Neuroscience for Kids
http://faculty.washington.edu/chudler/neurok.html

Our Sense of Sight: Part 3. Color Vision

Student Guide

How does *COLOR VISION* work, and how does it help us to see better?

"So, what did you do last night?" Matt asked Alex. "Oh, my Mom and I watched an old Alfred Hitchcock movie—it was kinda good, you know, a mystery story. But it was like 1950, watching a video in black and white!" "Yeah," replied Matt. "It must have been so boring when all movies and TV were just black and white." "I guess so," said Alex. " But my Mom says when you don't have color, you pay attention to different things, like the shadows that are making things scary, maybe."

"Hey guys, smile!" It was Jenny, taking pictures of people for the school newspaper. "Wow!" complained Matt. "Why do things always look weird after somebody takes your picture with a flash? It looks like things are blotted out for a while." "Yeah," added Alex, "reminds me of black and white videos—first a white flash, then things look black."

We rely on our vision perhaps most of all our senses. With it, we recognize shape, movement, distance and perspective, and color in our environment. Color vision adds information and pleasure to what we would get if the world looked only black and white, but it can also distract us from certain features of a scene, such as shape and shades of light and dark.

How do our eyes detect color? How do our brains interpret it? Your teacher will discuss in class the parts of the visual system and how they work. This system includes special **receptor nerve cells** in the **retina**, called **rods and cones**. The cones detect color and pass this information on to other nerve cells, which send messages to the brain through extensions called **axons**.

After your class discussion and experiment, use what you have learned to explain why things look weird after someone takes your picture with a flash.

Name:________________________ Date:__________

Can I Believe My Eyes?

CLASS EXPERIMENT

LAB QUESTION

PREDICTIONS

SUPPLIES

Black adhesive dot, about 2 cm in diameter
Bright red adhesive dot, about 2 cm in diameter
Other colors of adhesive dots as available: 4 to 6 colors
Several unlined white index cards, each 5 x 7 inches
Timer

PROCEDURE

1. Your teacher will divide the class into groups.
2. Your teacher will demonstrate how to look for a color afterimage.
3. With your group, write the **Lab Question** and then write your prediction in the boxes above.
4. Follow all **safety procedures** your teacher recommends.
5. Let your teacher know if you do not want to be a Subject.

6. Place a red adhesive dot in the center of a white index card.

7. Each Subject should hold the card about 20 cm (8 to l0 inches) from your eyes, so that the card fills most of your visual field.

8. Hold the card still and stare at the dot for **30 seconds—**use a timer.

9. Flip the card over and **look immediately** at the white side. Report the color you see. **Time** how long it takes for this afterimage to fade and record the time.

10. Repeat the procedure, staring at the dot for **one minute**, then flip the card over and time how long it takes for the afterimage to fade. **Record the time** it takes for this afterimage to fade.

11. **Repeat the procedure**, without timing the afterimage, for the black dot and any other colors your teacher makes available. Record the colors you see in response to the color of the dots.

12. **Clean up** your lab area when you finish.

DATA AND OBSERVATIONS

- Your teacher will ask someone in your group to write your results in a class chart.

- When all results are written, note whether everyone agreed on the color of the afterimages for each dot.

- Calculate the **average** time, for all Subjects, that the afterimage persisted after initially staring at the red dot for **30 seconds**, and the **average** time after staring at it for **one minute**.
- Write down any other interesting things you noticed while doing this experiment.

ANALYSIS: THINK ABOUT IT!

1. How do your results compare with those of other groups?

2. Do different shades of red give different shades of green afterimages? What about shades of other colors?

3. Does the length of time you stare at a colored dot affect the time it takes the afterimage to fade?

4. Did anyone see an afterimage that was very different from what most of the class saw? If so, can you think of a reason for this?

5. How does information from the color receptors in the retina, the cones, get to the brain? Illustrate with a simple diagram.

6. Briefly explain why we see afterimages. Include receptor fatigue and opponent colors in your explanation.

CONCLUSIONS

How was the Lab Question answered in your experiment? Include concepts of receptor fatigue and color channels.

List three findings you think are important from today's experiment. Were you surprised by anything you found?

How could you improve this experiment?

Color Vision

WHAT ELSE CAN WE FIND OUT ABOUT COLOR VISION?

You can use what you have learned about the visual system to develop your own experiment. Explore the materials your teacher makes available and think of some things you can investigate.

