

511-2017-10-13-perception-II

Rick Gilmore

2017-10-17 08:24:47

Prelude

Johnny Nash - I Can See Clearly Now



I can see clearly now.

Today's topics

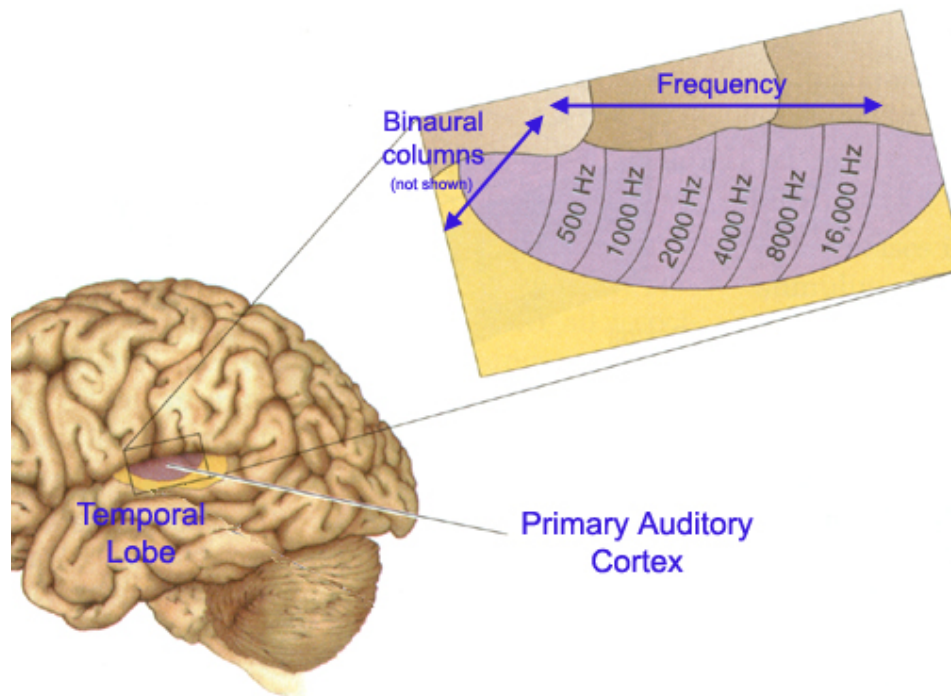
- Common principles in sensation & perception
- Case study: Vision

Common Principles

- Topographic maps

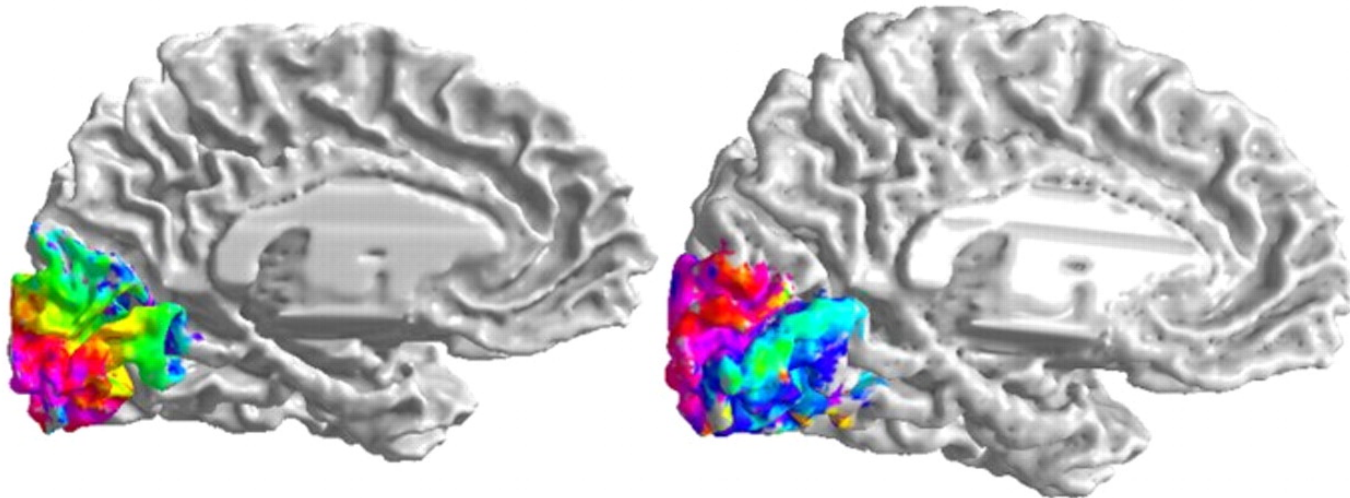
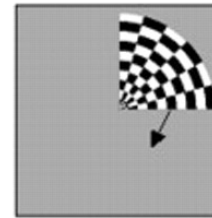
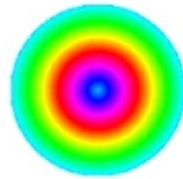
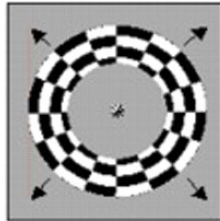
Tonotopic (frequency) maps in auditory cortex

