Rose-colored Glasses: How Our Eyes Perceive Color and How You Can Manipulate Color Like a Wizard

Cira Collins, ABOC-ADV, MPH

1

Cira Collins

- Photo

- Sorted into House Opticianro 17 years ago
- Corporate and Private Practice
- Dispenser, Buyer and Vendor
- ABO-Advanced, working toward ABOM
- NAO Fellow, Member of State Associations
- Master of Public Health, International Health and Development – Tulane University
- Returned Peace Corps Volunteer

2

Class Overview

Color Perception
- Brief Review of the Anatomy of Color Perception
- Dig Deeper into Cones and Electric Impulses to Brain
- Understand how the brain interprets color
- Understand how culture interprets color

Color Manipulation:Wizardry
- Filters: Tints and Polarization
- Mirrors

3

Why?

When we understand how we perceive color and then learn to manipulate color, we can better understand the tools that we already use (mirrors, polarization, tints) to improve the cosmetic outcomes of the eyewear we make and address real patient problems.

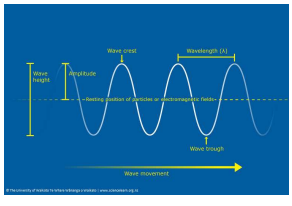
4

Understanding Light and Color

5

Wavelength vs Frequency of Light

- The distance between two consecutive crests or troughs, or light waves, is measured in wavelength.
- The number of times light waves recur per unit of time is referred to as frequency.
- Wavelength and frequency are inversely proportional to each other. This means, the higher the value of wavelength, the lesser the frequency and vice versa.
- Example – Amplitude of wave (height), Frequency of wave (how many waves in a given period), Wavelength (how long it took to make a wave)



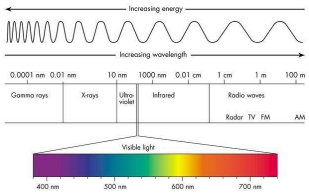
6

We focus on Light Wavelengths

- Wavelength:
- Visible Light (400-700 nm)
- Electromagnetic Spectrum
- Short wavelengths have highest energy, most potential to do harm
- Long wavelengths are least likely to penetrate lids, ocular structures
- Each wavelength in the visible light spectrum corresponds to a color in the electromagnetic spectrum

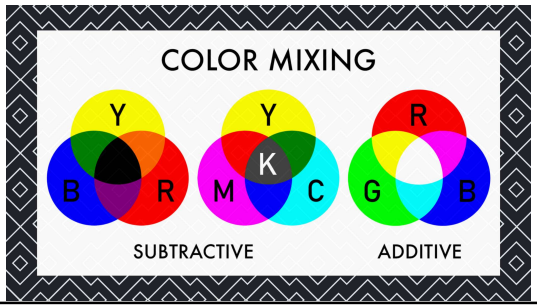
7

Electromagnetic Spectrum



8

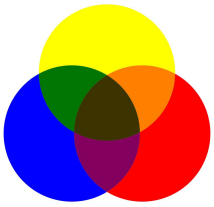
Color Models - Additive or Subtractive



9

RYB

- Color Mixing – Pigments
- Subtractive – Think of light reflective off the subject to create color.
- Combine all colors, get Brown or Black
- Reflected Light, Chromophores absorb light in matter (usually in molecules as double bonds)



10

CMYK

- Subtractive – Removes Light
- Reflective Light – We start with White and subtract colors out (think white page)
- Printing
- Combine all colors, get black
- Reflected Light

11

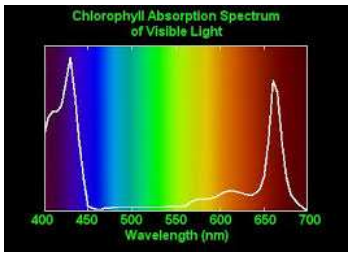
RGB

- ADDITIVE – By adding colors of LIGHT
- Digital Media
- Combine all Colors, get WHITE
- Red+ Green = Yellow
- Red + Blue = Magenta
- Blue + Green = Cyan
- Absorbed Light

