Physiology Team 439

MED439
KING SAUD UNIVERSITY

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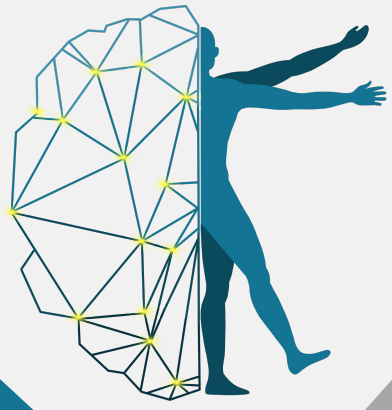


Color Vision

Objectives:

- Define color vision
- Identify and describe the mechanism of colour vision and the three types of cones, including the range of spectral sensitivity and color blindness
- Identify color vision theory
- Describe the items needed for any color perception
- Compare different types of color blindness

Color index:

- Important.
- Girls slide only.
- Boys slide only.
- Dr's note.
- Extra information.

Editing File

Color vision:

It the ability to discriminate between different colors.

There are **3 primary colors** (blue-red-green) sensed by **cones** in fovea & appreciated by photopic vision.

Only one of three types of color pigments is present in each of the different cones.Thus making the **cones selectively sensitive to different colors:** blue green, or red.*

Sensation of the **extra spectral colors** as white, yellow, orange, purple, can be produced by **mixing properties** of the blue, red, green in different combinations.

Colors have three attributes: **hue**(means shadow), **intensity**(قوة اللون), and **saturation** (degree of freedom from dilution with white).*

For any color there is a complementary color that, when properly mixed with it, produces a sensation of white.*

The three primary colors are perceived by three photoreceptor pigments (with broad absorption curves).*

Perception of Black(black has no wavelength):

Black means absence of light (not darkness because in dark we do not see black only). Black is the sensation produced by the absence of light, but it is probably a positive sensation because the blind eye does not “seeblack;” rather, it “sees nothing at all”.

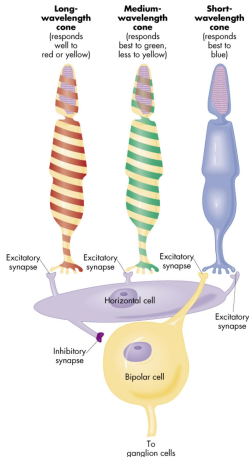
Color vision theory (Young- Helmholtz theory)

L11

1

We have 3 kinds of cones each has a specific photopigment (rhodopsin/iodopsin) & is sensitive to one of the 3 primary colors.
Figure 50-8 shows the absorption curve for the rhodopsin of the rods, with a peak at 505 nanometres.*

Cone system	Blue cone system	Green cone system	Red cone system
Pigment	**S** pigment Blue sensation pigment	**M** pigment Green sensation pigment	**L** pigment Red sensation pigment
Wavelength	SHORT wavelength (**440** nm)	MIDDLE wavelength (**535** nm)	LARGE wavelength more than (**535** nm)-(**565** nm)
Color sensation	senses the **blue color**	senses the **green color & less to yellow**, & absorb light at the green portion.	senses the **red & yellow color** & absorb light at the red portion.



The action potential converts light energy into electrical energy causing the neurotransmitters to transfer the electrical impulses to the horizontal and bipolar cells. Then the bipolar cells transfer it to the ganglion cells where these impulses get carried to the brain to form the action potentials that interbreed the color according to the wavelength.

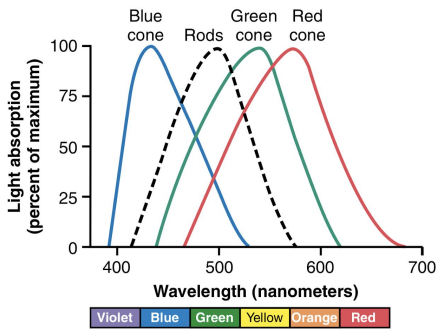


Figure 50-8 Light absorption by the pigment of the rods and by the pig
retina. (Drawn from curves recorded by Marks WB, Dobelle WH,

2

Sensation of any color determined by:

A	Wavelength of light S, M and L cones.
B	Amount of light absorbed by each type of cones other colors.
C	Frequency of impulses from each cone system to ganglion cells which is determined by wavelength of light.

