
COLOR
BLIND

# What is color blindness?

Color blindness occurs when there is a problem with the color-sensing granules (pigments) in certain nerve cells of the eye. These cells are called cones. They are found in the retina, the light-sensitive layer of tissue that lines the back of the eye.

You may have trouble seeing certain colors if one of the pigments is missing. You may also have trouble seeing colors and the brightness of colors in the usual way as well as an inability to tell the difference between shades of the same or similar colors.

There is no known treatment, but there are special contact lenses and glasses that may help people tell the difference between similar colors.

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# John Dalton (1766-1844)

English chemist, meteorologist, and physicist.

Wrote “Extraordinary Facts Relating to the Vision of Colours” in 1798.

Shortage in color perception was caused by discoloration of the liquid medium of the eyeball. This had not been formally described until Dalton wrote about it.

Color blindness is hereditary.

Daltoism became a common term for color blindness.

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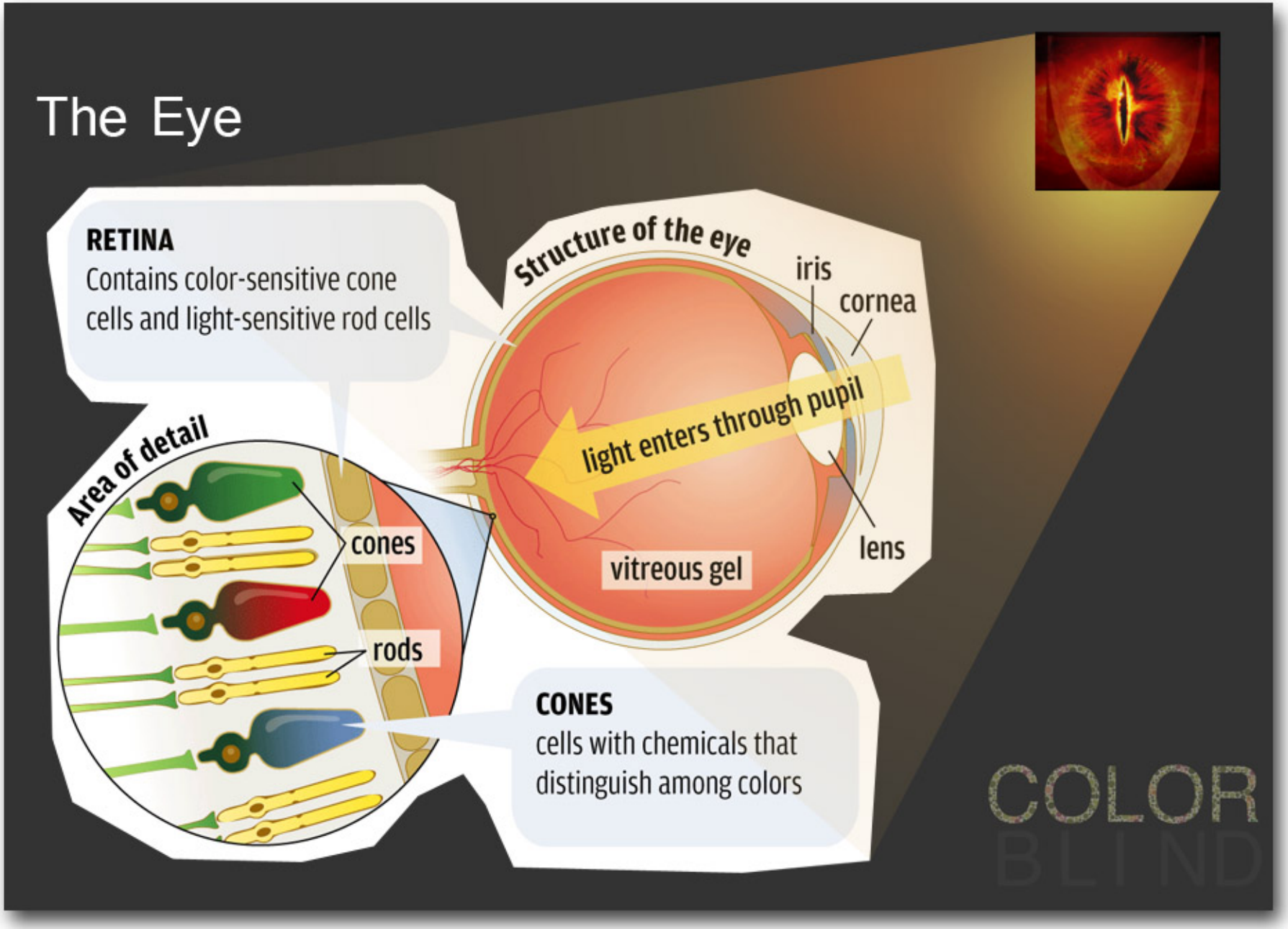
The Eye
RETINA
Contains color-sensitive cone cells and light-sensitive rod cells
Structure of the eye
iris
cornea
light enters through pupil
lens
vitreous gel
Area of detail
cones
rods
CONES
cells with chemicals that distinguish among colors
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# The X-Men

