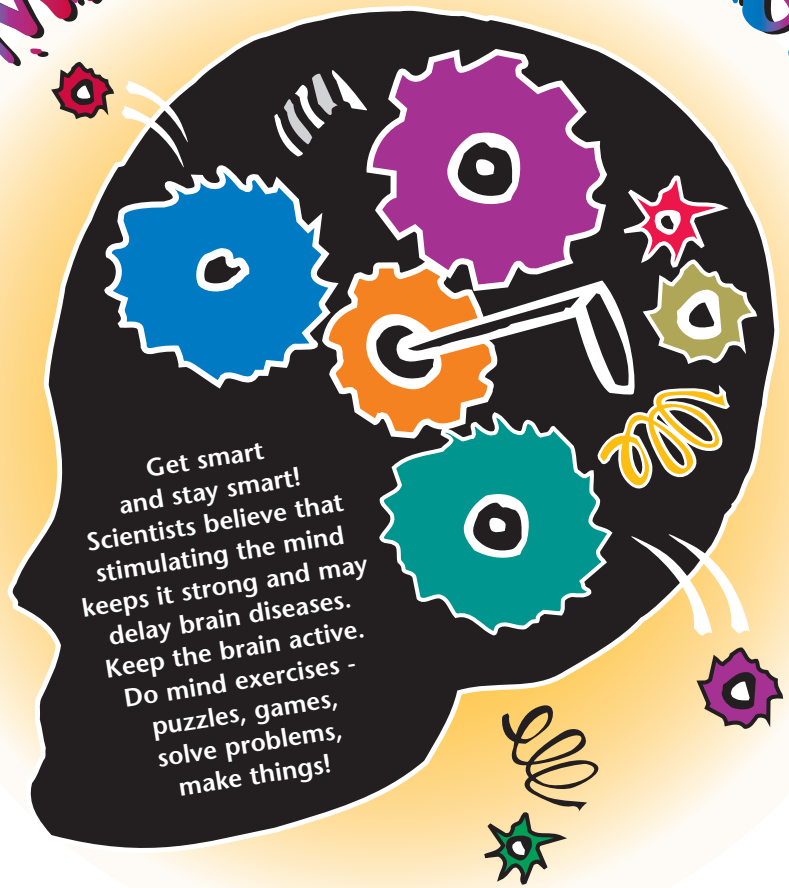
In a noisy cafeteria, your ears send your brain an overload of signals. So why can you hear your name used in a conversation (not directed at you) across the room?

IT'S MINDBOGGLING!

Time yourself to see how long it takes to find the correct answer to this multiplication problem. 25 x 20 x 52 x 12 x 365 x 0 = ?



A scientist performed the same experiment every day for a month. She discovered that it took her 90 minutes to complete the experiment on odd days of the month and 1 1/2 hours on even days. Why?

The information in It's Mindboggling! is excerpted from The Dana Sourcebook of Brain Science: Resources for Secondary and Post-Secondary Teachers and Students, Second Edition, a publication of the Dana Press. Access the online edition of It's Mindboggling! at www.dana.org/publications/print.

The Dana Alliance for Brain Initiatives is a nonprofit organization committed to advancing public awareness about the progress and benefits of brain research and to disseminating information on the brain in an understandable and accessible fashion. Supported entirely by the Dana Foundation, the Dana Alliance does not fund research or make grants.

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Do each of the following in succession.

1. Visualize a place you'd like to be. Maybe it's riding the crest of a monster wave, or skateboarding down a halfpipe? Soaking up the rays on a sandy beach? Or maybe it's your room, catching some much-needed ZZZ's? Create the image of that place in your mind and hold it for a minute or two.

2. Listen to the sounds in the room around you. Really listen. What do you hear? The cracking of someone's gum? Muffled laughter in the hall? The low buzz of music humming in the background? See how many sounds you can differentiate.

3. Silently tap your fingers, one tap, one finger at a time, in succession. Then reverse the order of tapping. Then tap each finger twice, in succession, then in reverse. Then three times…

4. Starting at 100, count backwards by 7's.

5. Remember some event from your past. The first time you rode a bike all by yourself; your grandmother baking your favorite cookies. Put yourself back in that place, and recall everything you can about it: Who was there with you? What were you wearing? What emotions were you feeling?

