

Minor Challenge Set #1

STEM Field: Biology / Biomedical Engineering

Level: Senior

Challenge Name: Tricky Eyes

Project Cost: 0-20 USD

Materials Required:

- Stopwatch
- Printer (optional)
- A lab partner or helper (recommended)
- Pen and paper
- Computer with internet access

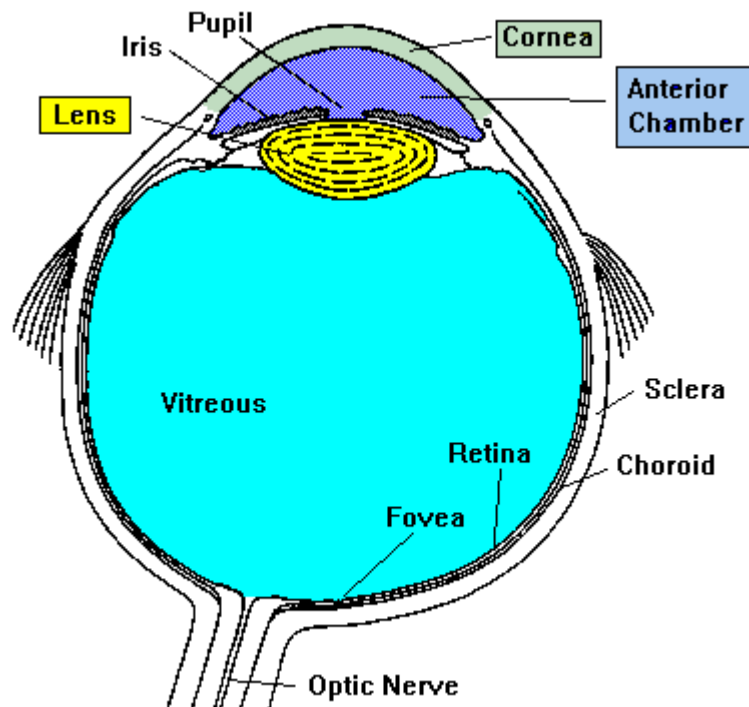
Duration:

- The challenge take approximately 1-2 hours to finish, however, the time guideline is an estimation only, and students and mentors can complete the tasks around their schedules

Introduction:

In this project, we will do some experiments related to our **vision**. We rely on our sense of sight to interpret the world around us. So, how do we see and interpret the world with our eyes?

The labelled figure below shows the anatomy of our eye. The human eye weighs about 7 grams (or 0.015 pounds). Light passes through the cornea, pupil and lens before hitting the retina. The **retina** is the area that contains **receptors** that respond to light. These receptors generate electrical signals that travel through the **optic nerve** to the brain.



You can read more about the eye here:

https://www.ducksters.com/science/sight_and_the_eye.php, and here:
<https://faculty.washington.edu/chudler/bigeye.html>.

We can perceive colour in the world around us with **cone cells**. These cells function in bright light and are located in the region at the back of the eye called the **fovea**. There are three types of cone cells, loosely called blue, green, and red, depending on the type of light they respond to best. For example, when you look at a red object, the red cone cells are stimulated, and send a message to the brain saying “the colour of the object is red”.

When we look at a particular colour for a very long time, we experience **cone cell fatigue**. When your cone cells get tired, they are temporarily unable to respond to the colour. So, instead of seeing the correct colour, you will see an image that is the same size and shape as the original image, but a different colour. This image is called an **afterimage**. After a few seconds, your cone cells recover and become active again.

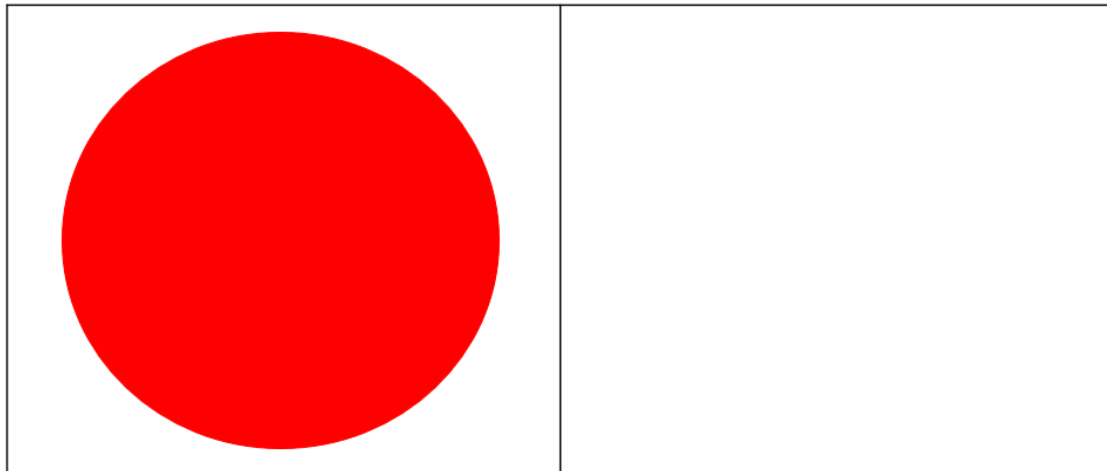
Instructions:

Note: You can print out the instructions to see the images better, or view the image on a tablet or computer with full brightness. It is also recommended you read and understand the instructions before carrying out the experiment.

