L A B

21

Senses and Perception

We must be aware of our environment and make adjustments to its demands. The senses provide the necessary information, and our perception provides an evaluation of that information through the experiences of trial and error. Working together, these two processes have defined the success of the human species. Today's lab is designed to demonstrate some of the sensory and perceptual mechanisms of the nervous system. Our senses depend on specialized receptors located in various parts of the body. These receptors are activated by only one kind of stimulus (sound, touch, light, chemicals, etc.). The information from one receptor is kept separate from that sent by another sense organ. In the brain, particular areas are specialized for processing and interpreting the information pertaining to each of the senses.

Exercise #1 **Touch**
Exercise #2 **Temperature Sensation**
Exercise #3 **Hearing**
Exercise #4 **Smell**
Exercise #5 **Taste**
Exercise #6 **Vision**
Exercise #7 **Reflexes**

Exercise #1
Touch

A string-line that loops over on the top of your head from ear to ear approximately separates the motor cortex of the frontal lobes from the touch areas of the parietal lobes. The ***motor area*** controls movement of individual muscles and patterned movement of groups of muscles. The ***touch area*** localizes which parts of the body are sending signals, and it interprets the meaning of those signals.

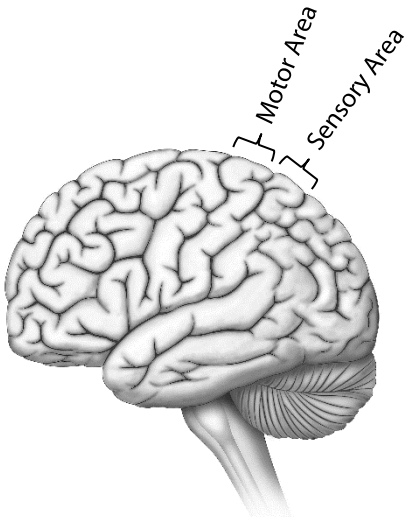


Figure 21.1. Location of the sensory area in the human brain.

In this Exercise you will determine the density of touch receptors in several areas of your body. Using that information, you can test the idea that the areas with greater sensitivity have more touch receptors.

Materials

- ✓ horse hair
- ✓ metric ruler
- ✓ compass or two-point discriminator
- ✓ fine hair brush

Procedure

Mark off a 1 cm square.

- Be sure to perform all the tests on each person in your lab group.
- Mark off a 1 cm x 1 cm square on your fingertip, back, and another area of your body that you would like to test.
- Close your eyes while your lab partner lightly touches you 25 times with the horse hair. The touching should be done in a grid-like pattern that covers all of the square you have marked.

Use either a compass or two-point discriminator.

Lightly touch with a fine brush.

- Each time you feel the touch of the horse hair, say so. Record the number of positive responses in the Data Table 21.1.
- Next, use the points of a compass or two-point discriminator to lightly stimulate the subject's skin in the area of the marked boxes. The compass points must be blunt and not poke through the skin. *File the points if necessary*. Start with the points close together, then increase their distance apart until the subject definitely feels two distinct points. Be sure that the two points are applied simultaneously each time, and retest to see if there is error due to imagination.
- Measure the distance between the two compass points when the subject clearly perceives two points. This is called ***two-point discrimination***. Record the results for each area of the body that you mapped for touch receptor density. Include the results from everyone in your lab group.
- Another clinical tool to detect damage in sensory pathways is to brush an area of the skin with a very fine soft brush. Different areas of the body have different sensitivities, but an experienced clinician can determine if a particular patient has lost some of the normal sensitivity. Practice with this technique on each of the areas of the body that you tested for two-point discrimination. Make sure the subject closes their eyes.

Table 21.1. Results of Touch Discrimination Experiment. Record results for everyone in your lab group.

