DO YOU SENSE WHAT I SENSE?

Exploring Differences in Human Sensory Experiences

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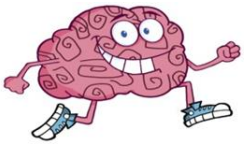
Authors' Note

We created this workbook to provide you with the most up-to-date information about the brain. More specifically, this workbook focuses on how the brain helps you to make sense of the world by using information that it receives from your eyes, ears, nose, mouth, and skin. Throughout this workbook, you will find neuroscience-inspired hands-on activities. We selected these activities from a wide range of possible activities described on neuroscience websites because they were relatively simple, low-cost, and could be completed in a short amount of time. You also will find "Quiz Yourself" activities throughout the workbook so that you can test your knowledge about the brain and how it works. In addition, we added checklists throughout the workbook to encourage you to think about how you perceive the sights, sounds, smells, tastes, and touches that surround you each day.

Upon completing this workbook, we hope that you will have a better understanding of the complexity of the human brain and how it attempts to make sense of the world. We also hope that this workbook's emphasis on individual differences in sensory processing will increase your awareness and appreciation of how you make sense of your world. Finally, we hope that the information and activities presented in this workbook will foster a deeper level of respect in your relationships with classmates and teammates who are abled as well as those who are differently-abled.

YOUR AMAZING BRAIN!



Your brain is your body's most complex organ! Even though your brain only makes up about 2% of your body's weight, it uses up to 20% of your body's energy. It needs so much energy because it is always hard at work trying to make sense of the world around you.

How big is your brain?

You can estimate the size of your brain. First, make a fist with each of your hands. Then, press your fists together so that your thumbs are side by side. Ask someone to trace your fists in the space below. What are its measurements?

How much does your brain weigh?

Your brain weighs about **3 pounds**—the weight of a half-gallon of milk. In the space below, list other common objects that weigh about 3 pounds. If a scale is available, check your guesses.

1.
2.
3.
4.
5.

What does your brain feels like?

Circle the words that you think best describe how your brain would feel to the touch.

Firm WET WARM

BUMPY STICKY SQUISHY DRY

COLD Smooth Slippery

Find out for yourself by completing the activity below:

YOUR BRAIN IN A BAG

You will need:

- 1.5 cups (360 ml) instant potato flakes
- 2.5 cups (600 ml) hot water
- 2 cups (480 ml) clean sand
- 1 gallon zip lock bag

Combine all of the ingredients in the zip lock bag and mix thoroughly. It should weigh about 3 pounds (1.35 kg.) and have the consistency of a real brain!

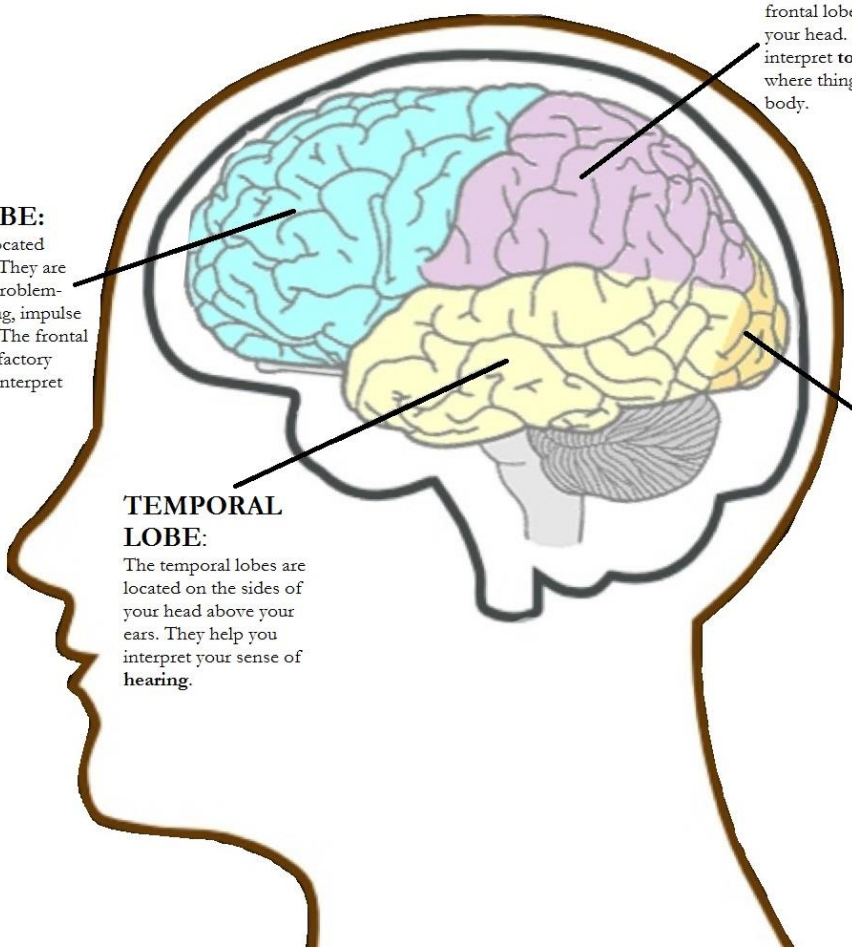
WHAT DOES YOUR BRAIN DO?

In the space below, write three things that your brain helps you to do.
1.

2.

3.

Most young people report that their brains help them to think, to learn, or to remember things. But your brain helps you to do so much more than that. Every day researchers discover new things that the brain helps you do and how the brain does them. For example, your brain helps you to make sense of and respond to the world around you. Take a look at how each of your brain's lobes helps you to see, touch, taste, smell, and hear!



PARIETAL LOBE:
The parietal lobes are located behind the frontal lobes in the middle top part of your head. The parietal lobes help you interpret **touch, taste,** and perceive where things are located relative to your body.

FRONTAL LOBE:
The frontal lobes are located behind your forehead. They are involved in planning, problem-solving, decision making, impulse control, and attention. The frontal lobes also house the olfactory bulb, which helps you interpret **smell**.

OCCIPITAL LOBE:
The occipital lobe is located in the back of your head. The occipital lobe helps you interpret what you **see**.

TEMPORAL LOBE:
The temporal lobes are located on the sides of your head above your ears. They help you interpret your sense of **hearing**.

EXTRA RESOURCE

LOBEORATORIUM: This interactive resource walks you through the lobes' functions and tests your knowledge with a matching game. Go to the National Institute of Health's page:
http:www.ninds.nih.gov/education/Lobeoratorium/index.html

Quiz Yourself

1. The lobe of the brain important for vision is called:
   A. the temporal lobe B. the parietal lobe C. the occipital lobe D. the frontal lobe

2. The lobe of the brain important for the sense of touch is called:
   A. the temporal lobe B. the parietal lobe C. the occipital lobe D. the frontal lobe

3. The lobe of the brain important for hearing is called:
   A. the temporal lobe B. the parietal lobe C. the occipital lobe D. the frontal lobe

4. The lobe of the brain important for smell is called:
   A. the temporal lobe B. the parietal lobe C. the occipital lobe D. the frontal lobe

5. The lobes that are located behind the forehead are called:
   A. the temporal lobe B. the parietal lobe C. the occipital lobe D. the frontal lobe

6. The lobe that is located at the back of the head is called:
   A. the temporal lobe B. the parietal lobe C. the occipital lobe D. the frontal lobe

7. The lobes located on the side of the head are called:
   A. the temporal lobe B. the parietal lobe C. the occipital lobe D. the frontal lobe

8. The lobes located on the top middle part of the head are called:
   A. the temporal lobe B. the parietal lobe C. the occipital lobe D. the frontal lobe

