

The Five Senses

Introduction

Humans are born with five basic senses—hearing, sight, smell, taste and touch. Perform tests to determine the acuity of each of these senses.

Concepts

- Five senses
- Sensory acuity
- Thresholds
- Genetics

Background

Hearing

The ear is an organ that serves two distinct functions—hearing and equilibrium. Hearing is our perception of energy carried as sound waves. *Sound waves* are alternating pressure waves with peaks of compressed air and valleys of diffuse air. *Sound* is a person's interpretation of the amplitude, frequency, and duration of the sound waves (see Figure 1).

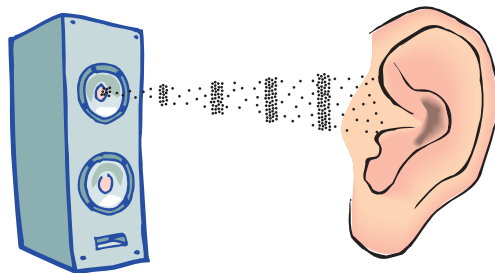


Figure 1.

Audiologists are professionals who diagnose and treat hearing loss. One test they perform to test hearing is called the Weber test. During the Weber test a vibrating tuning fork is placed in the middle of the subject's forehead. The sound will seem louder in the ear with conductive hearing loss. If the sound seems to be evenly distributed between both ears it may indicate proper hearing or symmetrical hearing loss (equal loss in both ears).

Sight

In order to test visual acuity ophthalmologists often use an Eye Test Chart also known as the Snellen Chart. The test compares the relationship between the sizes of the letters to the distance the subject is located from the chart to measure visual acuity. *Visual acuity* is a quantitative measurement of the eye's ability to identify black letters on a white background from a specified distance.

To begin the Snellen Test the subject stands 20 feet from the chart. The subject is instructed to read the smallest line possible. Normal or ideal vision is classified as 20/20 meaning the subject can clearly read line 8 (also called line 20/20) of the Snellen chart from 20 feet away. This is defined as normal or ideal vision in that a person should be able to clearly read line 8 from 20 feet away. Conversely, if the subject stands 20 feet away and the smallest line they can read is line 6 (also called the 20/30) means that someone with ideal vision could read the same line from 30 feet away. This is also classified as 2/3 normal.

Smell

Humans are able to detect more than 10,000 different odor molecules. The *olfactory bulb* is the extension of the forebrain that receives signals from the primary olfactory neurons. The olfactory system is made up of primary sensory neurons (also called olfactory cells) and secondary sensory neurons. The primary sensory neurons synapse with the secondary sensory neurons located in the olfactory bulb.

Olfactory cells are located in the olfactory epithelium in the upper nasal cavity. Figure 2 diagrams the olfactory bulb and olfactory epithelium. In order for the brain to detect odor, the stimulus travels by the following path. It is first detected through the olfactory cells to the secondary neuron in the olfactory bulb which travels to the cranial nerve I to the olfactory cortex in the temporal lobe of the brain.

Taste

The sense of taste in humans depends on clusters of sensors called *taste buds*. Taste buds are embedded in the epithelium of the tongue, and many are found on the raised *papillae* of the tongue. A tongue viewed in a mirror might actually look fuzzy because of the papillae. There are many taste buds on each papilla.

It is generally accepted that humans can perceive basically four tastes: sweet, salty, sour, and bitter. See Figure 3 for generalized regions of taste often found on the surface of the tongue. The final ability to “taste” something is a complex interaction between olfactory sensors (ability to smell) and stimulation of the taste buds. When a substance is placed in the mouth it quickly disperses to all four taste areas and creates a nearly instant taste sensation. Where the taste sensation occurs is really not discernible and is of little consequence when we are actually tasting something. What is perhaps more interesting is our ability to taste or not taste a particular substance.

Several interesting chemicals have been discovered that have been used by scientists to explore the genetics of the sense of taste. One of these chemicals is PTC (phenyl thiocarbamide). Some people taste this bitter-tasting chemical very easily while other people cannot taste it at all! People who can taste PTC are referred to as “tasters.” Those who cannot taste PTC are called “non-tasters.” Not only is the difference in ability to taste this substance interesting, but it has also been found to be an inherited characteristic.

Touch

Mechanoreceptors are sensory receptors that are stimulated by touch, stretch, pressure, motion or sound. The density of mechanoreceptors differs from one part of the body to another. Some areas contain hardly any mechanoreceptors and others have so many that even very faint stimuli can be detected. In an area such as the back there are very few mechanoreceptors—simultaneously touching two points that are a large distance apart may feel like just one point. The fingertips and feet are two areas of the body that have the greatest concentration of mechanoreceptors. Since there are more mechanoreceptors, stimuli at two different points can be detected as separate at a much smaller distance.

