MedicalXpress

For the first time, patterns of excitation waves found in brain's visual processing center

July 31 2007

Neuroscientists have long believed that vision is processed in the brain along circuits made up of neurons, similar to the way telephone signals are transferred through separate wires from one station to another. But scientists at Georgetown University Medical Center discovered that visual information is also processed in a different way, like propagating waves oscillating back and forth among brain areas. Their findings are published in the July 5 issue of the journal *Neuron*.

“What we found is that signals pass through brain areas like progressive waves, back and forth, a little bit like what fans do at baseball games,” said the study’s corresponding author, Jian-young Wu, Ph.D., an associate professor in the Department of Physiology and Biophysics at Georgetown. Just as the stadium wave is coordinated and travels through the crowd, a collective pattern emerges from the activities of millions of neurons in the visual areas, he said, explaining, “It simply makes sense that brain function is the result of large numbers of neurons working together.”

This challenges longstanding notions about how the brain processes sensory information, Wu said. “One traditional model theorizes that neurons are hooked together into specific circuits. However, new imaging methods tell us that there are more than just circuits.”

Wu and his colleagues visualized wave-like patterns in the brain cortex

using a new method called voltage sensitive dye imaging. They used a special dye that binds to the membrane of neurons and changes color when electrical potential passes along active neurons.

Traditionally, scientists have studied brain activity by placing electrodes in the brain and measuring the electrical currents that are related to neuronal activity. Because it is difficult to put many electrodes into the brain, the spatiotemporal pattern of the neuronal activity has long been ignored. “Now, with optical methods, we can watch sequential activation of different sectors of the visual cortex when the brain is processing sensory information," Wu said.

Wu believes wave patterns play an important role in initiating and organizing brain activity involving millions to billions of neurons. A few years ago, Wu's imaging group uncovered spiraling waves resembling little hurricanes in animal epilepsy models. Wu thinks that through this hurricane-like spiral pattern, a small area of damaged neural tissue can generate a powerful storm that invades large normal brain areas and starts a seizure attack. This hypothesis would mean that disorders such as epilepsy could be viewed not just as mis-wiring in the brain, but as an abnormal wave pattern that invades normal tissue.

Finding waves during visual processing is an important step toward understanding how the brain processes sensory information, explained Wu. This understanding has the potential to help scientists understand the abnormal waves that are generated in the brains of patients with Parkinson's disease and epilepsy, and how the mind fails when the brain of an Alzheimer’s disease patient cannot properly organize population neuronal activity, he said.

Wu believes that additional research is needed in order to understand both normal and abnormal waves in the human brain. “Understanding how the brain handles these waves will provide further insight into the

functioning of one of the most complex systems in the universe," he said.

Source: Georgetown University Medical Center