# Study reveals how birds learn through imitation

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A tutoring male finch teaches a courtship song to a younger finch as researchers record nerve circuits. Credit: NYU Langone Medical Center

Precise changes in brain circuitry occur as young zebra finches go from listening to their fathers' courtship songs to knowing the songs themselves, according to a study led by neuroscientists at NYU Langone Medical Center and published online in a *Science* cover report on January 14.

The study reveals how birds learn songs through observation and practice, and the authors hope the work will guide future research into how patients with brain injuries might reacquire the ability to learn skilled behaviors like speech.

"While we have known for decades that adolescent songbirds only learn

their songs if exposed to a tutor, we believe our study is the first to detail changes in nerve networks that make this mastery possible in maturing brains," says senior study investigator Michael Long, PhD.

"Our results show that finch song learning reflects a 'dance' inside the brain's vocal control center between nerve cells that capture information as the bird listens and those that direct muscle movement as it sings," says Long, an assistant professor of neuroscience at NYU Langone.

In the current study, led by Daniela Vallentin, PhD, and Georg Kosche in the NYU Neuroscience Institute, the research team found that early in adolescence, just listening to a father's song turns on the same brain cell networks that the young bird will use later to sing the song once learned.

A second result revolves around a set of nerve cells in the brain - inhibitory interneurons - which dampen the activity of surrounding nerves to sculpt sensory input into function. Researchers found that interneurons suppress the impact of each note in a father's song as soon as it is learned, "locking" it into the younger bird's memory piece by piece.

"Our research advances the understanding of how skilled behaviors are learned, and the role played by sensory inhibition in making memorized patterns permanent," says Long. Such a framework, he says, could apply to complex behaviors in people, such as dancing or hitting a baseball.

For the study, researchers used electrodes to track brain cell activity in young zebra finches as they learned songs from a mentoring parent over several weeks. Typically zebra finches learn songs during their adolescence, which begins roughly a month after birth and lasts 100 days, during which they practice each song hundreds of thousands of times.

Specifically, researchers found that the influence of the parent on the adolescent's nerve circuits gradually decreased as songs were learned, and that fast learners had faster brain changes.

The electrode experiments examined the cooperation between premotor neurons that control singing and inhibitory interneurons that together enabled song learning. After the courtship songs were learned, none of the premotor neurons turned on in response to a tutor's song. Inhibitory signals from interneurons had formed "a barrier" over the learned notes, rendering them impervious to parental influence.

Long says the team will next conduct experiments that seek to clarify how networks of inhibitory interneurons "tell the difference" between songbird notes that have been mastered and those still being learned. Knowing that may guide future attempts to roll back inhibitory barriers established as behaviors are learned, making brain circuits available once again for the learning of skilled behaviors lost to injury or stroke.

**More information:** "Inhibition protects acquired song segments during vocal learning in zebra finches," www.sciencemag.org/lookup/doi/ … 1126/science.aad3023

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