Tonotopic Map Has Columnar Organization



<http://www.his.kanazawa-it.ac.jp/~tomi/public/MEGLab/Auditory/tonotopy.gif>

Retinotopic maps in visual cortex

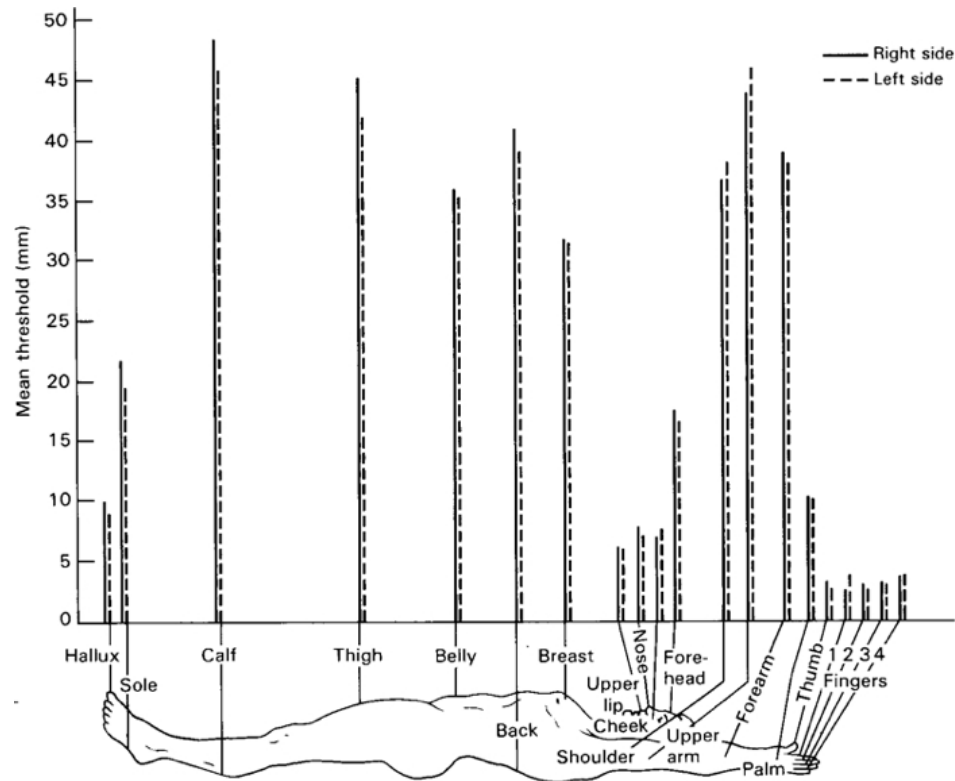


<http://jov.arvojournals.org/data/Journals/JOV/933499/jov-3-10-1-fig001.jpeg>

