Vision Lab (Advanced) - Overview

Sight is one of the five senses that we rely upon to observe the world. The eyes are adaptable and versatile organs that help us perform our everyday duties. They detect light and send signals along the optic nerve to the brain to process the images we see. In this lab, we will explore some of the capabilities and limitations of the eye. We will look at the extent of peripheral vision, the size of the blind spot, depth perception, and color vision.

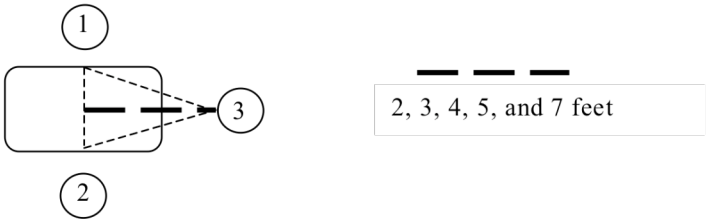
The lab is split into two stations. One station covers peripheral vision, the blind spot, and depth perception. To test peripheral vision, we will examine how far students can see by counting the number of fingers that are held up as those fingers are positioned farther and farther away from them. To examine the blind spot, we will trace out the diameter of it to measure the size of the blind spot. We will use a simple coin drop test to examine depth perception. The second station (at the computers) covers color vision. Here, you will examine afterimages and optical illusions. Please finish one station before moving onto the next. Answer the questions at the end.

Peripheral Vision, Blind Spot, and Depth Perception

Materials: measuring stick or tape, piece of paper, 10 pennies/buttons, a cup/container

I. Peripheral Vision (groups of 3): *Peripheral vision is the portion of vision that occurs outside of the center of gaze. Peripheral vision helps us catch things out of the corner of our eyes. In this lab, we will try to measure how far one's peripheral vision extends.*

1. Have two people sit across from each other (about 3-4 feet apart) and the third person stand an equal distance from both (as diagrammed below).
2. Each person sitting covers one eye such that, facing each other, they have the same eye open (one person covers their left eye and the other covers their right). The two people sitting down are allowed only to look straight at each other.
3. The third person will then stand 1 foot to the side of the two people sitting and hold up different numbers of fingers and ask each person sitting down to identify the number of fingers. Repeat this three times and record the number answered correctly on the table below.
   Note: The two people sitting will record each of their results while the third person states whether they are correct or incorrect. (Have the table at hand)



4. Repeat for a distance of 2, 3, 4, and 5 feet away from seated students. Record your results
5. Have two people sitting switch seats in order to test their remaining eye.
5. Switch roles until everyone in the group has tested their peripheral vision.

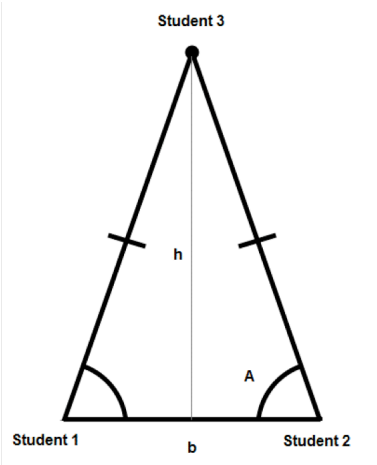
Number Correct

	1 foot		2 feet		3 feet		4 feet		5 feet	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Trial 1										
Trial 2										
Trial 3										

QUESTIONS:

1. Approximately what is the extent of your peripheral vision? Think about a clock, with your nose facing 12:00.

2. Convert this into an angle measurement. Assume that the distance between the two seated people is the base of an isosceles triangle and the distance from each seated person to the standing person is equal.



3. Peripheral vision in humans, especially in distinguishing color and shape, is weaker compared to animals. What is a possible reason for this? (Think about the location of receptor cells on the retina).

II. The Blind Spot (groups of 3): *Blind spots are regions of the visual field that are permanently obscured. The blind spot is a particular spot where there is a lack of light-detecting photoreceptor cells on the retina where the optic nerve passes through it to the brain. In this portion of the lab, we will measure the diameter of an individual's blind spot.*

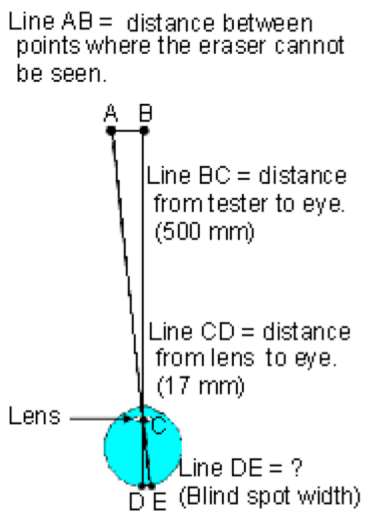
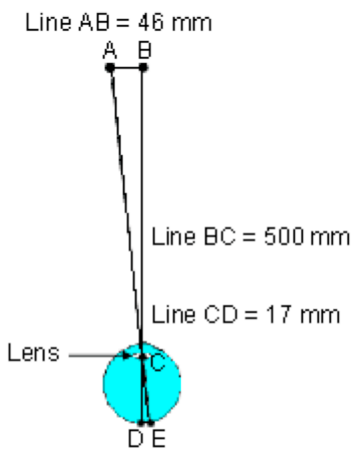
1. Make a tester by marking + on the far right side of a piece of notebook paper.
2. Stand with your back to a wall, with your head touching the wall.
3. Have someone hold the tester 500 mm (0.5 m or 50 cm) in front of your eye (place the + between your eyes, with the paper extending to the left).
4. Close your right eye and look at the + with your left eye.
5. Place a pencil eraser or bright object on the far left side of the tester.
6. Slowly move the pencil eraser to the right.
7. When the eraser disappears, mark this location on the tester. Call this point "A."
8. Continue moving the eraser to the right until it reappears. Mark this location on the tester. Call this point "B."
9. Repeat the measurements until you are confident that they are accurate.
10. Measure the distance between the spots where the eraser disappeared and reappeared.

