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CH151 2016

Optics

Teacher's Instructions

ACTIVITY: This series of activities allow students to explore the wonders of the eye. To start, students utilize optical illusions to trick the eyes and to show students that some things require an extra look. Then, students can explore the wonders and benefits of binocular vision with activities and games. Finally, students can assess their visual reaction time with a quantitative experiment.

LEARNING GOALS:

- Students will test their visual reaction time.
- Students will observe the complex benefits of stereo vision.
- Students will understand the complexity of vision and the benefits of such a complex system.

RECOMMENDED GRADES: This activity can be adapted to any age group from grades K-8.

KEY CONCEPTS, DEFINITIONS OF TERMS:

Stereo Vision/ Binocular Vision- Vision involving or designed for both eyes

Blind Spot- the small circular area in the retina where the optic nerve enters the eye that is devoid of rods and cones and is insensitive to light

Optical Illusion- visual perception of a real object in such a way as to misinterpret its actual nature

Hand-Eye Coordination: the ability to move your hand well or easily as assisted by your vision

Depth perception: the ability to judge the distance of objects and the spatial relationship of objects at different distances

MATERIALS NEEDED:

Consumables: 1 skewer or other similar object per person, one piece of paper per person, tape

Non-consumables: examples of optical illusions (see below), 10 coins/paper clips/small objects per pair, 1 plastic cup per pair, 1 ruler per pair, 1 empty paper towel roll

ESTIMATED COST: Under \$10

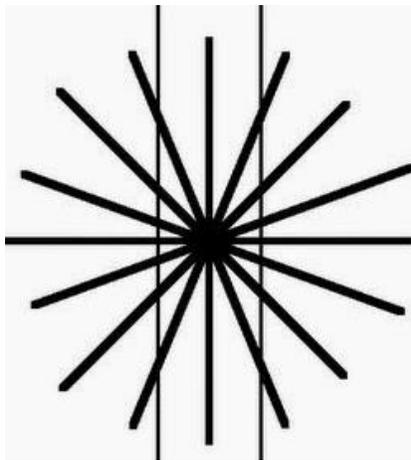
ESTIMATED TIME: Preparation time: 10-20 minutes to make posters of illusions and to cut out shapes for reaction time project.

Presentation time: 20-60 minutes. The procedure is flexible to changes. Activities can be altered or removed if needed. For example, fewer replicates of the depth perception and reflex activities can be used to shorten the time of the program.

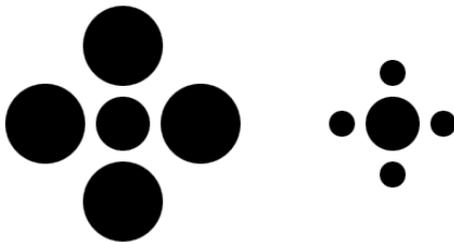
PROCEDURE:

Part A: Optical Illusions

Present optical illusions to students. Some examples are found below, others can be used as well.



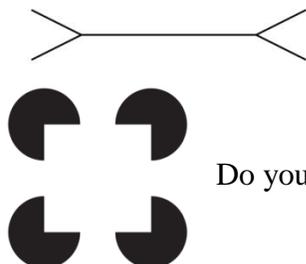
Are the two vertical lines straight or are they curved?



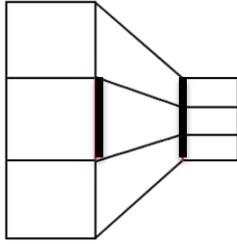
Which of the two center circles is bigger?



Which center line is longer?



Do you see the white square?



Which thick black line is longer?

Effect: The lines are straight, the center circles are the same size, the center lines are the same length, the white square does not exist, and the two thick black lines are the same size. Your brain, however, perceives each of these images differently due to forced perspective.

Summary: Everything is not what it seems. The brain can be fooled into seeing things that do not exist.