Photo Credit: Colormeaning.com

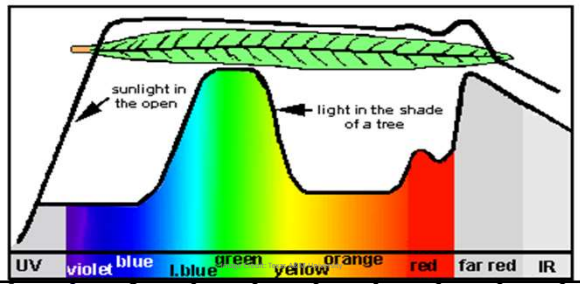
12

Reflected Light – Chromophore Absorption



13

Absorbed Light by the eye



14

All colors are a combination of RGB Light

Yellow = Red + Green
Orange = Also Red + Green with more Red
Black = Absence of all Light
White = Presence of all Light
Brown = Presence of some level of specific colors
Pink = Presence of a lot of red light and a little of all else

15

The Anatomy of Color Perception

16

Scotopic vs. Photopic Vision

Scotopic Vision
- Black and White
- Motion
- Rhodopsins
- 120 Million + Rods, mostly in periphery
- Bleached – Broken down into All Trans Retinal and Opsin
- Regenerated

Photopic Vision
- Color
- Tremendous Acuity
- Photopsins
- 6-7 Million Cones
- Mostly in Macula Lutea and Fovea Centralis
- Fewer Blue (Short) Cones than Green (Medium) or Red (Long)

17

Rods and Cones

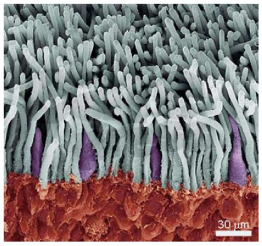
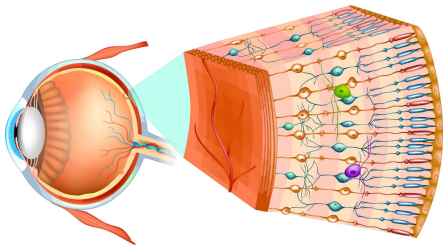


Photo Credit: Douglas R Keene

18

Anatomy of Color Perception



19

Movement of Light to the Cones

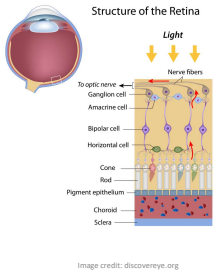
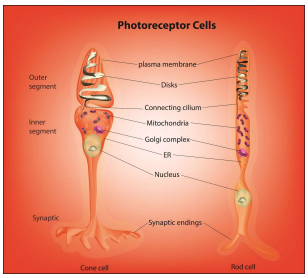


image credit: discovereye.org

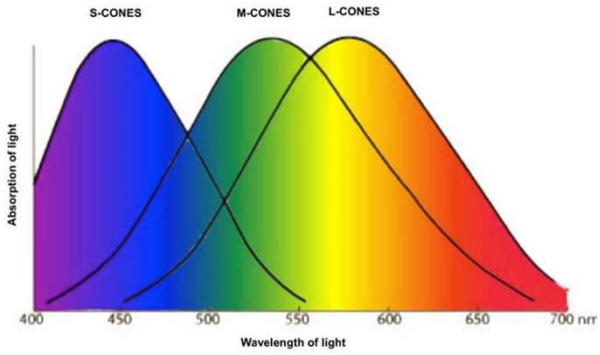
20

Cone and Rod Cells

- Opsins – Light senstive and reactive compounds
- Photopsins are found in the Disks at the top of the cell.
- The type of photopsin determines the wavelength of light (Short, Medium or Long, i.e Blue, Green or Red) that the cone will be.
- Cone opsins use the same 11-cis-retinal as rhodopsin in rods, but have very different spectral sensitivity.