Materials

Phenyl thiocarbamide (PTC) paper
Alcohol wipes
Eye Test Chart (Snellen chart)
Masking tape
Measuring tape, 20'

Paper clips, 2
Ruler, metric
Sample containers with scent solutions, 3
Tuning fork, 512-Hz

Safety Precautions

Phenyl thiocarbamide has a very low LD₅₀—about 3.4 mg/kg. The amount of PTC used in each strip is extremely low. A student weighing 50 kg would have to lick and ingest more than 500 2" × ¼" strips of PTC to reach the LD₅₀ level. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling and disposal information.

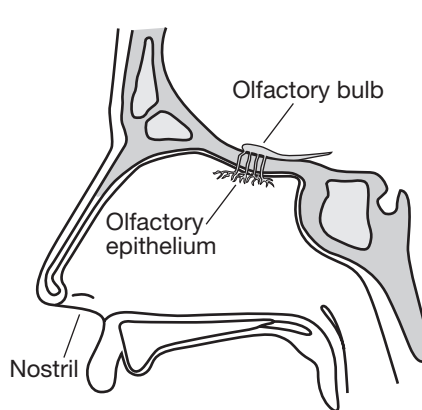


Figure 2.

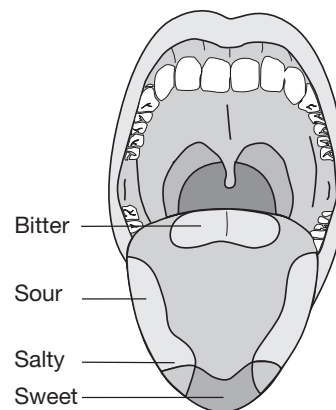


Figure 3. Generalized taste regions of the tongue.

Procedure

Hearing

1. Strike the tuning fork against the heel of a rubber-soled shoe.
2. Hold the fork to the middle of the subject's head as shown in Figure 4.
3. Ask the subject which side the sound seems louder, if either. Record results on worksheet.
4. Repeat steps 1–3 while the subject plugs his or her left ear using a finger. Record results on worksheet.
5. Repeat steps 1–3 while the subject plugs his or her right ear using a finger. Record results on the worksheet.
6. Clean with an alcohol wipe.

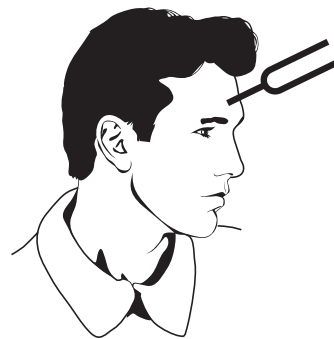


Figure 4.

Sight

7. Attach the Eye Test Chart to the wall in a well-lit area.
8. Using a measuring tape to measure 20 feet from the Eye Test Chart. Mark the correct location using masking tape.
9. Position the subject at the testing location. Ask the subject to cover their right eye and read the smallest line possible using only their left eye from that distance. Note the results.
10. Repeat step 9 covering the left eye and reading with the right eye.

Smell

11. Three sample containers hold solutions with characteristic aromas. Waft the contents of each container (see Figure 5).
12. Complete the data table on the worksheet and predict the contents of each sample container.



Figure 5.

Taste

13. Obtain a test strip of PTC paper.
14. Place the paper on your tongue for five seconds. Do you taste the characteristic bitterness of PTC or is there no taste detected? Record the results on the worksheet.

Touch

15. Obtain two paper clips and bend them into a “V” shape.
16. Using a metric ruler, adjust the distance between the ends of the “V-shaped” paper clips so that the two end points are separated by the following distances: 2.0 cm, and 0.5 cm.
17. Working in pairs, one student will be the subject and the other student will administer the test.
18. The subject should sit with his or her eyes closed.
19. While the subject's eyes are closed, obtain the 2.0 cm paper clip and touch your partner's hand five times using both points of the paper clip and five times using just one point. Mix up the order so that your partner does not notice a pattern.
20. After each touch ask your partner if he or she felt one paper clip point or two. Record the number of points actually used and the number of points felt in Table 3.
21. After ten trials are completed using the 2.0 cm paper clip, switch to the 0.5 cm paper clip and repeat steps 16–19 for a total of 10 trials.
22. Repeat steps 16–19 with both paper clips on the back of the upper arm (tricep area).
23. Clean with an alcohol wipe.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. PTC test paper may be disposed of in the regular trash according to Flinn Suggested Disposal Method #26a. All other materials may be stored for future use.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12

Evidence, models, and explanation

Form and function

Content Standards: Grades 5–8

Content Standard C: Life Science, structure and function in living systems, reproduction and heredity

Content Standard F: Science in Personal and Social Perspectives, personal health

Content Standards: Grades 9–12

Content Standard C: Life Science, the cell, molecular basis of heredity, biological evolution, interdependence of organisms; matter, energy, and organization in living systems, behavior of organisms

Content Standard F: Science in Personal and Social Perspectives, personal and community health

Answers to Worksheet Questions

Hearing

Table 1. Weber Test

Test Performed	Conditions	Location where sound perceived loudest (circle answer)		
Weber	None	Left Ear	Right Ear	Equal
	Left ear plugged	Left Ear	Right Ear	Equal
	Right ear plugged	Left Ear	Right Ear	Equal

1. According to the information in the background section do your results from the Weber test indicate hearing loss?

Student answers will vary. If the sound is equally loud in both ears the results indicate either normal hearing or equal hearing loss in both ears.

