Medical Xpress

Researchers link neural variability to short-term memory and decision making

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A team of University of Pittsburgh mathematicians is using computational models to better understand how the structure of neural variability relates to such functions as short-term memory and decision making. In a paper published online April 2 in *Proceedings of the National Academy of Sciences* (*PNAS*), the Pitt team examines how fluctuations in brain activity can impact the dynamics of cognitive tasks.

Previous recordings of neural activity during simple cognitive tasks show a tremendous amount of trial-to-trial variability. For example, when a person was instructed to hold the same stimulus in working, or short-term, memory during two separate trials, the brain cells involved in the task showed very different activity during the two trials.

"A big challenge in neuroscience is translating variability expressed at the cellular and brain-circuit level with that in cognitive behaviors," said Brent Doiron, assistant professor of mathematics in Pitt's Kenneth P. Dietrich School of Arts and Sciences and the project's principal investigator. "It's a fact that short-term memory degrades over time. If you try to recall a stored memory, there likely will be errors, and these cognitive imperfections increase the longer that short-term memory is engaged."

Doiron explains that brain cells increase activity during short-term memory functions. But this activity randomly drifts over time as a result of stochastic (or chance) forces in the brain. This drifting is what Doiron's team is trying to better understand.

"As mathematicians, what we're really trying to do is relate the structure and dynamics of this stochastic variability of brain activity to the variability in cognitive performance," said Doiron. "Linking the variability at these two levels will give important clues about the neural mechanisms that support cognition."

Using a combination of statistical mechanics and nonlinear system theory, the Pitt team examined the responses of a model of a simplified memory network proposed to be operative in the prefrontal cortex. When sources of neural variability were distributed over the entire network, as opposed to only over subsections, the performance of the memory network was enhanced. This helped the Pitt team make the prediction published in *PNAS*, that brain wiring affects how neural networks contend with—and ultimately express—variability in memory and decision making.

Recently, experimental neurosciencists are getting a better understanding of how the brain is wired, and theories like those published in *PNAS* by Doiron's group give a context for their findings within a cognitive framework. The Doiron group plans to apply the general principle of linking brain circuitry to neural variability in a variety of sensory, motor, and memory/decision-making frameworks.

More information: For more information on Doiron's lab, visit www.math.pitt.edu/~bdoiron/Welcome.html

Provided by University of Pittsburgh