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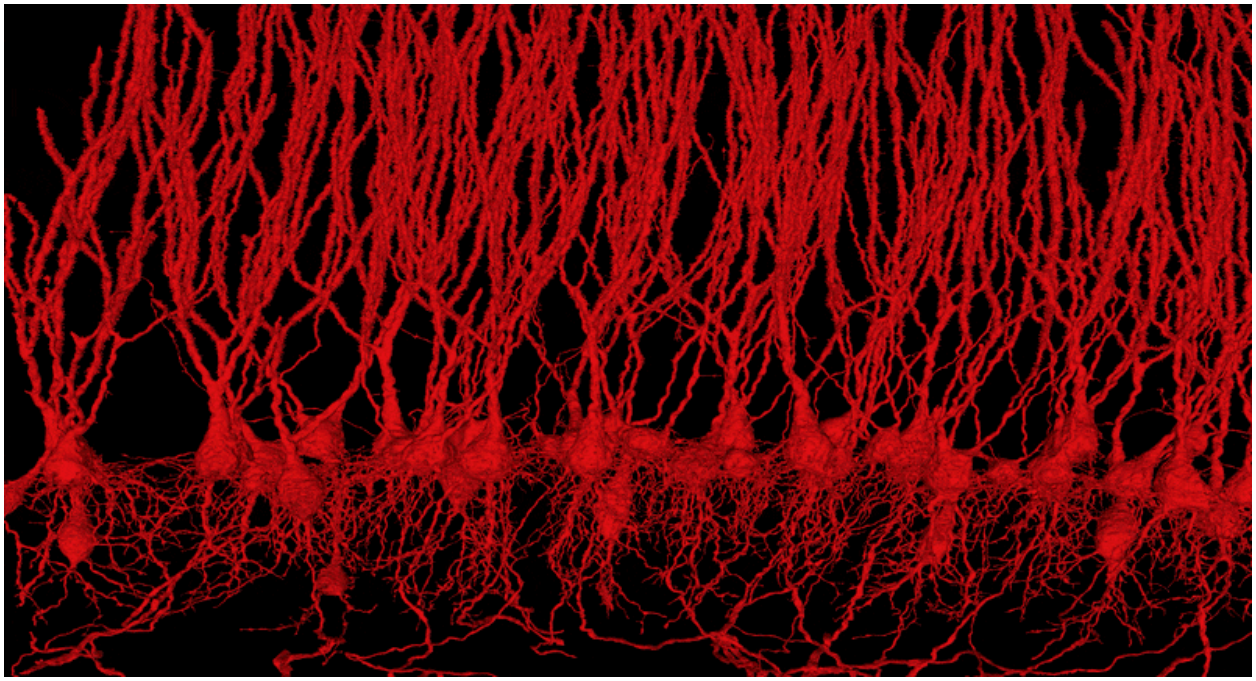
Electric Fish Keep From Blinding Themselves With These Brain Cells

Combo of fast and slow changes to cell connections helps fish continually learn and filter out electrical interference



Brain cells of different types that filter out noise in a fish that senses its environment using electric pulses. (Krista Perks / Sawtell lab / Columbia's Zuckerman Institute)

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NEW YORK, NY — The brain cells you see in the above image help an African fish decode electric signals to spot prey, scan its murky surroundings and communicate with its fellows. By rigorously mapping how these cells in the electrosensory lobe are wired together, scientists at Columbia's Zuckerman Institute and their colleagues reveal how this brain area continually learns to filter out interference that would otherwise blind the fish's electric sense. They report their findings in *Nature*.

The African weakly electric fish, also known as the elephantnose fish, possesses specialized organs on its skin to not only detect electric fields, but to also emit electric signals that help it scan the environment and communicate with other members of its species, similar to what bats and dolphins do with acoustic signals. However, the electric signals this fish radiates interfere with its ability to sense electric fields from its surroundings, much like screaming makes it hard to hear anything else.

For decades, scientists have been fascinated with a specific circuit in this fish's electrosensory lobe, which learns to make predictions that enable the fish to compensate for the interfering signals it generates. This learning manifests as the strengthening or weakening of connections between a subset of cells in this circuit, a process known as synaptic plasticity.

However, there were many questions as to why some of the cells in this circuit displayed a slow form of plasticity, while others exhibited fast plasticity. How did these different kinds of cells coordinate to compensate for noise correctly? Why did different types of plasticity even exist at all in this circuit?

To discover how this brain circuit achieves its goal, the scientists used electron microscopy to create an extremely high resolution map of the network formed by the brain cells within the fish's electrosensory lobe. They found that the electrosensory lobe always pairs cells that have fast plasticity with cells that possess slow plasticity.

"The faster cells may learn quickly, but they are more vulnerable to random, less consistent, noise," said study co-lead author Salomon Muller, PhD, a postdoctoral researcher in the Abbott & Sawtell labs at Columbia's Zuckerman Institute. "The slower cells help provide stability, helping cancel out what are ultimately the consistently interfering signals."

All in all, this brain circuitry lets the electrosensory lobe continually learn what interference the fish are generating from their own emissions and rapidly filter it out.

"Anything else that's detected will pop out and be readily perceptible," said study co-lead author Krista Perks, PhD, an associate research scientist in the Sawtell lab.

These findings not only shed light on how biological brains keep learning throughout life but could also yield insights on building better mechanical brains. Artificial intelligence often struggles with continual learning. When AI models learn new information, they sometimes catastrophically forget much of what they learned before.

"Biological systems have a lot to teach artificial systems," said Nathaniel Sawtell, PhD, the study's co-senior author, a principal investigator at Columbia's Zuckerman Institute

and a professor of neuroscience at Columbia's Vagelos College of Physicians and Surgeons.

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The paper, "Connectome analysis of a cerebellum-like circuit for sensory prediction" was published in *Nature* on September 2, 2026.

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