Purpose
In this laboratory, you will perform a series of exercises that measure the capabilities of your sensory systems. Cutaneous, olfactory, auditory, proprioceptive, and visual systems will be examined to observe basic principles of human sensory physiology.

Procedures
6/7-A: Tests of cutaneous sensation A-1: Two-point discrimination

The ability to distinguish two distinct points on the skin surface will be recorded.

Procedure

1. With your partner's eyes closed, apply two caliper pinpoints as closely together as possible on your partner's skin on the palm of his/her hand.
2. Remove the pins and move them 1 millimeter apart. Reapply the caliper points to your partner's skin. Repeat this procedure until your partner can discriminate two distinct points.
3. Record this distance between pins at which your partner can discriminate two separate caliper points.
4. Compare results obtained from the following areas: a. palm of hand
   b. back of hand
   c. fingertip
   d. outer edge of the lips e. back of neck
5. Have your partner repeat this experiment on your skin.
6. Interpret the results you have obtained.

A-2: Accommodation of thermoreceptors.

Accommodation, or sensory adaptation, occurs when receptors generate fewer impulses during constant stimulation. Accommodation of cutaneous thermoreceptors will be recorded.

Procedure

1. Place your left fingers in 15C water and your right fingers in warm water (37 C) and record the sensation of each. Keep hands immersed for 2 minutes.
2. After two minutes, describe the sensation in each hand.
3. Remove hands and promptly place them both in 25 C water. Describe the immediate sensation in each hand.

6/7-B: Olfactory adaptation
The adaptation of olfactory chemoreceptors will be timed.

Procedure

1. Block your left nostril. Uncork and hold the bottle of camphor oil under your nose until you can no longer detect the camphor. Do not consciously sniff the contents of the vial! Record the adaptation time.
2. Remove the camphor and place the bottles of cloves, then peppermint oil under your nose. Distinguish the smells of cloves and peppermint oil.
3. Uncork and hold the bottle of camphor under your nose again until the smell is no longer recognized. Record this second adaptation time
4. Unblock your left nostril determine if the camphor is detected.
5. Interpret these results.

6/7-C: Auditory measurements

Sound is measured in terms of amplitude (decibels – dB) and frequency (Hertz – Hz). Tuning fork tests and an audiometer will be used to evaluate auditory function.

C-1: Tuning fork tests

These tests utilize the principle of bone conduction to directly vibrate the cochlear hair cells. They should be done in a quiet room for most reliable results.

1. Rinne's test (checks for middle ear damage)

Procedure
1. Plug your left ear with cotton or hold your hand over it and test the right ear.

2. Hold the handle of a vibrating tuning fork to the right mastoid process.
3. When the sound disappears, move the fork near the external auditory canal. 4. Reappearance of the sound indicates no middle ear damage.
5. Repeat the test with your left ear
6. Record the results for each ear.

2. Weber's test (checks for nerve or conduction deafness)

NOTE: This test does not need to be performed if no middle ear damage was detected by the Rinne's test.

Procedure
1. Hold the handle of a vibrating tuning fork (512 Hz) to the bridge of your

nose.

2. Lateralization of sound to one ear indicates deafness.
a. Lateralization to poor ear indicates conduction deafness. b. Lateralization to better ear indicates nerve deafness.

C-2: Audiometry

An audiometer measures hearing acuity by presenting pure tones to the subject's ear through a set of color-coded earphones (red = right ear, blue = left ear). The intensity required to first perceive the signal is recorded for each ear at a number of frequencies. The presentation of signals should be randomized. The results are plotted on an audiogram to determine individual hearing acuity compared to normal values.

Procedure
1. In a quiet room, the instructor will demonstrate the proper method of operating the

audiometer.

2. Audiometry tests will be conducted in pairs. Each student will take his/her partner's audiogram.

3. Record your results on the worksheet on page 44.

4. Analyze the audiograms in the following way:
a. Average the values obtained for each ear for the frequencies of 500 Hz, 1000 Hz, and

2000 Hz.
b. Subtract 26 dB from each average.
c. If the difference is greater than 26, multiply this number by 1.5%. This equals

Example:

Hz Right 500 10 1000 15 2000 10 Total 35 Average = 12

ear

Left ear 20 30 40 90 30

the percent impairment of each ear.

