Medical Xpress

Uncorrelated activity in the brain

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Interconnected networks of neurons process information and give rise to perception by communicating with one another via small electrical impulses known as action potentials. In the past, scientists believed that adjacent neurons synchronized their action potentials. However, researchers at Baylor College of Medicine and the Max Planck Institute for Biological Cybernetics in Germany said in a current report in the journal *Science* that this synchronization does not happen.

Their findings provide detail as to how the brain accesses and processes information.

"Understanding healthy neuronal activity is one of the first steps to unlocking the brains of those with illnesses such as autism," said Dr. Andreas S. Tolias, assistant professor of neuroscience at BCM and senior author on the paper.

The patterns of action potentials are organized to allow our brain to work efficiently. For example, the visual cortex, which is the area of the brain where information from the eyes is processed, contains around two dozen distinct regions organized in a hierarchical fashion. People can see and interpret the surrounding world because the information is processed (through action potentials) through this organized system from one region to the next.

Tolias, who is also on the staff at with the Michael E. DeBakey Veterans Affairs Medical Center, said, "If you were to eavesdrop on the activity of a neuron in the visual part of the brain while a person is looking at a picture over and over again, the neuron will respond differently each time. In other words, a substantial part of the activity is unrelated to the picture itself. It is this activity that was believed to be common among many adjacent neurons because they are densely interconnected."

"Here is where problems begin to arise," Tolias said. "If the activity that is unrelated to the picture is common to many cells, it would build up from one stage of processing to the next, ultimately dominating brain activity and making information processing impossible - a scenario called runaway synchrony."

To find an answer to this paradox, Tolias and his colleagues, including Alexander S. Ecker, the paper's first author who is a graduate student in Tolias' lab at BCM and the Max Planck Institute for Biological Cybernetics in Tübingen, Germany developed a new technology that allowed more precise measurement of action potentials. They found that the groups of neurons believed to be reacting in a related fashion actually had a weak relationship. They were reacting on their own, not dependent on each other.

"We measured correlations in awake, behaving primates, allowing us to have control of the experimental conditions. This gave us the chance to eliminate the possibility of a number of artifacts affecting our measurements," Ecker said. "For recording, we used chronically implanted multi-tetrode arrays - a technique that offered us the chance to monitor many neurons at extremely high recording quality."

According to the chair of the Department of Neuroscience, Dr. Michael Friedlander, "The authors achieved this result using a clever combination of recording technology and experimental paradigm that builds on their profoundly interdisciplinary approach to neuroscientific study including experimental, computational, engineering, mathematical and behavioral research skills."

The testing involved a variety of visual stimulation ranging from bars and grating to natural images. The groups of neurons tested were physically close to each other with highly overlapping receptive fields and all receiving strong common input.

One reason Tolias believes the neurons behave without correlation is to allow information to be sent through the brain in the most efficient way possible.

"Such a mechanism that allows the decorrelation might be a crucial prerequisite to prevent small correlations from accumulating and dominating network activity along the visual hierarchy," Ecker said.

The "decorrelated state" may also have other benefits, Tolias added. "Information processing in the brain is much easier if nerve cells' activity is uncorrelated. If one level of the hierarchy wants to know what the previous area is doing, it can simply forget about correlations in this case. Otherwise, it has to perform more complex computations to get to the same result."

Tolias said these findings open the door for new important questions about the brains of those with illnesses such as autism or epilepsy. Questions such as, "Are the neuron correlations higher or lower among these groups of people and are these patterns in the brain being disrupted?"

More information: www.sciencemag.org/

Provided by Baylor College of Medicine