Common principles

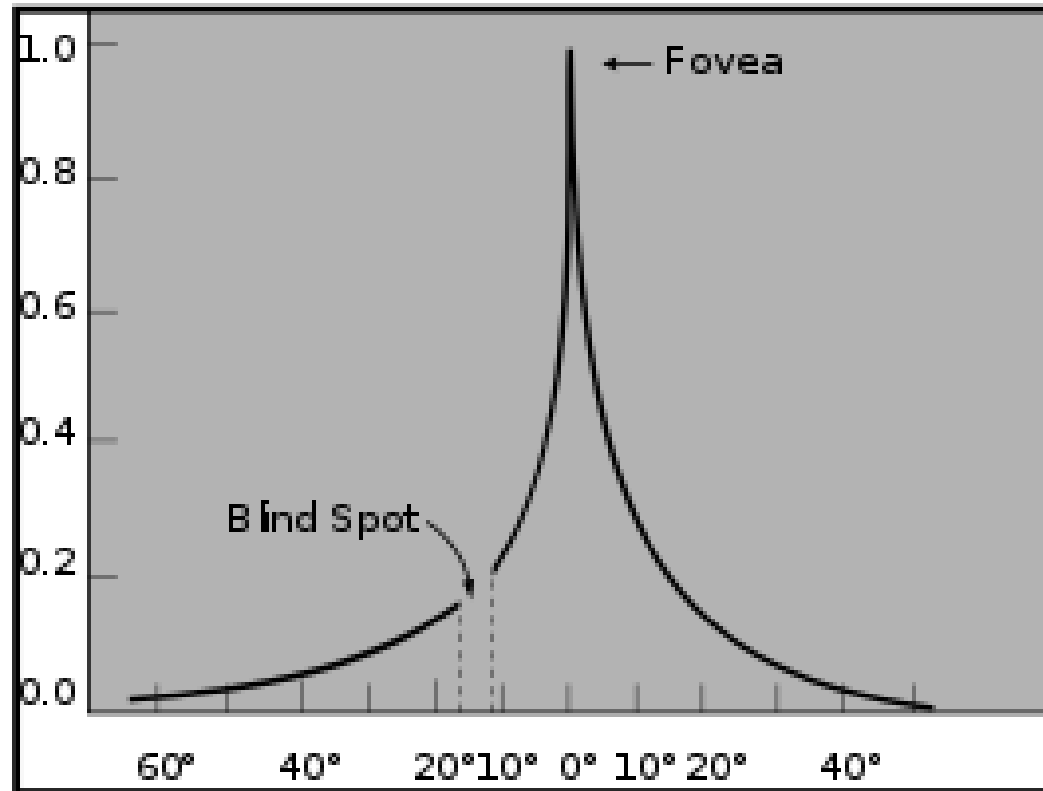
- Non-uniform sensitivity

Two-point touch thresholds



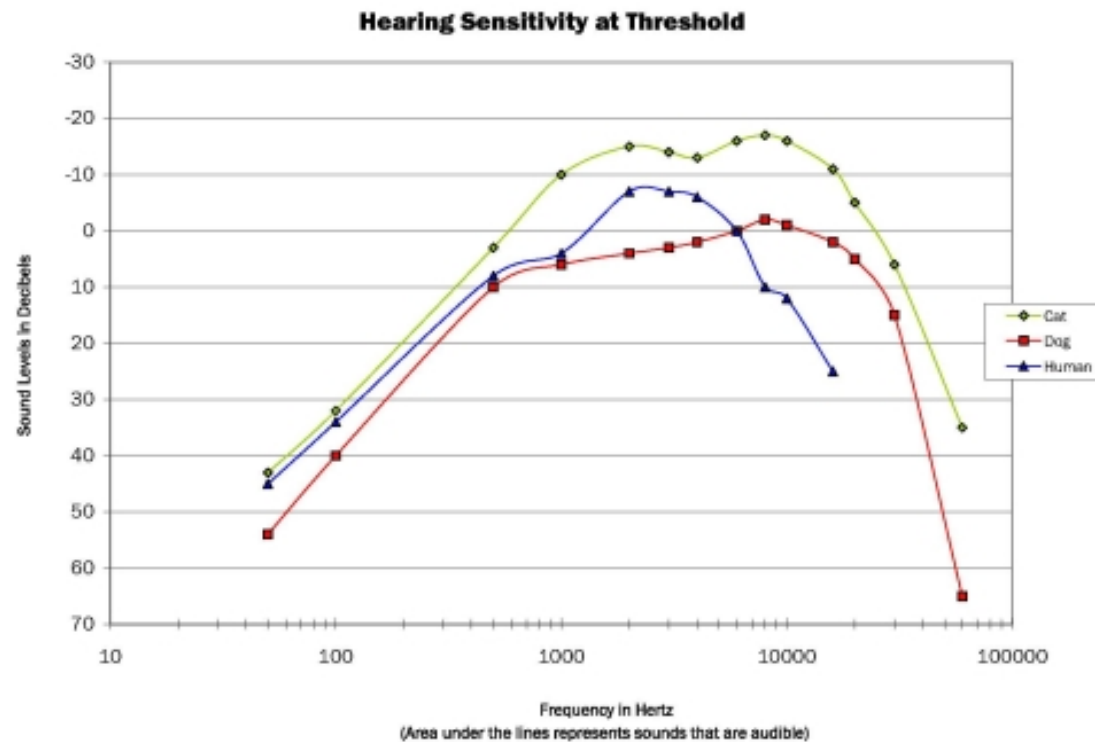
<http://jov.arvojournals.org/data/Journals/JOV/933499/jov-3-10-1-fig001.jpeg>

