Brain regions 'tune' activity to enable attention

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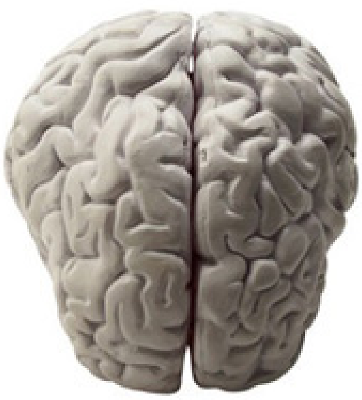

The brain appears to synchronize the activity of different brain regions to make it possible for a person to pay attention or concentrate on a task, scientists at Washington University School of Medicine in St. Louis have learned.

Researchers think the process, roughly akin to tuning multiple walkie-talkies to the same frequency, may help establish clear channels for communication between brain areas that detect sensory stimuli.

"We think the brain not only puts regions that facilitate attention on alert but also makes sure those regions have open lines for calling each other," said first author Amy Daitch, a graduate student researcher.

The results are available in the *Proceedings of the National Academy of Sciences*.

People who suffer from brain injuries or strokes often have problems paying attention and concentrating.

"Attention deficits in brain injury have been thought of as a loss of the resources needed to concentrate on a task," said senior author Maurizio Corbetta, MD, the Norman J. Stupp Professor of Neurology. "However, this study shows that temporal alignment of responses in different brain areas is also a very important mechanism that contributes to attention and could be impaired by brain injury."

Attention lets people ignore irrelevant sensory stimuli, like a driver disregarding a ringing cell phone, and pay attention to important stimuli, like a deer stepping onto the road in front of the car.

To analyze brain changes linked to attention, the scientists used grids of electrodes temporarily implanted onto the brains of patients with epilepsy. Co-senior author Eric Leuthardt, MD, associate professor of neurosurgery and bioengineering, uses the grids to map for surgical removal of brain tissues that contribute to uncontrollable seizures.

With patient permission, the grids also can allow Leuthardt's lab to study human brain activity at a level of detail unavailable via any other method. Normally, Corbetta and his colleagues investigate attention using various forms of magnetic resonance imaging (MRI), which can detect changes in brain activity that occur every 2 to 3 seconds. But with the grids in place, Corbetta and Leuthardt can study the changes that occur in milliseconds.

Before grid implantation, the scientists scanned the brains of seven epilepsy patients, using MRI to map regions known to contribute to attention. With the grids in place, the researchers monitored brain cells as the patients watched for visual targets, directing their attention to different locations on a computer screen without moving their eyes. When patients saw the targets, they pressed a button to let the scientists know they had seen them.

"We analyzed brain oscillations that reflect fluctuations in excitability of a local brain region; in other words, how difficult or easy it is for a neuron to respond to an input," Daitch said. "If areas of the brain involved in detecting a stimulus are at maximum excitability, you would be much more likely to notice the stimulus."

Excitability regularly rises and falls in the cells that make up a given brain region. But these oscillations normally are not aligned between different brain regions.

The researchers' results showed that as patients directed their attention, the brain regions most important for paying attention to visual stimuli adjusted their excitability cycles, causing them to start hitting the peaks of their cycles at the same time. In regions not involved in attention, the excitability cycles did not change.

"If the cycles of two brain regions are out of alignment, the chances that a signal from one region will get through to another region are reduced," Corbetta said.

Daitch, Corbetta and Leuthardt are investigating whether knowing not just the location, but also the tempo of the task, allows participants to bring the excitability of their brain regions into alignment more rapidly.

More information: Daitch AL, Sharma M, Roland JL, Astafiev SV, Bundy DT, Gaona CM, Snyder AZ, Shulman GL, Leuthardt EC, Corbetta M. Frequency-specific mechanism links human brain networks

for spatial attention. *Proceedings of the National Academy of Sciences*, Nov. 26, 2013.

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