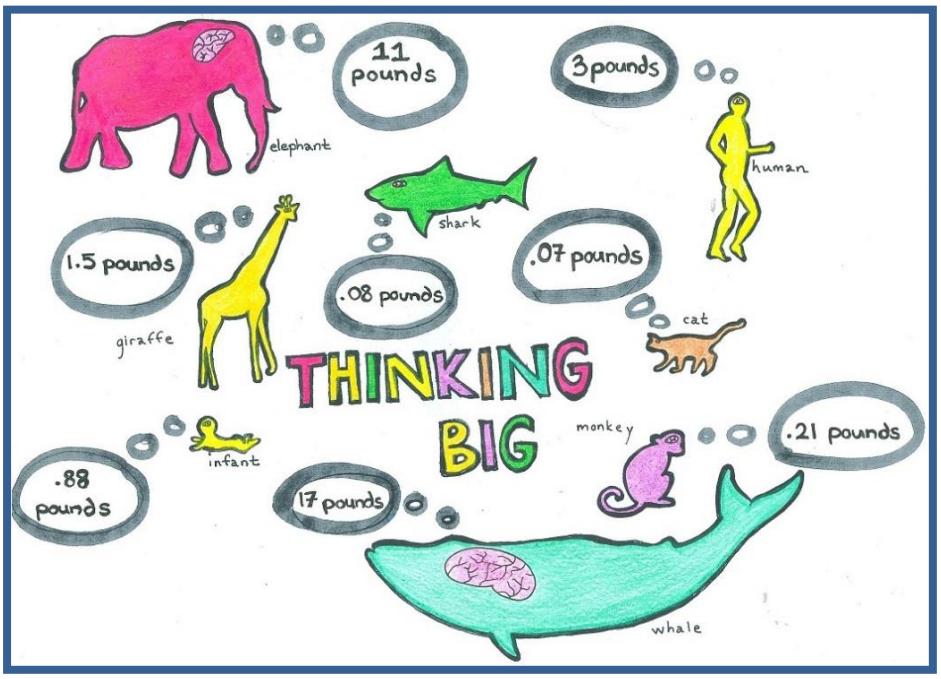
9. Your brain weighs approximately:
   A. 1 lb. B. 3 lb. C. 5 lb. D. 7 lb.

10. A person's brain is about the size of:
   A. their heart B. their stomach C. 1 fist D. 2 fists

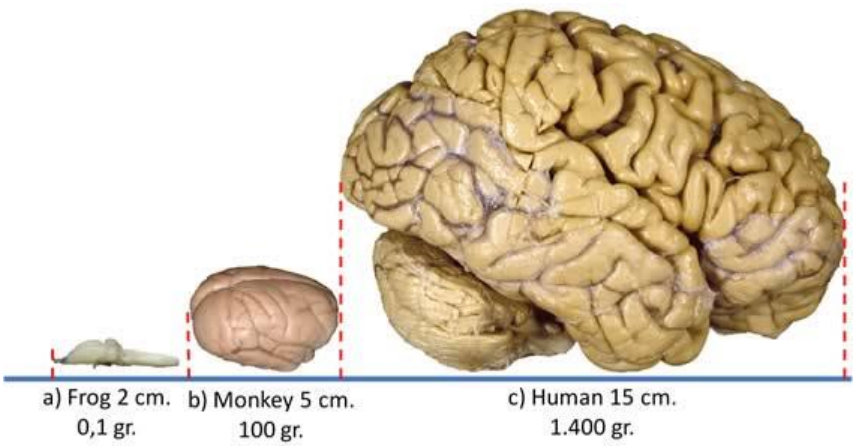
Answers: 1.C 2.B 3.A 4.D 5.D 6.C 7.A 8.B 9. B 10. D

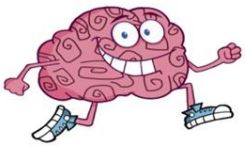
PUTTING YOUR BRAIN IN PERSPECTIVE

Your brain might look pretty small and not weigh very much, but don't let that fool you. Larger and heavier brains don't always result in increased intelligence. The size of an animal's brain compared to its body can give you a better idea of how intelligent an animal is. Whales have much bigger brains (17 pounds!) than humans (3 pounds), but they also have much bigger bodies. So, humans are still more intelligent. Check out some of these other mammals' brains!



Brain size and weight are not the only factors that suggest an animal's intelligence! Over many, many years complex brains developed wrinkles, or folds. In order to keep the brain compact enough to fit into a skull that would actually be in proportion with the rest of our body size, the brain folds in on itself as it grows. This change in brain structure allows for more complex thinking in smaller mammals. You might notice that some animals- like frogs- have brains with a smoother appearance. There are fewer bumps and grooves. In contrast, highly intelligent animals like humans, dolphins, and apes have brains with a bumpier appearance. Check out the images below.





Your brain is about 3 pounds and the size of two fists. But, if you could unfold your brain, it would be about the size of a basketball!

BUILD A BRAIN ACTIVITY

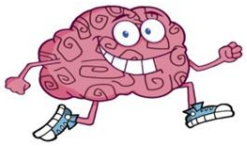
Now it's your turn to create an animal—real or imaginary. What is it called? How big is it? How much does it weigh? What can it do? Does it have any special sensory abilities? Write a brief description in the space provided.

Using what you have learned about the brain and the outline of the brain below, show what your animal's brain looks like. Color each lobe a different color. How big is the animal's brain? How much does it weigh? Does it have a lot of wrinkles (or folds) or not too many? Does it have a large occipital lobe for seeing? Does it have a large temporal lobe for hearing? Think about how this brain helps your animal survive!

Extension activity: Sculpt the brain out of Playdoh, clay, or other materials.

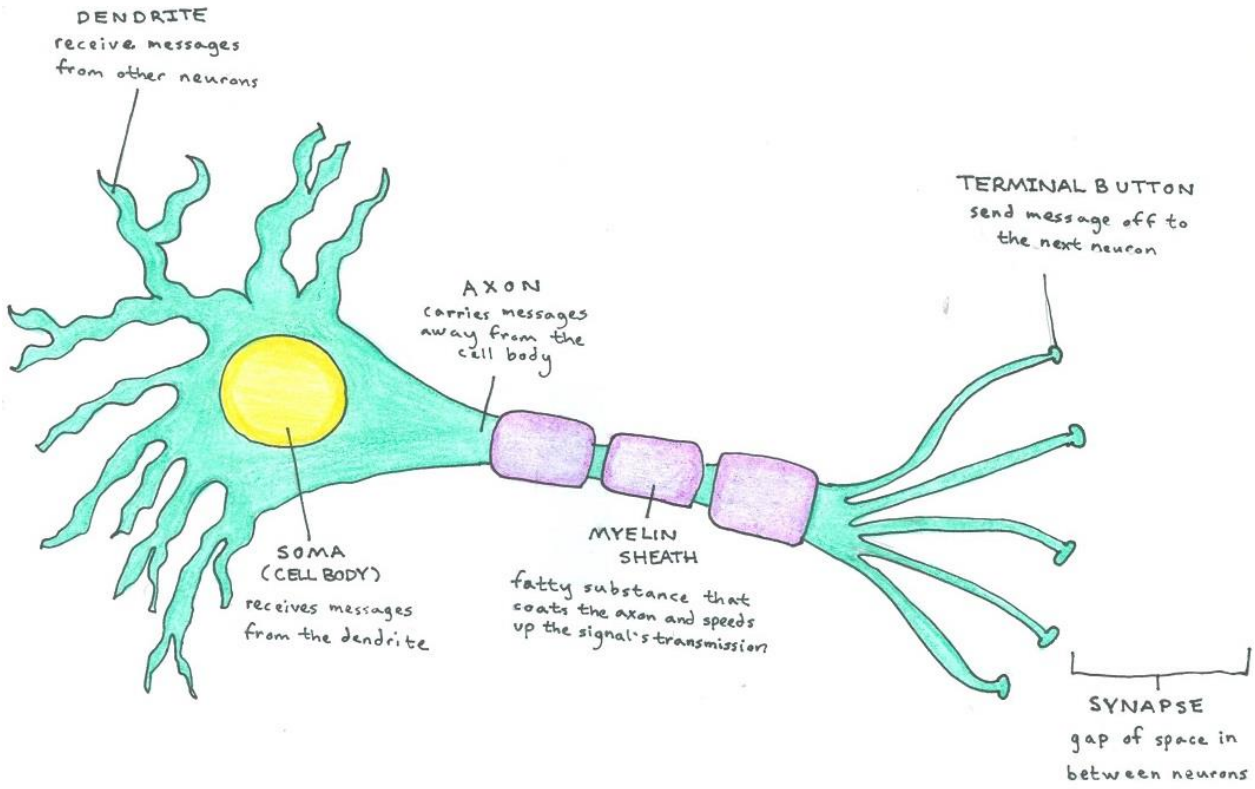
HOW DOES YOUR BRAIN WORK?