- For example, how good are humans at telling apart close shades of color? Researchers tell us that we can tell apart almost two million shades! See how good you are by trying to match paint chips from a store, or by making a series of solutions with food coloring.
- Does color change what we notice in a scene? Get a print of a color painting or a colorful picture from a magazine—make sure these have a number of objects in them rather than just one or two. Make a black and white copy on a good copier. Figure out how to test differences in black and white versus color vision using these pictures.
- Another way to test whether color helps us see things would be to make a black and white copy of a page from a *"Where's Waldo?"* book. How can you test people's ability to find Waldo in black and white versus color?
- Do people like and dislike the same colors? Use some colored paper or paint chips to find out about color preferences. How can you make an experiment of this, rather than just asking people to choose or write their favorite colors?
- How do we name colors? Ask people to write all the names of shades of red they can think of. What is "true red?" Can you get people to agree?
- Can humans see colors in dim light? How could you test this? Think of a way to measure your results, rather than just looking at colored items in a dimmed room and estimating how dim it is.

HOW CAN YOU DESIGN A GOOD EXPERIMENT?

In designing experiments to answer questions like these, keep in mind what a **successful investigator** must do:

- Ask a **very specific question**: not, for example, "Can people tell close shades of a color apart?" Try to think of an experiment using food coloring and water, and make your question a detailed one. It's good to have the general question in mind, but ask a narrow question for each experiment.
- Be sure you understand the **control condition** for your experiment, and then **change only one thing, or variable,** in the experiment.
  - ➢ For example, if you tested for differences in what people notice in a black and white picture versus a color picture of the same thing, you can define the black and white test as the control and in the next experiment, add color as your variable.

- Some new experiments are themselves just control experiments. For example, if you test people's ability to line up a series of colored solutions in order, that could be your control experiment. If you have time, you can add a variable in the next experiment by changing the lighting conditions or using a different color in the solutions.

- Researchers try to change only one variable in a new experiment after they do a control experiment. Sometimes this is difficult, but at least they must be aware of other variables and think about what effects they might have.

- Try to make your activity a real **experiment**, with a **prediction**, a **test** for the prediction, **analysis**, and **conclusions**. Some activities are not experiments, but rather are ways of collecting information or data. If you ask people their favorite colors, you can make a chart and show what percentage of people like different colors, but this is not an experiment. To make this activity into an experiment, figure out a way to predict a number or percentage of people who will or will not like a color. Then set up your experiment, collect data, analyze, and determine if your prediction was correct. This can be a control experiment. What could you do to change a variable? Could you use a different set of colored objects? Would you expect different results?

- Keep good records of everything you do.

NAME:________________________DATE:_______

Can I Believe My Eyes?

TRY YOUR OWN EXPERIMENT

LAB QUESTION

PREDICTIONS

PROCEDURE (Use as many steps as needed.)

1. After you **explore** materials and **brainstorm** ideas for your experiment, each group should agree upon and write a Lab Question in the box above.

2. Write a **prediction** for the answer to your question in the box above.

3. **List the steps** you will take to perform your experiment. Include a list of supplies.

4. Figure out what the **control conditions** for your experiment will be, and whether your experiment is one that sets control conditions, or one that tests a new variable, or both.
5. Try to change only one **variable**.

6. **Design** a data sheet or table to record your results.

7. Get your **teacher's OK** before beginning your experiment.

8. **Clean up** your area when you finish.

DATA AND OBSERVATIONS

Your teacher will give you **supplies** for your new experiment.

In addition to recording your data, such as the time it takes for your experiment or the concentration of colored solutions, **write down** observations on what worked well and what didn't, problems with supplies, or disagreements people had in their groups.

ANALYSIS: THINK ABOUT IT!

1. What is the control condition for your experiment?

2. What did you change or add for your new experiment? Did you change only one variable?

3. If you tested people's ability to line up a series of colors from lightest to darkest or to match close shades of colors, what did you find?

4. If you tested color preferences, what were your results? What are some reasons why people have different favorite colors or colors they don't like?

5. If in your new experiment you compared people's ability to find things in black and white versus color pictures, were the results different? If so, how do you explain this?

CONCLUSIONS

How did your results answer your Lab Question?

How certain are you of your conclusions? Would you need more evidence to convince yourself or others that your conclusions are right?

What are some other ideas for experiments on color vision?

MORE *COLOR VISION* ACTIVITIES

- How many color names can you write down for red (such as pink, fire engine red, cinnamon…)? Blue? Would everyone agree with the names you have chosen? While most people agree that a given color is a shade of red or blue or green, further naming is quite subjective.

- Do other animals see the same colors we do? Are there animals that can see more colors? Do some library or World Wide Web research and report to your class.

- Find out about abnormalities in color vision by searching the **World Wide Web or your library.**

Here are some good **Web sites** to visit for visual system information:

http://www.illusionworks.com/index.html

http://www.illusionworks.com/html/color_aftereffect.html

http://faculty.washington.edu/chudler/chvision.html
http://faculty.washington.edu/chudler/bigeye.html
http://faculty.washington.edu/chudler/retina.html
} All from Neuroscience for Kids

http://www.accessexcellence.org/AE/AEC/CC/vision_background.html

http://www.nei.nih.gov (look under Educators)