Area of the Body	# of Positive Responses during 25 "touches" in 1cm²	Two-Point Discrimination (in cm)
Fingertip		
Back		
Other _____		

? Question

1. Which test area had the greatest density of touch receptors?

2. Which test area had the best two-point discrimination?

3. How is two-point discrimination related to density of touch receptors?

4. When you have an itch somewhere on your back, why does it take so much scratching before you finally find it?

5. Did you discover any particular value for using the fine brush test? Describe.

Exercise #2
Temperature Sensation

During this Exercise you will determine whether your body detects the actual temperature or the change in temperature.

Materials

- ✓ a large beaker of cold water (10^0 C)
- ✓ a large beaker of hot water (50^0 C)
- ✓ a large beaker of 30^0 C water

Procedure

- If the water beakers are already set up at the demonstration table, then check and adjust the temperatures using water from the hot plate or ice cubes in order to maintain the three temperature conditions listed above.
- Place the index finger of one hand into the cold water, and put the index finger of the other hand into the hot water for 15 seconds.
- After 15 seconds, quickly place both fingers into the 30 °C water.
- Record the sensations.

  Cold-water Finger feels _____.
  Hot-water Finger feels _____.

? Question

1. What seems to be the most important factor related to your perception of skin temperature?

   actual temperature or change in temperature

2. If you wanted your clients to swim in a pool that was 76^0F, what kind of shower would you have them rinse off with before entering the pool?

Exercise #3
Hearing

The ear is divided into three parts: the outer, middle, and inner ear. When sound waves enter the ear, the ***eardrum*** (between the outer and middle ear) is shaken, and special small bones attached to the eardrum vibrate. These ***middle ear bones*** transmit the sound vibrations to a small membrane (oval window) opening into the inner ear. The vibrations of the oval window create oscillations in the fluid of the ***inner ear*** (cochlea). This moving fluid activates the ***auditory nerves*** leading to the brain. The ***auditory cortex*** of the brain is specialized for interpreting sounds.