6. Now pinch yourself. Pick a tender spot on the inside of your elbow, and pinch the skin just hard enough to feel pain.

Food For Thought

Brains work best when you eat well-balanced meals. Without a balance of nutrients, it does not function to its full potential. You could become forgetful, overly emotional, tongue-tied, or light-headed.

In performing these six tasks, you've just activated a good portion of your brain. Even something as "simple" as tapping your fingers in succession requires a phenomenal act of coordination among millions of nerve cells through the brain all acting together in perfect timing to produce the signals that commit your fingers to move.

If you had been lying inside a PET or MRI scanner – tools of modern neuroscience that enable scientists to take images of the living brain as it works - the scans would show distinct areas of your brain "lighting up" as you did each task. Tapping your fingers in succession would activate groups of neurons in at least four distinct areas of the brain:

- the prefrontal cortex, where the brain makes the conscious decision to do the task,
- the premotor cortex, where you formulate the instructions for doing the task,
- the motor cortex, a sort of relay station that sends those instructions on to the arm and hand muscles that move the fingers, and
- the cerebellum, which supervises the whole process and adjusts your actions as necessary in response to external cues, such as where your hand is in relation to the desk.

All this takes place in a mere fraction of a second. Not such a "simple" task after all, from the brain's perspective.

Sleepy Head

Missing one night's sleep makes you crabby. Two sleepless nights and you have trouble concentrating. Several nights of no sleep and you hallucinate (see things that aren't there).

Brain Power!

Give yourself two minutes to memorize these ten words in order:
Candy, Head, Bear, Farm, Ring, Cat, Jennifer, Necklace, Nine, Pen
Cover up the list. Now recite it – first forward, then backward.
What was the seventh word on the list?
Next time, make up a list of reminders for each word, like:
Candy is number one with me.
Two Head[s] are better than one.
The Three Bear[s] is a great story.
A farm is for[four] animals.
Five ring[s] for five fingers.
You get the idea, now try again!

