Lab: Testing Your Sensory Organs

Name ___________________

Period ________________

Introduction

Have you ever wondered why many doctors wear pale green or blue scrub suits in the operating room? These colors are often chosen because they reduce the perception of the after-image produced when a person stares at one color for long periods of time. The perception of an after-image occurs because the photosensitive pigments have bleached or degraded to the components that make up the color being stared at. So, for example, if a surgeon were to look at someone dressed in a white scrub suit after looking for a long period of time at something red, the person in white would appear to be wearing an intense blue-green color. However, since the scrub suits are usually blue or green, the after-image – although still present – is almost unnoticeable.

This is just one example of the tremendous ability of the human body to adapt to the surrounding environment. The ability to adapt to our surroundings is the underlying basis behind the study of sensory perception. However, in order to understand how sensory perception works, you must first begin to understand how the sensory organs work.

The first organ to be discussed is the ear. The ear serves an important role in two types of sensory perception. The first is the detection of sound, and the second is the maintenance of equilibrium. Sound waves originate from the compression and decompression of air as an object vibrates. They travel outward from the object in much the same way that a stone causes ripples when dropped in a pond. In addition, the velocity or force with which the object is vibrating affects the volume of the sound wave in much the same way that the size of the rock affects the size of the ripples in the pond. For example, when you blow a whistle, the air being forced from your lungs is pushed into the whistle and around the ball inside. This causes the ball to vibrate, which in turn causes the molecules of air around the ball to begin to vibrate. If the force of air due to the velocity of breath is small, the whistle will emit a lower, or weaker, sound wave. However, as the force of air entering the whistle is increased, the ball will vibrate more rapidly and, thus, the air around the ball will vibrate more quickly, causing a stronger sound wave.

When these vibrations hit the tympanic membrane inside the ear, the tympanic membrane begins to vibrate as well. The vibrations of the tympanic membrane are transferred to the auditory bones, which in turn conduct the sound wave to the oval window. The oval window transmits the sound wave into a fluid-filled chamber where the receptors, called hair cells, are sandwiched between two specialized membranes. These membranes move as the fluid is disturbed and activate the hair cells. As the hair cells are activated, they transmit electrical impulses to the brain. Hair cells in humans are activated at frequencies ranging from 20 to 20,000 cycles per second (or hertz – Hz). Compression waves at frequencies above 20,000 Hz are in the ultrasonic range and waves below the 20 Hz are in the infrasonic range.

The components of the ear responsible for maintaining equilibrium are found in the middle and inner ear. The most important of these structures is found in the inner ear and is called the semicircular canal. There are three in each ear and they are responsible for providing sensory information regarding changes in orientation of primarily the head.

The eye is responsible for the detection of visual images. The detection of visual sensations occurs at the back of the eye on the retina. An image is projected onto the retina, which is then converted into nerve impulses through degradation of photosensitive pigments in structures called rods and cones. Rods are the receptors which are most operable in night vision. They are responsible for black and white vision, while cones are the receptors for bright and colored light. The human eye possesses three types of cones, each containing a different combination of retinal and photopsin. Each cone type is characterized by a sensitivity to a different colored light, which is dependent upon varying proportions of retinal and photopsin. One cone type is sensitive to blue light; another is sensitive to green light; and the third type is sensitive to red light. We are able to see more than these three colors because each color stimulates a different combination of the three different types of cones. Rods and cones are found in varying densities across the retina, however they are not found at all where the optic nerve enters the eye. This area is called the blind spot, since no image can be registered here.

The related sense of taste and smell are dependent upon chemoreceptors, which detect different chemical molecules in the substances we eat and smell. In humans, these receptors are located on the roof of the nasal cavity, on the tongue, and on the surfaces of the soft palate, pharynx, and epiglottis. A tasted or a smell is perceived when a chemical molecule comes into contact with appropriately shaped chemoreceptor.