21



22

Opsins are Photoreactive Protiens

Rhodopsin
- Found in Rods
- Vitamin A Gets Broken down into 11 Cis Retinall and Hydrogen Ions – Ions, Sodium and Calcium are used to send electrical signal to brain by turning off channels of ion flow
- Converts light to electricity
- Most sensitive at about 498nm

Cone Opsins
- L Cone Opsin – Red 557 - 564nm
- M Cone Opsin – Green 527- 533 nm
- S Cone Opsin – Blue 420 - 437 nm

23

Phototransduction Cascade

- How the eye translates light into chemicals
- Opsins – are Photoreceptor Compounds.
- Vitamin A Gets Broken down into 11 Cis Retinal, then Transducin and Hydrogen Ions – Ions, Sodium and sometimes Calcium and Magnesium, are used to send electrical signal to brain by turning off channels of ion flow.
- Charged ions travel via the ganglion cells, back to the cranial nerve II (Optic Nerve) and to the brain.

24

Contact me: Cira@me.com

Pathway to the Brain

- Retina Ganglion Cells send electricity to the brain
- Eye via Cranial Nerve II (Optic Nerve)
- Thalmus
- Midbrain (temporal lobe and perietal lobe)
- Occipital Lobe, near the back of the skull
- Interpreted in the Striate Cortex in what we call VISUAL PERCEPTION.

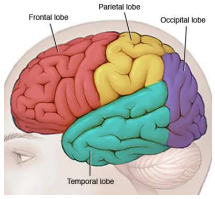


Image Credit: Mayo Clinic

25

Melanopsin Retinal Ganglion Cells (Intrinsically Photosensitive Cells)

- In the RPE, we have melanocytes that contain MELANOPSIN (5 of 9)
- Melanopsin triggers the chemical cascade that creates Melatonin, controlling Wakefulness
- Controls:
  - Wakefullness
  - Blood Sugar Levels
  - Dopamine Levels
  - Pain Receptors
- Analagous to frog eyes
  - Especially dense below macula
  - Ten Minutes of being outside when the sun is low in the sky each day can help regulate all of the above as a result, even in people with no vision.

26

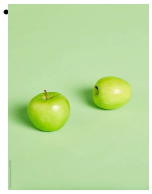
Color Blindness - Cones lack photopsins

Image Credit: Sightsavers.org

27

Visual perception is context specific

Color Comparison



Color Contrast

28

Color Language is CULTURALLY Specific

29

Color attaches to our emotion culturally

Color	Western Europe & North America	Asia	Middle East
red	danger, anger, love, passion, excitement, action, adventure	joy, happiness, celebration, luck, prosperity	danger, evil, caution
green	nature, progress, regeneration, eco-friendliness, luck, money, jealousy	youth, eternity, future, energy, exorcism, infidelity	fertility, strength, luck, wealth, prestige, spirituality
blue	masculinity, calm, authority, trust, peace, sadness, calm, loyalty	femininity, immortality, wealth	protection, safety, heaven, immortality, spirituality

Chart Credit: Eriksen Translations

30

Color is SPECIES Specific

- Dogs and cats lack red and green cones. Green lawns look brown or orange.
- Mantis Shrimp see hundreds of colors we cannot see.
- Pit vipers can SEE heat emissions
- Ground Squirrel can see UV light.
- Diving Birds have bisected pupils and their brains can calculate the refractive properties of water.

31

WIZARDRY!

Photo Credit: Lego

32

Absorption and Transmission

Absorption
- the reduction of transmission of radiant energy through a medium
- The more dense a tint, the more absorption
- Example: G-15 absorbs 85% of light

Transmission
- the transit or passing of radiant energy through a medium
- The more dense the tint, the less transmission
- Sun Lenses should allow 15-30% of transmission, Absolute darkest about 8%

33

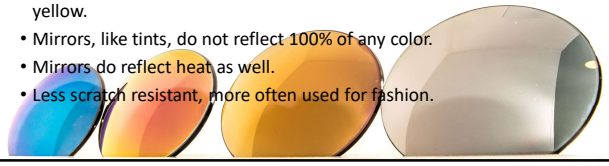
Polarization

Photo Credit: BBC, This Old House

34

Mirrors

- Mirrors reflect back the color that you see on the outside, letting complementary colors through the lens more vibrantly.
- Think of Blue Mirrors used for fishing glasses: The water's surface is absorbing everything but blue and shooting it at you, your mirror lens reflects blue back, making the image you see look warmer, more yellow.
- Mirrors, like tints, do not reflect 100% of any color.
- Mirrors do reflect heat as well.
- Less scratch resistant, more often used for fashion.



