The Amazing Brain

A Reading A–Z Level Z2 Leveled Book
Word Count: 2,070

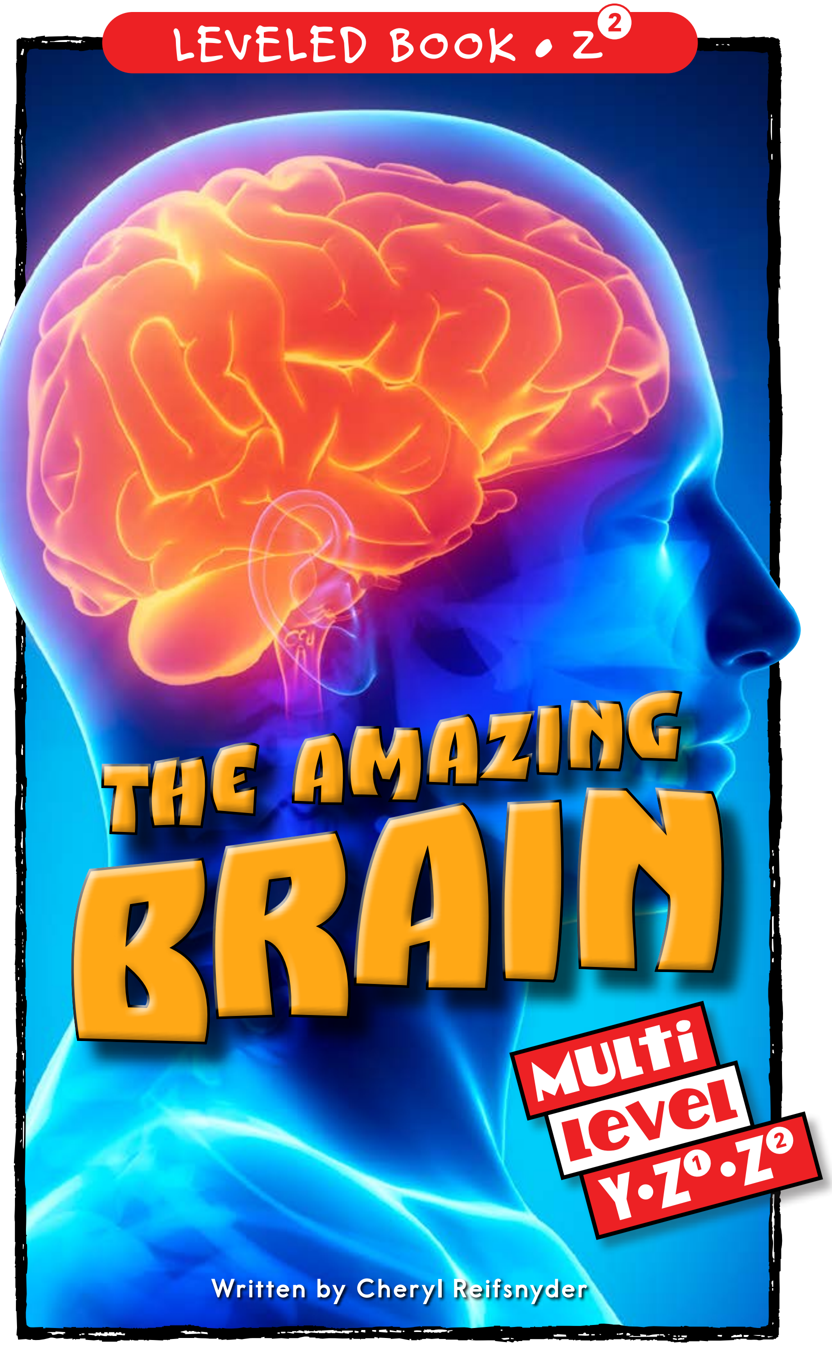
Connections

Writing

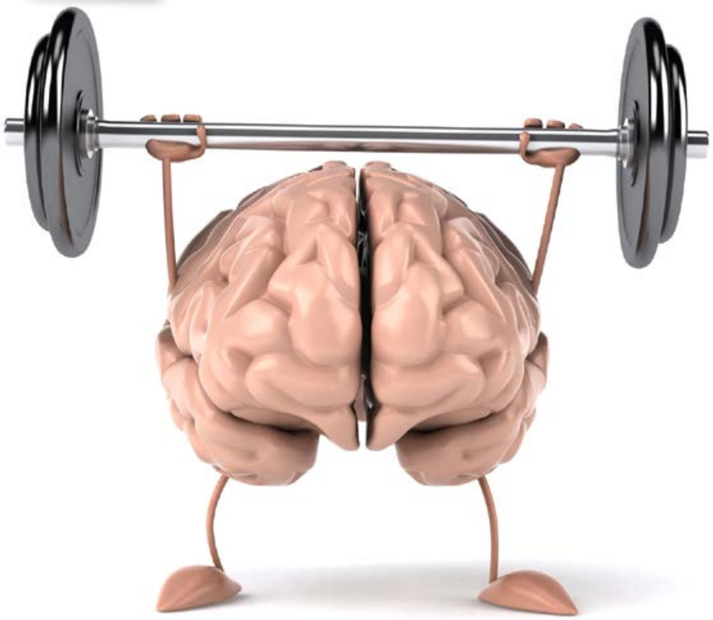
Write an article called "Your Brain at Work" to be published in a magazine or newspaper. Include a diagram that is labeled with the parts of the brain.

Math

Exercising your brain by playing games such as sudoku helps keep your brain sharp. Create a sudoku puzzle with a solution. Have a partner try to solve your puzzle.



THE AMAZING BRAIN



Written by Cheryl Reifsnyder

www.readinga-z.com

Focus Question

What makes the human brain amazing?

Words to Know

autonomic	lobes
brain stem	motor
cerebellum	network
cerebrum	neurons
corpus callosum	noninvasive
decipher	onset
electrodes	signals
hemispheres	

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Correlation

LEVEL Z2	
Fountas & Pinnell	Y–Z
Reading Recovery	N/A
DRA	70