Acuity variations across visual field



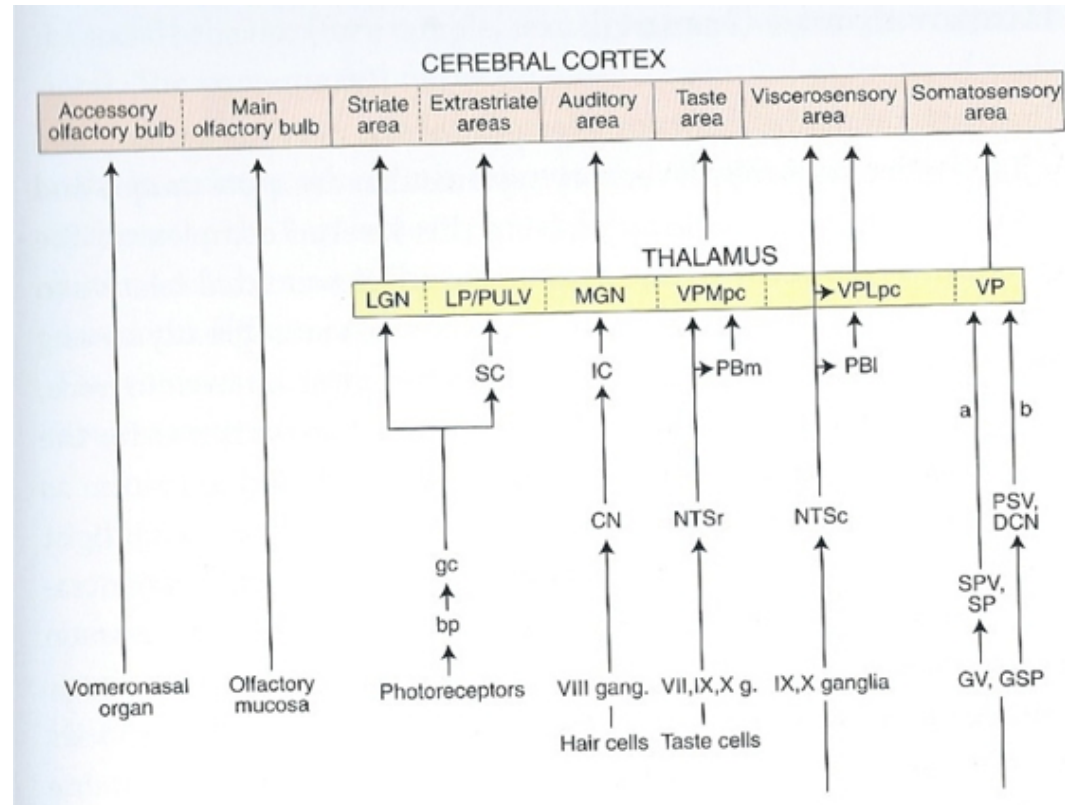
<https://upload.wikimedia.org/wikipedia/commons/thumb/2/27/AcuityHumanEye.svg/270px-AcuityHumanEye.svg.png>