2. In step 4 the left ear was plugged. Did the sound seem to be louder or quieter than when it was not plugged? Explain.

The sound was louder in the left ear because plugging the ear simulated conductive hearing loss in the left ear.

Sight/Vision

3. What was the smallest line you were able to read on the Eye Test Chart from 20 feet away for each eye?

Student answers will vary.

4. Based on the results of Question 3, what does this indicate about your vision in your left eye? In your right eye?

Student answers will vary. A person who can read line 8 from 20 feet away is said to have normal vision without need for corrective lenses. Some students will have the same results for each eye. Other students will have better vision in one eye than another.

Smell

Table 2. Detectable Odor

Sample Container	Contents
A	<i>Answers vary depending upon chosen contents.</i>
B	<i>Answers vary depending upon chosen contents.</i>
C	<i>Answers vary depending upon chosen contents.</i>

Taste

5. Were you able to detect the characteristic taste of PTC?

Student answers will vary. They will detect a very bitter taste or will not taste anything at all.

6. How might a person's ability to taste PTC affect his or her food choices?

If a person does not have the ability to taste PTC he or she might be more tolerant of bitter tasting foods as they do not leave an unpleasant taste in his or her mouth. Whereas someone who very specifically can detect a bitter taste usually is adverse to foods with that taste.

Touch

Table 3. Back of the Hand

Trial	2.0 cm		0.5 cm	
	Points Used	Points Detected	Points Used	Points Detected
1	1	1	2	1
2	2	1	1	1
3	2	1	1	1
4	2	2	2	1
5	1	1	1	1
6	2	2	2	1
7	1	1	1	1
8	1	1	2	1
9	2	2	2	1
10	1	1	1	1

Table 4. Back of the upper arm (tricep)

Trial	2.0 cm		0.5 cm	
	Points Used	Points Detected	Points Used	Points Detected
1	1	1	1	1
2	2	1	2	1
3	1	1	1	1
4	2	1	2	1
5	2	2	2	1
6	1	1	1	1
7	1	1	1	1
8	1	1	1	1
9	2	1	2	1
10	2	1	2	1

7. Based on the results of Tables 3 and 4, does the back of the hand or the back of the arm have more mechanoreceptors? Explain.

The back of the hand has more mechanoreceptors because the results show more accurate detection between number of points.

Tips

- This lab may reasonably be completed in one 50-minute class period.
- Be creative when making the scent solutions. It is best to add scents that are not visually detected. For example place a few drops of fresh lemon juice into water as opposed to lemon peel shavings. Suggestions include lemon, orange, vanilla extract, etc.
- To further test the ability of the body to detect sense of touch call Flinn Scientific at 1-800-452-1261 and request Mechanoreceptors activity (Publication No. BF10852).

Name: _____

- For further explanation regarding inheritance patterns and PTC genetics Flinn Scientific offers *Understanding the Human Genome: Student Laboratory Kit* (Catalog No. FB1802).

References

Silverthorn, D. U. *Human Physiology: An Integrated Approach*; Pearson Benjamin Cummings: San Francisco; 2004; pp 336–337.

Materials for The Five Senses are available from Flinn Scientific, Inc.

Catalog No.	Description
AP7989	PTC Test Paper, 100 strips
AB1128	Containers, sample, 4 oz
AB1240	Eye Test Chart
AP6981	Tuning Fork, C-512

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

The Five Senses Worksheet

Hearing

Table 1. Weber Test

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2. In step 4 the left ear was plugged. Did the sound seem to be louder or quieter than when it was not plugged? Explain.

Sight/Vision

3. What was the smallest line you were able to read on the Eye Test Chart from 20 feet away for each eye?
4. Based on the results of Question 3, what does this indicate about your vision in your left eye? In your right eye?

Smell

Table 2. Detectable Odor

Sample Container	Contents
A	
B	
C	

Taste

5. Were you able to detect the characteristic taste of PTC?

6. How might a person's ability to taste PTC affect his or her food choices?

Touch

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9				
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Table 4. Back of the upper arm (tricep)

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	Points Used	Points Detected	Points Used	Points Detected
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