The final sense, touch, is dependent upon receptors that are located in the skin called mechanoreceptors. These receptors are sensitive to mechanical stimuli, such as pressure and gravity. There are three types of mechanoreceptors. They are free nerve endings, Meissner corpuscles, and Pacinian corpuscles. Free nerve endings and Meissner's corpuscles are located in the upper layers of skin and are usually sensitive to light touch, while Pacinian corpuscles are located in the deeper layers of skin and respond only to heavy pressure. Thermoreceptors are also involved in the sense of touch. These include heat receptors, which respond to temperatures between 25 and 45^0C; cold receptors, which respond to temperatures between 10 and 20^0C; and pain receptors, which are activated at temperatures greater than 45^0C and temperatures below 10^0C.

For any of the five senses, continuous stimulation of the receptor cells at a constant level results in sensory adaptation. This may occur in one of two ways. The first is that the receptor itself has adapted to the stimuli and stops transmitting the signal to the brain. The second way sensory adaptation may occur is that the lower parts of the brain adapt to the information being received and decide that the information is not important enough to relay to the areas of the brain where you would be consciously aware of the sensation. However, regardless of where the stimulus stops being transmitted, any large increase in the intensity of the stimulus will generally bring the stimulus back to your attention. This phenomenon of sensory adaptation is what the following lab activity will be focusing on.

Objectives: You should be able to test various aspects of perception, such as to observe after-images, the blind spot and field of vision, the taste regions of the tongue, the density of heat and cold receptors on the skin, and to experience how your senses affect your reactions.

Procedure:

Part 1: Vision

<u>Station 1</u> – After-images

1. Before performing the test, make a prediction as to what after-image color you will perceive.
2. Working with your partner, select one colored dot to stare at for approximately 30 seconds.
3. Focus on the colored dot for approximately 30 seconds while your partner times you. When your partner indicates that time is up, shift your gaze to a plain white section on the same sheet of paper. Record what you see on the sheet provided at your lab table under the appropriate color category.
4. Repeat steps 1-3 three more times using the other different colors.
5. Switch roles with your partner and repeat the previous steps.

Lab questions:

	Predicted color	**Actual color perceived**
Blue		
Green		
Red		
Yellow		

1) Did your predictions in the after-image exercise match the actual outcomes?

2) Did your partner perceive similar results with the perceived color?

3) Why might 2 different original colors produce the same one perceived color?

<u>Station 2</u> – Blind spots

1. Hold the paper marked with a black plus sign (+) and a black dot (·) at arm's length, with the dot on the left and plus sign on the right.
2. Cover your left eye and focus your right eye on the dot.
3. As you continue to stare at the dot, slowly move the paper toward yourself. Note that the plus sign is visible at first, then disappears completely, and then reappears. The point at which the plus sign was no longer visible was the blind spot for your right eye. Measure that distance and record the value for that eye in the space on the next page.

4. Repeat steps 1-3, covering your right eye and focusing on the dot with your left eye.

Lab questions:

1) What is the distance (in cm) of the blind spot for your right eye?

2) What is the distance (in cm) of the blind spot for your left eye?

3) What did you see when the (+) "disappeared"?

4) Would you expect the blind spot to be the of the same size and at the same distance for each eye? Explain your answer.

5) Name some instances where it would be beneficial to be aware of your blind spots present in your eyes (in your actual eyes, not in your car).

<u>Station 3</u> – Field of vision

1. Stand directly facing the line drawn on the whiteboard at a distance that is approximately <u>one marker's distance</u> away from your face.
2. Cover your left eye and look straight ahead at the line. Your partner will hold the pipe cleaner with the bead on one end and start by holding the bead on the black line, slowly moving the bead to the right. Continue to stare straight ahead at the black line with your right eye without moving your head. As soon as you cannot see the bead any longer, tell your partner to stop and place a blue X on the board and label it with your initials.
3. Continue to stare straight ahead with your right eye and repeat step 2, this time your partner will move the bead to the left of the black line. You now have a full field of vision indicated for your right eye.
4. Repeat steps 1-3, this time closing your right eye and testing your left eye.
5. Measure the total length (in cm) of your field of vision of each eye, along with the distance of overlapped vision between the eyes.
6. Repeat this process, switching roles with your partner.