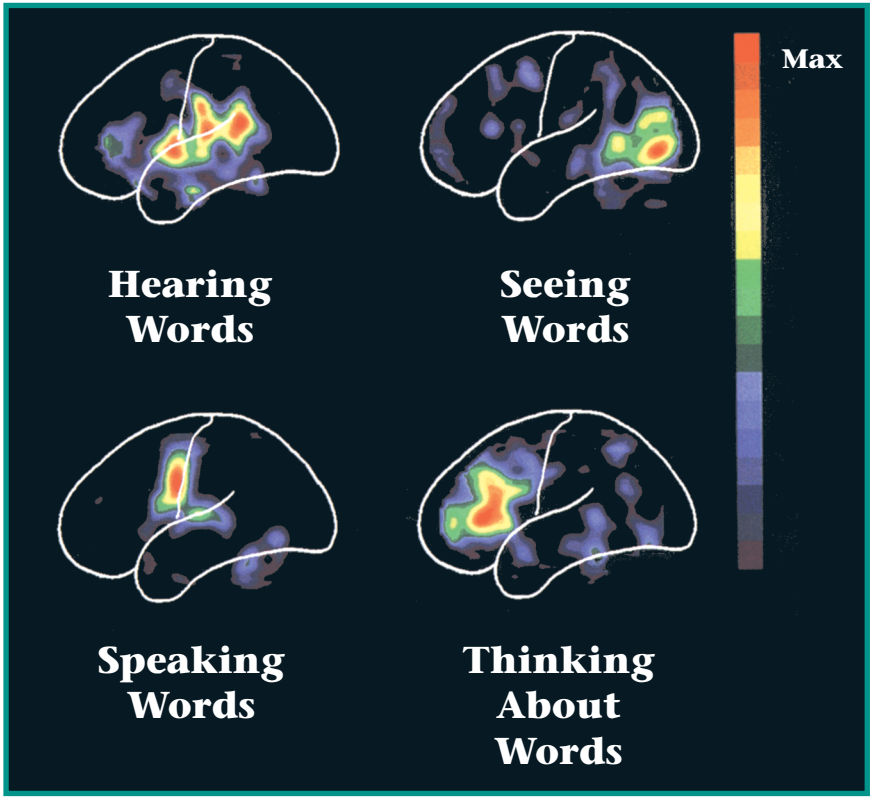
<u>In the tasks on Page 1:</u>

Task #1, visual imagery, lights up the visual cortex in the back of the brain, as well as pathways leading to it from the eyes, along the optic nerve. Differentiating individual sounds around you activates the auditory cortex and associated areas. Counting backward by 7s is a complex cognitive task, and calls upon the brain's center for higher thoughts in the prefrontal cortex.

Recalling a memory from the past will likely activate the hippocampus, an inner-brain structure involved in memory, as well as other areas of the brain that correspond to this type of memory. For example, remembering the first time you rode a bike, a motor task, will light up the motor area of the brain; recalling the smell of Grandma's cookies would activate the olfactory center.

Lastly, when you pinched yourself, pain receptors in the nerves of the skin sent signals back to the brain to alert it to the location and intensity of the pain, and to initiate corrective action if necessary (i.e. stop the pinching!). If the pain was intense, the brain might release endorphins, natural hormones that block the transmission of pain signals. Narcotic drugs like morphine imitate the action of these natural endorphins to fight pain.

This brief tour of the brain gives you some idea of its complexity.



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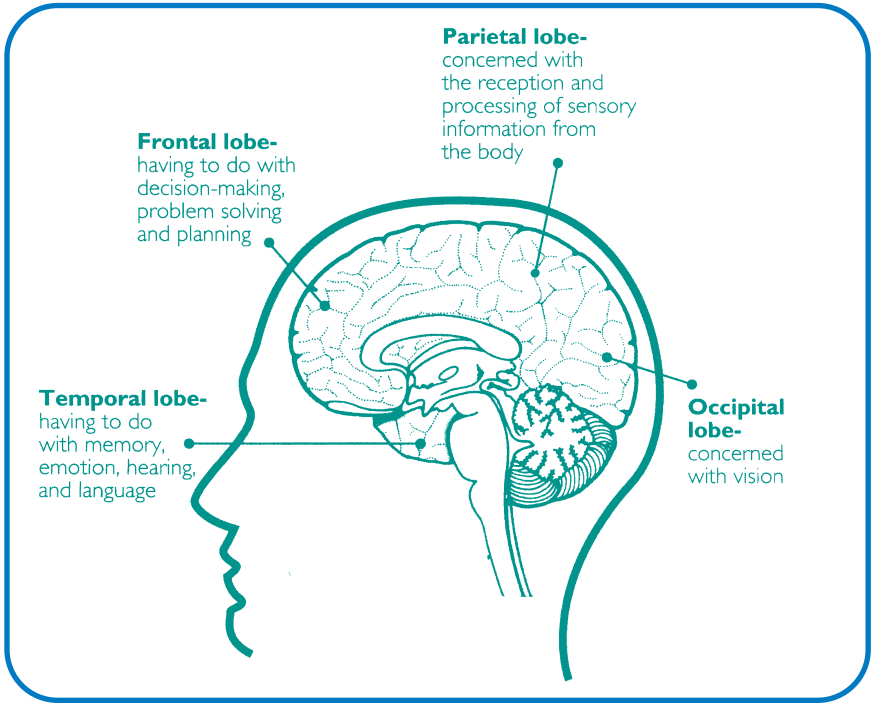
Positron Emission Tomography (PET):

A brain imaging technique that measures changes in brain metabolism to create three-dimensional images of brain activity. In a PET scan, a radioactive "marker" that emits or releases positrons (parts of an atom that release gamma radiation), is injected into the bloodstream. Detectors outside of the head can sense these "positron emissions," which are then reconstructed using sophisticated computer programs to create "tomographs," or computer images. Since blood flow and metabolism increase in brain regions at work, those areas have higher concentrations of the marker, and researchers are able to see which brain regions are activated during certain tasks or sensory stimuli.