Your brain is connected to each part of your body through specialized cells called **neurons**. Some neurons receive messages from your body and pass them along to your brain. Other neurons receive messages from your brain and pass them along to your body. Some neurons in your brain receive and pass messages from one part of your brain to another.



Your brain is made up of 100 billion neurons! If you lined up your neurons in one straight line, they would stretch 100 thousand miles—about 4 trips around the earth.

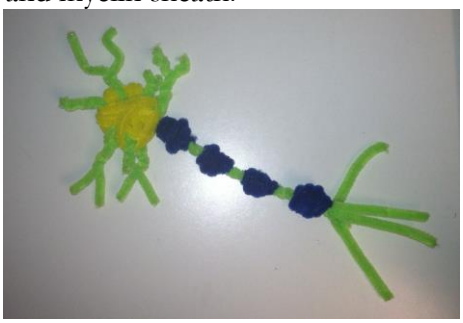
What are the parts of a neuron?



BUILD YOUR OWN MODEL NEURON

You will need:

- At least four different colored pipe cleaners/chenille stems to represent the cell body, axon, dendrites, terminal button, and myelin sheath.

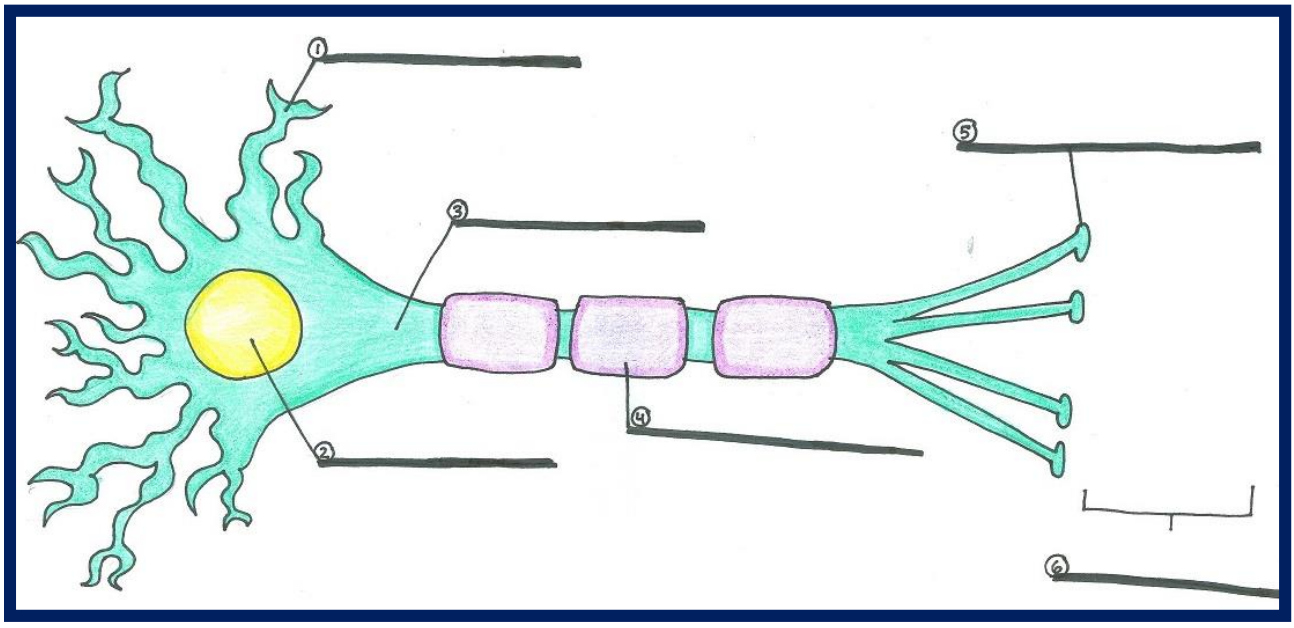


1. Roll one pipe cleaner into a ball. This will be the **cell body**.
2. Attach a second pipe cleaner to the "cell body" by pushing it through the ball so there are two halves sticking out. Twist the two halves together to form the **axon**.
3. Cut additional pipe cleaners in half or thirds and push them through the "cell body" on the side opposite of the axon to form the **dendrites**. Twist pipe cleaners together to make an elaborate array of dendrites.
4. Wrap small pipe cleaners along the length of the axon to represent the **myelin sheath**.

Review what each part represents and what each does. Link the class's neurons together into a long nerve. Hang it up in the classroom!

Go to: **http://faculty.washington.edu/chudler/chmodel.html** to see this resource online.

