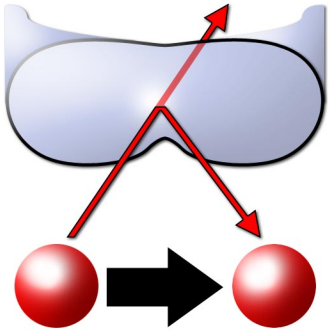
“Can you always trust what you see?”

How our eyes and brain work together to help us see

This lesson demonstrates how our brain works with our eyes to help us see. Students might think that “seeing” is a simple process of the eyes sending information to the brain. This lesson helps students experience what happens when the there is a difference between what we see and where our brain thinks we are in space. Using prism goggles, objects appear to be shifted in position because of the way the goggles bend light. Prism goggles can show us how visual perception depends not only on acuity of our vision, but a variety of brain processes that combine to create the image we experience. *The overarching theme of this lesson is that vision is an integrated brain process of which the eyes are only one part.*



Grade Level: 4-6+

Presentation time: 30-45 minutes

Lesson plan organization:

Each lesson plan is divided into three sections: *Introducing the lesson*, *Conducting the lesson*, and *Concluding the lesson*. Each lesson has specific principles with associated figures, class discussion (D), and learning activities (A).

Materials:

One set of Prism goggles per pair or group of students. The goggles are custom-built:

Cut and paste two sheets of prism onto a pair of cheap chemistry lab goggles. You can purchase the prisms at http://www.fresnelprism.com/ and by ordering the 3M Press-On Optics, Prism diopter 40.0 (about $30 per pair). Diopter 40.0 will shift the vision by about 20˚.

This lesson plan is provided by the Neurobiology & Behavior Community Outreach at the University of Washington: http://students.washington.edu/nbout/extras/LessonPlans.html

Something to throw (tennis balls, koosh ball, or even a crumpled up piece of paper)—1 per pair or group of students
Large piece of paper with picture of a face missing an eye—1 per pair or group
Plastic or paper eye with tape to adhere to the drawn face—1 per pair or group

Introducing the lesson

Principle 1: **Your body has a sense for where it is even without seeing.**

D: Your brain and movement

1. Ask students to think about how they know where their bodies are in space. The following discussion sequence is a guide:

a. Ask students to close their eyes and raise their right arm in the air. Have students open their eyes. Most students should have their right arm in the air. Ask students: how did you know where to put your arm? When I asked you to raise your arm, why didn't your arms end up down by your leg? How could you do this even with your eyes closed? How did you know when you had your arm raised? *(Students might say that they knew their muscles knew what to do, that they could feel where their arm was so they knew it was raised.)*

b. Discuss with students what their senses are. *(Students might list: hearing, touch, seeing, taste, smell.)* Ask students: did you actually know that you had a "sixth sense"? That sense is a "position sense"—where your body is positioned. (This is called "proprioception", but students don't really need to know this term.)

c. Ask students: why might it be important for you to have this sense? *(Students might say that it helps them move around, not bump into things, etc.)*

d. Explain to students that when you asked them to raise their hands in the air, they were using their body's position sense to know that their arms were in the air.

e. Explain to students that they will be doing an activity today to help them understand how this position sense works with other senses in their bodies to help them do the things they do everyday—writing on a piece of paper, catching a ball, etc.

Conducting the lesson

Principle 2: **When you change the information the brain receives, you make mistakes**

Principle 3: **The brain can learn and adjust to new information.**

A: Throwing and catching an object

1. Hand out the object to be thrown—1 per pair of students.

2. Have the students stand facing each other and toss the object back and forth. (most students will find this easy because they can clearly see the person to whom they are throwing the ball)

D: Motor skills involved in throwing and catching an object

1. Discuss students' experience throwing and catching the ball. What information did they use to know where to throw it? *(They could see where the other person was.)* If this activity was difficult for some students, ask them why it was difficult: what part of the activity was hard? Knowing where to throw the ball? Coordinating hands with eyes to catch the ball?

A: Playing catch with the prism goggles

Note: The prism goggles bend light, so the world appears to shift to one side. Ask them what they think will happen if they try to throw the ball while wearing the goggles.

> * It is important the thrower does not look at his or her arm because some correction may occur in the motion. *

1. Have the students put on the prism goggles and repeat the activity above. At first, students will probably throw far to the right, since they see their target as being way to the right. With a brief period of practice, they begin to adjust to the goggles, and students are able to toss the ball to their partner accurately.

D: What happened?

1. Discuss students' experiences with the prism goggles. Ask students: what happened when you threw the object this time? How did it compare with how you threw the ball the first time? What do you think was happening?

2. What happened after you had the goggles on for a little while? Did your throwing stay the same? *(Students might say that they got better at aiming, that they adjusted.)*

A: Pin the eye on the face

1. Tape the large face drawing to a wall at the students' chest height. Have students wear the goggles while attempting to tape the eyeball to the drawn face, as in "Pin the Tail on the Donkey." Have them hold their arm to their side until they are within an arm's distance of the face, and then reach up quickly to tape the eye on the face (if they go slowly or can see their arm, they will be able correct during their motion). Again, they will probably have trouble at first, but they can adapt over time.

Concluding the lesson

D: Adaptation

1. Ask the students what they thought was happening when they or their classmates tried to throw, catch, and hit the eye target with the prism goggles on. Why did they think they missed when they first had the goggles on? What did the goggles do to what they were seeing?

2. Explain to students that the prism goggles actually bend the light that they are seeing so that everything they see appears to be slightly shifted, even though it hasn't really moved. This means that what your brain was thinking it saw was different from what was actually there.

3. Ask students: what does this experience tell you about how your eyes work together with your brain to help you move around in the world? *(Your eyes see things, but your brain interprets what you see. You use both your vision and your body's "position sense" to help you move around in the world and know where things are.)*

4. Ask students: were they able to learn and adapt over time? How did they do that? (Was it a conscious decision to throw the ball farther right, or did they just find themselves doing it naturally? (Note: both occur—we compensate both consciously and unconsciously.))

5. Explain that your brain helps you to adapt in different ways, so you can still eventually throw the ball accurately. Why might this be important in real life? *(Examples: if you have bad vision, you can still get around; if something happens to your eyes, like losing one eye, you can compensate; if something happens to your brain, so that your perception from your other senses is thrown off, you can still make coordinated movements – after you adapt.)*