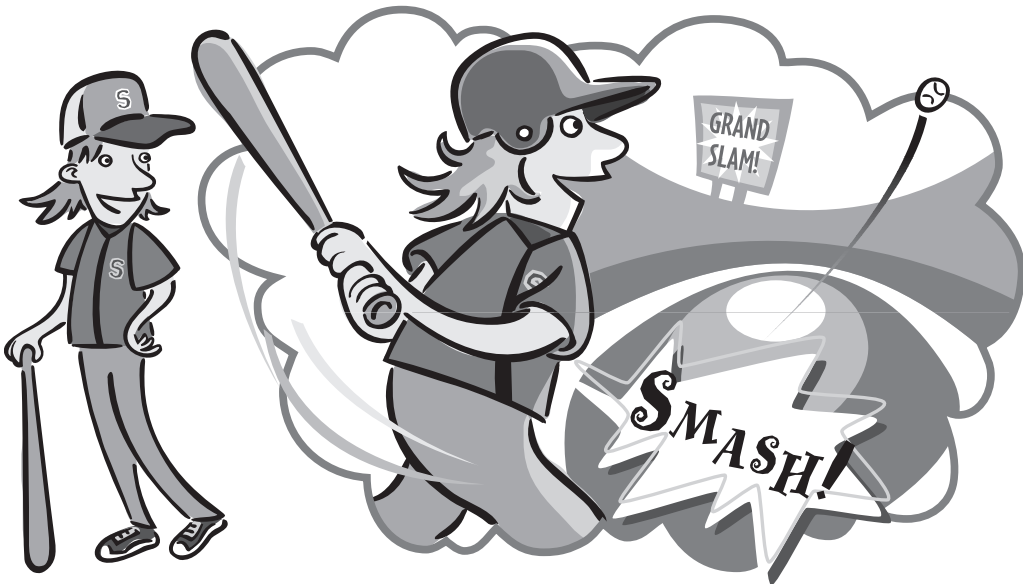




Getting in the Zone

Starting Right



You may not realize it, but your muscles are not the most important part of your body when you are doing a sport. Believe it or not, the most important part is your brain! The brain is part of your nervous system. The nervous system consists of your brain, spinal cord, and nerves. **Nerves** are special cells that communicate by using electrochemical impulses. An **electrochemical impulse** uses chemicals to send an electrical signal. So, the nervous system is an elaborate communication system that collects information and sends messages throughout your body. Your brain alone contains more than 100 billion nerve cells.

Sensory nerves collect information about your environment. They then change this information into sensations such as hot, cold, touch, pressure, and pain. They send this information to your brain, which then decides how to react. Once your brain decides on the appropriate response, it sends messages to other nerves called **motor nerves**, which direct your muscles to move.

The activities in this section will help you investigate how your brain and nervous system help you perform better in sports.



Project 1 **THINK FAST**

In many sports you need to react very quickly to something. For example, you may have to return a tennis ball that is moving at 60 miles (100 km) an hour or more or swing a bat at a baseball moving just as fast. You barely have time between when you first see the ball moving toward you and when you have to hit it back. In that short time your brain has to tell your body to move, and your body has to react. How long does it take? And can you improve your reaction time? Try this activity to find out.

Materials

ruler
helper

Procedure

- 1.** Hold a ruler up vertically by the 12-inch (30-cm) end so that the 0-inch (0-cm) end is closest to the ground.
- 2.** Have a helper stand facing you so that his thumb and index fingers of one hand are on either side of the bottom of the ruler. The thumb and index finger should be close to the ruler, but not touching it.
- 3.** Drop the ruler at any time. With his hand held steady, your helper should try to catch the ruler as quickly as possible between his thumb and index finger.
- 4.** Measure the distance the ruler fell before it was caught. Use the Reaction Time Table below to convert the distance the ruler falls into a time.

REACTION TIME TABLE

Distance	Time (seconds)
2 inches (5 cm)	0.101 seconds
4 inches (10 cm)	0.143 seconds
6 inches (15 cm)	0.175 seconds
8 inches (20 cm)	0.202 seconds
10 inches (25 cm)	0.226 seconds
12 inches (30 cm)	0.247 seconds





More Fun Stuff to Do

Try this several times. Does the distance the ruler falls before your helper catches it decrease with practice? Have several friends try the same activity. Do some people have faster reaction times than others?