Hearing threshold varies across frequency

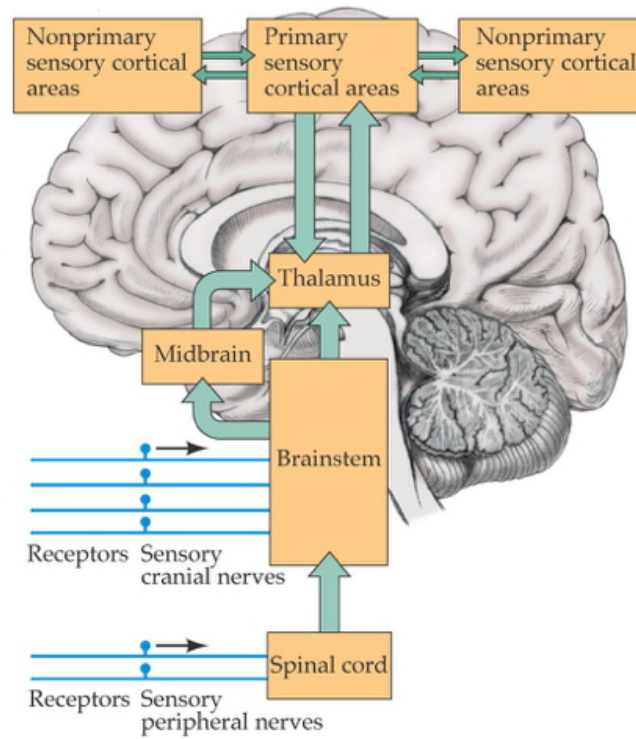


http://www.hearforever.org/userfiles/image/tools_to_learn/SS4_Hearing_Sensitivity.jpg

Hierarchical processing

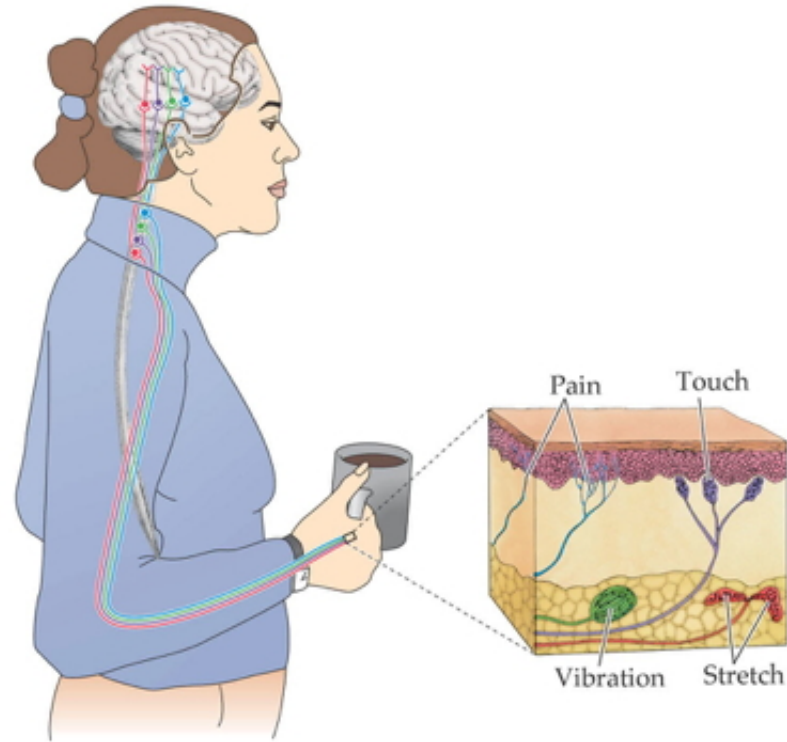


Parallel processing



BIOLOGICAL PSYCHOLOGY, Fourth Edition, Figure 8.8 © 2004 Sinauer Associates, Inc.