The longer the wavelength, the greater the frequency of the action potential

Color vision theory (Young- Helmholtz theory)

3

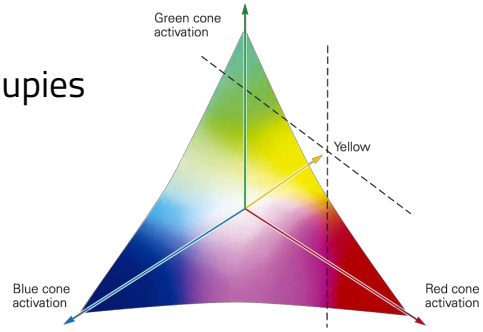
Each cone system respond to its color at a lower threshold than needed to sense other colors (red cones respond to red or yellow color at a lower threshold than to green color).*

4

Perception of white is due to equal stimulation of blue & red & green cones.There is no wavelength corresponds to white, white is a combination of all wavelengths.
there is no single wavelength of light corresponding to white; instead, white is a combination of all the wavelengths of the spectrum.

As can be seen in this vector diagram white occupies the middle of the vector.*

equal stimulation means equal percentage of all 3 types of cones.



Color vision is coded by:

different responses in ganglion cells that depends upon the **wavelength** of stimulus which determine **frequency of impulses** in ganglion cells

the color perception in the brain depends on the **amount of activity in each of the 3 cone** systems as mentioned above

Interpretation of color in the nervous system

Referring to Figure 50-10, one can see that an orange monochromatic light with a wavelength of 580 nanometers stimulates the red cones to a value of about 99, it stimulates the green cones to a value of about 42, but the blue cones not at all. Thus, the ratios of stimulation of the three types of cones in this instance are 99:42:0. The nervous system interprets this set of ratios as the sensation of orange.*

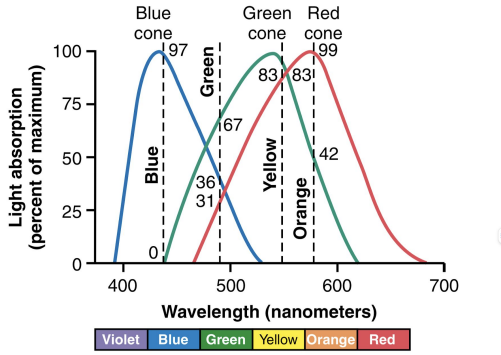
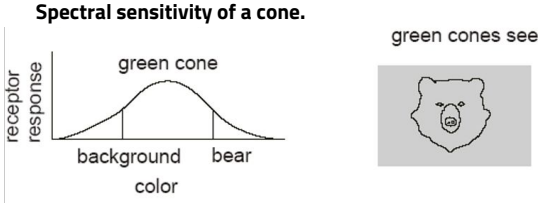


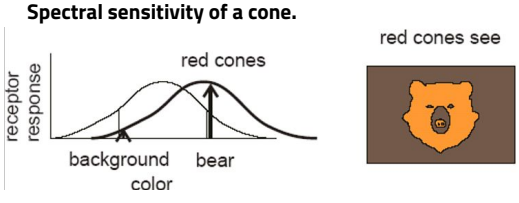
Figure 50-10 Demonstration of the degree of stimulation of the different color-sensitive cones by monochromatic lights of four colors: blue, green, yellow, and orange.

Color	Cone stimulation percentage imp	Ratio
Orange	99% of red cones 42% of green cones 0% of blue cones	(99:42:0)
Yellow	50% of red cones 50% of green cones 0% of blue cones	(50:50:0)* (83:83:0)*
Blue	0% of red cones 0% of green cones 97% of blue cones	(0:0:97)

what is the advantage of color vision?

color is important for distinguishing an object from its background



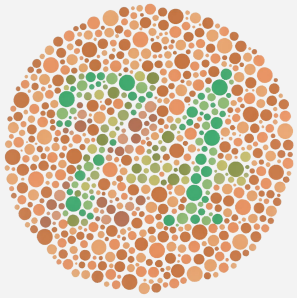


The Ishihara Charts

Ishihara charts, is **a test for color blindness** which are plates containing figures made of colored spots on a background of similarly shaped colored spots.*

The figures are intentionally made up of colors that are liable to look the same as the background to an individual who is color blind.*

Some color blind individuals are unable to distinguish certain colors, whereas others have only a color weakness.*



Genes of cone pigments*

- When a single group of color receptive cones is absent (due to absence of there gene) the person can not see or distinguish some colors from others.

Gene for	The chromosome
rhodopsin (**red**)	Chromosome (3)
S pigment (**blue**)	Chromosome (7)
Red & **green** sensitive pigments (L&M)	Chromosome (x)

Red-Green Blindness

- **Green** & **Red** cones see color between the wavelengths of **525-675 nm**.
- If either of these cones are absent, the person won't be able to distinguish between: **Red Green -Yellow-Orange.** and he can not distinguish red from green (primary colors) so called (**Red-Green blindness**).
- It's **X-Linked (recessive disease*)** disease that is transmitted by females to their male children (sons*), never occurs in females because they have 2X Chromosomes.
- 8% of female are carrier*.

