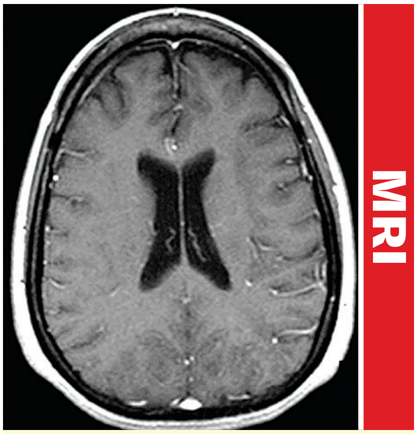
A Primer for Generation X

If you're confused by the alphabet soup of scanning technologies, this image glossary spells it out for you

»STRUCTURAL«

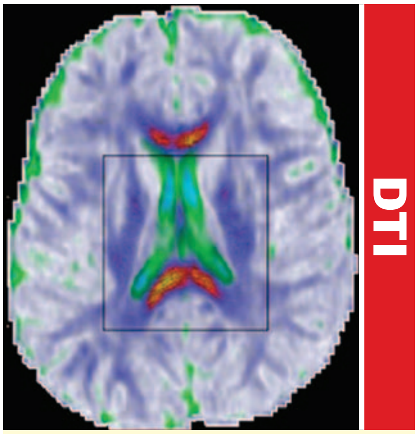
COMPUTED TOMOGRAPHY

The use of X-rays to generate detailed, three-dimensional images of the body part under examination. An invention that earned a 1979 Nobel Prize for changing the way we look at the brain, CT combines numerous two-dimensional X-ray images to generate 3D cross-sections. The patient lies on a narrow table that slowly passes through a large tube containing X-ray equipment, which takes images of the brain from all angles. A computer calculates the amount of radiation absorbed by the brain to generate a 3D picture that's clearer and more detailed than that produced by conventional X-rays. CT can show normal anatomy as well as abnormal processes like infections or brain tumors. In general, it shows bony structures in more detail than soft tissue. (Also called CAT, for computerized axial tomography).



MAGNETIC RESONANCE IMAGING

A major breakthrough in imaging technology featuring image creation that involves the use of magnetic energy. Patients undergoing MRI lie in a large, powerfully charged magnet that sends strong radiofrequency waves through the brain. That produces a momentary change in the alignment of the brain's hydrogen atoms, which in turn alters the signal emitted by the protons (positively charged particles) in those hydrogen atoms. As with CT, a computer translates this information into highly detailed, three-dimensional pictures of the brain. Invented in 1977, MRI is especially good at showing detail in soft tissue.



DIFFUSION TENSOR IMAGING

A new application of MRI specifically for creating images of the white matter in the brain. Developed in the mid-to-late '90s, DTI is used to detect tumors and other white matter lesions, and to determine a patient's white matter anatomy when planning for neurosurgery. It can also assess white matter maturation in children.

COURTESY OF AMERICAN SOCIETY OF NEUROIMAGING (CT), UNIVERSITY OF PENNSYLVANIA (MRI), WASHINGTON UNIVERSITY OF ST. LOUIS (DTI)

-Ray

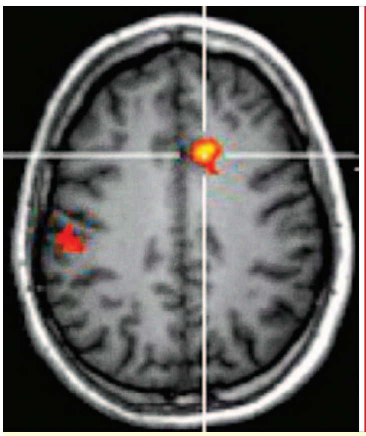
Today's mind-boggling advances in brain mapping are possible thanks to developments that have revolutionized imaging over the past three decades.

These new methods fall into two broad categories:

- *Structural* imaging shows brain anatomy but sheds little light on brain activity.
- *Functional* imaging shows metabolic brain activity, which allows doctors to detect abnormalities like tumors or to determine which areas are involved in certain thought processes and mood states. Often they combine both structural and functional types of images, such as MRI plus PET, for pictures of maximum detail.

Here's an introduction to the types of imaging technologies that scientists use to take ever more precise and accurate snapshots of the brain.

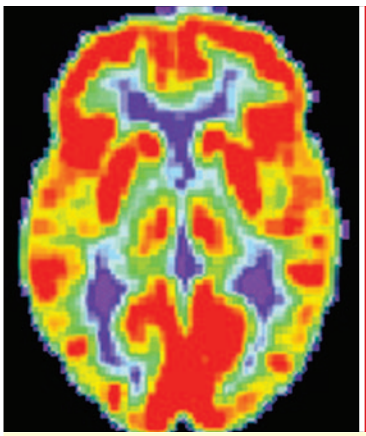
»FUNCTIONAL«



fMRI

FUNCTIONAL MAGNETIC RESONANCE IMAGING

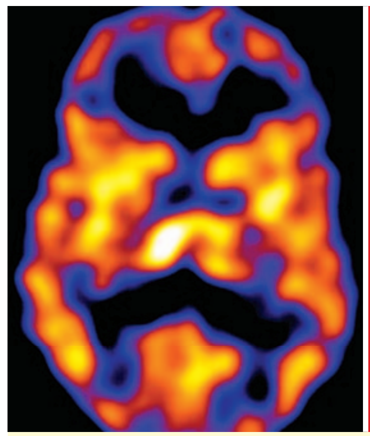
A type of MRI that shows brain activity by detecting changes in blood flow in different parts of the brain under various circumstances. The reasoning behind fMRI is that increased blood flow to a certain area reflects increased activity there. To perform fMRI, a series of MRI scans is first taken with the subject in a resting state. Then another MRI series is taken in very rapid succession while the person is performing a mental task, like listening to music or solving a mathematical problem. Images are generated by comparing the differences in brain blood flow between the resting and active states. The parts of the brain showing increases in blood flow (as depicted by the colored spots in this scan) are presumed to be the areas that are activated for that type of task.



PET

POSITRON EMISSION TOMOGRAPHY

An imaging method that measures metabolism changes in the brain, useful for monitoring blood flow and oxygen utilization. Developed in the '70s, PET is based on detection of radiation as measured in particles emitted by radioactive substances. Before undergoing a PET scan, the patient inhales or is injected with a radioactive tracer substance. In the blood, the tracer goes to the organs, including the brain, where it accumulates in regions that are most metabolically active. As the tracer breaks down, it releases the particles, which give off gamma rays. A 3D image is generated by measuring rays emitted from various brain regions. PET scans provide snapshots of metabolism, like protein synthesis or oxygen utilization, at very specific sites in the brain.



SPECT

SINGLE-PHOTON EMISSION COMPUTED TOMOGRAPHY

Like PET, SPECT is a functional imaging method based on measuring the radiation emitted by a radioactive tracer that is inhaled or injected before the test. The tracer substance used in SPECT breaks down more slowly than PET tracers. SPECT can provide 3D information about blood flow and metabolism in the brain, but it is less detailed than PET images. It is also less expensive to perform and more likely to be covered by insurance.

For more information about brain imaging, see Resource Central on page 46.

COURTESY OF STANFORD UNIVERSITY (FMRI), NATIONAL INSTITUTE ON AGING (PET), SOCIETY OF NUCLEAR MEDICINE (SPECT)