1038/srep08808 (2015).

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