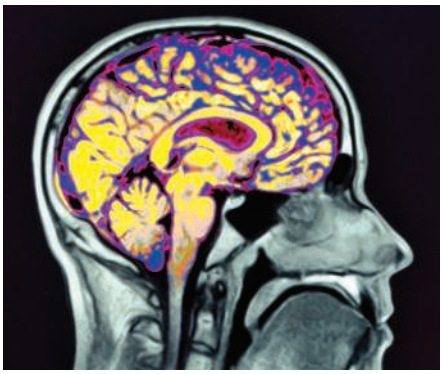
What Is the Biological Basis of Consciousness

For centuries, debating the nature of consciousness was the exclusive purview of philosophers. But if the recent torrent of books on the topic is any indication, a shift has taken place: Scientists are getting into the game.

Has the nature of consciousness finally shifted from a philosophical question to a scientific one that can be solved by doing experiments? The answer, as with any related to this topic, depends on whom you ask. But scientific interest in this slippery, age-old question seems to be gathering momentum. So far, however, although theories abound, hard data are sparse.

The discourse on consciousness has been hugely influenced by René Descartes, the French philosopher who in the mid–17th century declared that body and mind are made of different stuff entirely. It must be so, Descartes concluded, because the body exists in both time and space, whereas the mind has no spatial dimension.



CREDIT: LESTER LEFKOWITZ/CORBIS

Recent scientifically oriented accounts of consciousness generally reject Descartes's solution; most prefer to treat body and mind as different aspects of the same thing. In this view, consciousness emerges from the properties and organization of neurons in the brain. But how? And how can scientists, with their devotion to objective observation and measurement, gain access to the inherently private and subjective realm of consciousness?

Some insights have come from examining neurological patients whose injuries have altered their consciousness. Damage to certain evolutionarily ancient structures in the brainstem robs people of consciousness entirely, leaving them in a coma or a persistent vegetative state. Although these regions may be a master switch for consciousness, they are unlikely to be its sole source. Different aspects of consciousness are probably generated in different brain regions. Damage to visual areas of the cerebral cortex, for example, can produce strange deficits limited to visual awareness. One extensively studied patient, known as D.F., is unable to identify shapes or determine the orientation of a thin slot in a vertical disk. Yet when asked to pick up a card and slide it through the slot, she does so easily. At some level, D.F. must know the orientation of the slot to be able to do this, but she seems not to know she knows.

Cleverly designed experiments can produce similar dissociations of unconscious and conscious knowledge in people without neurological damage. And researchers hope that scanning the brains of subjects engaged in such tasks will reveal clues about the neural activity required for conscious awareness. Work with monkeys also may elucidate some aspects of consciousness, particularly visual awareness. One experimental approach is to present a monkey with an optical illusion that creates a "bistable percept," looking like one thing one moment and another the next. (The orientation-flipping Necker cube is a well-known example.) Monkeys can be trained to indicate which version they perceive. At the same time, researchers hunt for neurons that track the monkey's perception, in hopes that these neurons will lead them to the neural systems involved in conscious visual awareness and ultimately to an explanation of how a particular pattern of photons hitting the retina produces the experience of seeing, say, a rose.

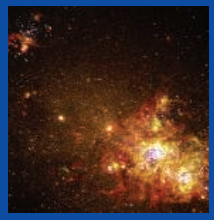
Experiments under way at present generally address only pieces of the consciousness puzzle, and very few directly address the most enigmatic aspect of the conscious human mind: the sense of self. Yet the experimental work has begun, and if the results don't provide a blinding insight into how consciousness arises from tangles of neurons, they should at least refine the next round of questions.

Ultimately, scientists would like to understand not just the biological basis of consciousness but also why it exists. What selection pressure led to its development, and how many of our fellow creatures share it? Some researchers suspect that consciousness is not unique to humans, but of course much depends on how the term is defined. Biological markers for consciousness might help settle the matter and shed light on how consciousness develops early in life. Such markers could also inform medical decisions about loved ones who are in an unresponsive state.

Until fairly recently, tackling the subject of consciousness was a dubious career move for any scientist without tenure (and perhaps a Nobel Prize already in the bag). Fortunately, more young researchers are now joining the fray. The unanswered questions should keep them—and the printing presses—busy for many years to come.

–GREG MILLER

When and how did the first stars and galaxies form?
The broad brush strokes are visible, but the fine details aren't. Data from satellites and ground-based telescopes may soon help pinpoint, among other particulars, when the first generation of stars burned off the hydrogen "fog" that filled the universe.



JPL/NASA

Where do ultra-high-energy cosmic rays come from?
Above a certain energy, cosmic rays don't travel very far before being destroyed. So why are cosmic-ray hunters spotting such rays with no obvious source within our galaxy?

What powers quasars?
The mightiest energy fountains in the universe probably get their power from matter plunging into whirling supermassive black holes. But the details of what drives their jets remain anybody's guess.

E. J. SCHREIER, STSCI/NASA

What is the nature of black holes?
Relativistic mass crammed into a quantum-sized object? It's a recipe for disaster—and scientists are still trying to figure out the ingredients.

continued >>

Published by AAAS