Many of the genes involved in color vision are on the X chromosome.

In humans, the sperm either contains an X or Y chromosome while the egg only contains an X chromosome. A zygote with XX is female while an XY is male. A zygote is the inital cell formed when two gamete cells are joined by means of sexual reproduction.

Since males have only one X chromosome and females have two, this makes the chances of having an x-linked disorder (1/100 men vs. 1/10,000 women) like color blindness more common in males. About 1 in 10 men have some form of color blindness. Very few women are color blind.

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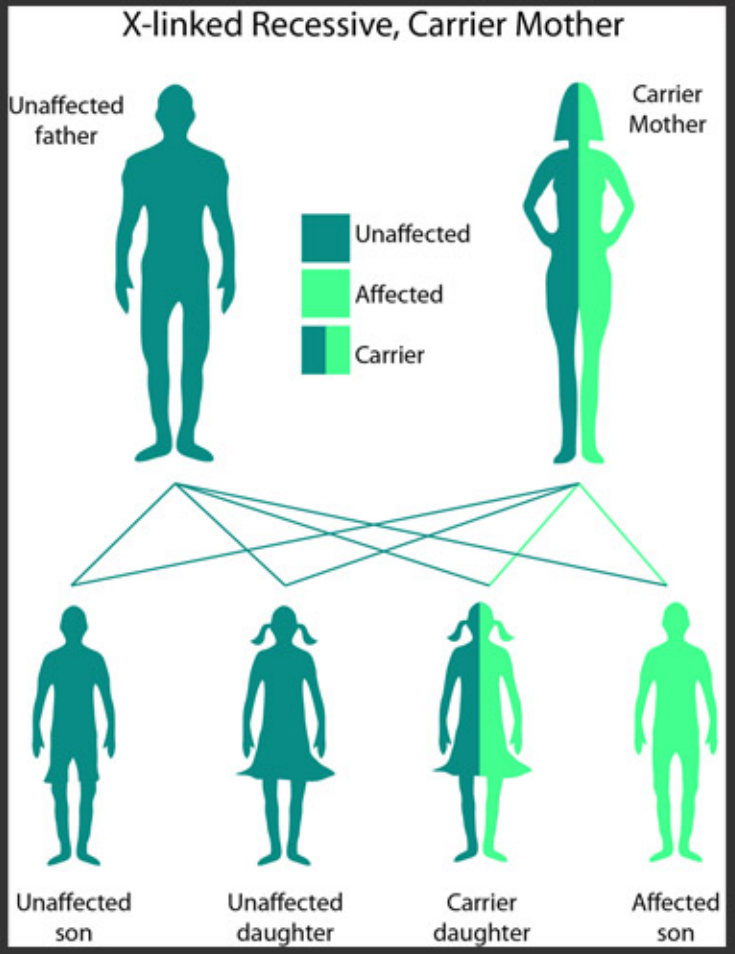
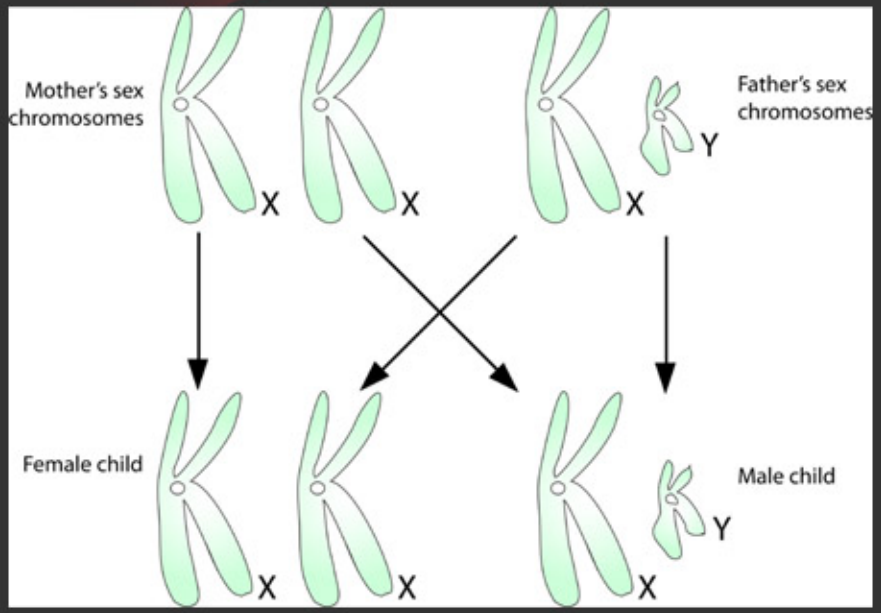
# The X-Men