Quiz Yourself: Label Your Neuron

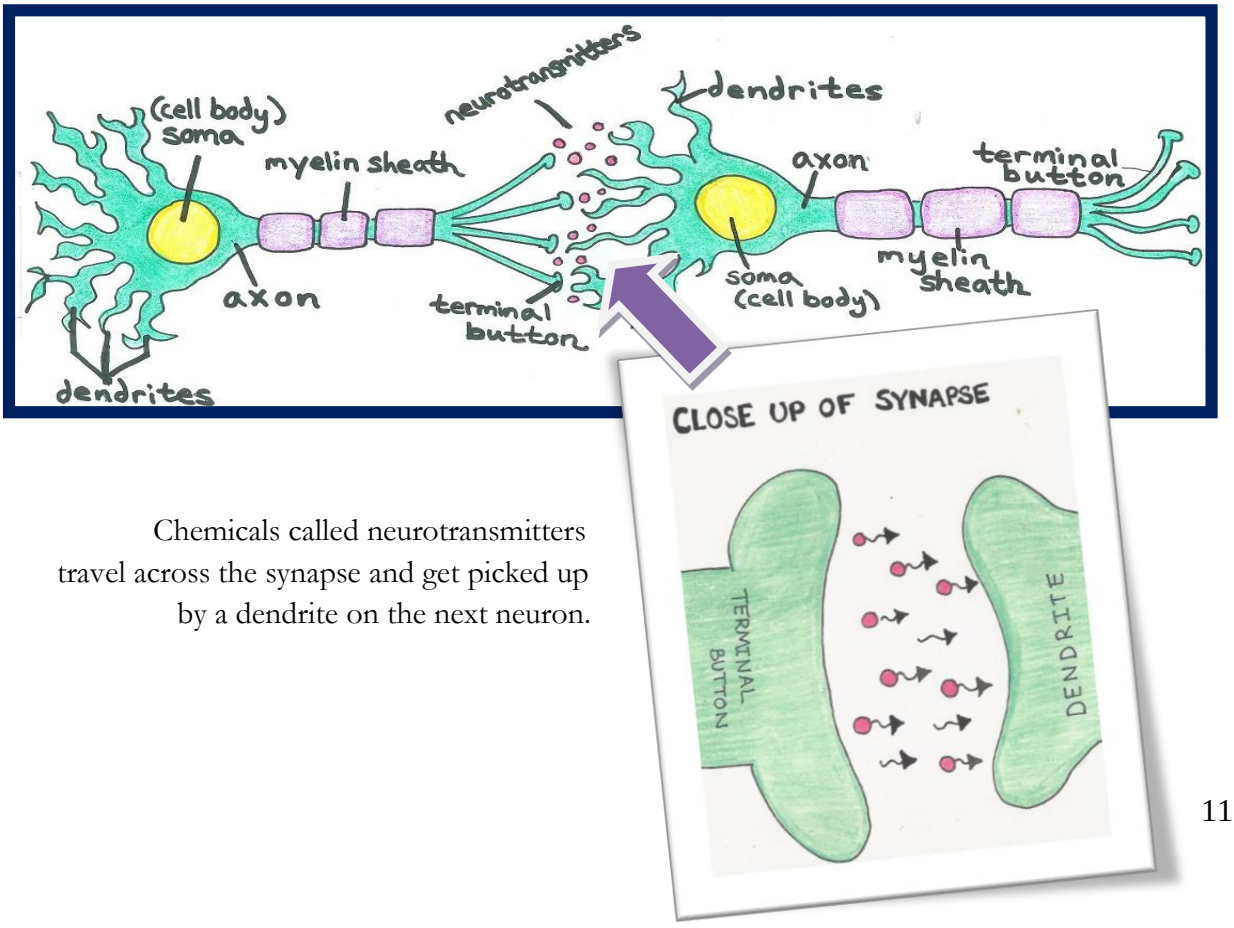


HOW DO YOUR NEURONS COMMUNICATE?

Neurons communicate using electrical and chemical signals. Electrical messages are sent down the axon of a neuron at speeds of up to 220 miles per hour!

When your eyes, ears, skin, nose, or tongue detect something in the environment, they send the sensory information to your brain. How does this sensory information travel from your eyes, ears, nose/mouth, or skin to your brain? Neurons change the sensory information into electrical and chemical signals as the sensory information travels from your sensory organs to your brain.

The **dendrites** of a neuron receive sensory information and send it to the neuron's **cell body**. Once a threshold has been reached, the cell body sends an electrical signal down the **axon**. Once the signal reaches the end of the axon (the **terminal buttons**), it has to travel to the next neuron. Neurons communicate with each other using chemicals called **neurotransmitters**. These chemicals pass from one neuron to the next across a space called a **synapse**. This chemical signal is picked up by the dendrites of the next neuron. If enough of the chemical signal is detected, the message continues on to the next neuron as it journeys to the brain.



Chemicals called neurotransmitters travel across the synapse and get picked up by a dendrite on the next neuron.

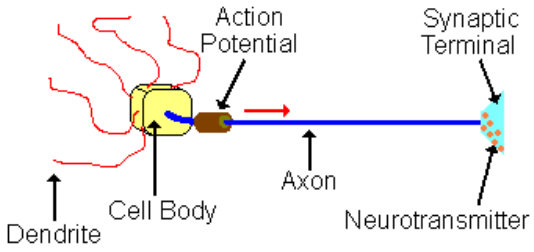
Rope Neuron Activity

You will need:

2-3 ft. lengths of rope for the dendrites
10-15 ft. piece of rope for the axon
Plastic containers for the cell body and synaptic terminal (or terminal buttons)
A pool float to represent the action potential, the signal that travels down the axon
Ping-pong balls

Set up:

1. Assemble the neuron as pictured below. Tie knots in the ropes so that the dendrites, cell body, axon, and synaptic terminal don't slip through holes in the containers. Thread the float onto the axon. Place small ping-pong balls in the synaptic terminal.
2. Ask volunteers to hold each of the dendrites.
3. Ask one volunteer to hold the cell body and one to hold the synaptic terminal.
4. Ask one volunteer to hold more neurotransmitters (ping-pong balls) near the dendrites.
5. Ask one volunteer to hold the action potential.



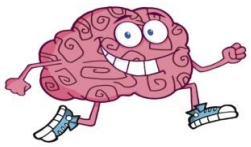
Demonstration:

1. Have the person holding the neurotransmitters toss them to the people who are holding the dendrites to model the release of neurotransmitters and their attachment to receptors on dendrites.
2. When 3 balls are caught by the people holding the dendrites, the person holding the action potential can slide the pool float down the axon to simulate the action potential.
3. When the action potential reaches the synaptic terminal, the person holding the container should spill of the neurotransmitters (ping-pong balls) to signal their release into the synapse.

Extension Activity: Make several rope neurons and practice sending a "message" from one neuron to the other.

Go to: **http://faculty.washington.edu/chudler/chmodel.html** to see this resource online.

YOU WERE BORN TO DO THIS…



Most neurons are created before you are born. Months before you are born, networks of neurons are pre-programmed to form by your genes.

You were born with the ability to take in information and make sense of the world around you. If you were like most babies, you were drawn to things in your environment that contained the most information. In other words, you preferred complex sounds to pure tones, three dimensional objects to two dimensional pictures. You also likely were drawn to new sensory experiences such as exploring unfamiliar objects with your mouth and hands longer than familiar ones.

Newborn Sensory Capacities

Touch

Before you were even born, your entire body was sensitive to touch. In fact, a baby's sense of touch more sensitive than an older child's or adult's. For example, newborn babies can feel changes in temperature and soft touches on their faces that you are unable to feel!

Taste and Smell

Babies are born with taste and odor preferences. If they smell or taste something sweet, their facial muscles relax. If they taste or smell something sour or bitter, they purse their lips. In addition, they can recognize their own mothers by smell shortly after birth.

Hearing

Newborn babies are very good at distinguishing sounds! Within days of birth, they recognize the sound of their caregivers. They can distinguish subtle differences in melodies and languages—some of which older children and adults would not even notice.

Vision

Vision is the least well-developed sense at birth. Yet, newborn babies' vision is as good as the uncorrected vision of most adults. They best see objects that are about 12 - 18 inches from their faces. It only takes about 4 months for babies' vision to fully develop.

Sensory Walk Activity

With teacher or parent supervision, take a 5 to 10 minute walk quietly around your classroom, school, playground, bedroom, house, yard, or neighborhood. Don't bring anything with you. Just walk.

Welcome back! Where did you walk? _____

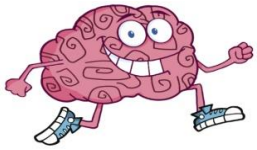
Take the next 10 minutes to record your sensory experiences from the walk in the table below. Don't worry if you cannot fill out the entire table. It is not a requirement of this activity.

Sights	Sounds	Touches	Smells	Tastes

Once you have recorded your observations, rate each observation as ☺ (pleasant), ☹ (unpleasant), or 😐 (neutral). Record your rating in the upper right hand corner of each box.

Compare your sensory experiences to those of at least one other person. Do you notice any similarities or differences in what you observed, how many observations each of you made, or how you rated your observations?