Distance from A to B

Left Eye	Right Eye
Average distance:	Average distance:

Calculate the diameter of your blind spot.

To calculate the width of your blind spot on your retina, let's assume that 1) the back of your eye is flat and 2) the distance from the lens of your eye to the retina is 17 mm. We will ignore the distance from the cornea to the lens. With the simple geometry of similar triangles, we can calculate the size of the blind spot because triangle ABC is similar to triangle CDE. So, the proportions of the lines will be similar. Follow this example:

Set up	Example	Calculations
		$\frac{17}{500} = \frac{DE}{AB}$ - - - - - - - - - - - - - - $\frac{17}{500} = \frac{DE}{46}$; $DE = (46)\ \frac{17}{500}$; $DE = \frac{782}{500} = 1.56$

QUESTIONS:

1. Where was the blind spot relative to your peripheral vision? Approximate answers are acceptable. (Think about the clock).

2. What is the diameter of your blind spot? Is it larger or smaller than you would expect?

3. What are scotomas?

4. Why do we not normally notice our blind spot when we have both eyes open?

III. Depth Perception (pairs): *Depth perception is ability to see the world in three dimensions. Depth perception is important for us to determine how far an object is away from us. When we are walking, we need to make sure that we need to perceive their distance from us correctly and not walk into them. In this lab, we will explore how depth perception changes when you are using one eye compared to two eyes and when the perceived object is at variable distances from you.*

1. Sit at a table with your partner.
2. Put a cup in front of your partner. The cup should be about one feet away from him/her.
3. Have your partner CLOSE one eye. Hold a penny/button in the air about 1.5 ft. above the table.
4. Move the penny/button around slowly. Ask your partner to say "Drop it!" when he or she thinks the penny will drop into the cup if you released it. When your partner says "Drop it," drop the penny and see if it makes it into the cup. Repeat this 5 times, changing the position of the cup by moving the cup left and right. Record the number (out of 5) that made it into the cup.
5. Try it again when your partner uses both eyes.
6. Try it again with the cup farther away (~ 2 and ~3 feet) from your partner (with one eye open and both eyes open)
7.. Change roles and repeat.

Distance: Cup to Guesser	One Eye Open (coins in cup)	Both Eyes Open (coins in cup)
1 foot		
2 feet		
3 feet		

Questions:
1. At what distance did you get the most pennies/buttons in the cup (i.e., you had the best depth perception?)

2. Is there improvement with the cup is closer to the subject? Why or why not?

3. Is there improvement of depth perception with two eyes open? If so, explain why.

Color Vision

Materials: A computer for each student or share computers among a couple of students

Instructions: Open your computer and find the four Vision stations: Color Vision, Afterimages, Swirling Ring, and Hollow Face. Follow the instructions for each individual station. Fill in the tables

below and then answer the questions at the end of this section.

I. Color Vision: *We are able to see colors when there is sufficient light, but when the light intensity is too low, we can only make out dark and light shapes. In this station, you will look at five different color images that have colored numbers on them. Fill in the table below with your guess for the number inside the circle for the five intensities of images on the website. Then place the mouse cursor over each image to reveal the actual number and record this number in the table. Note: the mouse cursor should not start over the image.*

	10% Intensity	15% Intensity	20% Intensity	25% Intensity	30% Intensity
Guess					
Actual					

Questions:
1. At what intensity could you begin to see the colored numbers? Explain what you saw in terms of the types of photoreceptors in the retina.

2. What is the retina and where in the eye is it located?

3. Name the two types of photoreceptors in the retina and describe what they do.

4. What is photoreception?

II. Afterimages: *Your eyes have blue cones, green cones, and red cones that are more sensitive to those three colors. The color of an object is detected by a mixture of these cones detecting light of different wavelengths. If one type is overstimulated by staring at one color, they become fatigued. If you then quickly look at a white background, the fatigued cones will not work very well. This causes an afterimage to appear. Follow the instructions on this station to observe an afterimage.*

1. What were the colors in the afterimage behind each colored square?

2. What are opsins and how do they work?

3. Use bleaching to explain the after image.

4. What is the wavelength of the visible spectrum?

5. Arrange the following in increasing order of maximum wavelength absorbed – red cones, green cones, and blue cones.

III. Swirling Ring Illusion: *Our brain responds to moving images by anticipating motion to continue in the same direction. Since we anticipate the motion of objects, we can sometimes observe patterns that are not truly there. In this optical illusion, there is a ring with randomly blinking dots that has a very interesting behavior. Follow the directions for this station to observe this optical illusion.*

1. Describe what you saw in this illusion.

IV. Hollow Face Illusion: *Face recognition is a very important part of our visual perception. Therefore, our brain responds strongly to images involving human faces, sometimes distorting our perception in interesting ways. Follow the instructions in this station to observe the Hollow Face Illusion (provided by Professor Richard Gregory). Then, look at the hollow mask presentation to see the Hollow Face Illusion.*

1. Describe what you saw in this illusion.

References

Depth Perception and Blind Spot:
1. http://faculty.washington.edu/chudler/blindspot.html
2. Cassin, B. and Solomon, S. *Dictionary of Eye Terminology*. Gainsville, Florida: Triad Publishing Company, 1990.
3. http://www.britannica.com/EBchecked/topic/69390/blind-spot
Color Vision
1. http://faculty.washington.edu/chudler/chvision.html