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Mapping the Mind

Our New Techniques for Scanning the Psyche

While maps of the genome provide a picture of humanity's biological building blocks, maps of the mind are beginning to alter our understanding of our mental life. Psychic cartography has become a favorite tool of neuroscientists and is offering some interesting and surprising insights about the workings of the brain.

There are four general ways for scientists to watch and measure the functions of the brain. Electroencephalography (EEG, first developed in 1929) is the most established and the simplest of the four. It measures brain activity by analyzing the frequency spectrum of electrical waves emitted by the brain. Its results usually do not allow for very specific study of individual regions of the brain, but it is well suited for researching general brain function. For example, in a study published last summer in the journal *Neuropsychopharmacology*, researchers reported that EEG results showed marked changes in the brain activity of patients taking antidepressant medication, often weeks before patients become aware of the drug's effects.

While EEG measures brainwaves, three other technologies developed in the second half of the twentieth century involve actual images of living brains. The most familiar of these is computerized axial tomography (the CAT scan, introduced in the 1970s), which uses x-rays and computers to produce clear cross-section images of body parts. CAT scans are routinely performed to examine brain damage and to look at structural abnormalities in the brain. Data from CAT scans has been helpful to researchers studying such phenomena as aneurysms and tumors.

In positron emission tomography (PET scanning, developed in the early 1970s) subjects are injected with a radioactive substance that can be detected as it breaks down in the body, allowing doctors and scientists to track blood flow in the brain and monitor activity in its different regions. Last July, researchers at the University of Pittsburgh announced a new technique which uses PET scanning to detect the onset of Alzheimer's disease, and which could potentially show the presence of the disease years before any symptoms become apparent. Alzheimer's replaces healthy brain tissue with clumps of plaque and dead neurons, but until the development of this latest scanning technique, doctors could not detect this process in a living patient. The new scans, while obviously preliminary, may offer early warning to potential Alzheimer's patients and perhaps enable scientists to learn more about the progression of the disease.

The most sophisticated of the scanning methods uses powerful magnets and radio waves to create a picture of the brain. This technique, magnetic resonance imaging (or MRI, first used in 1977) can be used to study the tissues and structures of the brain in outstanding detail. An updated version of the same technology, called functional magnetic resonance imaging (fMRI, first demonstrated in 1991), can

actually create movies of brain activity by precisely tracking the flow of blood in the brain and putting several images together. This method allows for accurate maps of the brain that can be correlated with different mental and physical activities. Such scanning has dramatically improved our understanding of the workings of the brain, leading to a range of new discoveries in neuroscience.

Some of the recent discoveries exist simply on the level of curiosities. For instance, fMRI has been used to study why songs stick in our heads and why some people cannot appreciate music. Researchers have also used fMRI to study how the brain responds when the body is tickled.

Other studies may have more obvious applications in medicine. Last May, researchers in St. Louis published results of a comparative fMRI study of child and adult brain activity that found substantial differences in the ways the young and the old perform basic mental tasks. Their results suggest that children rely far more heavily on the region of the brain used for visual processing than do adults, while adults make more use of the frontal cortex—the seat of "executive control"—than do children. This may mean that the frontal cortex fully matures only later in life, which could have consequences for the treatment of brain injuries and even psychological disorders.

According to press reports, about a dozen hospitals and research centers around the country are already using MRI technology to diagnose and assess conditions such as panic disorder, ADHD, and bipolar disorder. A study presented last November at the annual meeting of the Society for Neuroscience showed a strong connection between feelings of sadness and activity in a specific structure in the brain; that study might someday help in the diagnosis and treatment of clinical depression. Such diagnoses are still fairly crude, and at this point insurance companies will only pay for MRI scans used to rule out tumors or strokes as the causes of psychiatric conditions. In time, however, brain imaging may become a standard diagnostic tool for psychiatric disorders that have traditionally been diagnosed "on the couch."

The same techniques have also been used to study how the "normal" mind operates by making new maps of the psyche. In just the past two years, fMRI has been used to study the brain activities of liars, laughers, and lovers, and of people who were smiling, thinking, sexually aroused, or watching violence on television.

Surely some of these studies will produce both valuable new cures and new knowledge about our psychological life. But there is a risk, too, in learning about brain functions: We may be bewitched into thinking that all emotion and behavior is mere biology, or end up distorting how we understand the most fundamental human experiences, like love and mourning, by reducing them to the "matter in motion" of the brain. Such an account, however accurate it might become, will not likely be more truthful.

Psychiatric treatment has long been moving away from an engagement with the soul to an engagement with the body—from conversation to pharmaceuticals. But if diagnosis as well as treatment comes to abandon talking for mapping, and as we continue to medicalize human behavior, we may irrevocably damage our traditional notion of what it means to be "at work in the world"—what it means to be feeling, striving, active beings.

As one subject of a brain mapping study told the *Wall Street Journal* last May: "It

turns out that I'm really normal, but something abnormal is happening in my brain." Such peace of mind, however, comes at a cost: the separation of "I" from "my brain," and the reduction of human identity to its neural "machinery."