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The Brain Is Not Modular: What fMRI Really Tells Us

Metaphors, modules and brain-scan pseudoscience

By Michael Shermer

The atom is like a solar system, with electrons whirling around the nucleus like planets orbiting a star. No, actually, it isn't. But as a first approximation to help us visualize something that is so invisible, that image works as a metaphor.

Science traffics in metaphors because our brains evolved to grasp intuitively a world far simpler than the counterintuitive world that science has only recently revealed. The functional activity of the brain, for example, is nearly as invisible to us as the atom, and so we employ metaphors. Over the centuries the brain has been compared to a hydraulic machine (18th century), a mechanical calculator (19th century) and an electronic computer (20th century). Today a popular metaphor is that the brain is like a Swiss Army knife, with specialized modules for vision, language, facial recognition, cheating detection, risk taking, spirituality and even God.

Modularity metaphors have been fueled by a new brain-scanning technology called functional magnetic resonance imaging (fMRI). We have all seen scans with highlighted (usually in red) areas where your brain "lights up" when thinking about X (money, sex, God, and so on). This new modularity metaphor is so seductive that I have employed it myself in several books on the evolution of religion (belief modules), morality (moral modules) and economics (money modules). There is a skeptical movement afoot to curtail abuses of the metaphor, however, and it is being driven by neuroscientists themselves. The November 11, 2007, edition of the New

York Times, for example, published an opinion piece entitled “This Is Your Brain on Politics,” by neuroscientist Marco Iacoboni of the University of California, Los Angeles, and his colleagues. The writers presented the results of their brain scans on swing voters. “When we showed subjects the words ‘Democrat,’ ‘Republican’ and ‘independent,’ they exhibited high levels of activity in the part of the brain called the amygdala, indicating anxiety,” the authors note. “The two areas in the brain associated with anxiety and disgust—the amygdala and the insula—were especially active when men viewed ‘Republican.’ But all three labels also elicited some activity in the brain area associated with reward, the ventral striatum, as well as other regions related to desire and feeling connected.” So the word “Republican” elicits anxiety and disgust, except for when it triggers feelings of desire and connectedness. The rest of the conclusions are similarly obfuscating.

In a response befitting the self-correcting nature of science, Iacoboni’s U.C.L.A. colleague Russell Poldrack and 16 other neuroscientists from labs around the world published a response three days later in the Times, explaining: “As cognitive neuroscientists who use the same brain imaging technology, we know that it is not possible to definitively determine whether a person is anxious or feeling connected simply by looking at activity in a particular brain region. This is so because brain regions are typically engaged by many mental states, and thus a one-to-one mapping between a brain region and a mental state is not possible.” For example, the amygdala is activated by arousal and positive emotions as well, so the key to interpreting such scans is careful experimental design that allows comparison between brain states.

Additional skepticism arises from knowing that fMRI measures blood-flow change, not neuronal activity, that the colors are artificially added in order to see the blood-flow differences and that those images are not any one person’s brain but are instead a statistical compilation of many subjects’ brains in the experiment. “Some of the claims made by neuroscientists sound like astrology,” Poldrack told me in an interview. “It’s not the science itself that is the problem. It’s taking a little bit of science and going way beyond it.” For example, there is the problem of reversing the causal inference, “where people see some activity in a brain area and then conclude that this part of the brain is where X happens. We can show that if I put you into a state of fear, your amygdala lights up, but that doesn’t mean that every time your amygdala lights up you are experiencing fear. Every brain area lights up under lots of different states. We just don’t have the data to tell us how selectively active an area is.”

University of California, San Diego, philosopher of the mind Patricia S. Churchland told me with unabashed skepticism: “Mental modules are complete nonsense. There are no modules that are encapsulated and just send information into a central processor. There are areas of specialization, yes, and networks maybe, but these are not always dedicated to a particular task.” Instead of mental module metaphors, let us use neural networks.

The brain is not random kludge, of course, so the search for neural networks associated with psychological concepts is a worthy one, as long as we do not succumb to the siren song of phrenology.

Editor's Note: This story was originally printed with the title "A New Phrenology?"

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