Protect your Brain

Try this experiment. You will need a raw egg and a Styrofoam cup. Make a helmet for the egg using the cup. Test your helmet by dropping the egg in its helmet. In a bike or skateboarding accident, a helmet protects the brain in much the same way.



Visual Brain Test:

Count how many cubes are here. Be sure to think twice!

(answer on the last page.)

Check Out this Rhyming Game!
Fill in the Missing Word!

Headache = B R A I N _ _ _ _

Chief Genius = _ _ _ _ B R A I N

Tune you can't get out of your head = B R A I N _ _ _ _ _ _ _

Smart people leaving one country to work in another = B R A I N _ _ _ _ _

What a neurology professor does = _ _ _ _ _ _ _ B R A I N S

(answers on the last page.)

Train Your Brain!

Do you wake up at the same time every morning? Ask a friend to hold a watch with a second hand. When your friend says "Go," try to guess when exactly one minute has passed. Keep trying. With practice, you can guess almost precisely.

Neuroscience is the study of the brain and nervous system. Neuroscience is a vast field with opportunities for research in brain function, in diseases and disorders, in brain imaging and in providing important insights into thought, emotion and behavior. Scientists are able now to look into the living brain using different imaging techniques. Among them are Positron Emission Tomography (PET), Functional Magnetic Resonance Imaging (fMRI), and Diffusion Tensor Imaging (DTI).

Despite significant advances in neuroscience research, the brain is so complex that it is still a challenge to understand exactly how it works. The brain is composed of more than 100 billion nerve cells, each of which forms as many as 10,000 connections with other neurons. The human brain is, as neuroscientist Joseph LeDoux says in *The Emotional Brain*, "the most sophisticated machine imaginable, or unimaginable."

Some Diseases and Disorders of the Brain

Alcohol Abuse
Alzheimer's Disease
ALS or Lou Gehrig's Disease
Anxiety Disorder
Ataxia
ADHD - Attention Deficit Hyperactivity Disorder
Autism
Birth Defects
Blindness
Cerebral Palsy
Deafness
Depression
Drug Abuse
Eating Disorders
Epilepsy
Headache
Huntington's Disease
Learning Disabilities
Manic-Depressive Illness
Mental Retardation
Multiple Sclerosis
Muscular Dystrophy
Pain
Panic Disorder
Paralysis
Parkinson's Disease
Schizophrenia
Shingles
Sleep Disorders
Spina Bifida
Spinal Cord Injury
Stroke
Tourette Syndrome

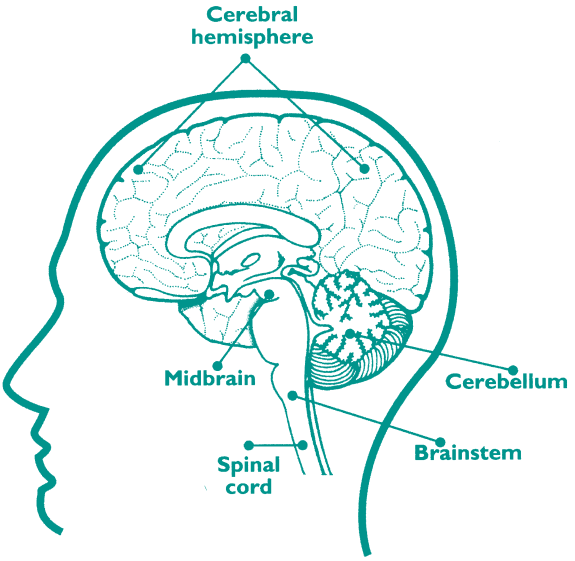
Lefty or Righty?

The right and left sides of the cerebrum have entirely different functions. Generally, the left hemisphere is responsible for analytical skills, like logic, language, and math, while the right side controls artistic ability and visual skills, like colors, shapes, patterns.

Try this! Time yourself as you balance a ruler on end in each hand. Then time yourself while balancing the ruler in each hand AND talking. Compare results.