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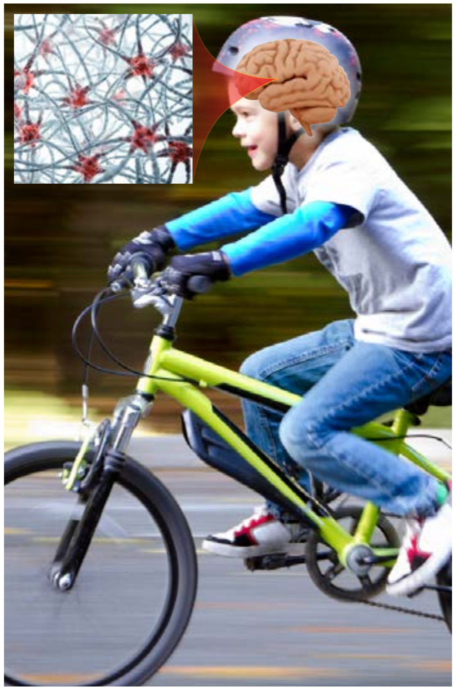
The Brain



Signals travel through neurons to different parts of the brain and body.

What weighs only 2 percent of your total body weight but uses more than 20 percent of your energy? Answer: Your most complicated body part—the brain.

Your brain needs plenty of energy to fuel about 86 billion **neurons**. These brain cells carry the electrical **signals** needed for thoughts, memories, and feelings. They're the reason you can ride a bike and remember your teacher's name.

Stephen Smith, a scientist who studies the brain at Stanford University Medical School, says that neurons form a **network** with more than 125 trillion connections. Each connection is called a *synapse*. Your brain contains more synapses than there are stars in 1,500 Milky Way galaxies! This complex wiring system enables your brain to act as the control center for your entire body.

