Birds' brains reveal source of songs

April 28 2005

Scientists have yearned to understand how the chirps and warbles of a young bird morph into the recognizable and very distinct melodies of its parents. Neuroscientists at the McGovern Institute for Brain Research at MIT now have come one step closer to understanding that process. They've shown for the first time how a particular brain region in birds serves as the source of vocal creativity.

"It's an extraordinary finding," says Sarah Bottjer of the University of Southern California. "Here's an organism that enables a direct investigation of how animals learn motor activities."

The songbird's creative, trial-and-error type of learning provides an ideal model for studying similar processes in humans, such as how a baby's babble takes on the conversational cadences and recognizable syllables of mama and papa. Likewise, the brain pathways involved in birdsong have a human counterpart, the poorly understood basal ganglia circuit, so birds may have something to teach us about our own brains and what we learn may eventually apply to human diseases that affect motor abilities, such as Parkinson's disease.

"The question we're trying to answer is how a young bird learns its song," says Professor Michale Fee of MIT's McGovern Institute about his recent study, which was published online in advance of the May issue of the free access journal, Public Library of Science Biology. "We've known there are several brain areas involved: a motor circuit for producing the song, and a learning circuit, called the AFP (for anterior forebrain pathway), that sends its output to the motor system."

Normally, the young zebra finch nursery resounds with ever-new, imperfect variations of the adult songs. Gradually, the youngsters' songs become less variable and more true to the old standards. Some years ago, Bottjer had observed that disabling a young finch's AFP circuit stopped the learning in midstream. The bird still sings, but never learns the right song. To explain this effect, scientists theorized that the AFP circuit helps the juvenile compare its immature efforts with its parent's (usually the father's) example. That hypothesis, however, did not explain how all the playful variability in the little bird's babble arose in the first place.

For years, nobody had followed up on that question.

"We framed the question in a different way," Fee says of his research with postdoctoral fellow Bence P. Ölveczky and graduate student Aaron Andalman. "We said, this young bird is being creative, exploring many different sounds through trial and error. We hypothesized that the AFP is the source of this creativity, generating the variations, rather than comparing them."

To test this theory, Fee's team studied finches that were just old enough to begin their vocal explorations. The researchers temporarily inactivated the part of the AFP connecting to the motor system used in producing songs. That inactivation shut down all the variability, temporarily stranding the young finch with an immature version of the song.

These results suggested that the AFP circuitry itself causes the juvenile bird's experimentation with various sounds and sequences, and that such explorations are essential to learning songs. Deactivating the AFP after a bird had already learned the correct song had no effect on its continued proficiency.

The researchers then learned that the AFP neurons produce random bursts of activity coinciding with new variations in the practice routine.

"We think the bursts of these neurons 'kick' the motor pathway that is producing a song, jarring it out of the routine and making it sing something new," Fee says. Then another, still unexplained, pathway compares that variation to the bird's memory of the father's song. Gradually, the bird gets it right more often and eventually sings only the songs of its elders.

Source: MIT

Citation: Birds' brains reveal source of songs (2005, April 28) retrieved 18 April 2024 from https://phys.org/news/2005-04-birds-brains-reveal-source-songs.html