'Dancing' laboratory rats show how the brain learns, perfects, then unconsciously performs a skillful movement

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Learning a complex skilled movement like tying your shoes or playing an instrument takes practice. After repeating the same movements over

and over, people often develop a formulaic way of performing the task, and may not even have to think about it anymore. Although we accomplish such repetitive tasks every day, little is known about how the brain learns, repeats, and perfects them.

Now, a researcher at the University of Maryland School of Medicine (UMSOM), and his colleagues at Harvard University, have shown in rats how several brain regions need to work together to acquire a skill and replicate it flawlessly with each rat adding their own personal flair in the form of a "dance."

Their study was published on February 25, 2022, in *Science Advances*.

"Besides following our basic curiosity to figure out how the brain works and how we learn movements, our work has many direct applications. Understanding the conditions under which healthy brains learn informs how people should train for highly skilled activities like certain sports," said Steffen Wolff, Ph.D., Assistant Professor of Pharmacology at the University of Maryland School of Medicine. "More importantly, one day hopefully the insights gathered from this basic research program will help people with brain damage or diseases that affect movements."

The research team trains rats to study how their brains learn and perform new skills. In these experiments, the rats learn to press a lever in a specific way to get a drink of water.

"During the learning process, they develop a little dance, and each rat comes up with their own choreography," said Dr. Wolff. "After they have perfected their technique, they continue to do whatever worked for them when learning: One animal will scratch the wall, another will tap their foot, and another sticks out their tongue, while simultaneously pressing the lever."

These dances are similar to the superstitious movements that baseball pitchers perform every time they wind up to pitch the ball, like tugging on the brim of their hat or scratching the sand with their foot.

In a former study, the team showed that when the researchers damaged the motor cortex—part of the outermost layer of the brain—the rats could not learn their little dances. Yet, once they had learned their dance to execute the task, they could perform it just fine without this brain region. In a different study, the researchers found another brain area essential for learning the task—the basal ganglia, a region deep in the brain. This region is also affected in Parkinson's disease.

In their newest study, the researchers put the pieces together, asking whether the motor cortex teaches the basal ganglia to produce the new skill. They used viruses to shut down the connection between the two brain areas. As the researchers expected, they found without the motor cortex teaching the basal ganglia, the rats could no longer develop any of their dances.

The researchers then wanted to see if the basal ganglia also worked together with other brain regions to execute the learned skill. They focused on another region deep in the brain, which also has strong connections to the basal ganglia—the thalamus.

When the researchers now disrupted the connection from the thalamus to the basal ganglia with their virus tool, the rats still pressed the lever, but they completely lost their idiosyncratic learned "dances." The rats fell back to repeatedly swatting at the lever, just as they all did when they first started to learn the task. Dr. Wolff explained that these simple movements could be produced by other, more basic parts of the brain, like the brainstem.

"This work helps to reveal the logic of how individual brain regions work together to control skill learning and execution, a first step in our quest to help treat patients with motor movement disorders like Parkinson's disease, and injuries from trauma or stroke to the motor-controlling parts of the brain," said Dean E. Albert Reece, MD, Ph.D., MBA, Executive Vice President for Medical Affairs, UM Baltimore, and the John Z. and Akiko K. Bowers Distinguished Professor at the University of Maryland School of Medicine.

Other authors on the study are Raymond Ko, Ph.D., and Bence Ölveczky, Ph.D., of Harvard University.

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