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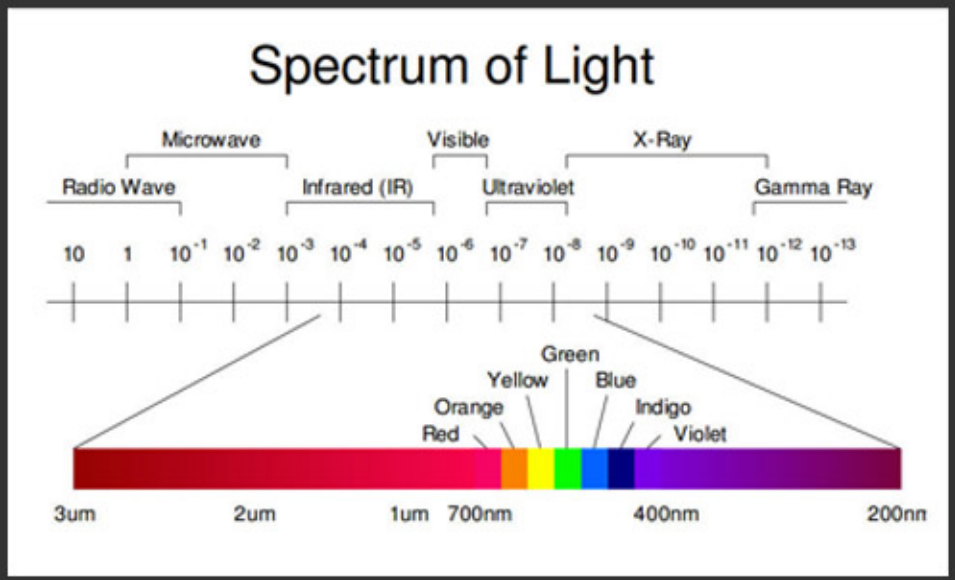
# Color Blind Types:

Each visible color is a different wavelength from approximately 400 to 700 nm.

If the coding instructions are wrong, then the wrong pigments will be produced, and the cones will be sensitive to different wavelengths of light (resulting in a color deficiency). The colors that we see are completely dependent on the sensitivity ranges of those pigments.

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# Color Blind Types: Nature of Light and Color

Light is electromagnetic radiation (EM), the fluctuations of electric and magnetic fields in nature. Light is energy and the phenomenon of color is a product of the interaction of energy and matter.

