BOOK REVIEW

Consciousness and the Brain: Deciphering How the Brain Codes our Thoughts

By Stanislas Dehaene
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The editors of *Science* asked young scientists, "What recent discovery in your field will still be remembered 200 years from now? Why?" The best replies ("NextGen Speaks," 2014) included no suggestions from psychology. The only reply from neuroscience pertained to research methods, not content.

If I were eligible to reply (as I am not, the exercise being limited to "young scientists"), I would make the same reply for both psychology and neuroscience: Around the year 2000, researchers began to uncover what aspects of brain activity accompany conscious experience.

In the late 1800s, psychology began as the study of the mind. Then the behaviorists convinced everyone to abandon the study of mind and consciousness, for good reasons. At the time, the only way to study consciousness was introspection, a source of no reliable information. Through most of the next century, experimental psychologists avoided not only research on consciousness, but also the term itself. Unconscious processes were equally taboo, to avoid any association with Freudian theories.

More recently, Stanislas Dehaene and others have made consciousness not only respectable, but an exciting area of research advances. One key to their success was to adopt an operational definition of consciousness: A cooperative person who reports awareness of one stimulus and not another is conscious of the first and not the second. A second key was a focus on a limited, answerable question: What type of brain activity occurs when we have conscious access to a sensory stimulus that does not occur when we lack access to the same stimulus? A third was the arrival of new methods such as fMRI that can localize brain activity in healthy people. The fourth advance came from presenting a stimulus under two conditions, one that permits conscious access and one that prevents it. For example, a brief stimulus followed by a blank screen is visible, but the same stimulus followed by a masking stimulus is not. In binocular rivalry, the left and right eyes view incompatible scenes, and the viewer alternates between awareness of one and awareness of the other. So, an experimenter presents a stimulus under conditions that do or do not permit consciousness, verifies consciousness by the viewer's report, and compares the resulting brain activity in the two conditions.

According to the research of Dehaene and others, the initial stages of processing are identical for stimuli that do or do not become conscious. In both cases the stimuli excite retinal receptors that send messages to the thalamus and then to the primary visual cortex. From that point on, the process bifurcates in an all-or-none manner. If interference from previous and subsequent stimuli is great enough, the response to the stimulus weakens as it passes to other cortical areas, where it may subtly bias behavior in ways that we call "subliminal perception." However, the person has no conscious perception and cannot report the stimulus verbally. In the absence of strong inhibition, the prefrontal and parietal cortices send messages back to the primary visual cortex and the message reverberates and amplifies through other brain areas. If you are recording with an EEG, you see a P300 wave resulting from all this activity. (Dehaene notes that the P300 wave, one of the signatures of conscious processing, occurs by definition about 300 ms after a stimulus. Consistent with other types of research, this finding indicates that our consciousness of something lags almost a third of a second behind the event itself. It lags even further behind in human infants.)

Consciousness, Dehaene concludes, means brain-wide information sharing. Extensive research to support this statement is clever, persuasive, and well worth reading. It also has a practical application. A stimulus to the brain, applied by a magnet on the surface of the head, produces a response that spreads through the brain of a conscious individual. It does not spread for someone in a coma, a vegetative state, or non-REM sleep. This and other methods can distinguish between unconscious people and others who may be conscious but unable to control their muscles. It might also distinguish between people who are about to emerge from a vegetative or minimally conscious state, and others who are not.

Is consciousness useful for anything? A recent trend has been to describe consciousness as virtually useless, a passenger rather than a driver (e.g., Norretranders, 1991/1998; Wegner, 2002). Some consider consciousness an epiphenomenon, a useless entity that emerges without accomplishing anything, like the noise a lawnmower makes. Dehaene disagrees. He describes visual patterns that are consistent with many interpretations, but which appear in consciousness in only one way at a time. Consciousness, he says, serves to settle on one interpretation of events. He also cites tasks we can perform while conscious that we cannot complete subliminally, such as mentally multiplying 13 x 12. From these examples he argues that the function of consciousness is to transform incoming data points into an unambiguous summary, which the system can carry forward in time, manipulate sequentially, and communicate to others. In this way Dehaene argues similarly to Roy Baumeister and colleagues, who describe tasks that people perform consciously that they cannot perform

unconsciously (Baumeister et al., 2011). The implication is that because consciousness always occurs during certain tasks, therefore, it is necessary for performing those tasks. Logically speaking, however, that argument is not airtight. Could someone program a computer to find a best interpretation of ambiguous data, carry it forth in time, manipulate information in sequence, communicate it, and perform the other tasks attributed to consciousness? Presumably, yes. In fact, computers do a good bit of this right now. Unless we assume that computers are conscious, the question remains why we are conscious when we perform certain functions, whereas computers can perform virtually the same functions without consciousness. (Yes, we should be open to the possibility of machine consciousness, but we don't want to be too quick to assume it.)

The dispute about the function of consciousness seems to be based on this dichotomy: Either consciousness is a useless epiphenomenon, or we evolved it as an extra function to solve certain tasks. In contrast, an identity position on the mind-brain relationship holds that brain activity of a certain type *is* mental activity. We couldn't have the mental activity without the brain activity, but equally we couldn't have the brain activity without the mental activity. Brains didn't evolve minds to solve a special task any more than hearts evolved mass to solve a special task. Rather, they couldn't operate without it.

Ah, but if brain activity really equals mental activity, why is it so? Near the end of Dehaene's book he turns to what David Chalmers (1995) calls "the hard problem." To paraphrase, Chalmers asks why, in a universe of matter and energy, consciousness exists at all. Why is it possible for a fluctuation of matter and energy in the brain to equal the experience of blue—not just the tendency to say blue, or the ability to sort a blue object with other blue objects, but the experience itself? Dehaene dismisses this "hard problem" in barely over a page of text, arguing that mental experience is a pre-scientific concept that will disappear, as we better understand the connections in the brain. Well, maybe so, but I find this part of his argument unconvincing.

Consciousness and the Brain is beautifully written, erudite, thoughtful, and likely to provoke discussion for years to come. For any psychologist or neuroscientist who is not already familiar with recent consciousness research, I recommend putting this book at the top of your reading list. Less than 20 years ago, Stuart Sutherland (1996) gave this definition: "Consciousness: the having of perceptions, thoughts and feelings; awareness…. Nothing worth reading has been written about it." Anyone who reads Dehaene's book can no longer justify that statement.

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