Part 1: Duration and Colour of an Afterimage

1. Stare at the red circle below for 30 seconds. Try not to blink.
(**Note:** You can time yourself or have a helper time you for exactly 30 seconds. The time starts when you begin looking at the object, and stops when 30 seconds have lapsed.)
2. When 30 seconds have lapsed, look at the white space in the square on the right.
3. Take note of the size, shape, and colour of the afterimage in your notebook.
4. Give your eyes a break for 15-20 seconds. Repeat steps 1-2 again. This time, record how long the afterimage is visible in the table below (30 seconds cone stimulation, trial 1).
5. Give your eyes a break for 15-20 seconds. Repeat step 4 for 2 more times. Record this in the 30 seconds cone stimulation row.
6. Repeat the experiment, varying the amount of time you look at the red circle. Look at the red circle for 10, 20, 45, and 60 seconds. Record your results in the table below.

Note: Remember to give your eye a quick break before each step!



7. Calculate the average time of afterimage persistence in the “Average” column.

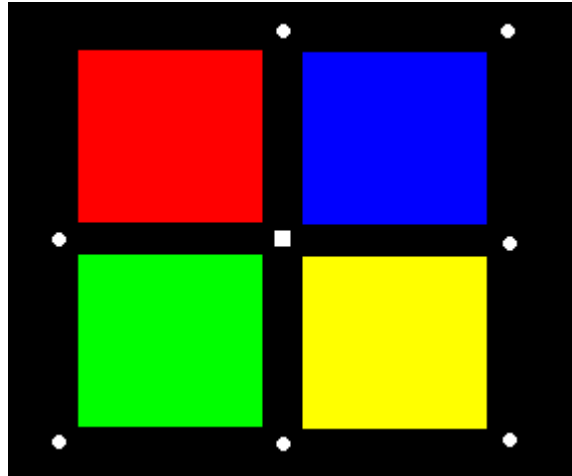
Table 1. Experimental results for afterimage persistence

Cone stimulation (seconds)	Afterimage persistence (seconds)			
	Trial 1	Trial 2	Trial 3	Average
10				
20				
30				
45				
60				

Part 2: Stationary and Moving

8. Navigate to the website on your computer:
<https://faculty.washington.edu/chudler/after.html>. It is recommended you use Chrome browser.
9. Focus on the small white square in the middle of the picture for about 15 seconds. Try not to blink. Then move your mouse so that the cursor moves into the picture, which will cause the picture to

turn into a white screen. Looking at the white screen, take note of the colour and shape of the afterimage you can see in your notebook.



10. Try the experiment again, this time move your eyes to follow the little circle. After 15 seconds, change the picture to white by moving your cursor. What do you notice?

So, what happened?

When you stare at a different colour for too long, your cone cells get tired and temporarily unable to respond to colours. However, when you follow the moving circle, your eyes are always moving. Therefore, you do not give any particular colour a chance to tire your cone cells.

Extension - More Experiments With Your Vision

There are more experiments you can do that are related to vision. For example, you can demonstrate the blind spot (area on the retina without receptors that respond to light, hence you cannot see images that fall in this area). You can also do experiments on visual illusions. You can find these experiments on the website listed here.

<https://faculty.washington.edu/chudler/chvision.html>

Reflection Questions:

- Are there any improvements you would make to this challenge?
- Do a quick research on our eyes. What are 3 interesting facts you discovered about our sense of vision from this project?

Part 1:

- In step 2, what were the size, shape, and colour of the afterimage you could see?
- Do a quick research on the colour of the afterimage. Why did you see that particular colour?
- What was the maximum amount of time that the afterimage persisted? If you stare at the object for longer periods of time (beyond 30 seconds), does the persistence time of the afterimage increase?
- Summarise your results and write a conclusion from the experiment.

Part 2:

- What do you notice from steps 9 and 10?

Submission Guidelines:

- Submit photos or a scanned copy of your lab results. Include a short summary that addresses the reflection questions.

Note: Remember, if you want to upload pictures of your Minor Challenge that also include you, please check if it is OK with your parent or guardian first.

- The submission form is on the Minor Challenges page:
<https://sciencechallenge.org.au/index.php/minor-challenges/>
Fill out the details and make sure you upload your submission.

Learn More! Resources:

- Optometrists are the primary caretakers of our sense of vision. You can read more about their careers here:
<https://careerdiscovery.sciencebuddies.org/science-engineering-careers/health/optometrist>
- This website listed resources on visual illusions, which you can explore further.
<https://www.sciencebuddies.org/blog/visual-illusions-when-what-you-see-is-not-whats-there>

Bibliography:

- Science Buddies. 2020. *Are Your Eyes Playing Tricks on You? Discover the Science Behind Afterimages! | Science Project*. [online] Available at: <https://www.sciencebuddies.org/science-fair-projects/project-ideas/HumBio_p021/human-biology-health/eyes-playing-tricks-afterimages>[Accessed 14 March 2022].
- Chudler, E., n.d. *Afterimages*. [online] Neuroscience For Kids. Available at: <<https://faculty.washington.edu/chudler/after.html>>[Accessed 13 March 2022].
- Chudler, E., n.d. *Neuroscience For Kids - The Eye*. [online] Neuroscience For Kids. Available at: <<https://faculty.washington.edu/chudler/bigeye.html>>[Accessed 13 March 2022].