Light has the properties of both particles and waves. Light particles, called photons, radiate from their source in a wave pattern at a constant speed of 186,000 miles per second.

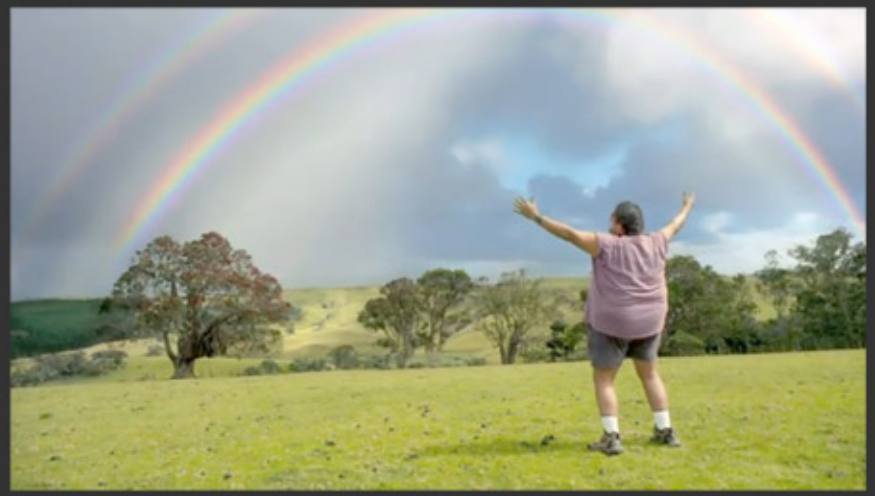
There are different types of EM radiation including gamma rays, x-rays, radio waves, ultraviolet, and infrared. The whole array of these is known as the electromagnetic spectrum, which runs in order of wavelength from longest (radio waves that range from 1 millimeter to several kilometers) to shortest (gamma rays at less than 0.1 nanometers, or 1/10,000,000,000th of a meter).

# Color Blind Types: Nature of Light and Color

The visible spectrum contains numerous colors that are distinguished by wave-length and amplitude.

Wavelength determines color and amplitude determines brightness. Of these colors, the human eye can distinguish about 10,000.

The visible spectrum, however, is often identified by the seven prominent colors we see in the rainbow.



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# Color Blind Types: Monochromacy

Monochromacy - lack of ability to distinguish colors caused by cone defect or absence. Two or all three of the cone pigments are missing reducing vision to one dimension.

Rod Monochromacy - very rare. Nonprogressive inability to distinguish any colors as a result of absent or nonfunctioning retinal cones. Associated with photophobia, nystagmus, and poor vision.

Cone Monochromacy - rare total color blindness accompanied with normal vision, electroretinogram, and electrooculogram. Can be a result of having di-chromatic color blindness.

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# Color Blind Types: Dichromacy

Dichromacy (2 out of 100 males) - moderately severe hederitary color vision defect. One or more three basic color mechanisms is absent or not functioning. One of the cone pigments is missing and color is reduced to two dimensions.

Protanopia (1 out of 100 males) - complete absence of red retinal photoreceptors. Red appears dark (red weak).

Deuteranopia (5 out of 100 males) - complete absence of green retinal photoreceptors. Affects red-green hue discrimination. There are only two cone pigments present (green weak).

Tritanopia - there are only two cone pigments present and a total absence of blue retinal receptors. Related to chromosome 7.

# Color Blind Types: Dichromacy

Normal

Protanopia

Deuteranopia

Tritanopia

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# Color Blind Types: Anomalous Trichromacy