Part B: Stereo Vision Activities:

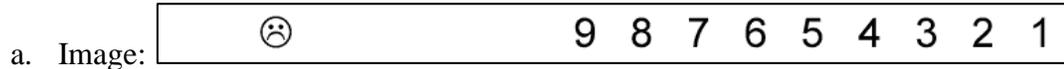
Walk students through as many of these activities as you wish.

1. Close one eye. Hold both pointer fingers up about 1 foot from face. Try to make the fingers touch. *Effect:* without the depth perception provided by both eyes, it is difficult to make both fingers touch perfectly.
2. Close one eye. Hold a “thumbs-up” at arms-length. Cover an object in the distance (approx. 20 feet away) with your thumb, hiding it from your vision. Switch which eye is closed. *Effect:* the object previously covered from sight by your thumb appears to move a great distance into your vision due to the slight difference in distance between your two eyes.
3. Hold empty paper towel roll up to right eye. Hold your left hand, palm facing you, approximately halfway down the tube. Keep both eyes open. *Effect:* due to the conflicting images of each eye, it appears that there is a hole in the middle of your left hand.
4. Sit across from a partner with a cup in between the two of you. Close one eye and have your partner slowly move a penny, paper clip, or other small object forward and backward in over the cup. Tell your partner to stop and drop the object when it is above the cup. Repeat 10 times and record the number of times the object landed in the cup. *Effect:* without binocular vision, it can be difficult to know when the object is over the cup. As a result, there are many misses.

Summary: Each eye produces its own image. As a result, the brain can interpret the difference in images to create a seamless combination of the two inputs. This also allows your brain to determine the distances of the objects around you.

Part C: Blind Spot

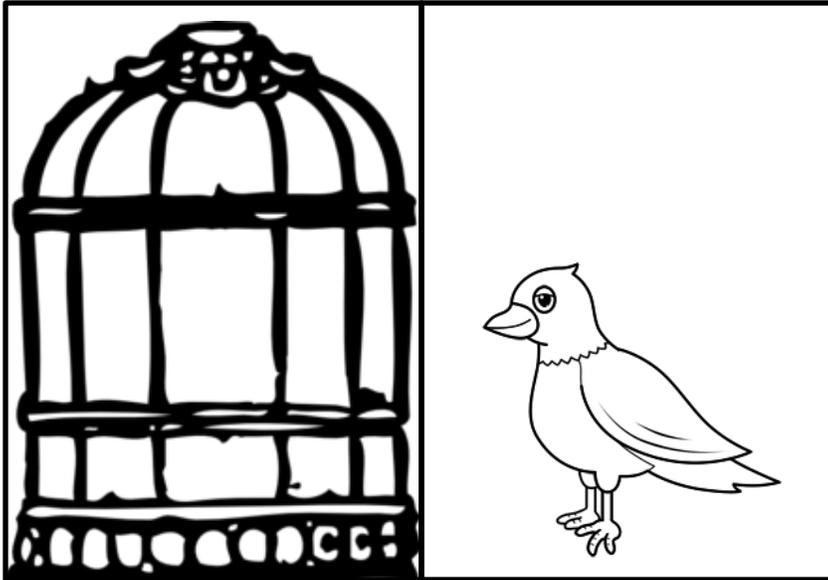
1. Hold up the image below approximately a foot in front of your face. Close your right eye and slowly switch the focus of your left eye from number to number. Note the distance at which the frowny face disappears from your peripheral view. Turn this image upside down and repeat to determine the blind spot of your right eye. *Effect:* many people can easily find their blind spot which is caused by a lack of cones and rods inside the eye due to the entrance of the optic nerve.



Summary: While the eye can be infallible in many areas of vision, it is not perfect. There are spots in the peripheral which the eye cannot see.