…BUT YOU HAVE TO TRAIN YOUR BRAIN, TOO!



Your brain continues to grow and change throughout your life! New connections form as you gain new experiences and learn.

Neural networks form, strengthen, and adapt over time and with experience. It is a phenomenon that scientists refer to as **neuroplasticity** (said like: noo r-oh-pla-**stis**-i-tee). Neural networks form when you challenge your brain with physical and mental activity that leads to new learning in school, sports, music, hobbies, etc.

In the space below, write up to three things that you have learned over the past few weeks.

1.

2.

3.

Neuroplasticity also occurs when the brain compensates for damage to neurons. Examples come from people with sensory impairments. Some people with severe hearing impairments learn to use the area of the brain typically devoted to processing sound to process vision so that they can expertly read lips. Other people with severe visual impairments use areas of the brain typically devoted to processing sight to process sounds that reflect off of objects to navigate their environments—a phenomenon known as **echolocation**. Just like bats and dolphins!

EXTRA RESOURCE

Check out human echolocation in action: search "Daniel Kish" or
https://www.youtube.com/watch?v=xATIyq3uZM4

Neuroplasticity: Mirror Tracing Task

The mirror-tracing activity is a visual and motor test that involves learning a new motor skill. The task requires you to trace an image as it appears on a computer screen. Then you will be challenged to trace the mirror image of the object that you see.

Note: For this activity, you will need access to a laptop or desktop computer.

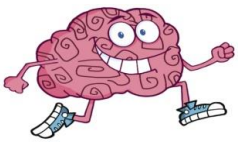
Search "mirror tracing task" or go to: **https://neuron.illinois.edu/games/mirror-tracing-game-intro**

Most people will report that the first time that they have to trace an image as it appears on the screen, they can complete the task fairly accurately and quickly. But what happened when you had to draw the mirror image? Most people find it much more difficult! The computer will compare how many seconds it took to trace the regular image and the mirror image.

What is the time difference (in seconds) between your two records? _____

Restart the game and trace the object and its mirror image 3-5 more times. You may notice that the more times you complete this task the better you get at it! Why? Neuroplasticity! Your brain learns that when the image is reversed, you have to do the exact opposite of what you would normally do in order to properly trace the image.

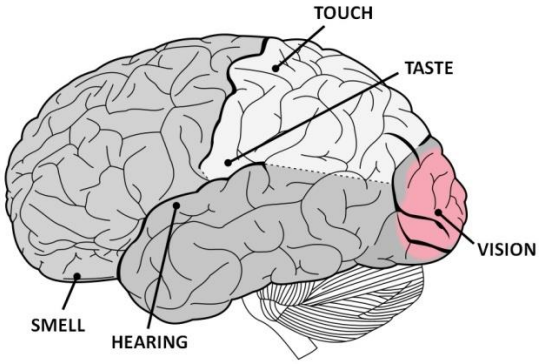
HOW DOES YOUR BRAIN PERCEIVE THE WORLD?



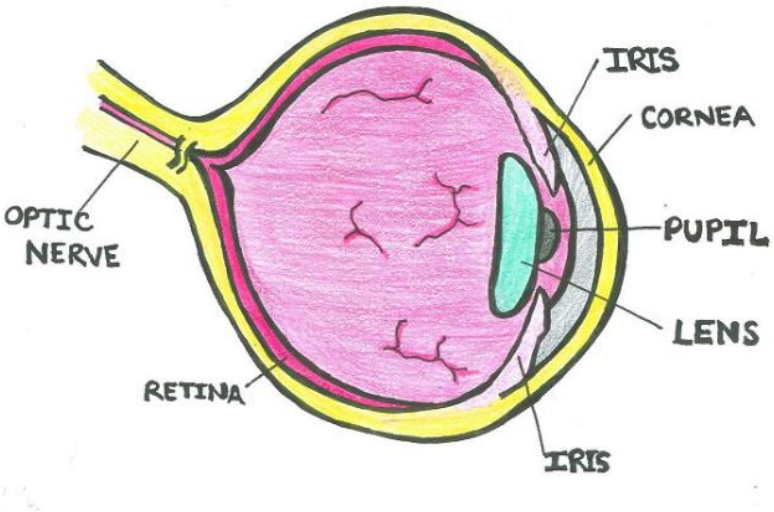
Your brain exists in darkness and silence. It makes sense of the world around you by receiving information from your eyes, ears, nose, mouth, and skin.

Vision

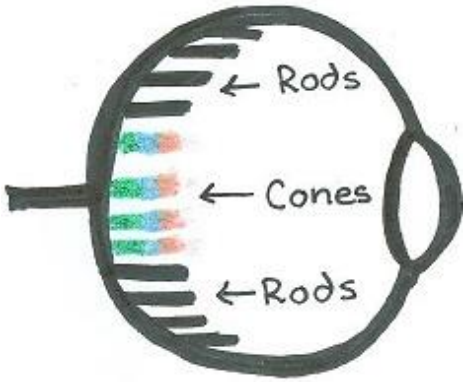
More space is dedicated to vision in your brain than all your other senses combined. That is because we rely on our vision so much. Neuroscientists have even found parts of the brain that are dedicated to processing very specific visual information such as faces, places, and words.



Light travels in waves. It enters your eye through the **pupil**, or the black hole in the center of your eye. The colored part of your eye, the **iris**, is a muscle that makes your pupil bigger and smaller to allow in more or less light. Your **lens** helps you focus on objects that are close by or far away.



When light reaches the back of your eye, the **retina**, it hits cells called **rods** and **cones**. Rods send black and white information to the occipital lobe of your brain. Cones send color information to the occipital lobe.



EXTRA RESOURCE

For an interesting video on how we see color, search: "Colm Kelleher: How We See Color"

There is an area on your eye's retina without cells to pick up on light. At that spot, everyone has a **blind spot**. Even though each eye has a blind spot, we don't walk around bumping into things. Our two eyes work together to give enough information to the brain so that we don't have a blind spot in our visual field. Close or cover your right eye and hold this paper out in front of you. Focus on the circle on the right of the paper. Very slowly, move the paper closer to your head and then back again. When the plus sign on the left disappears, you found your blind spot for your left eye! Your brain automatically fills in the blind spot with white to match the page you are reading.

How far away was the paper from your eyes when the plus sign disappeared? _____
Compare your response to others' responses. What did you observe?

EXPLORE YOUR VISUAL PROCESSING

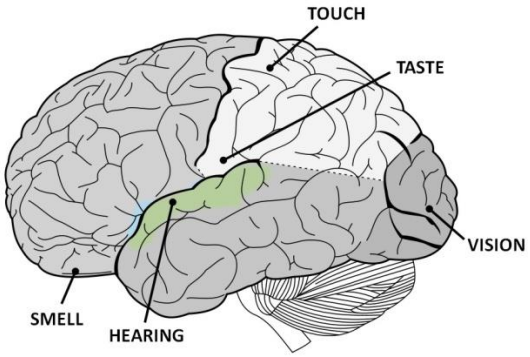
We all process visual information differently. Often, people are not aware of how they process visual information unless it interferes with their schoolwork or ability to get along with others. Take a minute to examine your visual processing. On the line provided, check the statements that describe you. Remember, there are no right or wrong answers.

