Scientists find neural match for complexity of visual world

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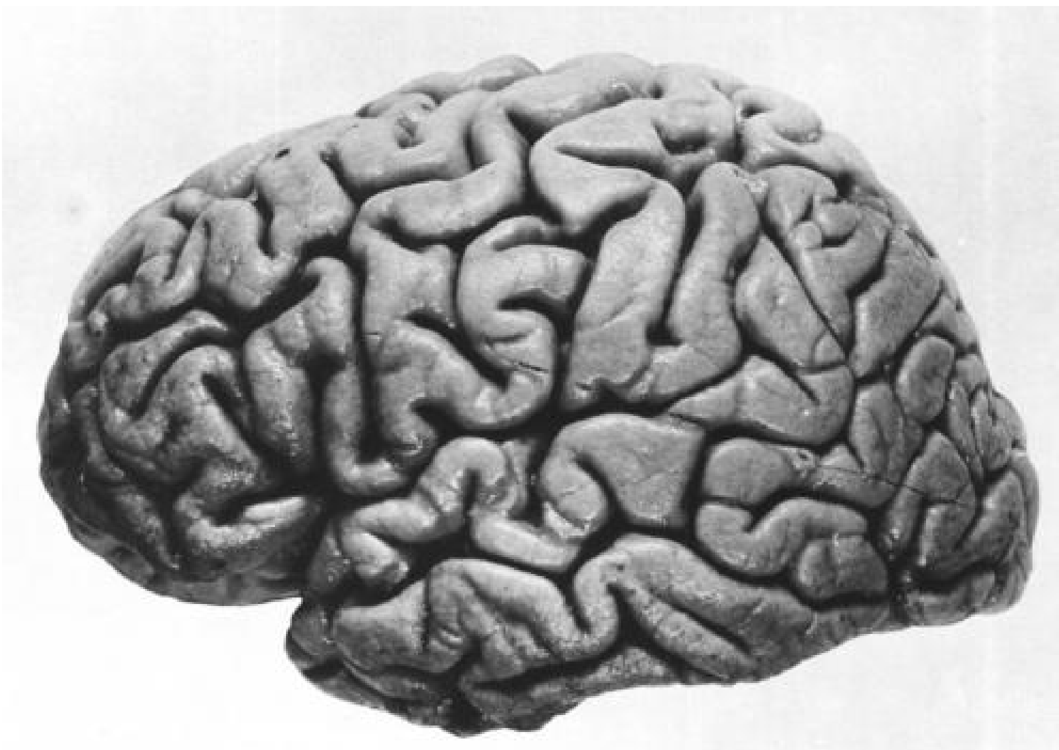

Left hemisphere of J. Piłsudski's brain, lateral view. Credit: public domain

The complexity of the neural activity we use to process visual images reflects the intricacy of those images, a team of New York University scientists has found. Their study offers new insights into how our brain extracts information about our natural surroundings from the light captured by our eyes.

"In order to efficiently process the thousands of images we come across on a daily basis, our brains calibrate in ways that are in sync with the characteristics of these images," explains Robbe Goris, an NYU postdoctoral fellow and the lead author of the study, which appears in the journal *Neuron*. The study's other co-authors include Eero Simoncelli, a professor in NYU's Center for Neural Science, and J. Anthony Movshon, a professor in NYU's Center for Neural Science as well as its director.

The research sought to better understand "orientation selectivity," a fundamental property of the neurons used by our brain to build a representation of the visual world that surrounds us. In the late 1950s, Torsten Wiesel and David Hubel discovered that the activity of neurons in the primary visual cortex strongly depends on the orientation of the visual features seen by those neurons—work for which they later received the Nobel Prize in Physiology or Medicine. However, not all orientation selective neurons are the same. Some are very selective and will only be activated by a single orientation (for example, a vertical line), but others are much less selective and will be activated by many different orientations (for example, a vertical line and slightly tilted lines). The origin and purpose of this diversity have remained open questions for many years.

In their study, the NYU researchers measured the activity of cells in the primary visual cortex and developed a mathematical model designed to predict the exact patterns of activity produced by individual cells. The model succeeded in reproducing the measured activity patterns and revealed that multiple mechanisms are responsible for the diversity in orientation selectivity. The most important mechanism, the model suggested, is the manner in which cortical neurons gather inputs from neurons in other parts of the brain.

This insight enabled the researchers to investigate the consequences of neural diversity in a systematic way. They computed how much information small groups of model neurons collectively transmitted when responding to real-world images. They varied the diversity of those groups and found that groups whose diversity matched the brain's diversity transmitted most information.

"The brain is a perplexing organ that we will probably never fully understand," observes Goris. "But sometimes, we find that a simple principle goes a long way in explaining some of its intricacy: The visual world is diverse, and the brain seems to mimic this diversity to maximize the amount of information it can extract."

Provided by New York University

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