Three Brains in One

Neurons connect the brain to the rest of the body, delivering instructions to muscles and bringing back information from your senses. They also connect the three main parts of the brain: the **brain stem**, **cerebellum**, and **cerebrum**. Each brain part controls specific body activities, and they have numerous connections so that each part can communicate with the others.

Brain Stem

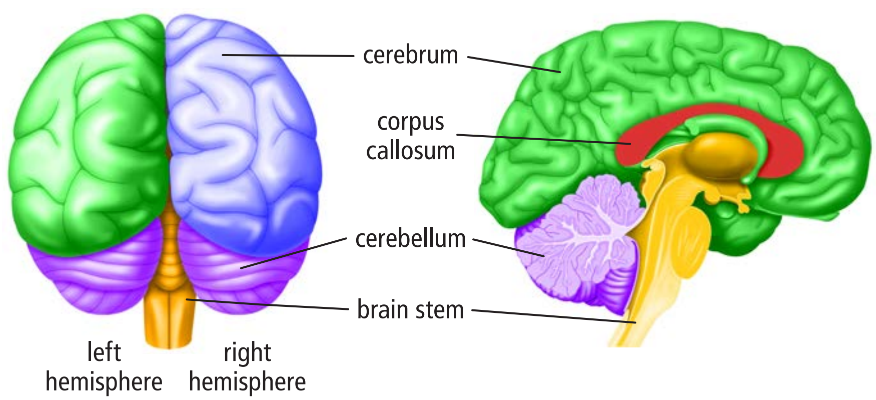
The brain stem is sometimes called the *lizard brain* because it does pretty much the same thing in lizards as in you: controls body processes that are essential for survival. Day and night, your brain stem keeps your breathing, digestion, heartbeat, and other **autonomic** body processes running smoothly. The lizard brain also controls your "fight, flight, or freeze" response—your immediate reaction to difficult situations.

Cerebellum

Each time you move your body, your cerebellum is at work coordinating muscle movements. It adds "targeting instructions" when other parts of your brain send signals using information such as your body's current speed and position. With the cerebellum's guidance, you can touch your nose in one smooth motion. Without it, the movement would be jerky, or you might even miss your nose completely!

The cerebellum also regulates balance and **motor** control as well as storing memories of muscle movement—called *procedural memory*, or the unconscious memory of how to do something. Muscle memories become stronger with repetition, which is why practice helps some movements—like playing guitar or skateboarding—become automatic. Some experts believe those muscle memories also reinforce pathways in the brain and make the **onset** of diseases such as Alzheimer's and other forms of dementia slower or less intrusive in daily life. Physical exercise strengthens more than just your body's muscles—it strengthens your brain.

Parts of the Brain



Cerebrum

The cerebrum is the largest part of the brain; it is almost 75 percent of the brain's volume and almost 85 percent of its weight. This is where most high-level brain activity takes place, including thought, speech, learning, and emotions. The cerebrum also interprets information from the senses. Sensory information reaches the brain as electrical signals, which the cerebrum interprets as sounds, images, and other sensations. It compares the results with your stored memories and attaches meaning to each one. A stream of electrical impulses becomes a purple bus or a crowing rooster.

You may be surprised to learn that ignoring things is an important part of the cerebrum's job. To understand why, take a moment to notice everything you see, hear, taste, smell, and feel. Your senses constantly flood the brain with information! By screening out some things, the cerebrum helps you focus on what remains—like an adjustable filter that only allows certain things to pass through it at certain times.

Brain vs. Computer: Which Is Smarter?

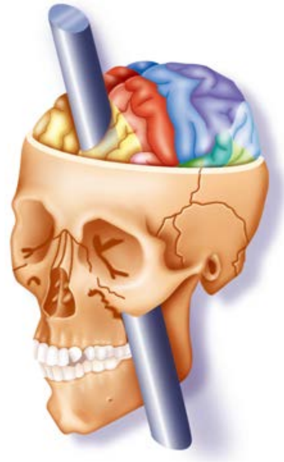
Computers remember information more precisely. Brains learn and adapt to changes better. Brains are also better at making sense out of jumbled or unrelated information.