Most righties find that talking interferes with their right-hand performance but not their left. Why? Language and right-hand abilities are in the same hemisphere and that side of the brain is overworked while talking and using that hand. Lefties can have language in either, or both, hemispheres. A lefty with right-side language would be better with the right hand; one with left-side language would be better with the left hand. A lefty with language use controlled in both sides would be able to balance the ruler equally well in either hand.

What Makes You So Smart!



Amygdala: Lying deep in the center of the brain, the amygdala is involved in emotional reactions such as anger, as well as emotionally charged memories. It also influences behavior such as eating, sexual interest, and the immediate "fight or flight" reaction to stress.

Brain stem: The part of the brain that connects to the spinal cord. The brain stem controls functions basic to the survival of all animals, such as heart rate, breathing, digestive processes, and sleeping.

Central Nervous System: The brain and spinal cord make up the central nervous system, and are part of the broader nervous system.

Cerebellum: Located at the top of the brain stem, the cerebellum coordinates the brain's instructions for skilled, repetitive movements, and helps maintain balance and posture. Recent research also suggests the cerebellum may play a role, along with the cerebrum, in higher cognitive (thinking and reasoning) processes.

Cerebrum (also called cerebral cortex): The largest brain structure in humans, accounting for about two-thirds of the brain's mass and positioned over and around most other brain structures. The cerebrum is divided into left and right hemispheres (sides), and has specific areas called lobes. The cerebrum is associated with higher cognitive processes, such as decision-making, reasoning, and planning.

Hemisphere: In brain science, refers to the two halves of the brain (the left and right hemispheres). These are separated by a deep groove, or fissure, down the center.

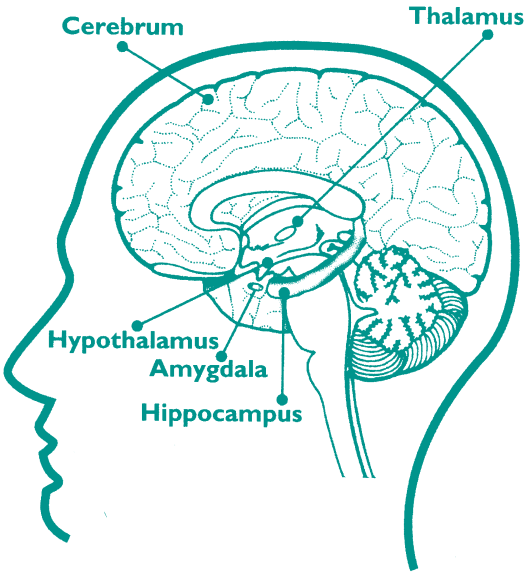
Hippocampus: Located deep within the brain, the hippocampus is involved in memory and learning.

Hypothalamus: A small structure located at the base of the brain where signals from the brain and the body's hormonal system interact.

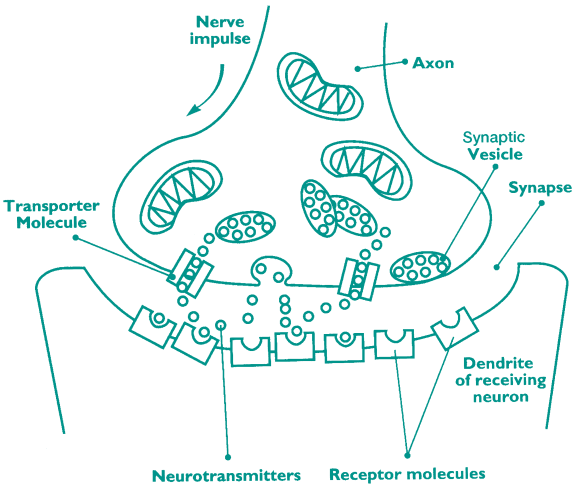
Spinal Cord: The "other half" of the central nervous system (with the brain). The spinal cord is a cable that descends from the brain stem to the lower back. It consists of an inner core of gray matter surrounded by white matter.

Sulcus: The shallower grooves on the brain's cerebrum (deeper grooves are called fissures). Plural is Sulci.

Thalamus: Located at the top of the brain stem, the thalamus acts as a two-way relay station, sorting, processing, and directing signals from the spinal cord and mid-brain structures to the cerebrum, and from the cerebrum down the spinal cord.



