# COLOR VISION

1) Color vision in nature

> If a tree falls in the forest, but no one is there, does it have a color?

   a) Utility

   b) Prevalence

   c) Camouflage

2) Color

   a) Hue
      i) Perception of wavelength

*table 5.2* Typical Hue Names Associated with Spectral Energy Bands

| Approximate Wavelength Region (in nm) | Associated Hue |
|---|---|
| 380–470 | Reddish blue |
| 470–475 | Blue |
| 475–480 | Greenish blue |
| 480–485 | Blue-green |
| 485–495 | Bluish green |
| 495–535 | Green |
| 535–555 | Yellowish green |
| 555–565 | Green-yellow |
| 565–575 | Greenish yellow |
| 575–580 | Yellow |
| 580–585 | Reddish yellow |
| 585–595 | Yelow-red |
| 595–770 | Yellowish red[a] |

   b) Brightness

      i) Note: Change in hue with changes in intensity – Bezold-Brucke shift

   c) Saturation

3) Color mixture

a) Primary Colors

b) Secondary Colors

c) Tertiary Colors

d) Additive color mixture

i) Color circle

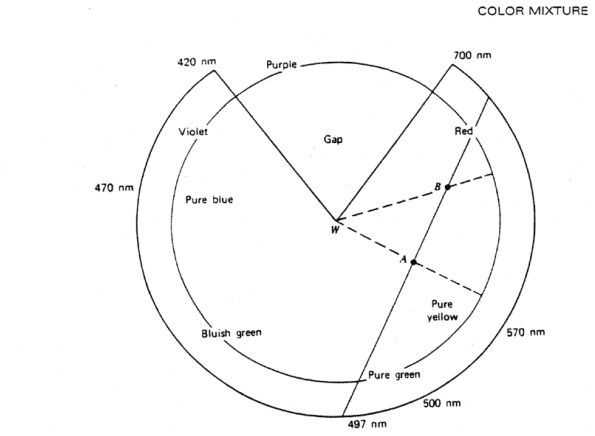



*figure 5.3* The color circle corresponding to the central circle of the color spindle of Figure 5.2.

ii) Complementary colors

(1) Adding even amounts of two colors

(2) Adding different amounts of colors

(3) Reducing intensity of each component

iii) Metamer

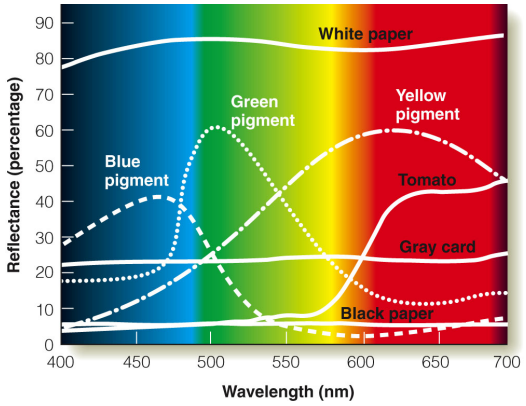
iv) Primary colors

(1) Why 3 colors? Why not 4 or 5 primary colors?

v) Pointillism (Seurat, Signac)

vi) Television/Computer Monitors

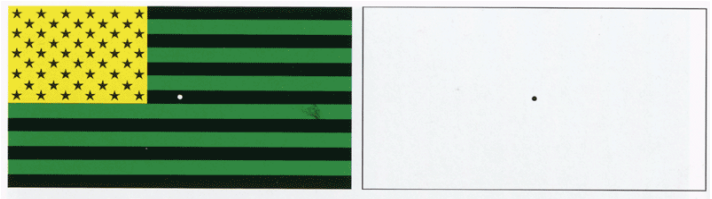
e) Subtractive color mixture




4) Effects in color vision

a) After images

i) Negative after image



b) Memory color

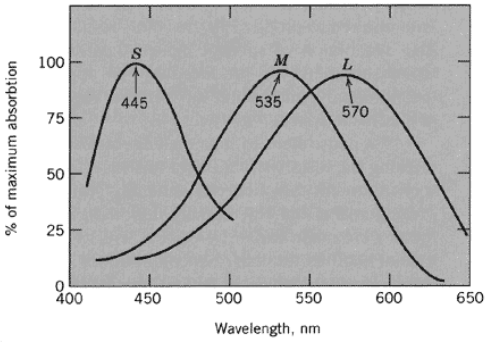
c) Color constancy

5) Theories of color perception

a) Need for a theory

b) Theories:
   i) Trichromatic Receptor Theory
   ii) Opponent Process Theory

c) Trichromatic Receptor Theory (Young-Helmholtz)