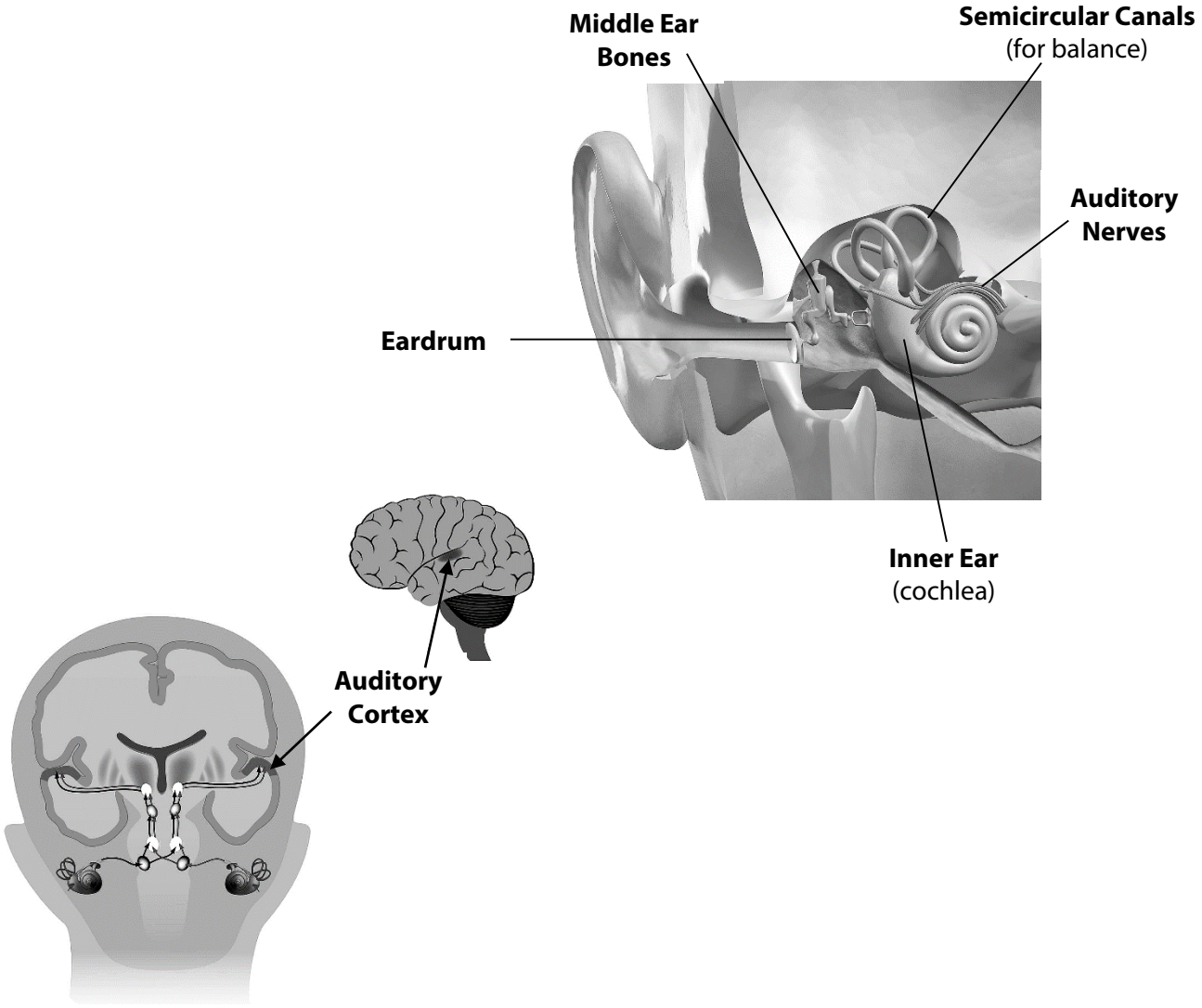


Figure 21.2. Anatomy of the Hearing Apparatus. Sound waves vibrate the eardrum which transmits those vibrations through the middle ear bones into the inner ear (cochlea) where the actual nerve receptors are located. Signals from the cochlea are sent to the auditory cortex where sounds are identified and interpreted.

Materials

- ✓ cotton for ear plugs.
- ✓ set of tuning forks.
- ✓ meter stick.

Procedure

- Do the first test in a quiet room. Have the subject close one ear with cotton and close his eyes. Strike the tuning fork against the table and hold it in line with the open ear. Move the tuning fork away from the ear until the subject just loses the ability to hear it. Measure that distance. Repeat the test again to validate your first measurement. Record the hearing distance for both ears (Table 21.2). Be sure to strike the tuning fork with equal force each time you do the test.
- Perform the same test with each of the six tuning forks of different tones to determine if you have hearing loss in any of the six ranges. If one of your ears has a hearing loss at a particular tone range, then do the next test.
- This next test should not be performed in a quiet room. It will determine whether your hearing loss is due to a problem in the middle ear or inner ear. Place the handle of a vibrating tuning fork on the midline of the subject's forehead. A person with normal hearing will localize the sound as if it were coming from the midline. If one ear has defective middle-ear function (ear bones), then the sound will be heard much better in the defective ear when the tuning fork is touching the forehead. If there has been damage to the auditory nerve, then touching the tuning fork to the forehead won't improve hearing in the defective ear.

Be consistent when striking the tuning fork.

Table 21.2. Results of Hearing Tests.

Sound Frequency (cycles per second)	**Farthest Distance sound is heard from the Left Ear**	**Farthest Distance sound is heard from the Right Ear**
128 cps tuning fork		
256 cps tuning fork		
512 cps tuning fork		
1024 cps tuning fork		
2048 cps tuning fork		
4096 cps tuning fork		

? Question

1. Middle ear damage often comes from serious ear infections during childhood. Check your class for anyone diagnosed with middle ear damage by our lab tests, and ask them if they had childhood ear infections.

2. Inner ear damage in young people is often because of exposure to very loud sounds. Check your class for anyone with inner ear damage (nerve), and ask them if they have been exposed to loud sounds.