Right Brain, Left Brain

If you could look inside your head, you'd see that the cerebrum is divided into two halves, called **hemispheres**. A bundle of nerves called the **corpus callosum** connects the hemispheres and carries messages between them, which allows the two halves to work together. The hemispheres control opposite sides of the body. Your left hemisphere sends the signal to raise your right hand; your right brain is in control when you shake your left foot. Although some tasks can be done by either hemisphere, the two are not identical. The right brain usually controls creativity, artistic skills, and interpreting what you see. The left brain generally controls speech, writing, and math skills. The corpus callosum allows the left brain to tell the right brain what it saw so that the right brain can decide what the vision meant. Without the corpus callosum, you could see the purple bus, but you couldn't tell anyone what it was.

Each brain hemisphere has four sections, or **lobes**: the frontal lobe, the parietal lobe, the occipital lobe, and the temporal lobe. Each lobe processes specific information or has a special job; however, scientists didn't realize this until the 1800s, when a doctor recorded the strange story of Phineas Gage.

Phineas Gage holds the iron rod that went through his left eye and frontal lobe.

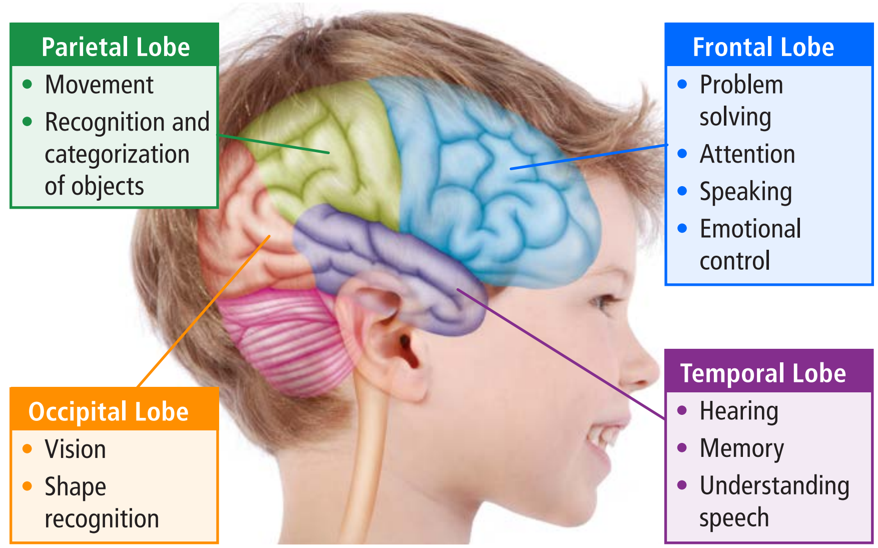


Studying the Brain

Phineas Gage was a foreman for the Rutland and Burlington Railroad who was injured in 1848 when an accidental explosion shot a three-foot iron rod straight through his head. Amazingly, Gage survived. The hole in his head didn't affect his memory or his ability to think, but it drastically altered his personality. Gage became rude, thoughtless, and as stubborn as a two-year-old, so different from his old personality that his friends said he was "no longer Gage."