i) Cone types

(1) S, M, L cones (=B, G, R cones)

(a) Photopigments

| |
|---|
| Blue (short wavelength) ~445 nm<br>Cyanolabe<br>5-10% of cones<br>sparse<br>periphery of fovea |
| Green (medium) ~535 nm<br>Chlorolabe<br>30% of cones<br>many more<br>center of fovea |
| Red (long) ~570 nm<br>Erythrolabe<br>60% of cones<br>many, many more<br>center of fovea |

(2) Retina acts as a spectral analyzer

ii) Explanatory power

(1) Sidebar: Cone functioning

(2) Complementary afterimages

iii) Questions

(1) Are there things that Trichromatic Theory cannot explain?

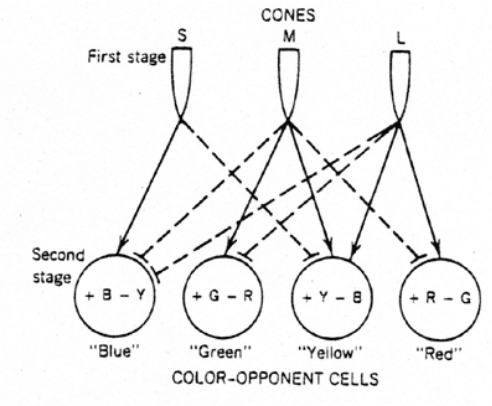
(a) Adding blue light to yellow light yields white or gray

(i) The Trichromatic Theory explains this as…

(ii) But…

(b) Visualization: You cannot visualize reddish-green or bluish-yellow

d) Opponent Process Theory (Hering; Hurvich & Jameson)




i) Two stage process

(1) 3 cones system at retina

(2) 3 opponent processes at higher levels

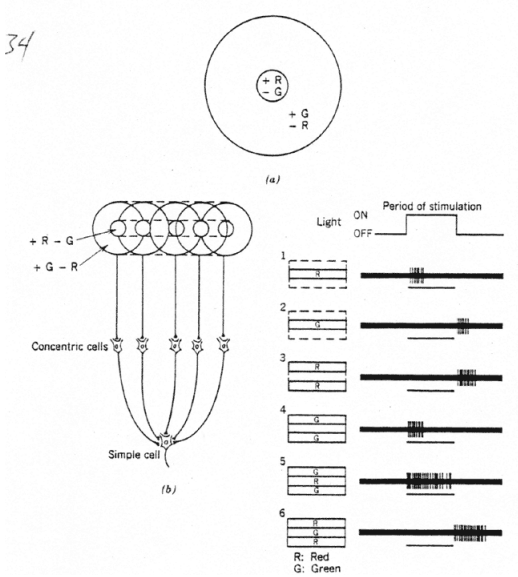
(a) white-black

(b) blue-yellow

(c) red-green

ii) Ganglion + LGN cells have opponent processes / center-surround with colors

e) Blobs in cortex




i) Color-opponent neurons with *double-opponent* receptive fields

ii) Center surround

iii) A series of these cells can detect color bars, as well as patterns of green-red-green-red, etc.

6) Defective color vision

    a) Monochromatism

    b) Dichromatism

        i) Protanopia

        ii) Deuteranopia

        iii) Tritanopia

    c) Trichromatism anomaly

        i) Protoanomaly

        ii) Deuteranomaly

    d) Achromatopsia

7) Subjective colors

    a) Benham's top

    b) Kinetic art (e.g., Jesus Soto)