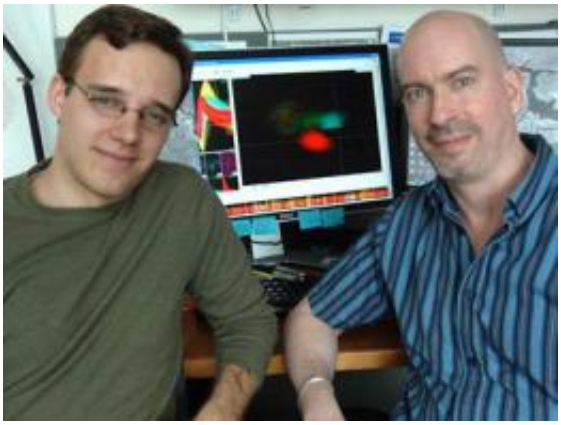
The mind's eye scans like a spotlight

August 12 2009



Picower Institute postdoctoral associate Timothy J. Buschman, left, and Picower Professor of Neuroscience Earl Miller. Photo / Donna Coveney

(PhysOrg.com) -- You're meeting a friend in a crowded cafeteria. Do your eyes scan the room like a roving spotlight, moving from face to face, or do you take in the whole scene, hoping that your friend's face will pop out at you? And what, for that matter, determines how fast you can scan the room?

Researchers at MIT's Picower Institute for Learning and Memory say you are more likely to scan the room, jumping from face to face as you search for your friend. In addition, the timing of these jumps appears to be determined by waves of activity in the brain that act as a clock. The study, which appears in the Aug. 13 issue of the journal *Neuron,* sheds new light on a long-standing debate among neuroscientists over how the

visual system picks out an object of interest in a complex scene.

In the study, monkeys were given the task of searching for one particular tilted, colored bar among a field of bars on a computer screen. By monitoring the activity of neurons in three of the animals' brain regions, researchers found that the monkeys spontaneously shifted their attention in a sequence, like a moving spotlight that jumped from location to location.

What's more, the study showed that brain waves act as a kind of built-in clock that provides a framework for shifting attention from one location to the next. The work could have implications for understanding or treating attention deficit disorder or even potentially speeding up the rate of cognition in the brain.

"For many years, neuroscientists have been debating competing theories on whether humans and animals spontaneously search elements of a visual scene in a serial or parallel manner," said lead author Earl K. Miller, the Picower Professor of Neuroscience. "Ours is the first study based on direct evidence of neurophysiological activity."

Like clockwork

Activity in the brain comes and goes in waves, cycling between high and low activity states. Researchers have been recording brain waves for more than 100 years and although they think they play roles in working memory, decision-making and communication among brain regions, no one is sure of their exact role in brain function. This work suggests a new role for brain waves — one in which they are directly involved in the brain's processing.

Picower Institute postdoctoral associate and co-author Timothy J. Buschman found that the spotlight of the mind's eye shifted focus at 25

times a second and that this process of switching was regulated by brain waves. "This is one of the first examples of how brain waves play a specific role in cognitive computations," Buschman said.

"Attention regulates the flood of sensory information pouring into the brain into a manageable stream. In particular, a lot of different areas of the brain are involved in vision. If they all competed at once, it would be chaos," Miller said. "Brain waves may provide the clock that tells the brain when to shift its attention from one stimulus to another. Oscillating brain waves may provide a way for several regions across the brain to be on the same page at the same time — very similar to the way computers use an internal clock to synchronize the many different components inside."

The researchers' next step is to expand their search for brain wave function beyond the visual. They hope to discover whether brain waves are specific to visual function or act as a "general clock" for the brain.

The researchers have found that in the experiment with the monkeys, the speed at which the animals searched was related to the speed of their brain waves. When the clock ticked faster, the animals "thought" faster. This implies that it may be possible to change the speed of cognition if researchers can learn to artificially manipulate brain waves. In separate studies outside MIT, researchers are looking at the correlation between the brain waves' "clock speed" in humans and the speed at which subjects shift attention from one task to another.

Source: Massachusetts Institute of Technology (news : web)