3. What is the best design for a hearing aid if a patient has hearing loss in a particular sound range?

4. What would be the design of a cheaper hearing aid?

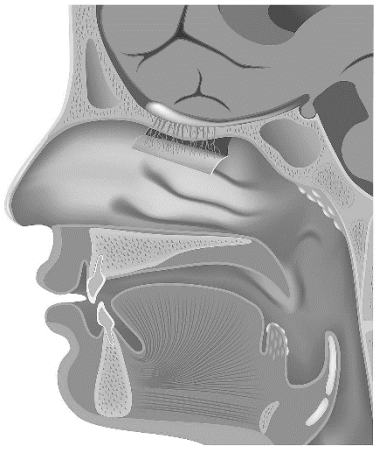
5. Which person would more likely be a candidate for surgery?

   Middle ear damage
   or
   Inner ear damage

Exercise #4
Smell

It has been observed that one's nose is never so happy as when it is thrust into the affairs of another, from which some physiologists have drawn the inference that the nose is devoid of the sense of smell.

- *Ambrose Bierce*



There are more than 30 million smell receptors that line the top of the nasal cavity.

Taste studies show that most of food flavor comes from smell rather than taste itself. Some researchers suggest that the evolutionary specialization of the mammalian forebrain began with the sense of smell because there are so many smells in the environment. Although the complete role of this sense is not understood, it seems more closely linked to emotional memories than to the conscious activities of our brains, and it can change in different conditions. As you experiment with the various odors in the smell experiment, describe the type of emotional reaction and memories that you have to each.

As air enters the nasal cavities, it swirls around and aromatic molecules contact specific nerve receptors in the roof of the nasal cavity. There are 30+ million receptors in your nose, and nerve cells are probably dedicated to particular odors. Each aroma has a chemical binding with specific nerve endings. Evidence suggests that learning is involved during the "wiring" of the smell neurons, and memory may be essential because Alzheimer's patients have no apparent smelling ability. Much of the neuron circuitry is not "hard wired" as other senses are, and it can be modified and improved somewhat during our life. Smell receptors are the only nerve cells that replace themselves every few months. This may be necessary because the nerve endings are directly exposed to the air. Smell may be the most adaptable sense.

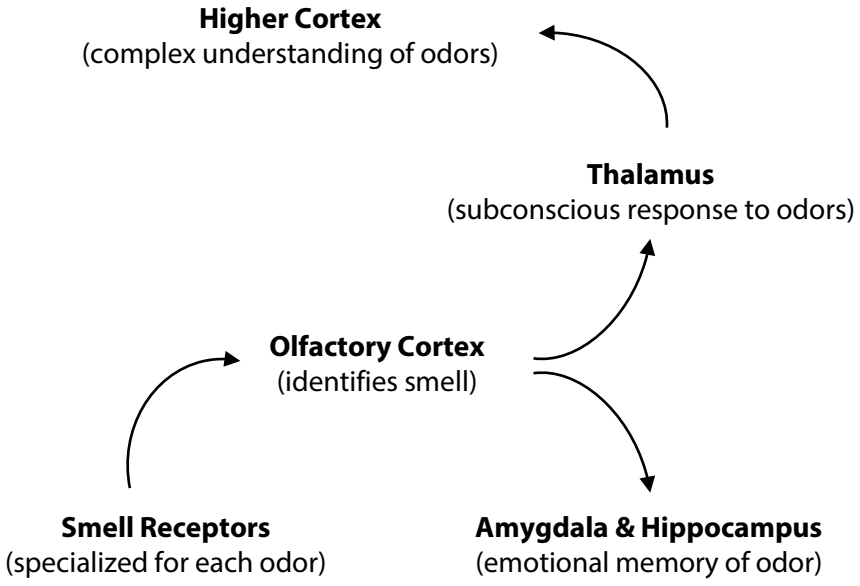


Figure 21.3. The Smell Sensory System and a general description of the detection and interpretation of smells.