Explanation

The ruler will fall a short distance and your helper will catch it between his thumb and index finger. The distance the ruler falls can be used to determine your helper's reaction time. **Reaction time** is the amount of time it takes for a message to travel from the brain to the muscles in the body and cause a movement.

When the ruler drops, the motor cortex of the brain sends an electrochemical message to the fingers. The **motor cortex** is the area of the brain responsible for creating and sending the messages that cause movement. The message travels along the thick bundles of nerve cells, the spinal cord, that are inside the bones of the spine. Then the message travels to the finger muscles through the smaller bundles of motor nerves that branch from the spinal cord. The finger muscles get the message and close, catching the ruler.

Sports Science in Action

A good pitcher in the major leagues can throw a ball at speeds of between 90 and 100 miles per hour (144 and 160 km/h). What does that mean to a batter? The ball will take about 0.46 to 0.41 seconds to travel from a pitcher's hand to the plate. If you figure it takes about 0.3 seconds to actually swing, the batter may have only 0.1 to 0.2 seconds to decide when and where to swing and get the message to the arm and hand muscles. It's truly amazing that the human body can perform at this speed.



Project 2

ON THE LEVEL

Your brain controls many functions in your body without your even having to think about them. For example, it keeps your lungs breathing in and out and makes your eyes blink. Your ability to balance or even just stand upright is also controlled by the brain. To learn more about how the brain does this, try this activity.

Materials

2-by-4-by-24-inch (5-by-10-by-60-cm) piece of wood
(measurements do not have to be exact)
stopwatch or watch with a second hand

Procedure

- 1.** Lay the board flat on the floor.
- 2.** Step on the board with one foot near the middle of the board.
- 3.** Lift your other foot off the ground and try to balance yourself on only one foot. Can you do it?
- 4.** Continue to try to balance over a period of 5 minutes. Does your balance improve in that amount of time?





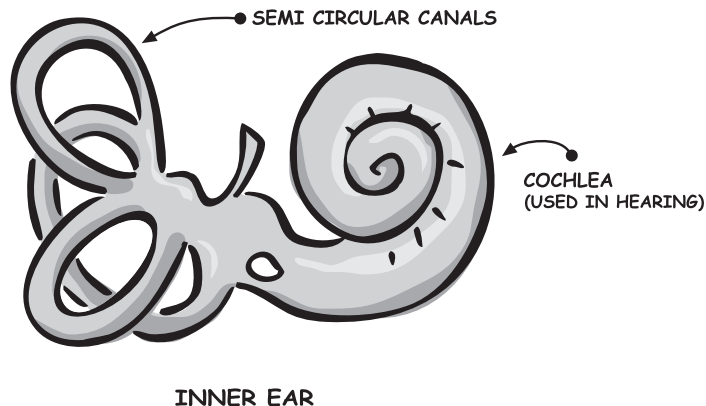
More Fun Stuff to Do

Get a longer piece of wood and lay it flat. Can you walk from one end of the board to the other without losing your balance and falling? Try practicing for several days. Do you get better at walking the length of the board?

Explanation

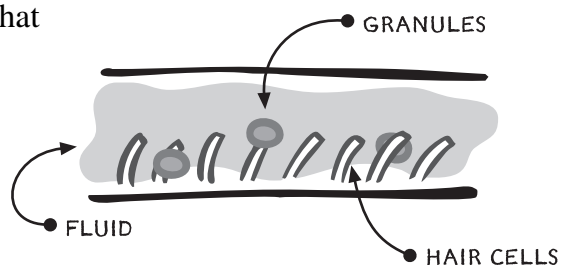
You should be able to learn to balance yourself on the board after several minutes.

Your sense of balance is controlled by parts of your inner ear. Small granules in two fluid-filled sacs detect which way is up and which way is down, and three fluid-filled semicircular canals detect motion.



