Color Vision

by

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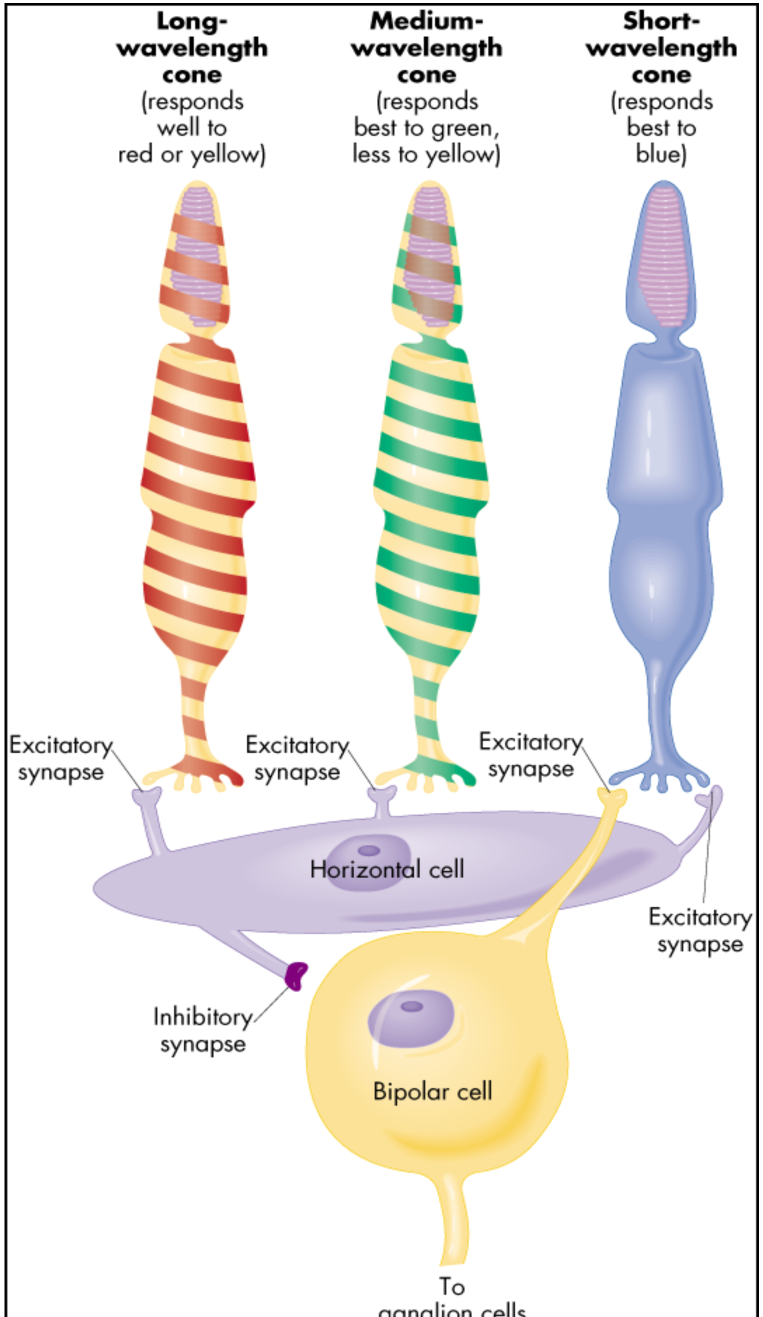
COLOR VISION

- It the ability to discriminate between different colors.

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

2- sensation of extraspectral colors as white, yellow, orange, purple, can be produced by mixing properties of the blue &red & green in different combinations.

3- black means absence of light (not darkness because in dark we do not see black only)


Long-wavelength cone
(responds well to red or yellow)
Medium-wavelength cone
(responds best to green, less to yellow)
Short-wavelength cone
(responds best to blue)
Excitatory synapse
Excitatory synapse
Excitatory synapse
Excitatory synapse
Horizontal cell
Inhibitory synapse
Bipolar cell
To ganglion cells

- Color vision theory : (Young- Helmholtz theory)
- 1- we have 3 kinds of cones each has a specific photopigment (rhodopsin)& is sensitive to one of the 3 primary colors
- a- Blue cone system:- has S pigment (blue sensation pigment) which respond to short wave length (440 nm senses the blue color)
- b- Green cone system:- has M pigment (green sensation pigment) which respond to middle wave length (535 nm senses the green color & less to yellow) & absorb light at the green portion.

c- Red cone system:- has L pigment (red sensation pigment) which respond to large wave length at or > 535 nm so senses the red & yellow color & absorb light at the red portion.

- 2- sensation of any color determined by:
- a- wave length of light
- b- amount of light absorbed by each type of cones
- c- frequency of impulses from each cone system to ganglion cells which is determined by wave length of light.