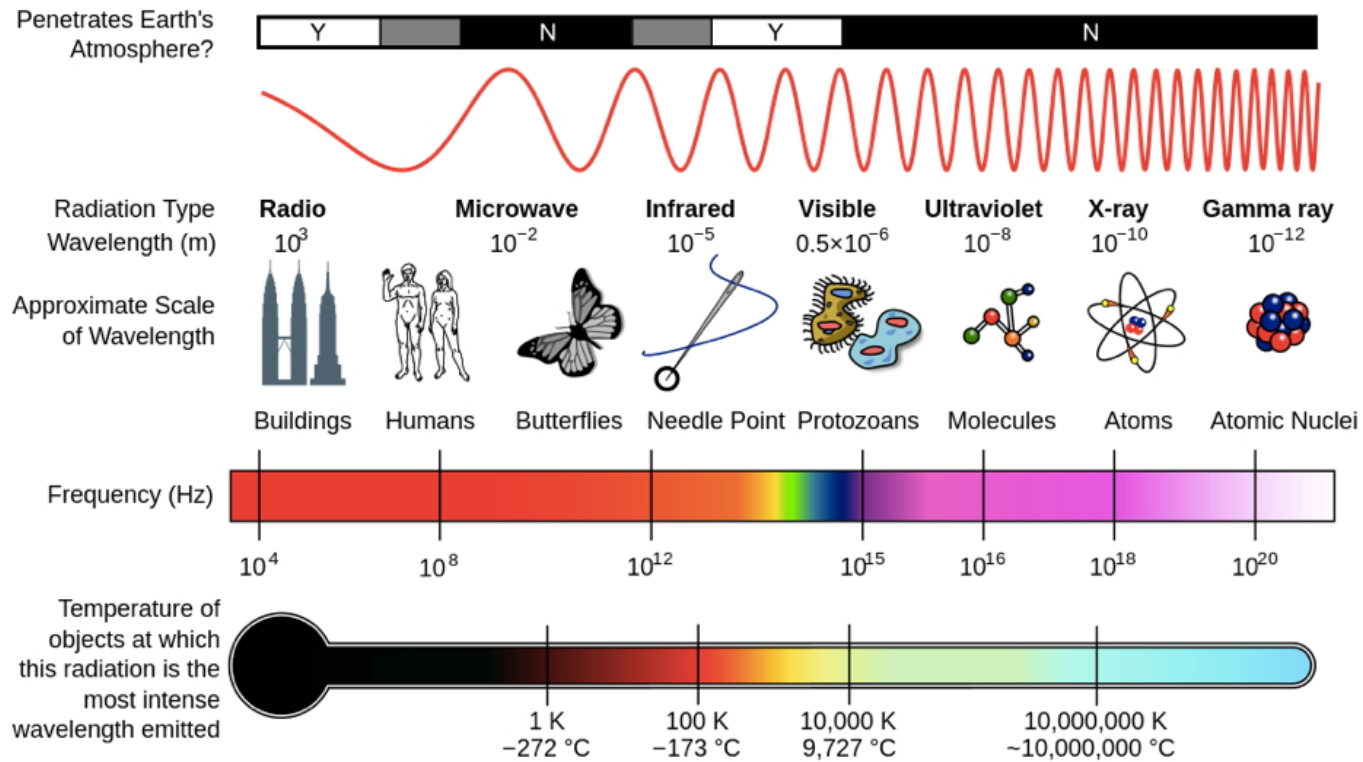
Parallel processing



BIOLOGICAL PSYCHOLOGY, Fourth Edition, Figure 8.3 © 2004 Sinauer Associates, Inc.