Have or carry the disease

Male

Males have one x & one y chromosome so **If this one x chromosome miss the gene for color vision , he will get red-green color blindness**(their gene is on x chromosome).

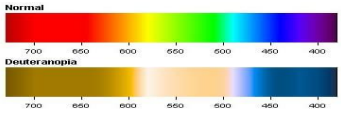
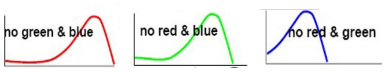
Female

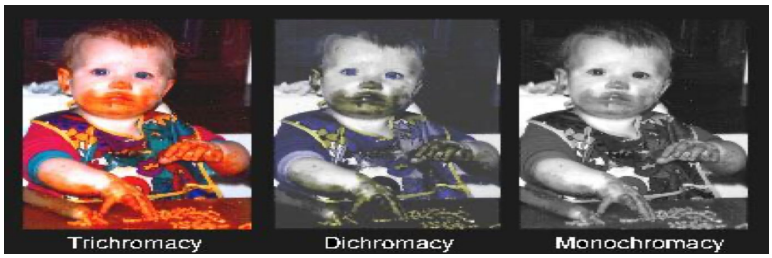
Female show the disease only if **both of their X chromosomes lack the gene.**

Female from color-blind fathers are only **carriers and transmit the disease to half (1/2) of their children.**

Nopia = blindness/total loss
Nomaly =weakness
Nomaly: يشوف الغامق بس ما يشوف الفاتح كويس

Types Of Color Blindness very important

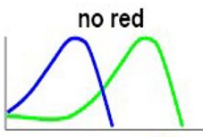
Trichromats	have **3** cone pigments normal or have slight weakness in detecting red or green or blue color.* See the 3 primary colors.*	**Protanomaly**	If only weakness in red color vision
		Deuteranomaly	If only weakness in green color vision
		Tritanomaly	If only weakness in blue color vision
Dichromats	have only **2** cone pigments systems only so he is completely blind to red or green or blue, (so they may have protanopia, deuteranopia, or tritanopia) they get color by mixing only 2 of the primary colors.* Blind to one primary color.*	**Protanopia (red-blindness)**	no red cones system so person has shortened spectrum wave length*
		Deuteranopia (green-blindnes)	no green cones system so person see only **long & short** wave length* 
		Tritanopia (blue-blindness)	no blue cones system*
Monochromats	have only **one** cone system or loss of all so see only black or grey or have no color perception.* Have only one color pigment.*		



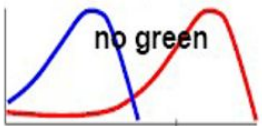
Summary

Types Of Color Blindness

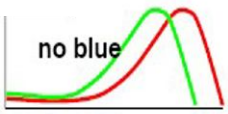
- **Trichromats**
- **Dichromats**
  - **Protanopia** (**red**-blindness)

  - **Deutranopia** (**green**-blindness)

  - **Tritanopia** (**blue**-blindness)

- **Monochromats**

MCQ & SAQ:

Q1: which one of the following responds optimally to high wavelength light?

A. Green cone.
B. Red cone.
C. Blue cone.
D. Rods.

Q2: Perception of the color yellow is due to stimulation of which cones system?

A. black and red.
B. blue and orange.
C. red and green.
D. white and green.

Q3: which one of the following is a prominent feature of of color vision:

A. blue cone system has S pigment.
B. Green cone system detects short wavelength.
C. primary colors are detected by rods.
D. white color is detected by blue cone system.

Q4: Which wavelength the green & red cons most sensitive to?

A.720nm.
B. 545nm.
C. 363nm.
D. 410nm.

Q5: tritanomaly is:

A. blue blindness.
B. red blindness .
C. red weakness.
D. blue weakness.

Q6: which one of these cones is affected in case of protanopia:

A. red cones.
B. blue cones.
C. green cones.
D. all of the above.

answer key:
1: B
2: C
3: A
4: B
5: D
6: A

1- sensation of any color is determined by?

2- What are the three attributes of color?

3- What does the wavelength looks like in case of deuteranopia?

A1: wavelength of light,amount of light absorbed by each type of cones,frequency of impulses from each cone system to ganglion cells which is determined by wavelength of light.

A2: hue, intensity, and saturation.

A3: long & short wavelength.

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