

## Of Two Minds

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The human brain is mysterious -- and, in a way, that is a good thing. The less that is known about how the brain works, the more secure the zone of privacy that surrounds the self. But that zone seems to be shrinking. A couple of weeks ago, two scientists revealed that they had found a way to peer directly into your brain and tell what you are looking at, even when you yourself are not yet aware of what you have seen. So much for the comforting notion that each of us has privileged access to his own mind.



Rodney Smith

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Opportunities for observing the human mental circuitry in action have, until recent times, been almost nonexistent, mainly because of a lack of live volunteers willing to sacrifice their brains to science. To get clues on how the brain works, scientists had to wait for people to suffer sometimes gruesome accidents and then see how the ensuing brain damage affected their abilities and behavior. The results could be puzzling. Damage to the right frontal lobe, for example, sometimes led to a heightened interest in high cuisine, a condition dubbed gourmand syndrome. (One European political journalist, upon recovering from a stroke affecting this part of the brain, profited from the misfortune by becoming a food columnist.)

Today scientists are able to get some idea of what's going on in the mind by using brain scanners. Brain-scanning is cruder than it sounds. A technology called functional magnetic resonance imaging can reveal which part of your brain is most active when you're solving a mathematical puzzle, say, or memorizing a list of words. The scanner doesn't actually pick

up the pattern of electrical activity in the brain; it just shows where the blood is flowing. (Active neurons demand more oxygen and hence more blood.)

In the current issue of *Nature Neuroscience*, however, Frank Tong, a cognitive neuroscientist at Vanderbilt University, and Yukiyasu Kamitani, a researcher in Japan, announced that they had discovered a way of tweaking the brain-scanning technique to get a richer picture of the brain's activity. Now it is possible to infer what tiny groups of neurons are up to, not just larger areas of the brain. The implications are a little astonishing. Using the scanner, Tong could tell which of two visual patterns his subjects were focusing on -- in effect, reading their minds. In an experiment carried out by another research team, the scanner detected visual information in the brains of subjects even though, owing to a trick of the experiment, they themselves were not aware of what they had seen.

How will our image of ourselves change as the wrinkled lump of gray meat in our skull becomes increasingly transparent to such exploratory methods? One recent discovery to confront is that the human brain can readily change its structure -- a phenomenon scientists call neuroplasticity. A few years ago, brain scans of London cabbies showed that the detailed mental maps they had built up in the course of navigating their city's complicated streets were apparent in their brains. Not only was the posterior hippocampus -- one area of the brain where spatial representations are stored -- larger in the drivers; the increase in size was proportional to the number of years they had been on the job.

It may not come as a great surprise that interaction with the environment can alter our mental architecture. But there is also accumulating evidence that the brain can change autonomously, in response to its own internal signals. Last year, Tibetan Buddhist monks, with the encouragement of the Dalai Lama, submitted to functional magnetic resonance imaging as they practiced "compassion meditation," which is aimed at achieving a mental state of pure loving kindness toward all beings. The brain scans showed only a slight effect in novice meditators. But for monks who had spent more than 10,000 hours in meditation, the differences in brain function were striking. Activity in the left prefrontal cortex, the locus of joy, overwhelmed activity in the right prefrontal cortex, the locus of anxiety. Activity was also heightened in the areas of the brain that direct planned motion, "as if the monks' brains were itching to go to the aid of those in distress," Sharon Begley reported in *The Wall Street Journal*. All of which suggests, say the scientists who carried out the scans, that "the resting state of the brain may be altered by long-term meditative practice."

But there could be revelations in store that will force us to revise our self-understanding in far more radical ways. We have already had a hint of this in the so-called split-brain phenomenon. The human brain has two hemispheres, right and left. Each hemisphere has its own perceptual, memory and control systems. For the most part, the left hemisphere is associated with the right side of the body, and vice versa. The left hemisphere usually

controls speech. Connecting the hemispheres is a cable of nerve fibers called the corpus callosum.

Patients with severe epilepsy sometimes used to undergo an operation in which the corpus callosum was severed. (The idea was to keep a seizure from spreading from one side of the brain to the other.) After the operation, the two hemispheres of the brain could no longer directly communicate. Such patients typically resumed their normal lives without seeming to be any different. But under careful observation, they exhibited some very peculiar behavior. When, for example, the word "hat" was flashed to the left half of the visual field -- and hence to the right (speechless) side of the brain -- the left hand would pick out a hat from a group of concealed objects, even as the patient insisted that he had seen no word. If a picture of a naked woman was flashed to the left visual field of a male patient, he would smile, or maybe blush, without being able to say what he was reacting to -- although he might make a comment like, "That's some machine you've got there." In another case, a female patient's right hemisphere was flashed a scene of one person throwing another into a fire. "I don't know why, but I feel kind of scared," she told the researcher. "I don't like this room, or maybe it's you getting me nervous." The left side of her brain, noticing the negative emotional reaction issuing from the right side, was making a guess about its cause, much the way one person might make a guess about the emotions of another.

Each side of the brain seemed to have its own awareness, as if there were two selves occupying the same head. (One patient's left hand seemed somewhat hostile to the patient's wife, suggesting that the right hemisphere was not fond of her.) Ordinarily, the two selves got along admirably, falling asleep and waking up at the same time and successfully performing activities that required bilateral coordination, like swimming and playing the piano. Nevertheless, as laboratory tests showed, they lived in ever so slightly different sensory worlds. And even though both understood language, one monopolized speech, while the other was mute. That's why the patient seemed normal to family and friends.

Pondering such split-brain cases, some scientists and philosophers have raised a disquieting possibility: perhaps each of us really consists of two minds running in harness. In an intact brain, of course, the corpus callosum acts as a constant two-way internal-communications channel between the two hemispheres. So our everyday behavior does not betray the existence of two independent streams of consciousness flowing along within our skulls. It may be, the philosopher Thomas Nagel has written, that "the ordinary, simple idea of a single person will come to seem quaint some day, when the complexities of the human control system become clearer and we become less certain that there is anything very important that we are *one* of."

It is sobering to reflect how ignorant humans have been about the workings of their own brains for most of our history. Aristotle, after all, thought the point of the brain was to cool

the blood. The more that breakthroughs like the recent one in brain-scanning open up the mind to scientific scrutiny, the more we may be pressed to give up comforting metaphysical ideas like interiority, subjectivity and the soul. Let's enjoy them while we can.

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