Part D: Reaction times

1. Rest your arm on a desk or table with your hand off the edge and your thumb and forefinger apart by about two inches. Have a partner hold a ruler between your fingers with the 0cm mark lining up with your thumb and finger. Have your partner drop the ruler. You then catch it as fast as possible. Record the distance (in cm) of where you caught the ruler. *Effect:* the longer your reaction time is, the larger the distance will be to where you caught the ruler. A slow reaction time would correlate with slow hand-eye coordination.
2. Print out the two images below (or recreate your own!). Tape both images back to back on either side of a skewer with the images lining up on both sides. Roll the skewer back and forth in your hands as quickly as possible. *Effect:* due to the inability for the eyes to distinguish between the two sides, the bird appears to be inside the cage.



Images:

Summary: the eye is used as a tool by the brain to interpret information very quickly, but not too quickly to measure.

WORKSHEETS:

Below are two versions of similar worksheets. The first is the more advanced version and would be best suited for students in grades 4 and up. The second is a simpler version. This version is recommended for students in grades 3 and below. Along with the simpler worksheet, it is recommended that the blind spot activity be omitted for younger students. This activity can be difficult for younger students.

REFERENCES:

All concepts and terms defined by <http://www.merriam-webster.com/>. (Accessed 14 January 2016)

Optical illusions:

Straight lines: <http://www.moillusions.com/parallel-lines-illusion/> (Accessed 14 January 2016)

Flower circles: <http://illusion.kitt.net/2005/12/big-circle-small-circle.html> (Accessed 14 January 2016)

Arrows: <http://blog.doctor-ramani.com/health-and-wellness/optical-illusions/> (Accessed 14 January 2016)

White square: <http://www.sciencefocus.com/news/why-we-see-shapes-aren%E2%80%99t-really-there> (Accessed 14 January 2016)

Black lines: <http://www.moillusions.com/21253-2/> (Accessed 14 January 2016)

Images:

Blind spot: <https://faculty.washington.edu/chudler/chvision.html> (Accessed 14 January 2016)

Bird cage: <http://www.clker.com/clipart-bird-cage.html> (Accessed 14 January 2016)

Bird: <http://www.how-to-draw-cartoons-online.com/cartoon-robin.html> (Accessed 14 January 2016)

Name _____

OPTICS

1. Which optical illusion was your favorite and which was most fooling?

2. Record your penny drop data below:
 - a. Number of Nickels in Cup with Right Eye Open = _____
 - b. Number of Nickels in Cup with Left Eye Open = _____

3. At what number(s) did you have a blind spot?
 - a. Right Eye: _____
 - b. Left Eye: _____

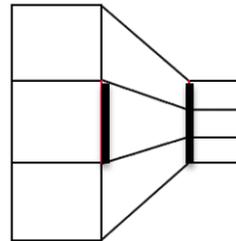
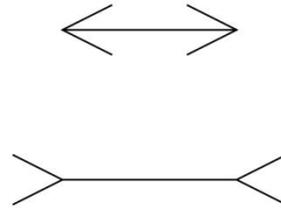
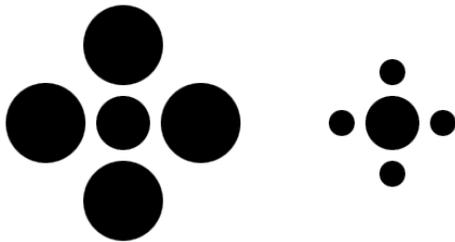
4. Use the table below to collect data for your reaction times as measured by the ruler.

Trial	My Distances (in centimeters)	Partner's Distances (in centimeters)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Highest reaction distance:		
Lowest reaction distance:		

Name _____

OPTICS

1. Which optical illusion was your favorite? Draw a circle around your answer.



2. How many nickels landed in the cup? _____

3. With which eye was it easier to get the nickels in the cup? Circle your answer

Left

Right

4. Use the table below to collect data for your reaction times as measured by the ruler.

	My Distances (in Centimeters)	My Partner's Distances (in Centimeters)
Highest reaction distance:		
Lowest reaction distance:		