

LEVELED BOOK • Q

Color Blindness

**Multi
level
Q•T•W**

Written by Cheryl Reifsnyder

www.readinga-z.com

Color Blindness



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Focus Question

What causes color blindness, and how can it affect a person's life?



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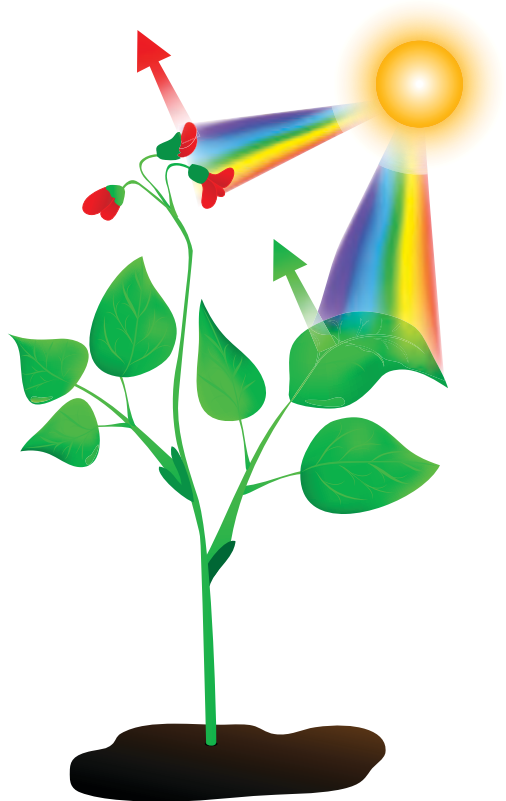
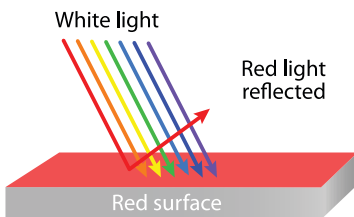
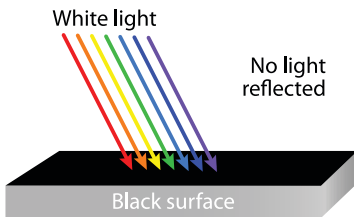
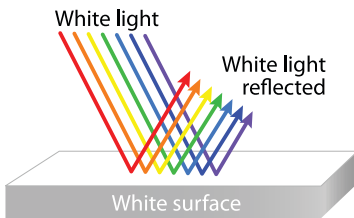
Choosing a red crayon is much easier for someone with full-color vision (top) than someone with red-green color blindness (bottom).

What Colors Do You See?

Imagine looking at a box of crayons and seeing only shades of gray, blue, and yellow. That's what they look like to many people who are **color-blind**. Most people who are color-blind can still see some colors. They just can't see as many colors as other people.

Where Do Colors Come From?

White light has every color of the rainbow hidden inside it. Each color is a different **wavelength**. Things appear to be different colors because they absorb and reflect different wavelengths of light. A strawberry looks red because it reflects red wavelengths while absorbing most others.



How an Eye Sees

The cornea gathers and begins to focus light from the outside world.

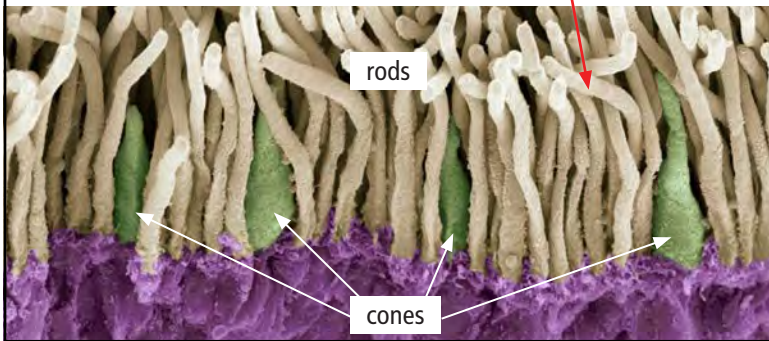
The iris opens or closes the pupil to allow more or less light into the eye.