At the bottom of the sacs are sensory cells that contain small hair fibers. When you stand up, **gravity**, a force that pulls all objects toward Earth, pulls down on the granules. The granules touch the hair fibers, which sends a message to the brain and tells it that you are upright.

For example, when you lose your balance and begin to fall to the right, gravity pulls the granules to the right. The hair fibers then send a message to the brain



telling it that you are tilting to the right. The brain sends a message to the muscles in your neck and legs, trying to get your head and the rest of your body back in balance. With practice, you learn what kinds of little adjustments your body needs to make to balance. When you walk the length of a longer board you learn to balance by a similar process.

SPORTS SCIENCE IN ACTION

Balance is very important in the sport of women's gymnastics. The balance beam is a piece of wood that is 4 inches (10 cm) wide, 5.5 feet (1.67 m) off the ground, and 16 feet (4.85 m) long. In addition to balancing on the beam and walking from one end to the other, gymnasts have to perform flips, spins, and other maneuvers on the beam without losing their balance throughout the entire routine! It's a remarkable skill that takes a keen sense of balance and many years of practice.



Project 3

DREAMING OF GREATNESS

You've been practicing shooting free throws for several days and still don't seem to get any better. Is there anything else you can do to improve your shooting ability? Try this activity to find out.

Materials

basketball
basketball hoop
paper

pencil
2 helpers

Procedure

- 1 After warming up, you and your two helpers should each take 20 free throws at the basket. (If shooting from the free-throw line is too difficult, take your shots from somewhere closer to the basket.) Record the number of baskets each of you makes.

- 2.** For the next week, you and your helpers should each do a different thing: one helper should not practice basketball at all; the other helper should shoot 10 free throws each day; and you should not practice with an actual basketball and hoop. Instead you should mentally shoot 10 free-throw shots each day. To mentally shoot free throws, close your eyes and picture yourself standing at the free-throw line, looking at the basket. Think about having the ball in your hand, doing any dribbles you might take before the shot, and finally making the shot itself. Picture yourself shooting the perfect shot and the ball going into the basket.
- 3.** After the week is over, return to the basketball court and have everyone shoot another 20 free throws. Record each person's results and compare them to the number of shots made the previous week.



Explanation

After a week, both the helper who practiced by actually shooting the free throws and you, who practiced only by mentally shooting free throws, should make more free throws than the helper who didn't practice at all.

Mentally practicing free throws, or any other sports activity, is an important way to improve your performance. Mental rehearsal is

believed to work in much the same way that physically repeating an activity does. Both mental and physical practice reinforce the messages that are sent from the brain to the muscles, coordinating the movement, so both lead to improved performance.

Mental rehearsal, sometimes called visualization, is used by most top-ranking athletes today. Gymnasts imagine doing a perfect routine on the uneven parallel bars, field goal kickers imagine a perfect kick that sends the football through the middle of the goal posts, and golfers imagine the swing and flight of the golf ball that lands perfectly on the green.

Although mental practicing can improve skills, you still need to physically practice to learn the skill in the first place and to build up your muscles as well. The coordinated message pattern from the brain to your muscles to perform a specific task needs to be in place first for the mental practicing to work.

SPORTS SCIENCE IN ACTION

In one study of visualization, scientists put electrodes on the muscles of a world-class skier to detect electrical activity. The skier was then asked to close his eyes and visualize each moment as he performed a perfect downhill race on a familiar ski slope. Bursts of muscular activity were recorded by the electrodes as the skier visualized hitting a jump or a rough part of the race. It was almost as if he were really skiing down the slope!



Project 4

CROSS OVER

Michael Jordan, the best basketball player in the world, once tried to play professional baseball. He turned out not to be that good at it. If Michael was such a good professional basketball player, why did he have trouble playing professional baseball? Try this activity to find out.

Materials

basketball
basketball hoop
paper
pencil

baseball
bat
helper

Procedure

1. Warm up by practicing shooting free throws with your helper at a basketball hoop. Then each of you should take 20 free throws. (If shooting from the free-throw line is too difficult, take your shots from somewhere closer to the basket.) Record the number of free throws you each make.
2. For the next week, you should each practice shooting 20 free throws each day.
3. After a week, return to the basketball hoop, and each shoot another 20 free throws. Record your results and compare them to the number of shots made the previous week. What happens?
4. Next, go to a field and each try to hit 20 baseballs. How does this activity compare to your free-throw ability?