35

Color Wheel

- Tints block the color of light that is across the color wheel and make you feel like you are perceiving more in the color of the tint.
- For example, a red lens is opposite Cyan on the RGB Color Wheel, thus Cyan, in addition to the red, will appear dark brown or black and seem to disappear.

36

Gray Lenses

- Reduce transmission of all wavelengths of colors, mostly uniformly*
- Thus is truest in color
- Good for: Photographers, color enthusiasts, getting darkest lenses
- Conditions: Optic Neuropathy, Albinism, Photophobia, Parkinson's Disease, Blinking Spasms in bright light.

37

Brown Lenses

- Enhance Contrast
- Most closely mimics Melanin
- Conditions: Sun Lenses for people with cataracts, glaucoma, low vision

38

Red

- Conditions: Retinitis Pigmentosa, Low Vision, Light-Induced Migraines, AMD, Brain Trauma, Color Blindness (Deuteranomoly), Dyslexia

39

Orange/Amber

- Conditions: AMD, Optic Neuropathy, Brain Trauma, Contrast Sensitivity, Computer Related Eyestrain, Dyslexia, Light-Induced Migraine, Low Vision, Retinitis Pigmentosa

40

Yellow

- The best starter lens for many comfort-related conditions, but may be cosmetically less appealing.
- These block blue, but usually, the concentration is so mild that it is only a partial blocker. It is very difficult to get fully absorptive yellow
- Adored by truckers and gamers for taking the edge off of oncoming bright lights
- Conditions: AMD, Autism, Cataracts, Computer-Related Eyestrain, Contrast Sensitivity, Glaucoma, Insomnia, Multiple Sclerosis, Visual Snow Syndrome

41

Green

- Conditions: Light-Induced Migraine, Visual Snow Syndrome, Dyslexia, Optic Neuropathy, Autism

42

Contact me: Cira@me.com

Blue

- Conditions: Think Blue=Brain – Soothes agitated brains
- Brain Trauma, Autism, Dyslexia, Parkinson's Disease, Light Induced Epilepsies, Strabismic Amblyopia (Lazy Eye), Visual Snow Syndrome

43

Purple/Plum/Magenta

- Color Blindness, Especially Protanomoly: Enchroma Lenses

44

Pink

- Conditions: Dyslexia, Computer-Related Eyestrain,

45

Specialty Tints: Expensive but Therapeutically Significant

- FL-41: A deep, orange/brown color. Used for: Photophobia, Light-Induced Migraine, Color Blindness, Brain Trauma, Lid Spasms.
- Deep Blue Zee: A very deep blue color, blocks a LOT of light. Used for: Photosensitive Epilepsy, Parkinsons, Strabismic Amblyopia,
- Omega: :Light Blue, similar to Maui Jim Opthalmics High Contrast Lens, Used for: Brain Trauma, Dyslexia, Autism

46

No Tint is a Cure All for Everyone

- Use tint samples to assess comfort of the wearer or Filter Simulators
- BPI Lens Color Filter Selector (callbpi.com)

47

A word about Syntonics

- Syntonics is an optometric phototherapydealing with the application of selected light frequencies through the eyes.
- It has been used clinically for over 70 years in the field of optometry with continued success in the treatment of visual dysfunctions.
- Effective for: Focusing issues, strabismus, amblyopia, convergence problems, learning disorders, affects of stress and trauma, brain injuries, emotional disorders, jet lag, PMS, sleep disorders, mood and behavior disorders.

48

Contact me: Cira@me.com

Thank you!

- Please remember to evaluate the session to receive credits at your VEW Login/App
- Reach out at cira@me.com

49