

Brain energy use proposed as key to understanding consciousness

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Courtesy Yale University and [World Science](#) staff

It takes high levels of brain energy to maintain consciousness. That suggests a new way to understand the properties of this still mysterious state of being, a group of Yale University researchers are reporting.

At its simplest, some scientists suggest, 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 Yale's Robert G. Shulman, lead author of the paper, published this week in the online edition of the journal *Proceedings of the National Academy of Sciences*.

First, brain imaging has shown that many areas of the brain, not just one or two, are recruited during tasks such as memory tests and are of 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.

Brain imaging "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's needed to maintain consciousness.

Heavily anesthetized people are known to show approximately 50 percent reductions in cerebral energy consumption, Shulman said. When the paws of lightly anesthetized rats were stroked, imaging signals were received in a wide array of brain areas, but in heavily anesthetized rats the signals stopped at a sensation-receiving zone known as the sensory cortex. Both the total energy and the brain imaging signals changed when the person or animal lost consciousness, Shulman noted.

"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, he added. "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 brain imaging 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 typically recorded during brain imaging studies.