Materials

- ✓ a smell kit

Procedure

- Close your eyes. Have your lab partner pass an open odor vial about 3" under your nose for a couple of seconds. Repeat the test if necessary.
- First determine if you can smell an odor. Then determine if you can correctly identify the smell. Finally, describe any special memories associated with the smell.
- Record the results of your test in Table 21.3.

What memories are associated with each smell?

Table 21.3. Data Table for Odor Recognition.

Sample	Can detect a smell	Can identify the smell	What are any memories associated with the smell?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total =		Total =	

? Question

1. There are two abilities being tested. One is to determine if you can detect an aroma. What was the average number of odors that students could detect but not necessarily identify?

2. What was the average number of odors that students could correctly identify?

3. Repeat the experiment after you have some more practice with the smells. Did your recognition improve?

4. How many of the smells were associated with emotional memories?

5. List three examples of how specific smells might be used to sell you a product.

Exercise #5
Taste

The tongue has at least four different taste receptors (salty, sweet, bitter, and sour). However, the taste of many chemicals is also influenced by your interpretation of their smell. In this Exercise you will examine several aspects of your ability to taste.

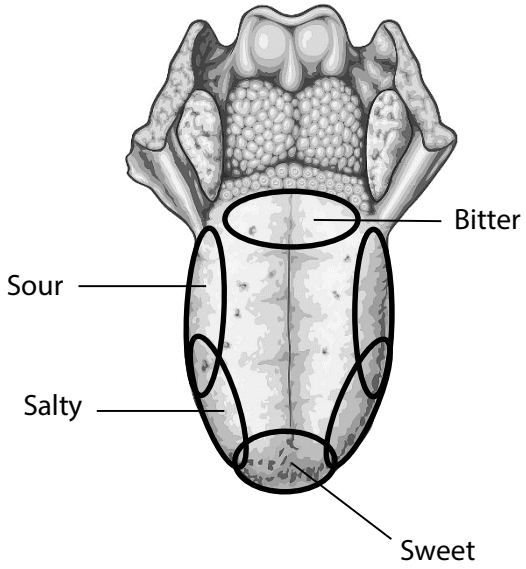


Figure 21.4. Location of four taste areas on the tongue.

Genetically Determined Taste

Your ability to taste some chemicals is determined by whether or not you have inherited the gene controlling the taste response to that particular substance. This is an important lesson for you to remember when certain foods don't taste bitter to you but other people complain about them (especially your children). They may have the gene to taste it, and you may not.

Materials

- ✓ special taste papers for PTC and thiourea

Procedure

- Take one of the taste papers, and touch it to your tongue. You will immediately know if you are a taster!
- Do the same test with the other taste paper.
- Put the used taste papers in the trash.

? Question

1. Are you a taster for thiourea?
2. Are you a taster for PTC?
3. If you are a non-taster and you want to be a high-class chef, what might you do to compensate for this genetic limitation?

Some have a more refined sense of taste than the rest of us!

Sugar Taste Threshold

This experiment will determine differences in sugar tasting threshold among students, and the results might help us to understand why some people prefer more sugar in their foods.

Procedure

- Go to the demonstration table and determine your sugar ***taste threshold*** (minimum percent of sugar that you can taste).
- Dip a strip of tasting paper into each solution, and record whether or not you can detect a sweet taste. Discard the used taste papers.
- After testing all of the solutions, go to the front desk for the key to the sugar concentration of each solution.
- Record your results in the summary chart on the front chalkboard, and compile the class results below.

Table 21.4. Data Table for Sugar Taste Threshold.

Taste Threshold	Sugar Concentration				
	0.25%	0.5%	1%	2%	5%
# of Students Who Could Taste					
# of Students Who Could Not Taste					

? Question

1. What was your sugar tasting threshold?
2. What was the lowest percent of sugar tasted by your classmates?
3. What was the highest threshold in the class for tasting sugar?
4. Do the people with a high taste threshold also like more sugar in their food? (You could determine this by asking your classmates how much sugar they add to their coffee.)

