Of singing mice and gene mutations

Annie Roth on a study of neural pathways in a species of rodent and its revelations

In the balmy cloud forests of Central and South America, nightfall is marked by operatic calls of Alston's singing mouse, a small, short-tailed rodent famous for its courteous communication.

These minuscule mice, each of which weighs less than a lightbulb, sing unique, chirp-filled songs to one another that can last as long as 16 seconds. Both sonic and ultrasonic sounds flow from the mouse's mouth, creating a song reminiscent of the buzzing of a cicada. What's more, the mice never interrupt each other; they hold their tiny tongues until their conversational partner is done singing.

Scientists have long wondered what enables these mice to have such uncannily complex conversations. As it turns out, their brains may not be all that different from ours.

In a study published in *Nature*, researchers found that a simple expansion of existing neural pathways allowed these mice to broaden their vocal repertoire — the same mutation believed to have paved the way for the development of human language.

By studying the brains of Alston's singing mice and their non-singing (but closely related) lab mouse cousins, researchers at the Cold Spring Harbor Laboratory on Long Island, New York, US, were able to determine what evolutionary changes in the brain had given rise to the singing mouse. Now, scientists are wondering if the same method can be used to figure out the neurological basis for other animal behaviours.

COLD SPRING HARBOR LABORATORY

"This is relevant far beyond singing mice," said Mirjam Knörnschild, a behavioural ecologist who studies bioacoustics at the Museum of Natural History Berlin in Germany. Knörnschild, who was not involved in the study, said it could "inform work on vocal turn-taking, vocal learning and vocal flexibility in other mammals, including bats, primates and humans".

In 2019, Arkarup Banerjee, a biologist at Cold Spring Harbor Laboratory, and his colleagues discovered that the back-and-forth serenades of Alston's singing mice sound strikingly similar to our conversations. But at the time, he couldn't make sense of it. Banerjee had examined the brains of Alston's singing mice and non-singing lab mice, and they seemed more or less identical.

Scientists once believed that complex behaviours, such as tool use and peer-to-peer communication, required specialised neural circuitry. But when Banerjee went looking for such dedicated neural hardware in Alston's singing mice, he didn't find any.

"It didn't seem like things were that different," Banerjee recalls.

This prompted Banerjee and colleagues to set out in search of what gave these singing mice their vocal prowess. In their effort to find out, the researchers used a technique called Multiplexed Analysis of Projections by Sequencing or MAPseq.

This method allows scientists to map thousands of individual neurons by infecting them with a virus that delivers unique RNA bar codes into each cell. When scientists genetically sequence tissue from across the brain, the bar codes reveal a detailed map of where each neuron connects throughout the brain.

When the researchers used MAPseq on the brains of dozens of mice from both species, the differences became clear. The singing mice had approximately three times the number of neurons sending signals from the motor cortex to two specific downstream regions of the brain. While that may sound like a stark difference, the scientists say it's more akin to "a relatively subtle change in brain wiring", said Anthony Zador, a neuroscientist at Cold Spring Harbor Laboratory and co-author of the study.

According to Zador, the fact that such subtle neural changes can result in the development of a whole new vocal behaviour "raises interesting questions about how much rewiring was involved in the evolution of human language".

In addition to challenging our understanding of the evolution of our most novel behaviour, the findings of this study may help scientists learn more about the neurological basis for many animal behaviours.

NYTNS