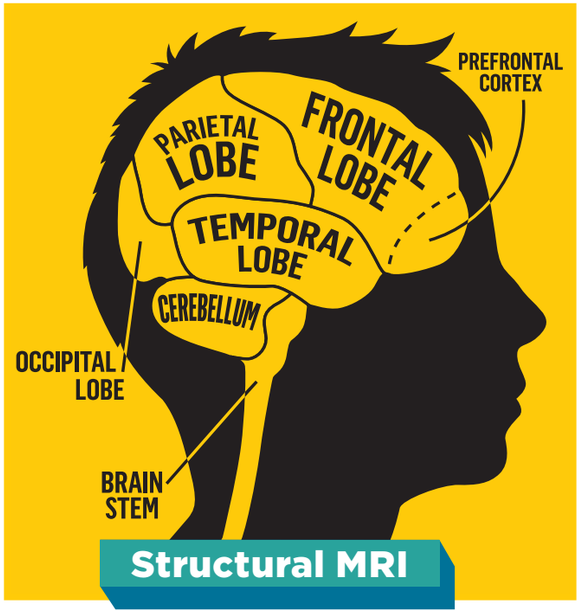
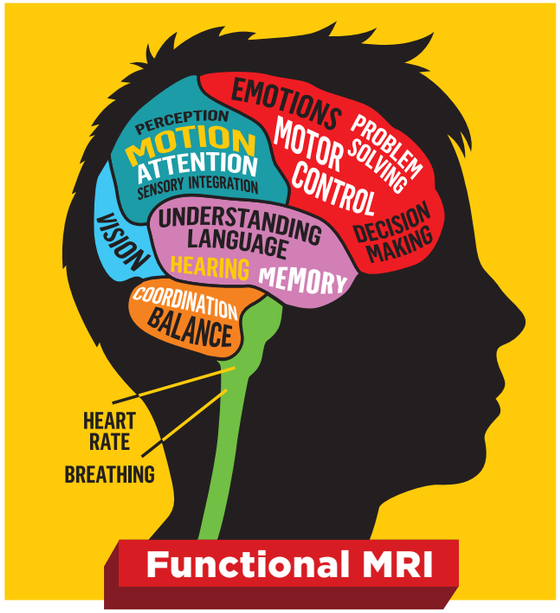
# MAPPING THE BRAIN




Structural MRI




Functional MRI

## How technology is shaping what we know about the brain

Your brain has an estimated 85 billion *neurons** (nerve cells) that send signals with speeds of up to 270 miles per hour. Through neurons, your brain controls every move you make and every thought you think.

We know this, and much more, from advancements in *neuroscience*—the study of the nervous system, including the brain. Neuroscientists use brain-imaging tools—**MRI**, **fMRI**, and **PET**—to study the brain's structures and functions.

With these technologies, neuroscientists have mapped out which brain regions control different bodily functions. They've identified the brain areas that control critical thinking, movement, and breathing, as well as feelings like pleasure, sadness, and fear. They've also learned what happens to the brain as we age, as well as the effects of injury and of using drugs.

But there is still a lot to figure out. Read on to learn how these technologies work and how they are helping to teach us about ourselves, now and in the future.

*The prefix *neuro-* signals a word related to the brain, nerves, or the nervous system—such as *neuron* (a nerve cell).

## The Future of Brain Research: The ABCD Study[1]

**We know the brain changes a lot during adolescence. But does sleeplessness or stress affect brain development? Does playing sports? Are there lasting changes to the brain that result from vaping e-cigarettes?**

To answer these questions and many more, neuroscientists will begin a study in 2016 that researches 10,000 9- to 10-year-olds for a period of 10 years. The researchers will use MRI and fMRI to track brain structure and function in the participants, as well as surveys and games to track the participants' behaviors. In the largest study of its kind, scientists will be able to look for patterns in how teens' lives affect their brains, and how teens' brains affect their lives. This information can be used to help future generations live better, healthier lives.

[1] Adolescent Brain and Cognitive Development Study

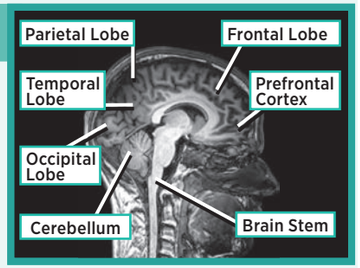
From Scholastic and the scientists of the National Institute on Drug Abuse, National Institutes of Health, U.S. Department of Health and Human Services

## Structural MRI
Structural Magnetic Resonance Imaging

### WHAT IT SHOWS

A detailed image of the structure (size and shape) of tissues, organs, and bones. Also shows the presence of disease.

### HOW IT WORKS




A person lies still in an MRI machine, which surrounds the body with a magnetic field and emits radio waves. Hydrogen atoms in the water of tissues and bones absorb and then release the energy from the radio waves. A computer maps and measures these changes to create an image. Changes in the size of tissues (such as from diseases like cancer that cause tumors) can increase the amount of water in different parts of the body, which can be detected by MRI scans.

### SOMETHING WE'VE LEARNED

MRI scans of the brain have shown that people who have been using drugs for a long time have a smaller prefrontal cortex than people who have not been using drugs. The prefrontal cortex is the area where decision making occurs.

## Functional MRI (fMRI)
Functional Magnetic Resonance Imaging

### WHAT IT SHOWS

Areas of the brain that are active during a task.

### HOW IT WORKS

The color areas in the fMRI above show brain regions active during laughter.

A person lies in an MRI machine while doing an activity such as looking at an image, hearing a sound, laughing at something funny, or completing a puzzle. The areas of the brain that are active during the behavior have increases in blood flow and blood oxygen levels. A computer analyzes these changes to map brain function.

### SOMETHING WE'VE LEARNED

In studies where adolescents played a game to earn rewards, their brain scans showed higher activity in the area of the brain that processes motivation and pleasure (the nucleus accumbens[2]) compared with the area of the brain that guides thoughtful decision making (the prefrontal cortex). Scientists think this imbalance in activated brain regions may lead teens to focus more on the possible rewards of a decision than on any drawbacks. This could increase a person's risk for using drugs.

## PET Positron Emission Tomography

### WHAT IT SHOWS

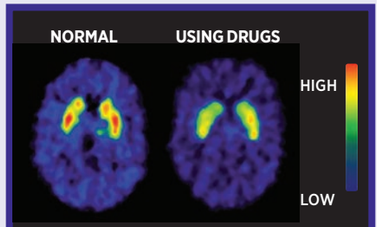
The brain and body at the cellular level.

### HOW IT WORKS

PET scans use radioactive chemicals, called radiotracers, that are injected into the body. The radiotracers go to different areas depending on the chemical that is used. The PET machine detects the radiotracers and computer programs use colors to show their location.

### SOMETHING WE'VE LEARNED

Dopamine is the brain chemical that helps us feel pleasure. By following radiotracers for dopamine receptors, PET scans have shown that using drugs heavily reduces the number of these receptors. Fewer receptors indicates less dopamine activity in the brain. This finding helps explain why people addicted to drugs experience less pleasure from everyday activities. They begin to crave the drug to get their dopamine activity back up to normal.




A normal brain (left) has high levels of dopamine. Using drugs may make levels decrease (right).

[2] The nucleus accumbens is a brain structure located at the base of the frontal lobe deep inside the brain. It does not appear on the MRI scan shown on this page.

▶ **More Info:** For additional facts about the brain, visit **scholastic.com/headsup** and **teens.drugabuse.gov**.