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Brain energy use key to understanding consciousness

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High levels of brain energy are required to maintain consciousness, a finding which suggests a new way to understand the properties of this still mysterious state of being, Yale University researchers report.

At its simplest, consciousness can be defined as the ability to respond meaningfully to external stimuli. Most studies of consciousness have used imaging technology to try to pinpoint areas of brain activity during tasks such as memorization or problem solving.

There are two problems with such an approach, said Robert G. Shulman, Sterling Professor Emeritus of molecular biophysics and biochemistry at Yale and lead author of the paper, to be published this week in the online edition of the journal *Proceedings of the National Academy of Sciences*. First, functional magnetic resonance imaging has shown that many areas of the brain, not just one or two, are recruited during tasks such as memory tests and are scant help in studying the state of being conscious. Second, the amount of energy used in such tasks is minute, about one percent of baseline energy available to the brain.

"Neuroimaging has been looking at the tip of the iceberg," Shulman said. "We looked at the rest of the iceberg."

What is the other 99 percent of energy consumption doing?

Shulman and colleagues have proposed that it is needed to maintain a person in a state of consciousness. Heavily anesthetized people are

known to show approximately 50 percent reductions in cerebral energy consumption. When the paws of lightly anesthetized rats with rather high baseline energy levels were stroked, fMRI signals were received in the sensory cortex and in many other areas of the brain. In heavily anesthetized rats the signal stopped at the sensory cortex. Both the total energy and the fMRI signals changed when the person or animal lost consciousness.

"What we propose is that a conscious person requires a high level of brain energy," Shulman said.

The finding has profound implications for our understanding of the connection between the brain and consciousness, Shulman said. "You can think of consciousness not as a property of the brain, but of the person."

Anesthesiologists consider a person to be in a behavioral state of consciousness when he or she can respond to simple stimuli. Properties of this state, such as the high energy and the delocalized fMRI signals, allow the person to perform the interconnected activities that make up our everyday lives. Shulman suggests that these more energetic properties of the brain support human behavior and should be considered when interpreting the much weaker signals that are typically recorded during fMRI studies.

Source: Yale University (news : web)