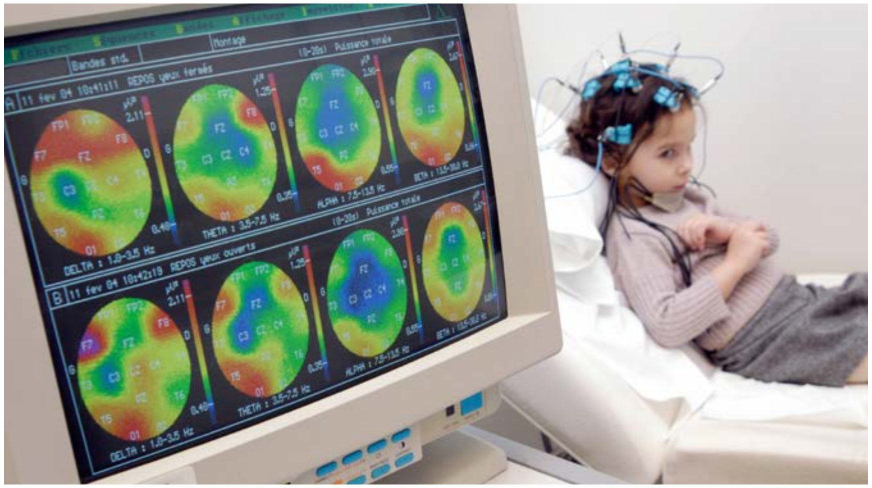
Gage had lost a portion of his frontal lobe, a part of the cerebrum that governs emotions and attention. His injury gave scientists one of the first clues that specific brain regions control specific brain functions. It also indicated that you could damage one part of the brain and the rest would keep working, but it wasn't a complete answer to all their questions about how the brain works.

Functions of Different Brain Lobes



Brain Mapping

Doctors studied Gage's case for many years, but they did not preserve his brain when he died. Then, in 1914, when World War I began, large numbers of soldiers suffered brain injuries, and the injuries to certain brain regions consistently caused the same symptoms. With this information, doctors were able to begin creating maps of brain regions and their functions. Trying to learn about the brain by studying brain injuries was much like trying to learn about cars by studying broken engines: scientists could identify essential brain regions, but not what each region did or how the different regions worked together. The ability to map brain structure is very different from the ability to map brain function.

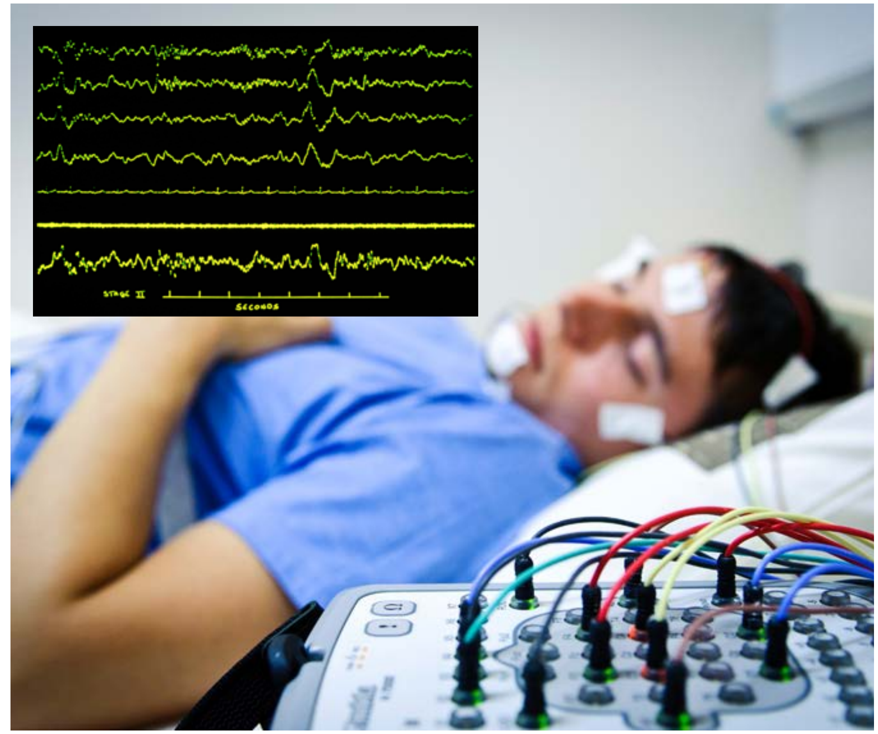


The screen of this EEG shows normal brain activity for this four-year-old girl.