- 26 04

- 26

37

Percent impairment:
Right ear = 0 x 1.5% = 0.0% Leftear =4x1.5%=6.0%

5. To determine the percent of biaural impairment perform the following calculation:

Biaural impairment = (% impairment of good x 5) + (% impairment of bad ear) 6

6. Record the results of these calculations.

6/7-D: Equilibrium - Demonstration of Nystagmus

Nystagmus, the slow drift of the eyes in one direction followed by a rapid movement back to the opposite direction, is a reflex that allows moving targets to be tracked. Nystagmus is under the control of the semicircular canals. When the semicircular canals are rotated in one direction, the cupula of the crista ampullaris is deflected in the opposite direction by the inertia of the endolymph and the eyes slowly drift in the direction opposite the movement, then, suddenly snap towards this direction. Nystagmus following body rotation will be demonstrated.

Procedure

1. A student volunteer will be seated on a swivel stool with his/her head bent 30 forward.
2. The instructor will spin the student rapidly to the right for 10 turns.
3. The instructor will suddenly stop turning the student and have the student look straight ahead.
4. Observe and note the subsequent movement of the student's eyes
5. Explain these eye movements in terms of direction of endolymph movement.
6. These procedures will be repeated with a second student spun to the left.

6/7-E: Visual measurements

The sense of sight is the most important of the senses. As such, a number of standardized tests have been developed to evaluate visual functions.

E-1: Demonstration of the blind spot

Procedure

1. Cover your left eye and focus the right eye on the center of the cross below.
2. Slowly bring the page closer to your eye until the spot disappears.

3. Have your partner measure this distance from your eye to the page.

4. The image of the spot is now superimposed on the optic nerve. Explain the lack of vision at this point.

E-2: The Snellen test

The ability to discriminate fine detail is known as visual acuity. The Snellen test uses a standardized eye chart to evaluate visual acuity. You will be using one of several versions of this eye chart in the form of the wall chart in the laboratory.

Procedure

1. Stand 20 feet away from the Snellen chart. Cover your left eye.
2. Attempt to read the line designated “20”.
3. If you cannot read line 20, attempt line 30, 40, 50, 70, 100 or 200 until a line is legible. Perform these attempts with your left eye, covering your right eye.
4. The Snellen chart is analyzed in the following way:
   Visual acuity = Distance you read the letters Lowest line read clearly at 20 feet
   Examples:
   Nearsightedness (myopia) = 20/30
   Normal = 20/20
   Farsightedness (hyperopia) = 30/20

E-3: Astigmatism

An abnormal curvature of the cornea may produce a blurred image on the retina known as an astigmatism.

Procedure

1. Stand approximately 8 – 10 inches away from the radial astigmatism eye chart so that it fills your field of vision. Cover your left eye.
2. Focus on the lines in the vertical plane with your right eye.
3. If a blur appears in the lateral lines or the lines converge into one, you have an astigmatism in this plane of your eye.
4. Record the results of this test and repeat with the left eye.

E-4: Color vision

Cones contain visual pigments that respond to specific wavelengths of light to produce nervous impulses pertaining to color. The next two tests will explore different aspects of color vision.

1. Negative After-images

Staring at an image of specific color for too long will “bleach out” visual pigments of that color. Glancing at a white surface will reveal an image of complementary color to the original.
NOTE: This test will be done first as a class, then may be repeated on an individual basis.

Procedure

1. Stare at different colored objects provided by your lab instructor for 30 seconds each, and then shift your glance to a white sheet of paper. These may include but not be limited to colored squares on white paper, stripes of various colors against white paper, colored flags or scenic views.

2. Record the negative after-images seen for each color. Were you able to predict any of these?

2. Color-blindness test

Color blindness is a genetic abnormality that is carried by the X chromosome. (See page 45.) The most common form is red-green color blindness, wherein one or the other pigment or sometimes both from the respective cone is in small amounts or lacking altogether. Several versions of the test for color blindness are available. In this laboratory, you will be using the Ichikawa color blindness charts.

Procedure

1. Obtain the Ichikawa color blindness charts.
2. Attempt to read the numbers of each pattern on the test panels. (There are some "practice" panels before the actual test panels begin.)
3. After the first 10 test panels, if your score indicates color blindness, continue with the next five test panels to determine which color deficiency exists.
4. Record your results on the worksheet on page 46.

E-5: Perimetry

The arrangement of rods and cones in the retina is not at random. Using objects of different colors, you will map the locations of the cones in your retina for one eye.

Procedure

1. Seat yourself before the perimeter board with your right eye at the edge of the semicircle. Cover your left eye. Stare at the center line.
2. Your lab partner will introduce several different colored blocks into your field of vision. Identify these blocks by color. Do not take your eye from the center of the chart or uncover your left eye.
3. Your partner will record the degree at which the colors were discriminated on the perimetry score sheet on page 47.
4. Repeat these procedures for each block for both the horizontal and vertical perimetry charts. Record the data and connect the same colored dots to form an outline of cone placement of your right eye on your data sheet.
5. Explain these results in regards to cone placement in your retina.