Low sensitivity	High sensitivity
__ Do you have difficulty telling the difference between letters such as b and d, signs such as + and x, shapes such as square and rectangle, colors, or objects' sizes?  **https://neuron.illinois.edu/games/color-sorting-paint-chip-activity**	__ Are you sensitive to bright lights and find yourself squinting or cover eyes to get some relief?
__ Do you have difficulty keeping the spacing and size of letters or numbers consistent when writing? Do you tend to write at a slant on a page?	__ Do you have difficulty keeping your eyes focused on something to finish a task?
__ Do you have difficulty locating items among other items such as food in a refrigerator, clothes in a drawer, or a pencil in a drawer of art supplies?	__ Are you easily distracted by other things to look at such as movements or decorations?
__ Do you tend to lose your place when copying notes from a book, reading, or doing math problems?	__ Do you tend to avoid eye contact when speaking or listening to someone else?
__ Do you have difficulty tracking and following moving objects such as a basketball or soccer ball when watching or playing sports?	__ Do you prefer to work and play in dimly lit spaces?

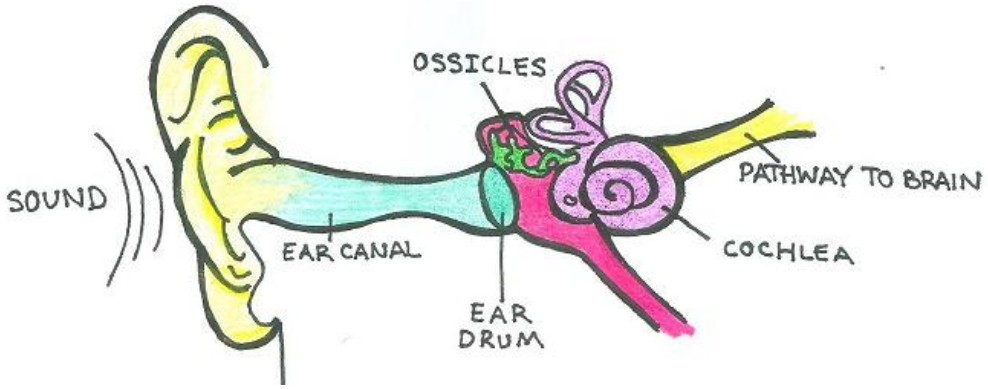
Did you notice that you checked more statements on the "low sensitivity" or the "high sensitivity" side? Because we all see the world around us differently, your answers may be different from the person beside you. It's interesting to learn how much of a role vision plays in your attempts to make sense of the world!

Hearing

Remember, your temporal lobe is the part of your brain that helps you perceive sound.



Sound, like light, travels in waves. Your ears transform the mechanical energy of sound waves into electrical and chemical signals that are sent to your brain. You process noises when sound waves reach your **ear drum** and make it shake. The shaking of the ear drum causes little bones in your middle ear, called **ossicles**, to wiggle around. The ossicles pass on the vibrations to the inner ear, or **cochlea** (said like: **koh**-klee-uh). Neurons in the cochlea are connected to your brain!



TWO EARS ARE BETTER THAN ONE ACTIVITY

What you will need:

- Blindfold
- Toy ball (preferably one that rattles or makes a noise such as those found in pet stores)

Choose one person to be blindfolded while a group of students circles around him or her. An adult or teacher will point to a person in the circle who will clap their hands one time. The blindfolded person in the middle will try to locate where the sound came from by pointing in the direction of the sound.

First, ask the blindfolded person to use both ears to locate the sound. Then, ask the blindfolded person to try the activity again with one ear covered. What did you notice?

Alternate activity: *Sit across a table from another person. Close your eyes and roll the ball slowly back and forth. Can you locate and catch the ball by listening with both ears? Can you locate and catch the ball by listening with only one ear? What did you notice?*

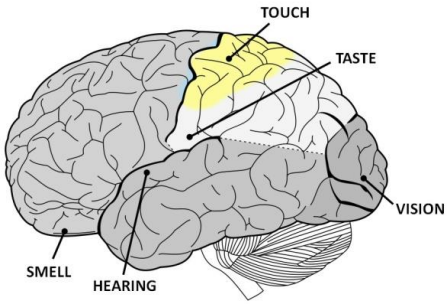
EXPLORE YOUR AUDITORY PROCESSING

We all process auditory information differently. Often, people are not aware of how they process auditory information unless it interferes with their schoolwork or ability to get along with others. Take a minute to examine your auditory processing. Remember, there are no right or wrong answers.

Low sensitivity	High sensitivity
__ Do people tell you that you often fail to respond to sounds or to your name being called?	__ Are you distracted by sounds that others don't usually hear such as humming lights or ticking clocks?
__ Do you usually talk out loud to yourself?	__ Are you fearful or easily startled by loud sounds such as flushing toilets, vacuums, or hairdryers?
__ Do you prefer loud music or TV?	__ Do you refuse to go to movie theaters, parades, skating rinks, musical concerts etc. because of the noise?
__ Do you tend to need to hear directions more than once or do you often ask, "What?"	__ Do you decide whether you like certain people by the sound of their voice?
__ Do you have trouble locating the source of a sound?	__ Do you often ask (or want to ask) people to stop making noise, talking, whistling, or singing?

Did you notice that you checked more statements on the "low sensitivity" or the "high sensitivity" side? Because we all hear the world around us differently, your answers may be different from the person beside you. It's interesting to learn how much of a role hearing plays in your attempts to make sense of the world!

Touch

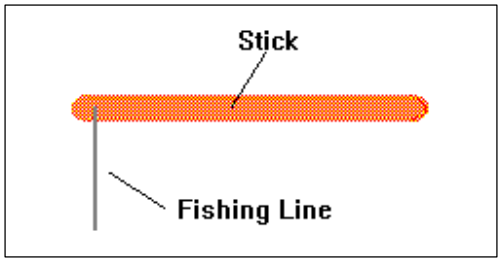


The body's sensitivity to touch (temperature, pain, pressure, texture) differs depending on the area of the body. Some areas are more sensitive than others. Areas of the skin that are more sensitive have more neurons. Areas of the skin that have a lot of neurons such as the lips, fingers, and toes are more sensitive to touch. Your hands are very sensitive because there are 17,000 tactile receptors and 1,300 nerve endings per square inch in your hand. If you injure the skin on your hands, it will hurt a lot. Areas of your skin that contain fewer neurons such as your back, thighs, and shoulders are not as sensitive. If you injure the skin in those areas of your body, it will not hurt as much.

DETECTING TOUCH

You will need:

- Fishing lines (of three different thicknesses)
- Glue and scissors
- Popsicle sticks



Make a device to detect your tactile threshold! Your tactile threshold is the smallest amount of touch necessary for you to feel it. To make it, get various thicknesses of monofilament fishing line from your local sporting goods shop or hardware store. From each thickness of fishing line, cut a piece about 1.5 in. (4.0 cm) long. Glue each piece of line at a right angle onto the end of a popsicle stick. The sticks serve as the holders. Write the thickness of the fishing line on each stick. When it's finished, it should look like this:

To test your partner's tactile threshold, have your partner close his or her eyes. Ask your partner to tell you when they feel something. Touch the fishing line to your partner's skin until the hair bends. Using the table below, mark Y if your partner reports feeling it and N if your partner does not report feeling it. Repeat with different thicknesses of fishing line. Repeat on different parts of body. Record and discuss your observations.

Thickness	**Shoulder**	**Hand**	**Cheek**	**Leg**
Thin (mm)				
Thicker (mm)				
Thickest(mm)				

Go to: **https://faculty.washington.edu/chudler/chtouch.html** to see this resource online.