"Seeing" Brain Activity

For a clearer understanding of brain function, scientists needed a way to study healthy brains without damaging them. In the 1920s, a German scientist named Hans Berger created a machine that could measure the electrical activity in the brain. This machine, called an *electroencephalogram* (il-LEK-troh-en-SEH-fuh-loh-GRAM) (EEG) machine, provided a partial solution.

Everything you do—running, singing, thinking, and more—begins with tiny electrical signals in your brain. An EEG measures these signals through **electrodes** placed on the head's surface so that researchers can "see" brain activity when you walk, talk, read, and more. The brain wave rhythm that an EEG measures is called a *Berger's wave* after this scientist-inventor.



This EEG (inset) shows the brain functions of a person in a light sleep (main).

Unless electrodes are surgically implanted inside a person's skull, though, an EEG can only detect signals near the brain's surface. Observing activity deeper in the brain was difficult and potentially dangerous until a test called an *fMRI* became available in the 1990s.

Unlike an EEG, which measures electrical activity, an fMRI identifies and maps active brain regions by measuring blood flow. This technique, which is **noninvasive**, gives an indirect measurement of brain activity because electrically active neurons require more oxygen.

A person reviews an fMRI.

Since blood is your body's oxygen delivery system, brain areas with more blood flow generally have more electrically active neurons, and unlike electrical signals, changes in blood flow can be noninvasively detected deep inside the brain.

An fMRI allows scientists to detect the precise brain regions used when you sing, laugh, or watch a scary movie—with far more detail than an EEG can provide.

Mind Control!

The ability to detect brain signals raised another question: is it possible to decode these signals? If a computer could **decipher** a brain's electrical signals, people might learn to control an artificial limb or a robot through a brain-computer interface.

Word Wise

fMRI stands for *functional magnetic resonance imaging.*

If this sounds like science fiction, think again: experimental mind-controlled devices already exist! Electrodes detect the brain signal, which is decoded by a computer, and the information can be used to control a mechanical device. Researchers hope this technology can be used to help people with disabilities move and communicate better.

This technique could also be used to send brain signals from one person to another. In early experiments, one person's "brain signal" for finger movement traveled over the Internet to another room. There, a special device delivered the signal to a second person. His finger moved—following instructions from another brain. This type of human brain-to-brain communication was first done at the University of Washington in 2013, just three weeks after a Harvard Medical School team used a different computer-brain interface to link up with a rat's brain in an experiment in which a scientist used his brain to move the rat's tail.

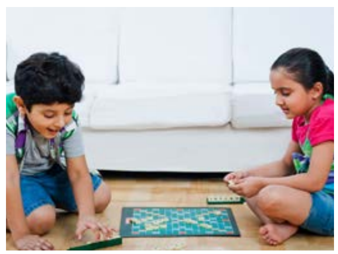
In an experiment at the University of Washington, one researcher (left) was able to send a brain signal over the Internet to another researcher (right), causing his finger to move on the keyboard.

Maintain Your Brain

Your brain is an amazing machine, and, like a machine, it operates best with proper care. How do you keep your brain in top condition?

For starters, use it! Exercising your brain helps it grow in the same way that muscles grow with physical exercise. Take violin players: they learn complicated finger movements for the left hand, and the brain area controlling that hand is larger than in most people who haven't practiced those finger movements.

Don't play the violin? Try puzzles and games you are not good at. It sounds weird, but if you are already good at a particular game or activity, your brain won't create new neural connections. If you are a language person, try number or logic puzzles like sudoku; if you are good with numbers, try learning to draw—hands are especially difficult to get just right. These activities will keep your brain healthy and strong.



Playing word games is a good way to make your brain work harder.

Also, remember to feed your brain what it needs to keep working for you. Blueberries and walnuts have lots of the right nutrients to keep your brain working smoothly.