More Fun Stuff to Do

Repeat the investigation using two other activities. For example, practice shooting free throws all week then try kicking a football. What effect does practicing one sport have on your ability to perform another?

Explanation

After a week's practice, you should improve the number of free throws that you make. However, your practice probably won't affect your ability to hit a baseball.

Although there are some activities, such as running and jumping, that are common to many sports, the ability to perform a specific task, such as shooting a basketball or hitting a baseball, is not easily transferred from one sport to another, especially when performing at the highest level. For example, most athletes will lift weights to make their muscles stronger and run or cycle to improve their heart and lungs. But each athlete will spend hours and hours performing their specific task, teaching the brain and muscles how to coordinate the movements in their event. Each time an athlete performs a task, such as shooting a basketball, the proper nerve path that carries the message to the muscles in the arm and hand, as well as the proper sequence of muscle contractions that produces a shot that goes in the basket, are reinforced. With repeated practice, the information for this basketball shot becomes imprinted in the memory of the brain and can be recalled the next time you want to make the same shot.

SPORTS SCIENCE IN ACTION

When Michael Jordan first retired from professional basketball, he was the greatest player in the world. He was a finely tuned athlete who had practiced basketball for years. After he retired, he wanted to become a professional baseball player, a sport that he had excelled at in high school. Although he learned to become a good fielder, he always had trouble with his batting. It wasn't that he didn't practice enough, it was just a matter of neurology (the study of how the brain and nerves work) and physiology (the study of how the body works). Michael had trained his brain, nerves, and muscles to perform in a certain way, to play basketball. When he tried to teach them to perform a new way, they just couldn't respond quickly enough. Michael went back to playing basketball, where his years of training paid off, and he again became the best player in the world!

After time, the athlete's body becomes trained to make that shot extremely well. If the athlete suddenly asks her body to do a different thing, the body won't respond as well. Whether you're a skateboarder learning to perform an "ollie" or an ice-skater learning a "triple axle," you have to practice the series of movements that allow you to perform each task. To perform at the highest level, you need to practice a lot!



Project 5

LEARNING NEW TRICKS

You have learned how to do a lot of sports activities in your life. When you were little, you learned how to run and how to throw a ball. Later on, maybe you learned how to swim and how to skateboard. What is the best way to learn how to play a new sport? Practice, practice, practice, of course. Try the next activity to learn more about how the brain learns new things, and why practice is important.

Materials

broom
2-by-12-by-24-inch (5-by-30-by-60 cm) piece of wood plank
stopwatch or watch with a second hand
helper

Procedure

1. Lay the broom flat on the floor.
2. Place the wooden plank on the handle of the broom so that the broom is near the center of the length of the plank.
3. Have your helper step on the plank so that one foot is placed near each end of the plank.
4. Time your helper for 5 minutes while she tries to learn to balance the plank on the broom handle so that neither end is touching the floor.

5. After your helper has had 5 minutes to learn to balance, it's your turn. You will also have 5 minutes to learn this new task, but you will spread your 5 minutes out over the day. Practice for 1 minute at a time, then stop for several hours. Your total practice time should be no more than 5 minutes.
6. The next day, both you and your helper should try to balance on the board. Who has learned to balance better?



Explanation

Even though you both had the same amount of practice time, because you spread out your practice over a longer period you learned to balance better than your helper, who tried to learn all at once.

Although no one is exactly sure how the brain learns, the most common theory is that it needs consolidation time to learn a new task well. **Consolidation time** is time when your brain stores the information about how to do a new task in a more permanent way. When you first learn a new task, whether it is how to balance on a board or how to do a new math problem, the information is stored temporarily as an electrical code within the brain. This electrical code is not stable, which means that you will quickly lose the information when you stop doing the task. However, if the task is practiced over a longer time, the electrical code is changed and stored in a more permanent, stable chemical code. Memory stored as a chemical is remembered better in the long term, so you perform the task better the next time you try it.