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)

5- perception of white is due to _equal stimulation of_ blue & red & green cones.There is no wave length corresponds to white, white is a combination of all wave lengths

- **#- <u>Color vision is coded by :-</u>**
- **--different responses in ganglion cells that depends upon the wave length 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.**

- 6-perception of orange is due to stimulation of 99% of red cones & 42% of green cones & 0% of blue cones(so ratio is 99:42: 0)
- 7--perception of yellow is due to stimulation of_ 50% of red cones & 50% of green cones & 0% of blue cones(so ratio is 50:50: 0)
- 8-perception of blue is due to stimulation of 0% of red cones & 0% of green cones & 97% of blue cones(so ratio is 0:0: 97)

- **COLOR BLINDNESS:-**
- **- There is gene for rhodopsin on chromosome(3)**
- **- There is gene for blue sensitive S cone pigment on chromosome(7)**
- **- There is gene for red & green sensitive cone pigment on x chromosome.**
- **- 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**

- - **red – green blindness:-**
- **-Green & red cones see different colors between wave length 525-675 nm & distinguish them.**
- **-If either of these cones are absent, the person can not distinguish 4 colors (red – green- yellow- orange)& he can not distinguish red from green (primary colors) so called**
- **(red – green blindness).**

-It is x- linked disease transmitted from females to their male sons, never occure in females as they have 2 x chromosomes

- 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).

-Females show the disease only if both x chromosomes lack the gene

- Females from color blind fathers are carriers transmit the disease to ½ of their sons.

- **Trichromats** :- have 3 cone pigments(normal or have slight weakness in detecting red or green or blue color
- **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.

Monochromats :- have only one cone system or loss of all so see only black or grey or have no color perception.

- **Nopia = blindness,   nomaly =weakness**

- **1-Protanopia(red- blindness) :- no red cones system so person has shortened spectrum wave length,**
- **if only weakness in red color vision is called protanomaly.**

2-Deutranopia (green - blindness) :- no green cones system
-so person see only long & short wave length)
- if only weakness in green color vision is called deutranomaly.
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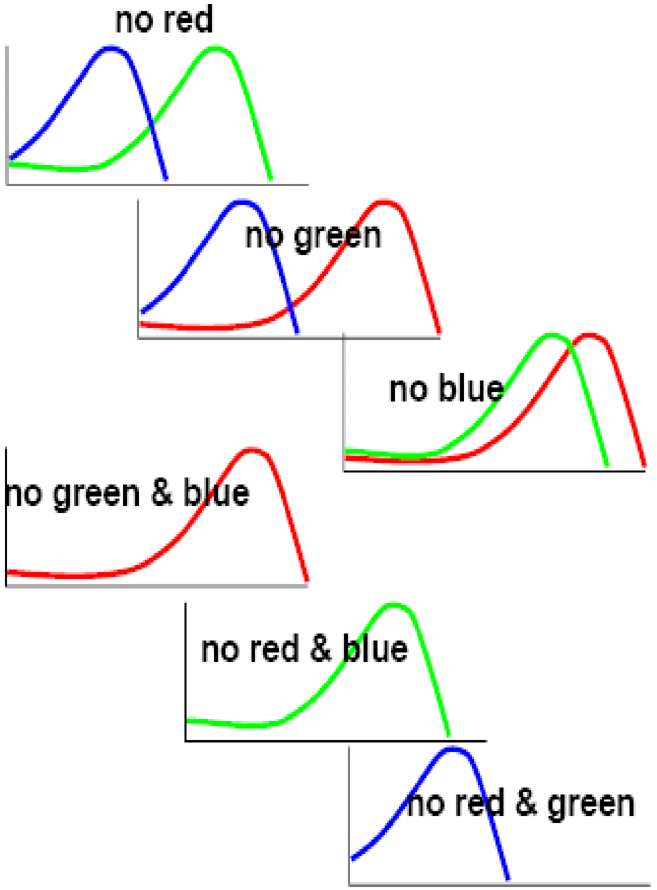
3-Tritanopia (blue - blindness) :- no blue cones system , if only weakness in blue color vision is called tritanomaly.

Colour blindness.

Each cone type contains a different light sensitive photo pigment. Colour blindness occurs when there is a defect in the genes that produce these photo pigments. Various combinations of defects can occur.

1) Missing one cone type
2) Missing two cone types
3) Missing all three cone types (vision is limited to the rods)
4) A cone type is made with a photo pigment different from normal.



How many gradations of colour can the human brain distinguish?

a) 200 **hues**
The brain transforms the single wavelengths of light seen in rainbow into a colour circle. Hues on opposite sides of the circle are complementary.

b) 20 levels of **saturation**
Combinations of two more wavelengths. When complementary wavelengths are combine equally one gets white.

c) 500 **brightness** levels
Any colour on the circle can be made brighter or darker.

Remarkably with only 3 cones types we can see 500x200x20 = 2,000,000 gradations of color