Case study: Vision

Electromagnetic (EM) radiation

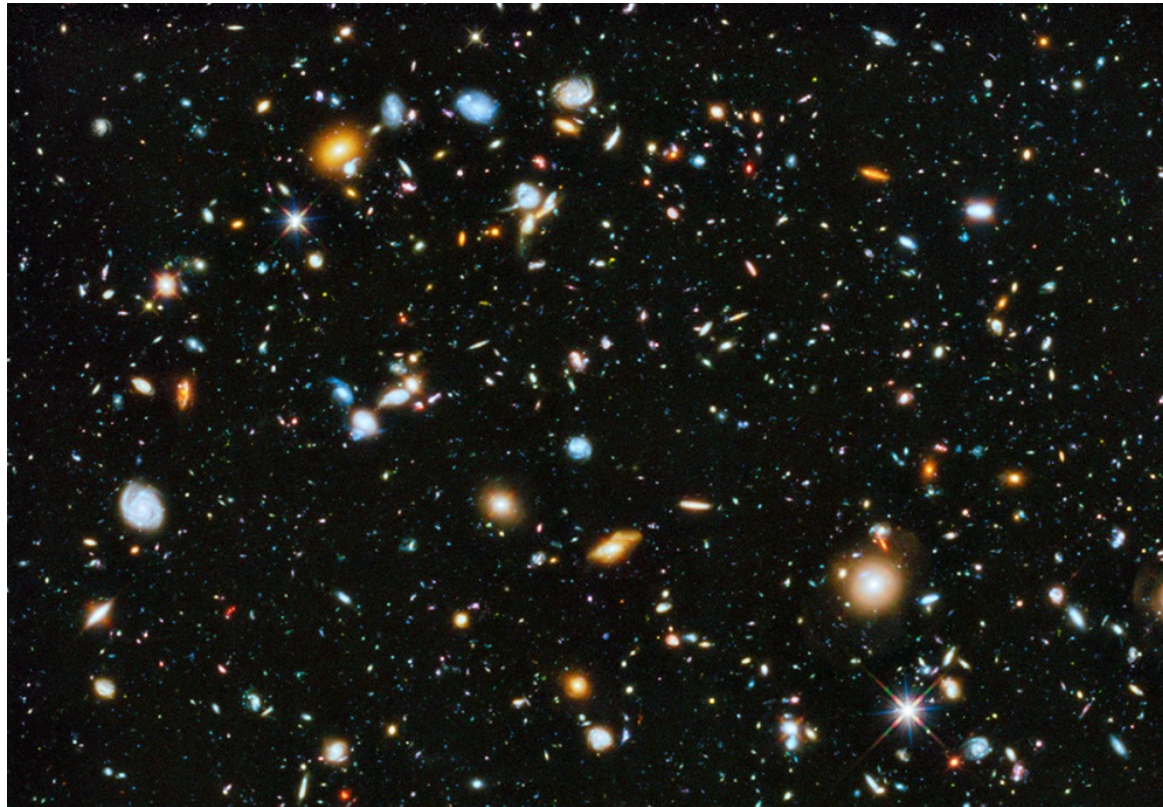


http://en.wikipedia.org/wiki/File:EM_Spectrum_Properties_edit.svg

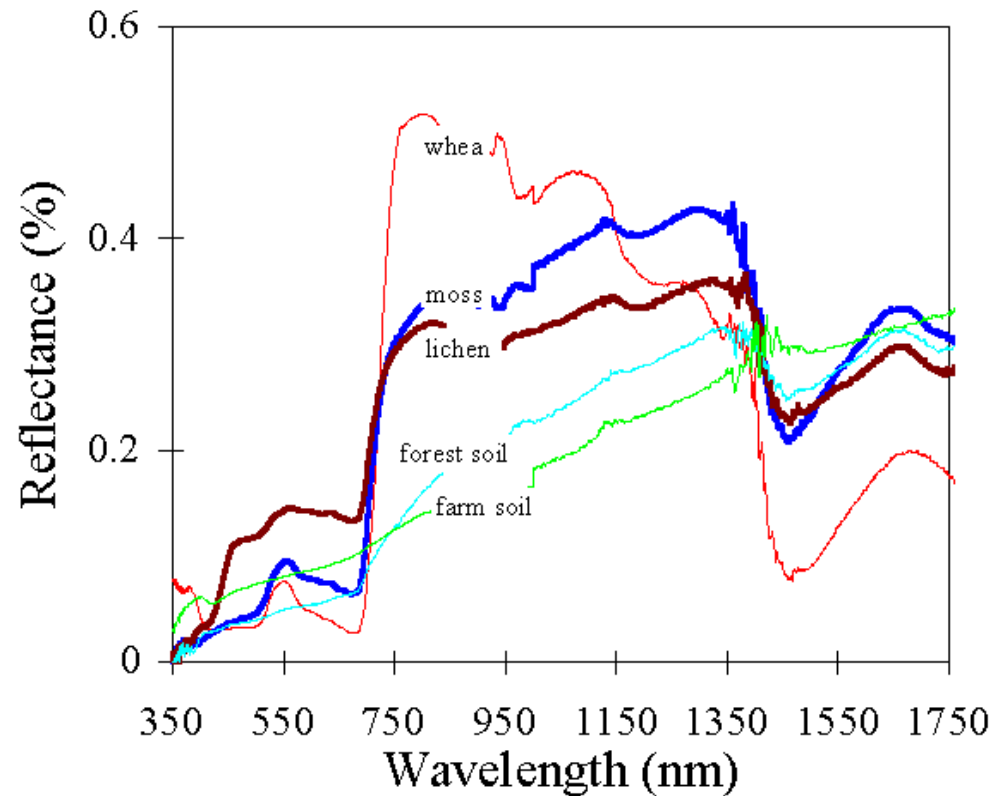
Features of EM radiation

- Wavelength/frequency
- Intensity
- Location/position of source