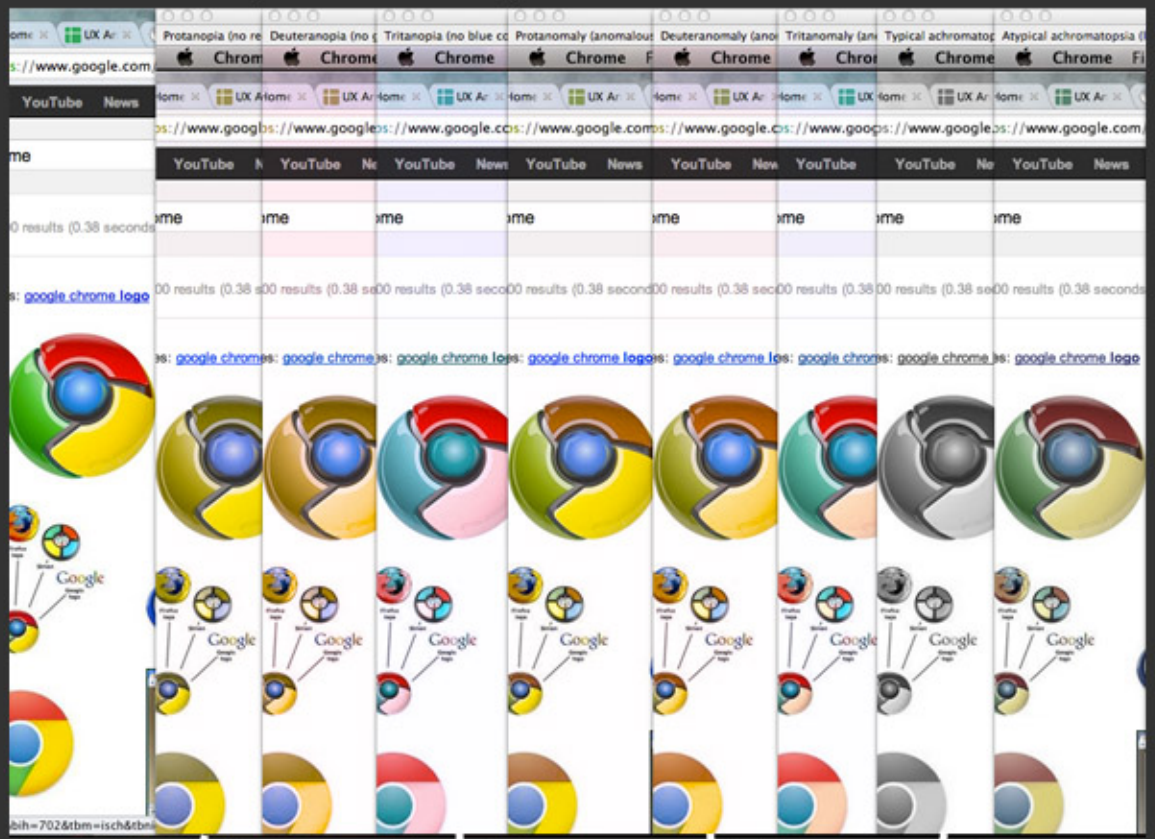
Anomalous Trichromacy - one of the three cone pigments is altered in its spectral sensitivity. Impairement of color with three dimensional color vision.