Estimating the Number of Taste Buds on Your Tongue

The ability to taste depends on many factors, but one of them is the density of taste receptors on your tongue. It is quite easy to make an estimate for your own tongue. The process involves putting a colored fluid (either food coloring or blue sucker) on your tongue and counting taste buds within a small circle. The taste buds will appear uncolored (pink) on the blue tongue. Each taste bud has many receptor cells (100 or so). You will be categorized as average, supertaster, or low taster based on the number of taste buds.

Materials

- ✓ paper towels
- ✓ paper-hole reinforcers (circle used for counting)
- ✓ blue sucker
- ✓ magnifying glass
- ✓ bright light or flashlight

Procedure

- Everyone wash their hands before starting.
- The subject is to suck on a blue sucker for a few minutes until the tongue is blue. (There are other instructions if you are using blue food coloring. Ask your instructor.)
- Use a piece of paper towel to slightly dry the tongue.
- Place one of the paper-hole reinforcers on the subjects tongue.
- The taste buds are slightly raised and are not stained blue as much as the rest of the tongue.

- Use a flashlight and magnifying glass to count the number of taste buds.
- Help the subject remove the paper circle with a paper towel.
- Repeat this procedure for each person in your lab group.
- Record your results in the summary chart on the front chalkboard, and compile the class results in Table 21.5.

Table 21.5. Tasting Ability Based on Density of Taste Buds.

Taster Category (# taste buds)	**# of Students in Each Category**
Low Taster ≤ 15	
Average Taster ≈ 16-29	
Super Taster ≥ 30	

? Question

1. How many taste buds did you count in your tongue sample area?

2. What is your taster category?

3. Analyze the class data to determine if there is a correlation between your genetically determined taste test, sugar tasting threshold, and density of taste buds. Use Table 21.6.

Table 21.6. Relationship Between Taste Bud Density and the Ability to Taste Sugar and PTC (or Thiourea).

Taster Category	**# of Students who could taste 0.25% or 0.5% sugar**	**# of Students who were tasters of PTC or Thiourea**
Low Taster		
Average Taster		
Super Taster		

Exercise #6
Vision

Human beings are primarily visual animals. It is our dominant sense for relating to the environment. There is a lot of scientific literature on visual perception, and we encourage you to investigate this information when you have time to do so. Most human behavior is strongly influenced by visual perception, and what we don't know can affect us without our knowledge.

Preferred Eye

This test is designed to reveal which one of your eyes is used for certain visual functions. Your preferred eye is the one your brain chooses to use when both eyes can see the same object.

Which is your preferred eye?

Procedure

- Pick an object that's about 30 feet away. Make a circle with your thumb and first finger of both hands.
- Straighten and raise your arms from your waist to a position where the circle surrounds the object. Keep your head and feet positioned straight ahead.
- Without further movement, close one eye. Then open the closed eye, and close your other eye.
- Which one of your eyes has the same view as the view with both eyes open? This is your preferred eye. When you close your preferred eye, the distant object will move out of the circle formed by your hands.

? Question

1. Which eye is your preferred eye?

2. If you are left-eyed, what problem will you have in shooting a rifle?

3. Why should you use your preferred eye when looking through a monocular microscope?

Eye with Best Vision

Procedure

- Use the classroom eye chart to determine which of your eyes has the best vision (without glasses).

? Question

1. Which of your eyes has the best vision?
2. Is this the same eye that is your preferred eye?
3. Are you left or right handed?
4. Talk with other lab students, and discover whether the eye with the best vision is always the same one as the preferred eye or handedness.

Results

Eye with Best Depth Perception

There are fairly simple ways of determining which of your eyes has the best depth perception. If the testing equipment is available in lab, then determine the depth perception for each of your eyes, and tabulate the class data like that in Table 21.7. If the depth perception equipment is unavailable, then use the information in Table 21.7 to answer the questions.

Table 21.7. Relationship Between Handedness and Vision Tests.