The pupil is a hole in the center of the eye that allows light to pass through.

The lens changes shape to finish focusing.

Rods and cones lining the wall of the retina at the back of the eye register what is being seen.

The optic nerve sends messages to the brain about what the eye is seeing.



How Color Vision Works

People see colors because our eyes respond differently to different wavelengths of light. When light enters one of your eyes, it gets focused on the **retina**. The retina is a thin layer of **tissue** at the back of the eyeball. The light triggers **rod cells** and **cone cells**. These cells send signals to the brain, which uses the signals to make images.

Rods and Cones

Rod cells are the most **sensitive** cells in your retina. They let you see in very low light. However, they can't tell different colors apart.

Cone cells handle color vision. There are three types of cone cells. One type absorbs blue light, one green light, and one red light. Combining these three main colors allows us to see thousands of colors. When one or more types of cone cells aren't working, though, color blindness results.



human vision



honeybee vision

Color Vision in Animals

Most animals can see fewer colors than humans. For instance, dogs can only see shades of blue and yellow, and bulls are completely color-blind! Other animals—including some birds, bees, and butterflies—see more colors than humans do, including wavelengths of light that are invisible to humans.

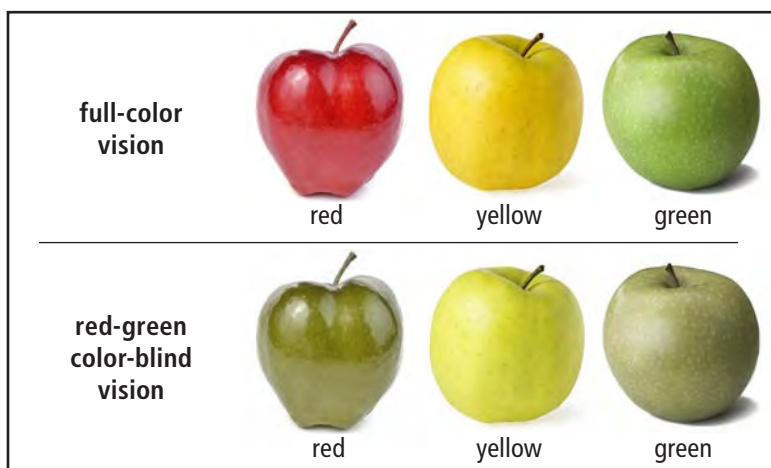
Different Types of Color Blindness

Red-Green Color Blindness

People with red-green color blindness have trouble telling red and green apart. This is the most common type of color vision problem. It affects about one out of every twelve men and one out of every two hundred women.

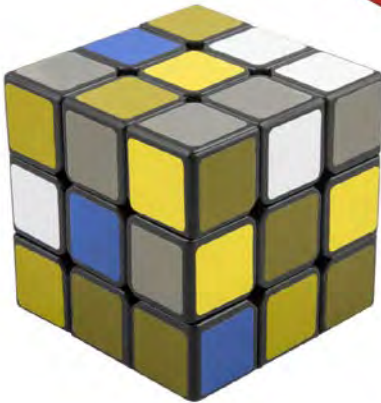
People with red-green color blindness usually have something wrong with their green cone cells. As a result, green and yellow objects appear reddish in color.

Sometimes red-green color blindness is caused by a missing or damaged red cone cell. In this case, red, orange, and yellow objects appear green or black.