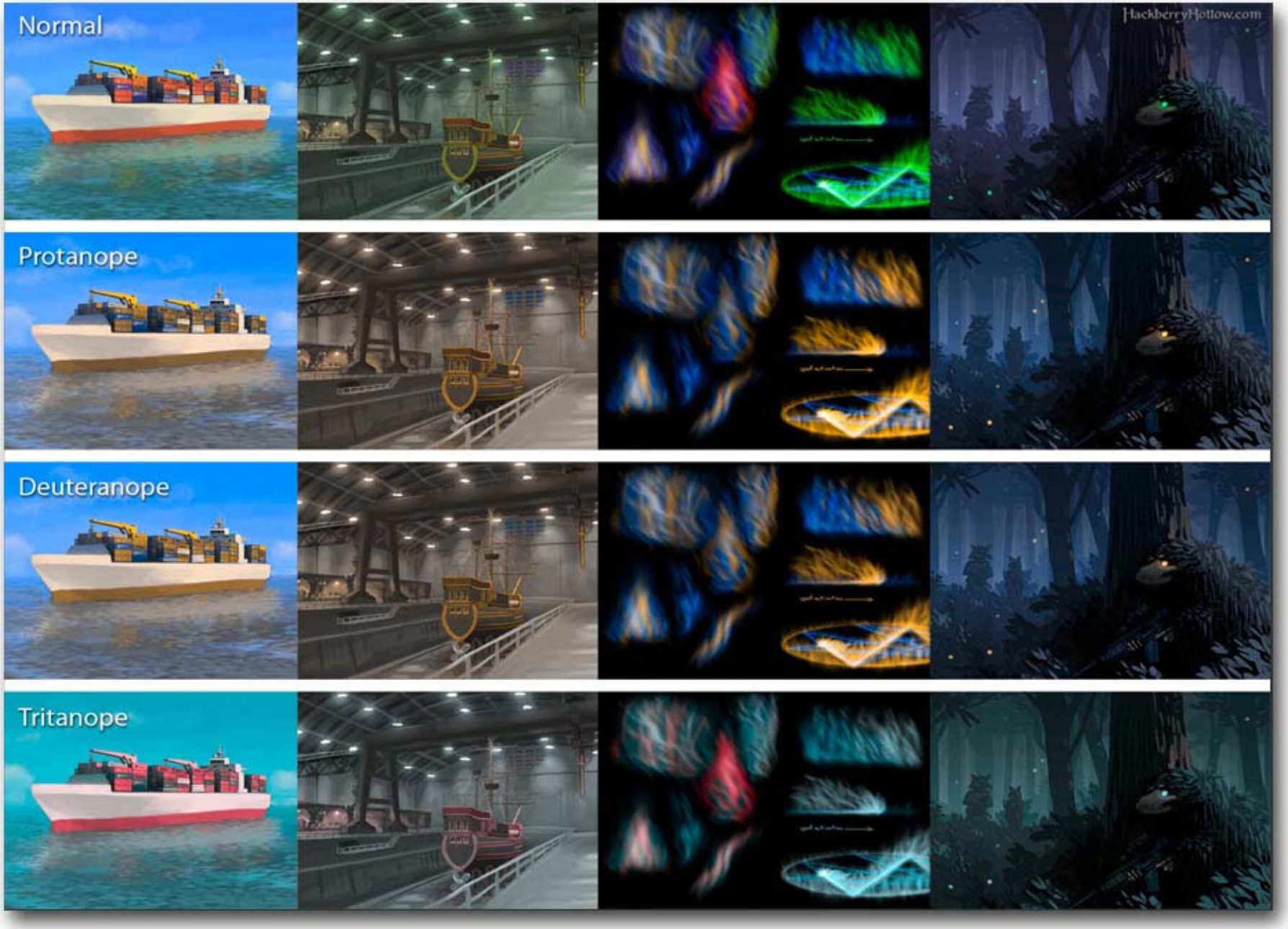
Protanomaly (1 out of 100 males) - mild defect with red retinal receptors resulting in poor red-green hue discrimination.

Deuteranomaly - mild defect with green retinal receptors. The most common type of color deficiency.

