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Imaging Studies Reveal How the Brain Takes Sides

It's an old myth that artists are "right-brained" and mathematicians are "left-brained." But each side of the brain does tend to specialize in different skills. Now, Howard Hughes Medical Institute investigator Randy Buckner of Harvard University and colleagues have developed a new imaging method to track how a person's brain divides up duties between the two halves. The approach could help scientists understand how genes influence brain development and provide doctors with a new tool for planning brain surgery.

The human brain is adept at solving many different types of problems, and one way it does this is by dividing up its tasks. "It may be quite critical for our ability to think as rapidly and flexibly as we do," says Buckner.

Some talents are more likely to be controlled by a particular half of the brain. For instance, areas on the left side tend to govern language, while the right side usually directs vision and spatial reasoning. But that's not absolute, and in some people the opposite side takes the lead.

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- Randy L. Buckner

It's important to understand how jobs are parceled out between the two brain hemispheres. For example, a surgeon operating on the brain needs to know which part of the brain has the most control over abilities such as language or memory. In addition, understanding how and why tasks are assigned to certain sides of the brain could lend insights into autism, schizophrenia, and other disorders. In people with these conditions, functions tend to be distributed more equally between the two halves of the brain, and this incomplete specialization of the brain's halves may mark impaired function.

Functional MRI (fMRI) is commonly used to map regions of an individual's brain associated with particular tasks. But this approach only reveals brain

activity linked to the specific tasks that doctors or researchers choose to focus on. Buckner and his team wanted a more comprehensive way to track the division of labor between the brain's hemispheres.

In the November 16, 2009, issue of the journal *Proceedings of the National Academy of Science*, Buckner and his colleagues describe a new method for identifying the brain's functional asymmetries that takes advantage of the fact that the brain is never silent. "There's an amazing amount of spontaneous activity in the brain," Buckner says, "and we used it to determine the architecture of the brain." Their findings indicate that many different factors help set up these asymmetries in a developing brain.

Buckner and his team imaged the brains of 300 people using fMRI, which measures blood flow in the brain. Increased blood flow in a specific region of the brain indicates neural activity because firing brain cells need the extra oxygen that an influx of blood provides. In typical fMRI experiments, participants perform specific tasks, such as memorizing a list of words or responding to a series of images, and scientists pinpoint which areas of the brain are active during those tasks. But in this experiment, Buckner's team measured brain activity while participants did nothing—they just lay still and looked straight ahead. "This approach allows us to measure all brain systems at once," says Buckner.

Parts of the brain that are connected tend to fire in synchrony, and Buckner's team used that fact to analyze the scans. The researchers compared the activity of connected regions on one side of the brain to that of connected regions on the other. If one side is dominant, it shows more activity.

Matching previous findings, the group found that regions known to be involved with language tended to be stronger on the left side, and regions linked to vision and spatial awareness tended to be stronger on the right side. But in some subjects the usual pattern was flipped, and some people's brains weren't as lop-sided as others.

To take the study further, Buckner and his colleagues looked at whether "sidedness" for different tasks tended to track with each other, or whether they were independent. They found that the degree of dominance for any particular skill did not completely track the degree of dominance for other skills. This finding suggests that many factors – which might be genetic or environmental -- contribute to setting up the brain's asymmetry. That's not too surprising, says Buckner, but it does challenge previous theories that proposed that a single gene controls the division of capabilities between the two halves of the brain. "More than one gene likely contributes," he says.

Buckner is eager to use his new method to look deeper at how genes influence specialization of different parts of the brain. The technique is quicker and easier than other types of imaging studies. That means it will be easy to collect huge numbers of scans. "Many thousands of people are

coming in [to the Massachusetts General Hospital imaging center]for scans already, and we can easily tack on these studies,” says Buckner.

Surgeons could also use the approach to plan surgery, such as removing the seizure-causing part of the brain in a person with epilepsy. In such procedures, the surgeon wants to steer clear of regions that are essential for language or memory. Standard fMRI is sometimes used to map the brain prior to surgery. In other cases, surgeons do this by inserting a catheter into the brain, delivering a drug that puts different parts of the brain to sleep and seeing whether a person has difficulty speaking or understanding language. The new fMRI method provides an alternative that is not as invasive, and makes it easier to map the whole brain, Buckner says.