Brain Training

Brain changes usually occur only in regions directly involved with your activity. However, research suggests that some "mental training" may cause broader changes. For instance, research at Harvard Medical School showed that people who practiced meditation for eight weeks had changes in brain regions used for learning, memory, and emotional control.

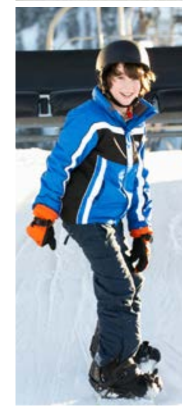
Physical exercise—especially exercise that raises your heart rate—also has brainwide benefits. Dr. Arthur Kramer is the director of the Beckman Institute for Advanced Science and Technology at the University of Illinois, where he studies how exercise affects the brain. "Exercising is good for your body and your brain," Kramer says. "Research has shown that children who regularly exercise have better memories and attention and often do better on school tests."

Dancing is good for your brain because learning new steps and patterns encourages the brain to form new neural connections. It also calms the brain's stress response, which lowers tension in the body and makes you a happier person.

Sleep is another key to maintaining healthy brain function. According to Dr. Ken Paller, director of the Cognitive Neuroscience Program at Northwestern University, evidence suggests that your brain replays memories during sleep. That may help skills and information “stick” in your memory. However it works, it’s clear that getting too little sleep decreases your ability to learn and think. Experts recommend between seven and nine hours every night.

Physical exercises such as running and jumping increase blood flow to the brain.

Protect Your Brain



Brain protection is the most important key to brain health. Shock-absorbing fluid, called *cerebrospinal fluid*, and a hard skull guard your brain against some injuries. If you land on concrete, though, a fall from only two or three feet can crack your skull or bruise your brain. This kind of injury, called a *concussion*, can come from a hard hit to your head or being violently shaken. Although most concussions from playing sports like football are mild, every one causes some damage to your brain. With rest and time, most mild concussions heal completely. More serious concussions can cause swelling or bleeding inside the skull, which can cut off the brain’s blood supply quickly—and your brain can survive only a few minutes without oxygen. Wearing a helmet while playing sports provides extra protection that may save your brain—and your life.

Your brain may be the most important part of your body. Exercise, eat brain foods, get enough sleep, and wear protective headgear to help your brain operate smoothly for years to come!

Glossary

autonomic *(adj.)* occurring or acting as an involuntary or unconscious process; relating to the involuntary nervous system (p. 5)

brain stem *(n.)* the part of the brain at the top of the spinal cord; controls basic body functions, such as breathing, heart rate, and blood pressure (p. 5)

cerebellum *(n.)* the lower back part of the brain; coordinates sensory information with muscle movement to allow the body to maintain balance and move smoothly (p. 5)

cerebrum *(n.)* the largest part of many mammals' brains; controls thinking, feeling, communicating, emotions, and some of the senses (p. 5)

corpus callosum *(n.)* the group of nerve fibers in the middle part of the brain in some mammals; connects and allows communication between the two hemispheres (p. 8)

decipher *(v.)* to make out the meaning of something that is difficult to understand (p. 13)

electrodes *(n.)* points through which electricity flows into or out of a device, such as a battery (p. 11)

hemispheres *(n.)* halves of a sphere or a mostly round object, such as a planet or a brain (p. 8)

lobes *(n.)* rounded or curved sections of a body or organ, such as the ear, brain, or lungs (p. 8)

motor *(adj.)* of or relating to muscle movement controlled by the nervous system (p. 6)

network *(n.)* a group of things that are connected to and communicate with each other (p. 4)

neurons *(n.)* nerve cells that carry information within the brain and between the brain and other parts of the body (p. 4)

noninvasive *(adj.)* of or relating to a medical procedure done without cutting or inserting anything into a body (p. 12)

onset *(n.)* the start of something (p. 6)

signals *(n.)* actions, sounds, or objects used to send a message (p. 4)