A Lot of Nerve



Axon: A long, single nerve fiber that transmits messages, via chemical and electrical impulses, from the body of the neuron to dendrites of other neurons, or directly to body tissues such as muscles.

Ions: Atoms or groups of atoms carrying a negative or positive charge of electricity. When a nerve impulse is fired, ions flow through channels in the membrane of a nerve cell, changing the charge in that local area of the cell to positive from its resting, negatively charged state. This sets off a chain reaction of positive charges that carries the nerve impulse along the cell's axon to the synapse, where it releases neurotransmitters into the synaptic cleft.

Dendrite: Short nerve fibers that project from a nerve cell, generally receiving messages from the axons of other neurons and relaying them to the cell's nucleus.

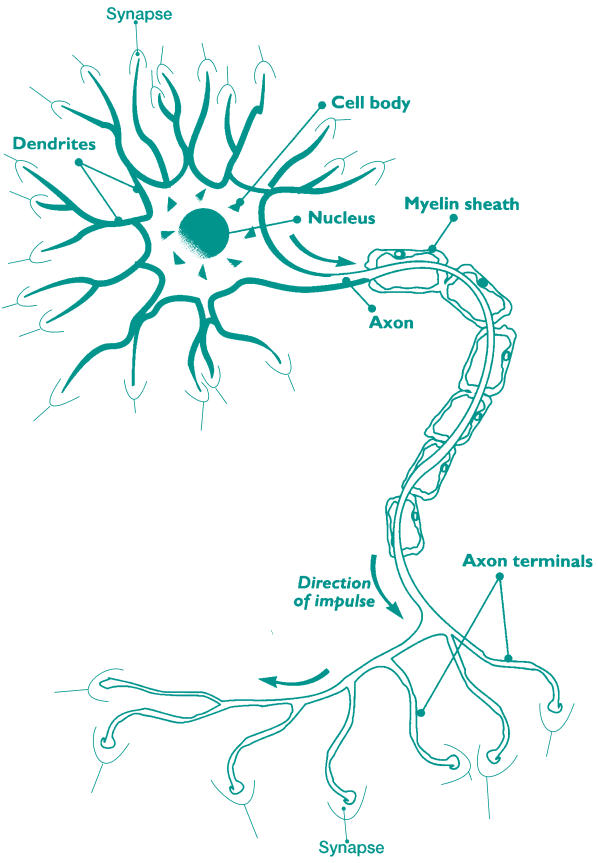
Myelin: The fatty substance that sheaths most nerve cell axons, helping to insulate and protect the nerve fiber and helping to speed up the transmission of nerve impulses.

Neuron: Nerve cell. The basic unit of the central nervous system, neurons are responsible for the transmission of nerve impulses. Unlike any other cell in the body, neurons consist of a central cell body as well as several threadlike "arms" called axons and dendrites, which transmit nerve impulses. Scientists estimate there are more than 100 billion neurons in the brain.

Neurotransmitter: A chemical that acts as a messenger between neurons, and is released into the synaptic cleft when a nerve impulse reaches the end of an axon. Several dozen neurotransmitters have been identified in the brain so far, each with specific, often complex roles in brain function and human behavior.

Receptors: Molecules on the surfaces of neurons whose structures precisely match those of chemical messengers (such as neurotransmitters or hormones) released during synaptic transmission. The chemicals attach themselves to the receptors, in lock-and-key fashion, to activate the receiving cell structure (usually a dendrite or cell body).

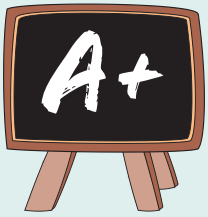
Synapse: The junction where an axon approaches another neuron or its extension (a dendrite or axon); the point at which nerve-to-nerve communication occurs. Nerve impulses traveling down the axon reach the synapse and release neurotransmitters into the synaptic cleft, the tiny gap between neurons.



Synaptic Transmission: The process of cell-to-cell communication in the central nervous system, where one neuron sends a chemical signal across the synaptic cleft to another neuron.

