How to read brain activity?

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(PhysOrg.com) -- For the very first time, scientists show what EEG can really tell us about how the brain functions.

The electroencephalogram (EEG) is widely used by physicians and scientists to study brain function and to diagnose neurological disorders. However, it has remained largely unknown whether the electrodes on the head give an exact view of what is happening inside the brain.

Scientists at the Max Planck Institute for Biological Cybernetics in Tübingen, Germany, have now found a crucial link between the activity generated within the brain to that measured with EEG. These findings will provide a better understanding of the waveforms measured with EEG, and thus potentially allow for a better diagnosis and subsequent treatment of patients. (*Neuron*, October 2009)

The electroencephalogram (EEG) has been widely used in research and medicine for more than 80 years. The ability to measure the electrical activity in the brain by means of electrodes on the head is a handy tool to study brain functions as it is noninvasive and easy to apply. The interpretation of the EEG signals remains, however, difficult. The main reason for this is that the exact relationship between the activity generated in the brain compared to that measured on the scalp is unclear. Therefore, a question of paramount practical importance is how EEG can be used to deduce neural activity in the brain.

Recently, Kevin Whittingstall and Nikos Logothetis from the Max Planck Institute for Biological Cybernetics in Tubingen have addressed this very question for the first time.

By combining recordings of both EEG and individual neurons in trained monkeys, Whittingstall and Logothetis found that a combination of specific waves in the EEG could indeed reliably predict the activity of cells in the brain. They presented different movie clips consisting of everyday natural scenes to trained monkeys.

While the monkeys watched, their brain activity was recorded via EEG and via electrodes that were placed directly on the neurons, thus allowing for a direct comparison between data sets. Specifically, they observed that the firing pattern of cells was highest during periods where bursts of ‘fast’ EEG activity were embedded within the slow-wave EEG. As the degree of this so-called ‘frequency band coupling’ changed, so also did the cells firing rate.

"We succeeded in identifying which aspects of the EEG best represent changes in the activity from a population of neurons in the brain", explains Kevin Whittingstall. "With this information, we can now move to better understand the cause of abnormal EEG waveforms in patients with certain neurological disorders."

More information: Kevin Whittingstall & Nikos K. Logothetis, Frequency-Band Coupling in Surface EEG Reflects Spiking Activity in Monkey Visual Cortex. *Neuron*, Volume 64, Issue 2, Pages 281-28, doi:10.1016/j.neuron.2009.08.016

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