Lab questions:

1. What was the total length (in cm) of your field of vision of your right eye?

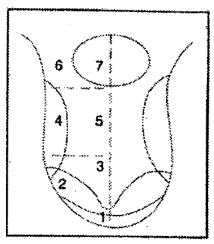
2. What was the total length (in cm) of your field of vision of your left eye?

3. What was the total length (in cm) of overlapped vision between your two eyes?

Part 2: Taste

<u>Station 4</u> – Mapping your taste receptors

1. Working in pairs (or using your cell phone so you can see your tongue), dip a clean swab into solution "A" and touch the swab to each of the seven areas of your tongue as shown in the diagram. **Keep your tongue out the entire trial to avoid mixing the solution to another region.** Rate your sensitivity with regard to the taste of each application as either absent (0), faint (+), or strong (++). Also, indicate whether the sensation was sweet, salty, bitter, or sour. Have your partner record your answers in the appropriate space in the data table below.
2. Dispose your used swab in the bucket provided at the lab table.
3. Repeat steps 1-2 for each of the remaining solutions of "B", "C" and "D".



Lab questions:

	Position on Tongue							**Sweet, salty, bitter, or sour?**
	Front			**Side**		**Back**		
Receptor	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
Solution A								
Solution B								
Solution C								
Solution D								

1) Chocolate is quite bitter in its natural state, then altered by the addition of sugar to make it more palatable to humans. In which two regions of the tongue are the chemoreceptors located that are primarily responsible for detecting these two flavors associated with chocolate?

Bitter:

Sweet:

Part 3: Thermoreceptors

Station 5: Sensory adaptation

1. Place the index finger of your right hand in a beaker containing warm water. Place the index finger of your left hand in a beaker containing of cold water.
2. Keep your fingers in their respective beakers for 60 seconds.
3. After the time is up, place both index fingers in a beaker containing water at room temperature.
4. After holding your fingers in the room temperature water for a while, answer the questions below.

Lab questions:

1) What sensation did you feel with your right finger after moving to the room temperature beaker?

2) What sensation did you feel with your left finger after moving to the room temperature beaker?

3) Why do you think you sensed this change?

Station 6: Mapping your thermoreceptors

1. After inking the stamp on the inkpad, stamp a grid on a hairless part of your forearm. While you are doing this, have your partner obtain two steel probes – one from the beaker of warm water and the other from the beaker of cold water.
2. Look away and have your partner randomly select either the warm or cold probe.
3. Have your partner lightly touch the probe to one point on the grid on your forearm.
4. Indicate whether you think the probe is warm or cold. Have your partner indicate your response in the appropriate section of the data table found on the next page. This should be indicated by writing a (+) if you guessed correctly or a (-) if you guess incorrectly. For example, if your partner chose the warm probe but you indicated that you felt a sensation of cold, your partner would write a (-) in the corresponding section of the warm grid in the data table on the next page.
5. Repeat steps 2-3 until all positions on both grids have been filled.
6. Change roles, recording heat and cold sensitive data for your partner.

Lab questions:

Warmth receptors				

Cold receptors				

1) Which temperature were you more accurate in predicting: warm or cold?

2) How would you predict your results to change if you were to test on a different region of your body? Explain why you would predict that change.

Part 4: Using your senses for responding to the environment

<u>Station 7</u>**: Reaction time**

1. Sit facing your partner. Have your partner hold the top of a meter stick (the end with the higher numbers). Hold your thumb and index finger about 2.5 cm apart at the zero mark without touching the stick.
2. Have your partner warn you verbally (3-2-1 countdown) and then have them drop the stick. As soon as it begins to fall, catch the stick with your thumb and forefinger.
3. Note the distance the meter stick fell by recording the number underneath your thumb and forefinger.
4. Repeat steps 1-3 four more times, recording the information for each trial.
5. Repeat steps 1-4, only this time your partner should NOT warn you before the stick is dropped. Compare the reaction times between the trials.
6. Change roles with your partner and repeat this experiment.

	Distance of reaction (in cm)				
	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**	**Trial 5**
With warning					
No warning					

Lab questions:

1) How would you respond change if you were texting during this experiment?