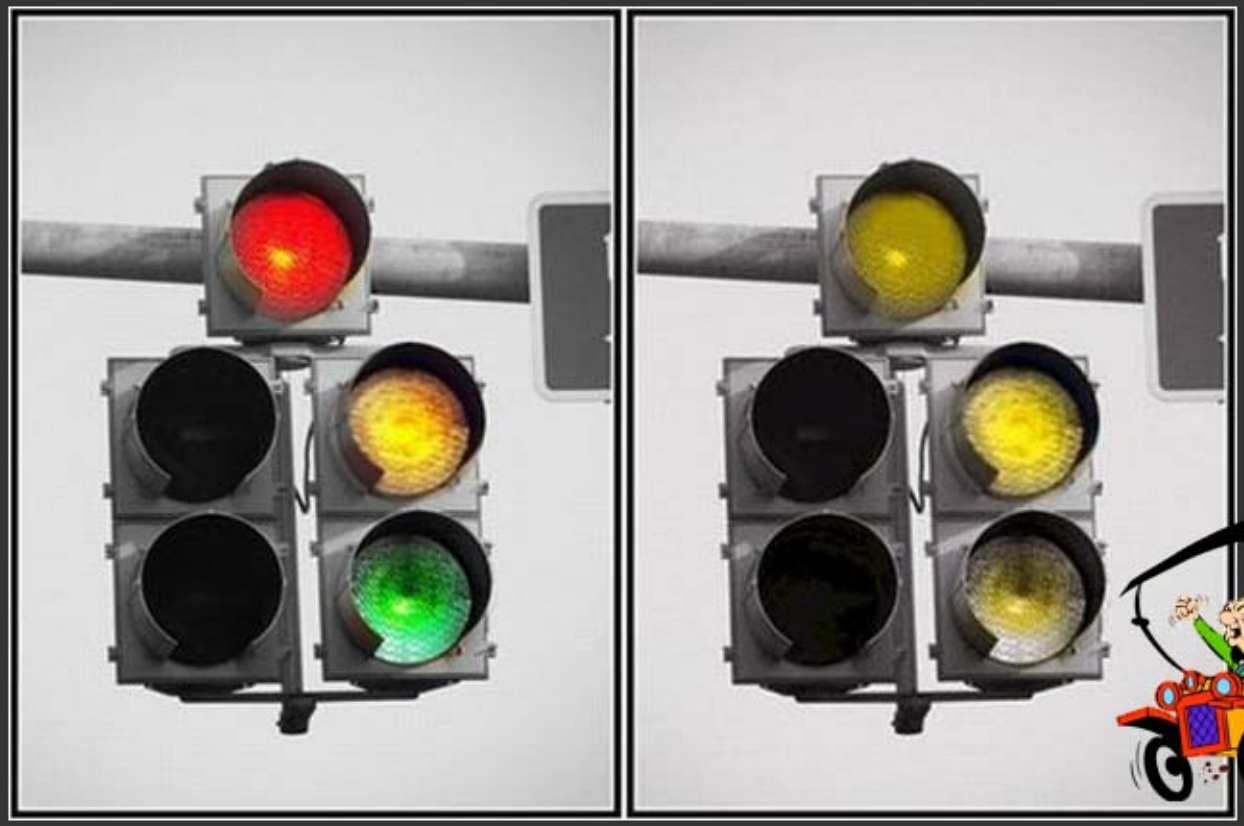
Tritanomaly - rare color vision deficiency affecting blue-yellow hue discrimination, linked to chromosome 7.