Vision Tests	13 Left-Handed People	11 Right-Handed People
Eye with Best Depth Perception	9 left eye 3 right eye 1 same in both eyes	2 left eye 8 right eye 1 same in both eyes
Preferred Eye	7 left eye 6 right eye	5 left eye 6 right eye
Eye with Best Vision	1 left eye 1 right eye 11 same in both eyes	2 left eye 1 right eye 8 same in both eyes

? Question

1. The preferred hand (whether left-handed or right-handed) is most closely associated with . . . (circle your choice)

Eye with best depth perception
or
Preferred Eye
or
Eye with best vision

Exercise #7
Reflexes

Which reflex personality type are you – calm or quick reacting?

The brain is capable of sending both ***fascilatory*** and ***inhibitory*** signals to the reflex centers in the spinal cord. The balance of these opposite effects determines the quickness and magnitude of reflexes and one aspect of your personality. When you are excited or threatened or preparing for competition, the balance shifts to faster and stronger reflexes and you are more excitable. There are differences in the normal disposition of the nervous reflex system among people. You can see this difference by watching

how reactive a person is under normal conditions (very calm vs. quick reacting).

A reflex test while reading can be used to determine which reflex type you are. Concentrating on reading reduces the effect your brain normally has on reflex centers. If reading reduces your reflex response, then normally your brain must be stimulating reflexes (you are a quick-reacting person). If reading increases your reflex response, then your brain normally inhibits reflexes (calm-reacting). This test is not 100% determinative because your brain's reflex emphasis does change under various circumstances, and this lab class could be one of them. No person is 100% one type or the other all of the time.

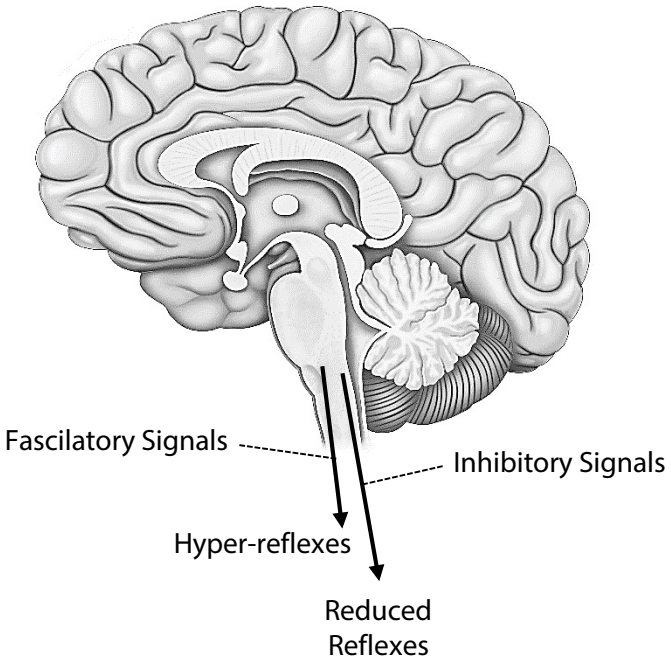


Figure 21.5. Excitation and inhibition of the spinal reflexes. Pathways leading out of the brainstem are capable of shifting the reactivity of the reflex centers in the spinal cord.

Materials

- ✓ patellar hammer
- ✓ meter stick

Procedure

- Before beginning the test, ask your lab partner to evaluate whether you are the calm or quick-reacting type.

Lab Partner's Opinion:

Your Opinion:

- Sit on a table so that your legs hang freely over the edge. Have your lab partner hit the patellar ligament (just below the knee) with the reflex hammer. Don't hit too hard. This may take some practice. Measure the amount of leg movement several times to get an average estimate of the reflex intensity.

  Normal Reflex =

- Next, read from a textbook while your lab partner measures the amount of reflex leg movement. Is the reflex more intense or less intense during the reading conditions?

  Reflex while reading =

? Question

1. Under normal circumstances, did your brain activate or inhibit your spinal reflexes?

2. So, which reflex type are you?

3. Does this agree with how you evaluated yourself before the test?

4. Compare your conclusions with those of other students in the class. What did you discover?