Brain study finds that practice doesn't always make perfect

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Credit: Human Brain Project

Even our most practiced movements are imperfect. When pro basketball players shoot free throws, they need to release the ball the same way every time. But they still miss game-winning shots.

The reason for this frustration, according to a new study by neuroscientists at Duke University, is in how we sense the world. The response of a given neuron varies in its activity even when we see exactly the same scene—essentially producing a certain kind of brain noise that affects our responding movements. These new findings are published April 6 in the journal *Neuron*.

"Understanding the noise in the nervous system and how it can work to cause inaccuracies in movement is a critical step in understanding how we move," said the study's senior investigator Stephen Lisberger, chair of neurobiology at Duke University School of Medicine.

These findings may help explain why our signatures don't look the same every time, why our tennis stroke doesn't always hit the ball where we want it, or why we mistype a key on the keyboard, he added.

It's not new that our brains, and the neurons within, are noisy. The exact timing of a neuron as it produces spikes of electrical activity transmits crucial information. But a single neuron fires irregularly—and inconsistently, even when a person is performing the same motion repeatedly.

In the new study, Lisberger's team analyzed electrical activity of single neurons firing in the brains of monkeys that were tracking a dot moving across a computer screen. A region called "MT" within the visual region of the brain is responsible for guiding these particular eye movements, and for perceiving motion in general. Each neuron responds to the moving dot with a particular delay.

Unexpectedly, the delay of one neuron in response to a particular motion linked up with the delay of another neuron in the MT, the group found. When one neuron fired a little early, so did its neighbor.

"I was extremely surprised by this finding," Lisberger said. "My intuition would have been that it would have been entirely random."

A group of neurons is a bit like a raucous crowd packed into a basketball stadium. When they are uncoordinated, individual cheers are hard to hear. But when everyone's chanting in synchrony, you can pick out the words from the other noise, Lisberger said.

The latter phenomenon, what the research team calls "correlated noise," becomes a meaningful signal. Remarkably, the delay in a single MT neuron predicts the size of the delay in the monkeys' responding eye movements.

"We get that finding because the whole population of neurons is correlated and they are fluctuating together. That's the key internal driver," Lisberger said, adding that this is likely happening all over the brain. Their future work will focus on variations of individual neurons in motor areas of the brain.

Lisberger's team acquired data from the brain during movement and developed new computational tools and simulations. Their efforts have resulted in a freely available computational tool for more precisely predicting when a neuron is responding to a single event. (The code may be downloaded here: https://www.dropbox.com/s/jfznf356sbl3gl0/LeeLatencyAnalysis.zip?dl=0)

Historically, it has been a challenge to separate noise from signal while recording from individual neurons. Other studies have recorded from single neurons multiple times and lined up electrical spikes from each trial to determine when the neuron might be responding to a given stimulus, as opposed to firing randomly. But in real life, our perceptions and actions arise from the single responses of many neurons rather than many responses of a single neuron.

"We think further analysis of variation in neural responses is going to allow us to understand how the sensory and motor parts of the brain work together to generate reliable and accurate movements," Lisberger said.

More information: "Signal, Noise, And Variation In Neural And Sensory-Motor Latency," Joonyeol Lee, Mati Joshua, Javier F. Medina, and Stephen G. Lisberger. *Neuron*, Early online March 10, 2016. DOI: 10.1016/j.neuron.2016.02.012

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