# Color Deficiency Examples




Normal
Protanope
Deuteranope
Tritanope
HackberryHollow.com

# Color Deficiency Examples



# Simple Color Blind Test

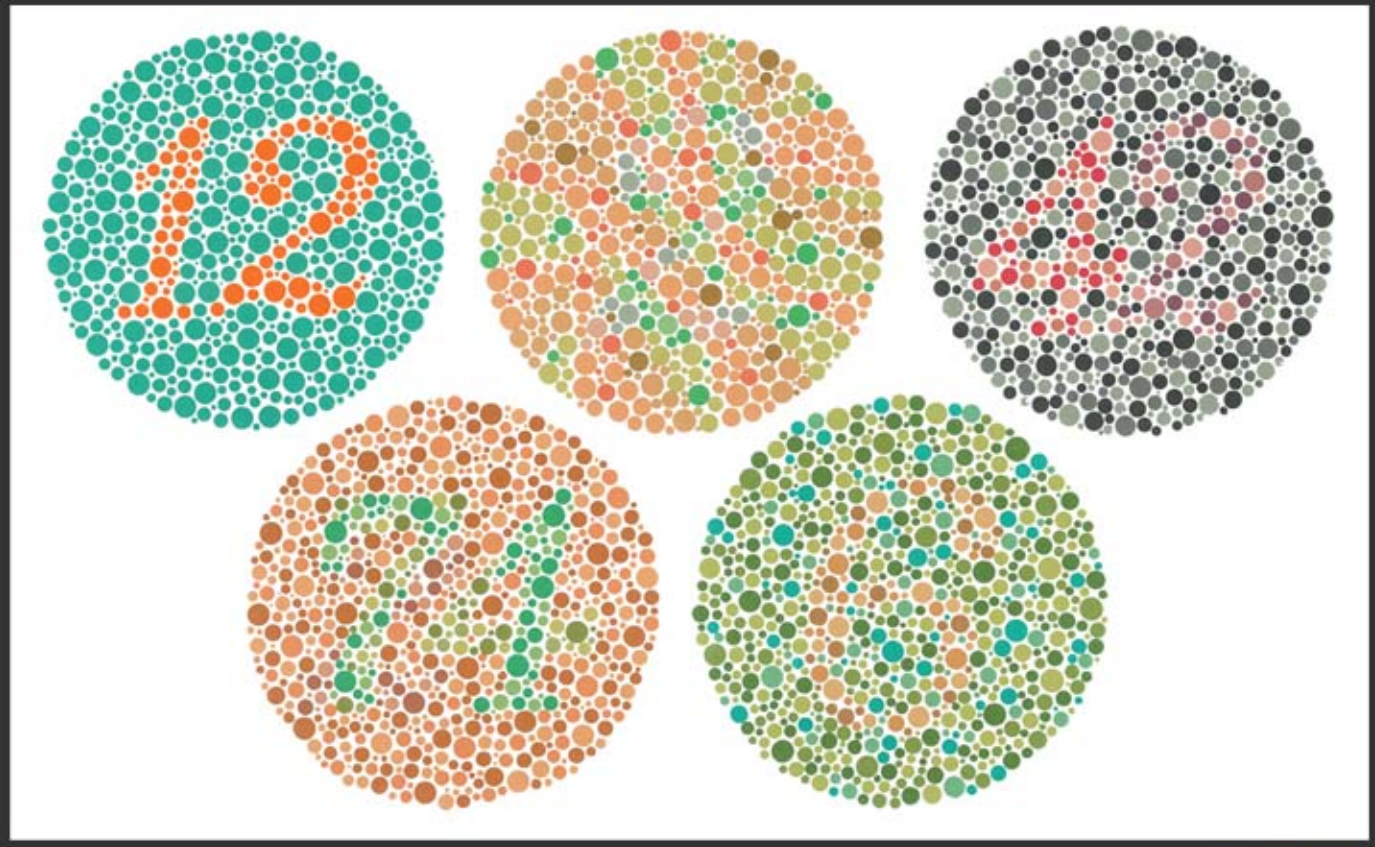
The Ishihara Color Test - an example of color perception for red-green color deficiencies named after Dr. Shinobu Ishihara. He first plublished his tests in 1917.

Test consists of a number of colored plates, called Ishihara plates, each of which contains a circle of dots appearing randomized in color and size.

Within the pattern are dots which form a number or shape clearly visible to those with normal color vision, and invisible or difficult to see to those with a red-green color vision defect.

Full test consists of 24 or 38 plates.

# Simple Color Blind Test



# So What Now?

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People who are colorblind may not be able to get a job that requires the ability to see colors accurately. For example, electricians (color-coded wires), painters, fashion designers (fabrics), and cooks (using the color of meat to tell whether it's done) need to be able to see colors accurately.

At one time the U.S. Army found that color blind people could spot "camouflage" colors that fooled those with normal color vision.

With technology a color blind person can now download applications that will enable color recognition.

The University of Washington and University of Florida were able to give trichromatic vision to squirrel monkeys, which normally have only dichromatic vision, using gene therapy (http://www.youtube.com/watch?v=MEeU8CV_3Mo)

# So What Now?

Neil Harbisson

Became the first person in the world to wear an eyeborg.

It picks up 360 hues through micro-tones and saturation through different volume levels.

Founded the Cyborg Foundation, an international organization to help humans become cyborgs.

http://www.youtube.com/watch?v=ygRNoieAnzI

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# There is Hope

Having a deficiency will not prevent a person from become an artist.

Artists like Charles Meryon, Clifton Pugh, or since we're talking about entertainment design, artists like J.P. Targete.


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The End
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