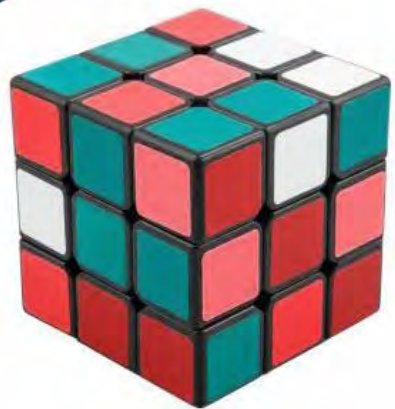




full-color vision



red-green color blindness



blue-yellow color blindness

Blue-Yellow Color Blindness

Blue-yellow color blindness happens when blue cone cells are missing or not working properly. This type of color blindness is fairly rare. It's only found in about one out of every ten thousand people worldwide. Unlike red-green color blindness, it's equally common in men and women.



Complete color blindness (right) is very rare.

Complete Color Blindness

Complete color blindness is the most serious type of color blindness. It happens when a person has problems with two or three types of cone cells.

People who are missing several types of cone cells tend to be very sensitive to light. They may also have difficulty seeing clearly, especially in bright light. This is because they rely on rod cells for most or all of their vision. Rod cells only work in low light.

About one in thirty thousand people worldwide are missing all three types of cone cells. People without any working cone cells only see shades of black, white, and gray.



Some traffic lights use shapes as well as colors to convey information to color-blind drivers.

Color Blindness Is No Joke

Color blindness can cause serious problems. People who are color-blind have trouble reading maps. Color-blind children may have trouble in school.

Color blindness can also cause safety issues. Fire hydrants and emergency equipment are often colored red or yellow to make them more visible. Someone who is color-blind may not notice bright colors that stand out to those with full-color vision.

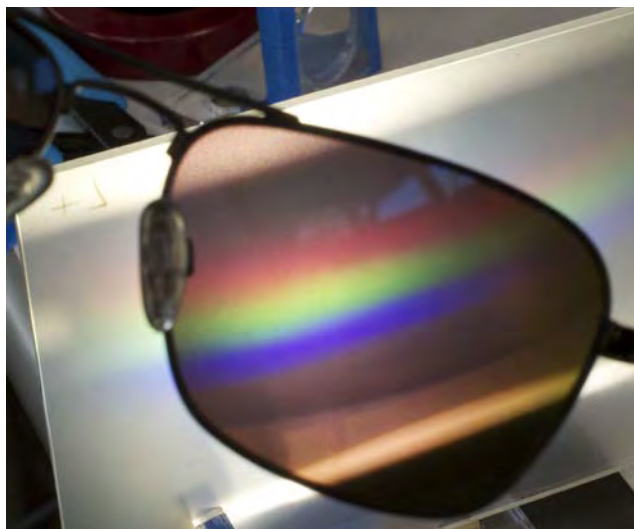
Color blindness can even limit a person's career choices. Some jobs, such as airline pilot, require full-color vision. Others, such as photographer, are much more difficult without full-color vision.

Testing for Color Blindness

Doctors use several types of tests to find out if a person has color blindness. One test uses images made up of dots that are different sizes and colors. People with full-color vision can see numbers or shapes inside the pictures. People with red-green color blindness have trouble spotting the hidden symbols.



Can you see the hidden numbers or shapes in the circles in this color vision test?