BRAIN FACTS

- The brain, the most complex structure of the human body, weighs about three pounds.
- The brain encases 100 billion or more nerve cells, and it can send signals to thousands of other cells at a rate of about 200 miles per hour.
- The Teenage Brain—It's, like, complicated! The dramatic remodeling of the brain during adolescence holds tremendous opportunities for growth and learning but also appears to increase a teen's vulnerability to the long-term effects of environmental influences such as stress and drug experimentation.
- Older people can't learn new things is just a myth. Brain research has found no evidence to support this in healthy older people. Nor does aging mean that one will lose his or her memory. In fact, research suggests that the more active you keep your brain as you age, the more mentally agile you will remain. It takes older people longer to learn, but they retain what they have learned as well as younger people.
- Many people do not realize the range of brain-related diseases and disorders. For instance, Alzheimer's disease, addiction, head injury, Huntington's disease, stroke, multiple sclerosis, depression, and epilepsy are all brain diseases and disorders.
- Pulling all-nighters is not recommended! Sleeping within 30 hours of new learning seems to be essential; "slow-wave" sleep—a type of non-REM sleep that generally occurs early in the night—is crucial to learning.



Testing! Testing! A+

Scientists have learned that a second exposure to information can double your ability to remember. It is also easier to remember information that means something to you. So relate and review.

Sources and Resources

On the Internet

- Dana Alliance for Brain Initiatives: www.dana.org
- Howard Hughes Medical Institute: www.hhmi.org
- National Institute on Alcohol Abuse and Alcoholism: www.niaaa.nih.gov
- National Institute on Drug Abuse: www.nida.nih.gov
- National Institutes of Health Office of Science Education: http://science.education.nih.gov/
- National Institute of Mental Health: www.nimh.nih.gov
- National Institute of Neurological Disorders and Stroke: www.ninds.nih.gov
- Neuroscience for Kids: http://faculty.washington.edu/chudler/neurok.html
- Society for Neuroscience: www.sfn.org

Printed Materials

- The Mindboggling Workbook
- More Mindbogglers!
- Q & A: Answering Your Questions About Brain Research

All of the above materials are available online at www.dana.org/publications/print.

Puzzle Answers and Explanations:

Front Cover (clockwise, L to R):

1) Your ears sense sounds, but it's your brain that does the "hearing." Your brain has to be selective about what it senses, or hears, otherwise it would be overwhelmed by sound. Your name is near the top of the list of things your brain considers to be important, therefore it will recognize it in a noisy room.

2) Zero times any number is 0.

3) They're the same thing! There are 90 minutes in 1 1/2 hours.

Back Cover (clockwise, L to R):

1) c. There are silhouettes of two faces in black, and a vase in the center.

2) c.

3) Colors and Words chart: Seeing colors and reading use two different pathways of the brain. If you read the words, your language pathways are stronger. If you stated the color, that means the visual part of your brain took over.

4) Neither. The circles are both the same size.

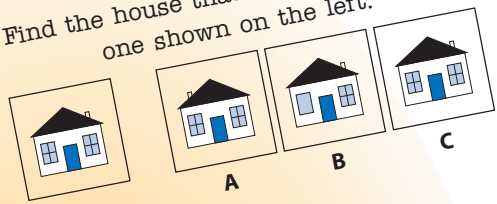
Page 5: If the white side is on the left of the cube, you count 14. If the white side is on the right of the cube, you count 16 cubes.

Page 6: 1) brain pain 2) main brain 3) brain refrain 4) brain drain 5) explain brains.

What do you see in this figure?

a. vase
b. human silhouettes
c. both

Find the house that is identical to the one shown on the left.

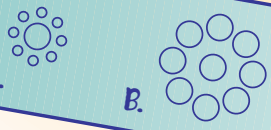


Taste and smell are related. Try this!

Hold your nose and taste a jellybean. Can you tell what flavor it is? Try another. Now just eat a jellybean normally. Can you tell the difference? Taste sensors detect only four flavors: salty, bitter, sweet, sour. These work with smell sensors that detect thousands of smells. That is why food seems bland when you have a stuffy nose!

Read this chart. Are you reading the word or saying the color?

Which center circle is bigger?



(answers on the last page.)