E-6: Dim-light vision

Cones are not able to function under dim-light conditions. Rods, however, do function well at these times. In this exercise, the ability of rods to detect dim-light images will be tested.

Procedure
1. The room will be darkened for a period of 15 - 20 minutes during this exercise.

2. As soon as the lights are extinguished, the instructor will produce an object on the front desk. After your dim-light vision improves, attempt to draw this object in detail.

3. At the end of the darkness period, reexamine your drawings and improve it, if necessary.

4. When the lights are turned on, identify the object on the front desk and compare it to your drawing.

5. Explain any increase in visual sensitivity in terms of rod photochemistry.

E-7: Demonstration of electrooculogram (EOG) (Optional)

The EOG is a useful tool for recording eye movement. These recordings reveal mechanisms of eye muscle activity. An analysis of the EOG tracings shows the degree of muscle activity that the eyes are continuously engaged in. These movements will be recorded from a number of normal eye activities (tracking, staring, reading, etc.). Label and diagram each of these tracings in your report.

Procedure

1. The instructor will connect EOG electrodes to the head of a student. Diagram the experimental set-up.
2. Once a trace is obtained, the student will perform the following activities: a. Casually glance at a stationary object.
   b. Follow a moving object.
   c. Read a few lines.
   d. Intently stare at an object.
3. Record the results of these activities.

6/7-F: Mapping gustatory receptors (Optional)

Locations of specific taste receptors of sweet, sour, bitter, and salt will be determined and mapped.

Procedure
1. Extend your tongue and pat it dry with a paper towel.

2. Dip a cotton swab into a 25% salt (NaCl) solution and gently dab the solution onto the surface of the tongue. Diagram the locations where the salt solution is detected.

3. Swab the tongue with distilled water and pat it dry.
4. Repeat these procedures in order to map the responsive areas for each of the following

solutions:
a. Sweet (25% sucrose solution b. Sour (25% vinegar solution) c. Bitter (25% aspirin solution)

5. Explain the results of this mapping.

Final review

Understand the three components of sensation. Understand the ultimate role of the interpretation centers.
Know the basic types of receptors and how they operate.
Understand the role of accommodation or sensory adaptation.
Understand the mechanism of intensity coding.
Understand the effect of receptor location on sensory perception.
Understand the basic auditory tests.
Understand the basic visual tests.
Understand the different light conditions in which rods and cones work best.
Understand the role of rods in dim-light vision.

Audiometry Directions
1. Working in pairs, have one partner sit facing away from the other partner.

2. The person undergoing the test will put on the earphones. The red earphone goes on the right ear, the blue earphone goes on the left ear.

3. The person administering the test will randomly select frequencies and the ear to which these frequencies will be applied.

4. At the start of each frequency test, the decibel level will be set to zero and the tone will be applied. The decibel level will be increased one notch at a time until the subject raises his/her hand indicating the ear in which the one was heard.

5. The examiner will then mark the audiogram with a red pen for the right ear and a blue pen for the left ear. Each mark will be made matching the tone frequency and the decibel at which it was first heard.

6. The test will continue until a good sampling of frequencies for each ear has been obtained. At the very least, a test will be conducted at the frequencies of 500, 1000 and 2000 Hz.

7. At the conclusion of the test, the colored marks on the audiogram will be connected to form a line graph of hearing ability for each ear.

Results

A – 1:

a. Palm of hand 4 mm
b. Back of hand 3 mm
c. Fingertip 3 mm

d. Outer edge of the lips 3 mm
e. Back of neck 5 mm
- I noticed the thicker the skin, the harder it was to distinguish the two points.

A – 2:

My left fingers in 15° C water felt very cold. My fingers began to hurt after around 15 seconds, and they went numb at around 1 minute. My right fingers in 37° C water felt hot. My fingers did not burn, but it felt like they were getting burnt. My fingers began to adapt to the water at 1 minute, they began to feel warm rather than hot. The immediate sensation I felt in my left fingers (cold water) in 25° C water was a warm sensation. It was a relieving and comfortable feeling. The immediate sensation I felt after I placed my right fingers (warm water) in the 25° C water was a cold sensation. My warm fingers felt uncomfortable and cold even though the water was at room temperature.