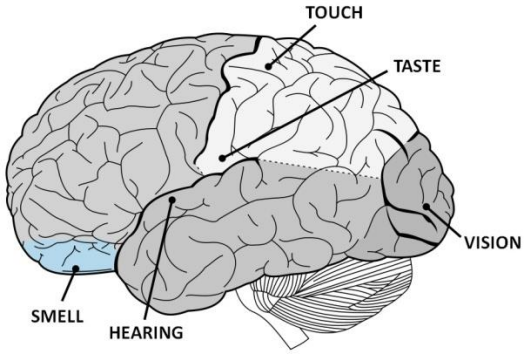
EXPLORE YOUR TACTILE PROCESSING

We all process tactile information differently. Often, people are not aware of how they process tactile information unless it interferes with their schoolwork or ability to get along with others. Use the checklist below to examine your tactile processing. Remember, there are no right or wrong answers.

Low sensitivity	High sensitivity
__ Do you like to touch everything and everyone? Do you repeatedly touch surfaces or objects that are soothing such as soft fabrics (blankets, clothes) or smooth rocks?	__ Are you bothered by the feel of certain bed sheets or clothes? Does a raindrop or wind blowing on your skin make you upset?
__ Are you often unaware of being touched/bumped unless done with extreme force or intensity?	__ Do you avoid standing in close proximity to other people (especially in lines)? Do you resist friendly or affectionate touch from anyone besides parents or siblings? Do you "wipe off" kisses given by family members?
__ Are you often not bothered by injuries, like cuts and bruises?	__ Are you picky about using a certain hair brush or tooth brush? Do you feel distressed during haircuts or when cutting your nails?
__ Do you tend to be unaware your hands or face are dirty? Do you often not notice if your shirt is half untucked, shoes are untied, or one pant leg is up and one is down?	__ Are you a picky eater, only eating certain tastes and textures? Do you avoid mixed textures? Do you avoid hot or cold foods? Do you resist trying new foods?
__ Do you enjoy and seek out messy play?	__ Do you avoid or dislike messy play?
__ Do you have trouble identifying objects by feel?	__ Does it bother you a lot when you have minor cuts, scrapes, or bug bites?

Did you notice that you checked more statements on the “low sensitivity” or the “high sensitivity” side? Because we all feel the world around us differently, your answers may be different from the person beside you. It’s interesting to learn how much of a role touch plays in your attempts to make sense of the world!

Smell



The sense of smell, called **olfaction** (said like ol-**fak**-shuh n), begins when a chemical signal reaches sensory receptors inside your nose. When enough of the chemical signal is present, a network of neurons transmits the electrical and chemical signal to your brain. Humans have about 12 million olfactory receptor cells. But rabbits have 100 million receptors and dogs have 1 billion! Compared to humans, animals like rabbits and dogs have a strong sense of smell that is essential for their survival!

WHAT'S THAT SMELL?

You will need:

- Five film canisters or small plastic containers
- Five distinctive smells (such as, but not limited to: lemon, orange peel, play-doh, cedar wood, peppermint, vanilla extract, or perfume soaked cotton)
- Blindfold

Keep the items separated and enclosed in plastic containers so that the odors do not mix. Put a blindfold on your partner (or punch holes in the top of the containers to eliminate the need for a blindfold) and ask your partner to complete the following table.

Identify the item by smell.	**Rate the item's odor. (Unpleasant , Neutral, Pleasant)** ☹ 😐 ☺	**Talk about a memory associated with this smell?**

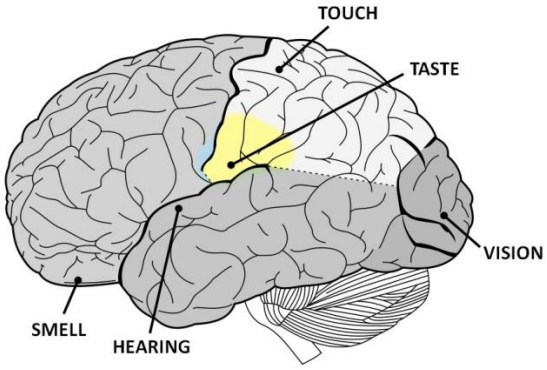
EXPLORE YOUR OLFACTORY PROCESSING

We all process smells differently. Often, people are not aware of how they process olfactory information unless it interferes with their functioning. Use the checklist below to examine your olfactory processing. Remember, there are no right or wrong answers.

Low sensitivity	**High sensitivity**
__ Do you fail to notice odors that others usually complain about?	__ Do you often react negatively to smells which do not usually bother other people?
__ Have you ever drank or eaten something poisonous because you did not notice the noxious smell?	__ Do you tend to refuse to eat certain foods because of how they smell?
__ Are you unable to identify smells from scratch 'n sniff stickers?	__ Are you bothered by household or cooking smells? Are you bothered by the way other people's houses smell?
__ Do you make excessive use of smelling when introduced to objects, people, or places? Do you often use smell to interact with objects?	__ Are you sensitive to how other people smell? Are you bothered/irritated by smell of perfume or cologne?

Did you notice that you checked more statements on the "low sensitivity" or the "high sensitivity" side? Because we all smell the world around us differently, your answers may be different from the person beside you. It's interesting to learn how much of a role the sense of smell plays in your attempts to make sense of the world!

Taste



Our sense of taste is called **gustation** (said like**: guh-stey-shuh n)**. There are different kinds of tastes. In the space below, list foods that are characterized by each taste.

Taste	Foods
Sweet	
Salty	
Bitter	
Sour	

Few people know about a fifth taste called **umami** (said like: **oo-mah-**mee**)**. Umami is a Japanese word meaning yummy! The taste of umami is savory. There is umami taste in things like meat, cheese, mushrooms, soup, and soy sauce.

You have between 5,000 and 10,000 taste buds in your mouth and they are not just on your tongue. You have taste buds all over your mouth! When food mixes with saliva in your mouth and touches your taste buds, a network of neurons send signals to your brain so that you can recognize what you are eating. Researchers believe that even though certain areas of your tongue are better at detecting certain tastes, a single taste bud may hold receptors for several tastes. In fact, as far as scientists know, the taste umami is distributed evenly across the tongue.

EXTRA RESOURCE

Are you a super taster? To find out, search:
"Super Tasting Science: How to Find Out If You're a Supertaster!"

LINKING SMELL AND TASTE

What you will need:

- Jelly beans (at least three different flavors separated by flavor)
- Plastic sandwich bags
- Glass of water (or alternatively crackers)
- Blindfold (optional)

Procedure:

- Ask your partner to close his or her eyes (or use a blindfold). Give your partner a jelly bean. Ask your partner to chew it and guess its flavor. Repeat with two other flavors. Offer your partner a sip of water or a cracker between samples to clean his or her palate. *How good is your partner at guessing the flavors?*
- Tell your partner to pinch his or her nose shut, then hand your partner a jelly bean. Ask your partner to eat the candy and tell you its flavor. Repeat with two other flavors. Offer your subject a sip of water in between samples to cleanse his or her palate. *Does being unable to smell change your partner's accuracy?*
- Finally, ask your partner to breathe deeply while you open one of the plastic bags that hold crushed jelly beans. Ask your partner to guess which flavor he or she smells. Repeat with the other two bags. *Is your partner better at guessing based on taste alone or scent alone?*
  - Switch roles with your partner. *Is it easier to recognize the jelly bean flavor by taste? By smell? How do your results compare with your partner's results?*

EXPLORE YOUR GUSTATORY PROCESSING

We all process tastes differently. Often, people are not aware of how they process gustatory information unless it interferes with their functioning. Use the checklist below to examine your gustatory processing. Remember, there are no right or wrong answers.