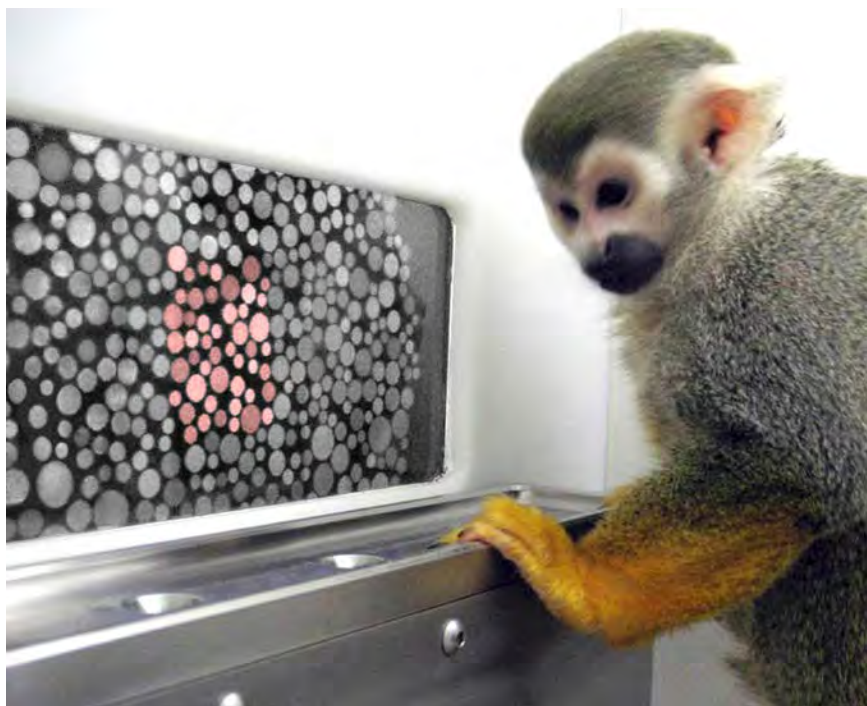


These special glasses from EnChroma allow people with red-green color blindness to see a much more colorful world.

Tools to Help Color-Blind People

So far, doctors can't cure color blindness. However, many new tools can help people deal with color blindness. Smartphone **apps** can do tasks such as identifying colors and picking colors that go together well. These apps can help people choose matching clothes or tell which fruits are ripe at the grocery store.

Researchers have also created high-tech sunglasses that filter out specific wavelengths of light. The sunglasses make it possible for people with red-green color blindness to tell the two colors apart.



A squirrel monkey takes a color vision test as part of an experiment.

Treating Color Blindness

Scientists recently corrected red-green color blindness in squirrel monkeys. The monkeys lacked red cone cells. As a result, they couldn't tell the difference between red and green.

Researchers were able to insert the missing **gene** into cells in the monkeys' eyes. Within about twenty weeks, the monkeys could tell the difference between red and green dots.

These successful experiments in squirrel monkeys provide hope for a cure in humans.

Color Vision for All?

Researchers gain a better understanding of color blindness all the time. Every year, new tools are developed to make life easier for people who are color-blind. Best of all, a treatment for color blindness may be available in the near future. Who knows? Maybe someday soon, color blindness will be a thing of the past!



Glossary

- apps** (*n.*) computer programs or applications designed for mobile electronic devices such as cell phones (p. 13)
- color-blind** (*adj.*) lacking the ability to distinguish between two or more colors (p. 4)
- cone cells** (*n.*) cells in the eye's retina that are color sensitive and work best in bright light (p. 6)
- gene** (*n.*) a basic unit of heredity that transfers a trait from one generation to the next (p. 14)
- retina** (*n.*) tissue at the back of the eye that receives images and transmits them to the brain (p. 6)
- rod cells** (*n.*) cells in the eye's retina that are light sensitive and work best in dim light (p. 6)
- sensitive** (*adj.*) able to feel or notice small changes; easily irritated or damaged (p. 7)
- tissue** (*n.*) material made up of a group of cells that are similar in form and perform a certain function (p. 6)
- wavelength** (*n.*) the distance between two consecutive high or low points of a wave (p. 5)

Words to Know

apps

color-blind

cone cells

gene

retina

rod cells

sensitive

tissue

wavelength

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Correlation

LEVEL Q	
Fountas & Pinnell	N
Reading Recovery	30
DRA	30

Color Blindness

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Word Count: 826

Connections

Writing

Choose two forms of color blindness. Write a report that compares the two conditions and their effects on a person's life.

Math

Research the statistics about the number of people with the various forms of color blindness in your country. Organize your results in a pie chart.

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