6/7 – B:

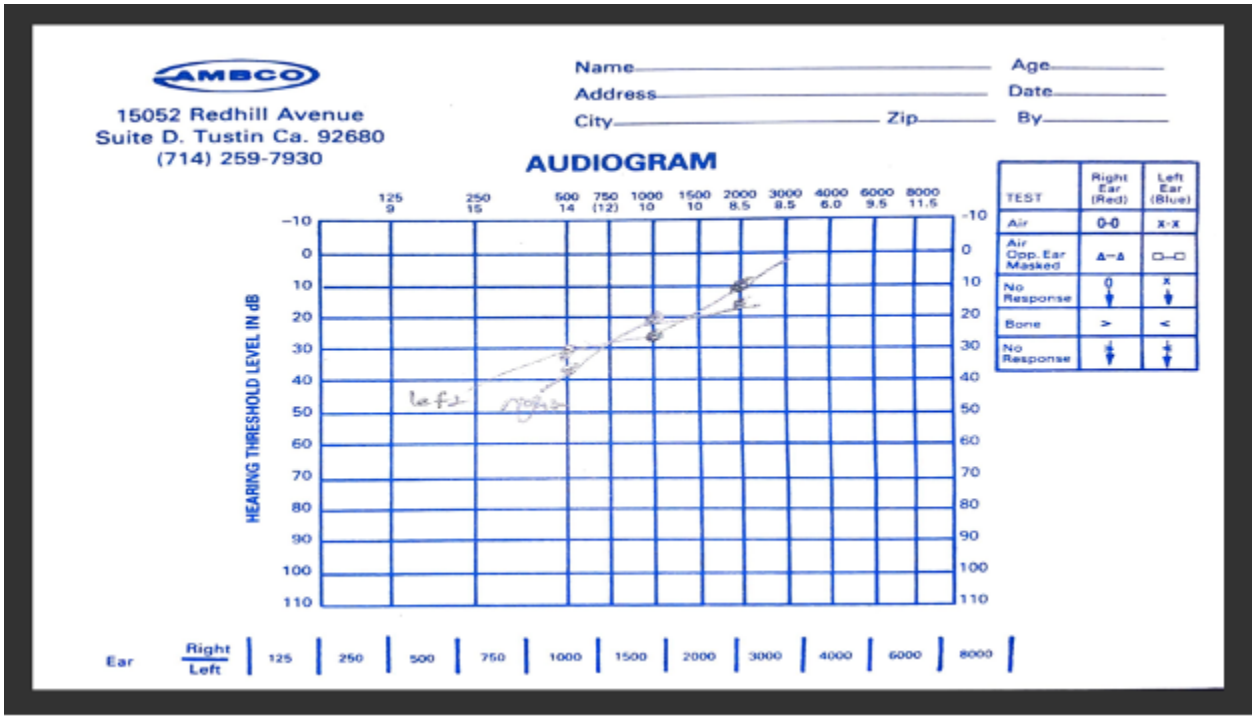
35 seconds - could not smell the camphor

1:15 - could not smell the peppermint and cloves

C – 1:

1.
- No middle ear damage in right ear.
- No middle ear damage in left ear.
2. Weber's test did not need to be performed due to no middle ear damage.

C – 2:



E – 1:

- The distance from my eye to the page was 8 inches.
- Everyone has a spot in their retina where the optic nerve connects. In this area there are no light-sensitive cells so this part of your retina cannot see.

E – 2:

- Right eye: 20/30
- Left eye: 20/30
- With these results it is determined that I am nearsighted (myopia).

E – 3:

- My results for this activity were that I did not have astigmatism in my left and right eye.

E – 4:

1.

- I was able to predict that the afterimage seen on a blank piece of white paper was indeed going to show the image I was staring at.

2.

- The Ichikawa color blind test determined that I do not have color blindness.

E – 5:

Flag from left

- Red: 83°
- Green: 69°
- Blue: 88°

Flag from right

- Red: 86°
- Green: 85°
- Blue: 82°

Flag from above

- Red: 30°
- Green: 32°
- Blue: 33°

Flag from below

- Red: 65°
- Green: 80°
- Blue: 81°

Discussion

Each activity in this lab was designed to help us measure the capabilities of our sensory system. There are many types of receptor cells, each of which responds to a specific kind of environmental stimulus. The Cutaneous, olfactory, auditory, proprioceptive, and visual systems were examined in these exercises. The strength with which a specific sensation was perceived depended on the rate that impulses were delivered to an interpretation center. The stronger sensations resulted from higher frequencies of nerve impulse arrival. This phenomenon is known as intensity coding, and is frequency, not amplitude dependent.

Conclusion

In conclusion, we were able to familiarize ourselves with sensory physiology. We learned about how our blind spot works, how to determine color blindness, how our sense of smell can adapt to different odors, and how astigmatism works. Overall, this lab experiment was a great way for us to learn about my senses and how each works.