Low sensitivity	High sensitivity
__ Do you taste or chew on inedible objects such as pencils, hair, or clothes?	__ Are you a picky eater with extreme food preferences for food temperature or brand? Do you resist trying new foods or eating at new restaurants or other people's houses?
__ Do you prefer foods with intense flavor?	__ Do you avoid seasoned, spicy, sweet, sour or salty foods? Do you prefer bland foods?
__ Do all foods taste the same to you?	__ Do you refuse to lick envelopes or stamps because of their taste? Do you dislike toothpaste or mouthwash?
__ Do you "pile on" condiments or seasonings?	__ Do foods with different textures make you gag?

Vestibular

Even though people usually mention only the five senses already mentioned in this workbook, your **vestibular** (said like: **ve-stib**-yuh-ler) sense is very important, too. Your vestibular sense is your sense of where you are relative to the earth's surface. It helps you to figure out which way is up and down and how to balance when you move around. There is liquid in your inner ear that causes hairs in your inner ear to bend when you move. When these hairs bend, messages are sent to the brain so that you know how you are oriented in space.

EXPLORE YOUR VESTIBULAR PROCESSING

Often, people are not aware of how they process how they are oriented in space unless it interferes with their functioning. Use the checklist below to examine your vestibular processing. Remember, there are no right or wrong answers.

Low sensitivity	High sensitivity
__ Are you in constant motion? Do you have difficulty sitting still? Do you tend to run, skip or jump instead of walking?	__ Do you avoid or dislike playground equipment? Do you avoid rapid or rotating movements?
__ Do you crave fast, spinning, and/or intense movement experiences such as amusement park rides?	__ Do you prefer sedentary tasks? Do you move slowly and cautiously?
__ Do you love being tossed in the air, jumping on trampolines, spinning in a swivel chair, or being upside down?	__ Do you avoid or dislike elevators and escalators? Are you fearful of feet leaving the ground? Are you fearful of going up or down stairs?
__ Do you like sudden or quick movements, such as going over a big bump in the car or on a bike?	__ Are you afraid of being tipped upside down, sideways or backwards? Do you have difficulty riding a bike, jumping, hopping, or balancing on one foot? Do you lose your balance easily and appear clumsy?

Did you notice that you checked more statements on the "low sensitivity" or the "high sensitivity" side? Because we all process the world around us differently, your answers may be different from the person beside you. It's interesting to learn how much of a role the vestibular sense plays in your attempts to make sense of the world!

Proprioceptive

Proprioception (said like: proh-pree-uh-**sep**-tion) refers to your awareness of your body's position relative to other people or things in your environment. Proprioception uses input from the muscles and joints about body position, weight, pressure, stretch, movement, and changes in position in space. It allows you to move objects with precision.

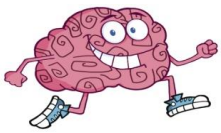
EXPLORE YOUR PROPRIOCEPTIVE PROCESSING

We all process our own movements differently. Often, people are not aware of how they navigate around other people or objects unless it interferes with their functioning. Use the checklist below to examine your proprioceptive sense. Remember, there are no right or wrong answers.

Low proprioception	High proprioception
__ Do you often seem to do things with too much force and always seem to be breaking things?	__ Do you like to be tightly wrapped in many or weighted blankets, especially at bedtime? Do you prefer clothes, belts, hoods, or shoelaces to be as tight as possible? Do you seek out other "squishing" activities (e.g., bear hugs)?
__ Do you tend to write too lightly to see or so hard the tip of your pencil breaks?	__ Do you stomp your feet when walking?
__ Is your written work often messy or do you often rip the paper when erasing?	__ Do you kick your feet on the floor or chair while sitting at a desk/table? Do you frequently crack your knuckles or drum your fingers?
__ Do you understand the idea of "heavy" or "light"? Are you able to hold two objects and tell you which weighs more?	__ Do you grind your teeth throughout the day? Do you often chew on pens, straws, shirt sleeves etc.?

Did you notice that you checked more statements on the "low proprioception" or the "high proprioception" side? Because we all process the world around us differently, your answers may be different from the person beside you. It's interesting to learn how much of a role the proprioceptive sense plays in your attempts to make sense of the world!

HOW DOES YOUR BRAIN MAKE SENSE OF ITSELF?



Your brain endows you with a natural curiosity to ask important questions and to seek answers. It's no wonder that your brain consumes about 25 Watts of power each day!

Neuroscientists who study the brain and nervous system have made some amazing discoveries about how the brain works and how to promote brain health. These discoveries benefit humanity by giving us a better understanding of our remarkable capabilities as well as our untapped potential.

Perhaps even more importantly, neuroscience discoveries give us an appreciation of and respect for the extraordinary diversity that characterizes every member of the human race. For example, neuroscientists are just beginning to understand a condition known as **synesthesia** (said like**: sin-uh s-thee-zhuh)**. Individuals with synesthesia are especially skilled at integrating sensory information. In other words, they expertly blend sights, sounds, smells, tastes, touches, etc. in their attempts to make sense of the world.

Daniel Tammet, a synesthete, characterizes this ability as "cross talk" across the senses. He describes his thinking as based on art and personality, rather than reason or logic. For example, he perceives the number 1 as a flash of bright light, the number 6 as sad and lonely, and the number 9 as loud, arguing voices. He perceives the number 3 as green, the number 4 as blue, and the number 5 as yellow. Here is a visual of what numbers may look like in Daniel Tammet's mind:

Neuroscientists' research suggests that, at some level, we may all be synesthetes. Stay tuned!

EXTRA RESOURCE

Get on your computer and search Richard E. Cytowic's intro on synesthesia: "What color is Tuesday? Exploring synesthesia"!

Want to learn more about what everyday life is like for a synesthete? Search: "Daniel Tammet" as well!

EXTRA RESOURCE

With more than seven billion humans perceiving the world each in their own unique way, there is so much left to discover about the human brain. What will neuroscientists discover next?

Do you have a neuroscience question? Visit http://students.washington.edu/nbout/TheBrainQuestion/ to ask a neuroscientist.

OTHER RELEVANT WEBSITES

The following websites and resources were referenced when creating this workbook. They contain more information and many more activities than we could integrate into this booklet.

- **BioEd Online's Lessons on the Brain and Behavior**
  - http://www.bioedonline.org/lessons-and-more/lessons-by-topic/brain-and-behavior/
- **BrainU**
  - http://brainu.org/neuroscience-concepts-activities
- **Center for Behavioral Neuroscience Education**
  - http://cbn-atl.org/education/index.shtml
- **Chudler's Brain Awareness Week**
  - https://faculty.washington.edu/chudler/baw.html
- **Dana Foundation**
  - http://www.dana.org/BAW/Education/
- **HDNet World Report**
  - https://www.youtube.com/watch?v=Z_E3zxx2l9g
- **National Institutes of Health**
  - http://www.ninds.nih.gov/education/Lobeoratorium/index.html
- **Rupestreweb**
  - http://www.rupestreweb.info/mimesis.html
- **Scientific American's Mind and Brain Activities**
  - http://www.scientificamerican.com/mind-and-brain/
- **Sensory Processing Checklist**
  - http://www.sensory-processing-disorder.com/sensory-processing-disorder-checklist.html
- **Society for Neuroscience's Brain Facts**
  - http://www.brainfacts.org/sensing-thinking-behaving/senses-and-perception/
- **TED-Ed**
  - https://www.youtube.com/watch?v=rkRbebvoYqI
  - https://www.youtube.com/watch?v=Pzd7ReqiQnE
- **The University of Illinois's Do You See What I See?**
  - http://neuron.illinois.edu/units/do-you-see-what-i-see
- **The University of Washington's The Brain Question**
  - http://students.washington.edu/nbout/TheBrainQuestion/