- Reflects off some materials
- Refracted (bent) moving through other materials

EM radiation provides information across space (and time)

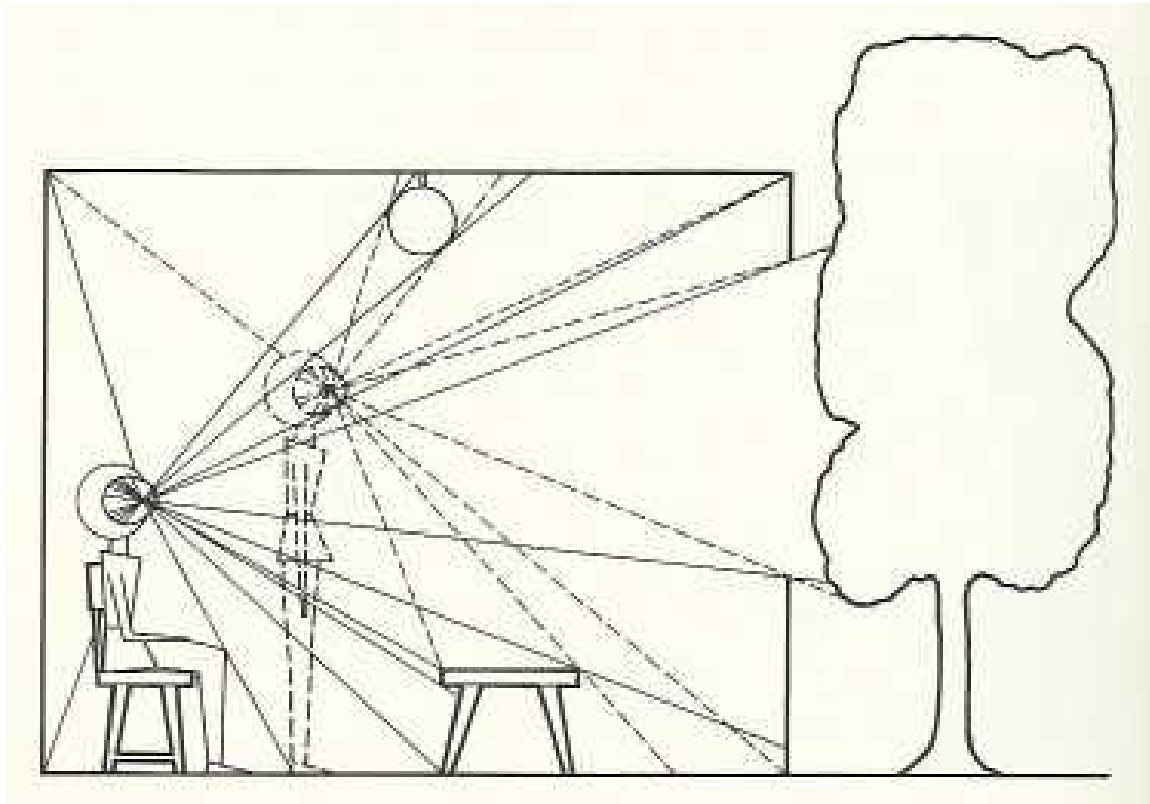


Reflectance spectra differ by surface



http://http://www.vgt.vito.be/userguide/book_1/4/42/ie42bd.gif

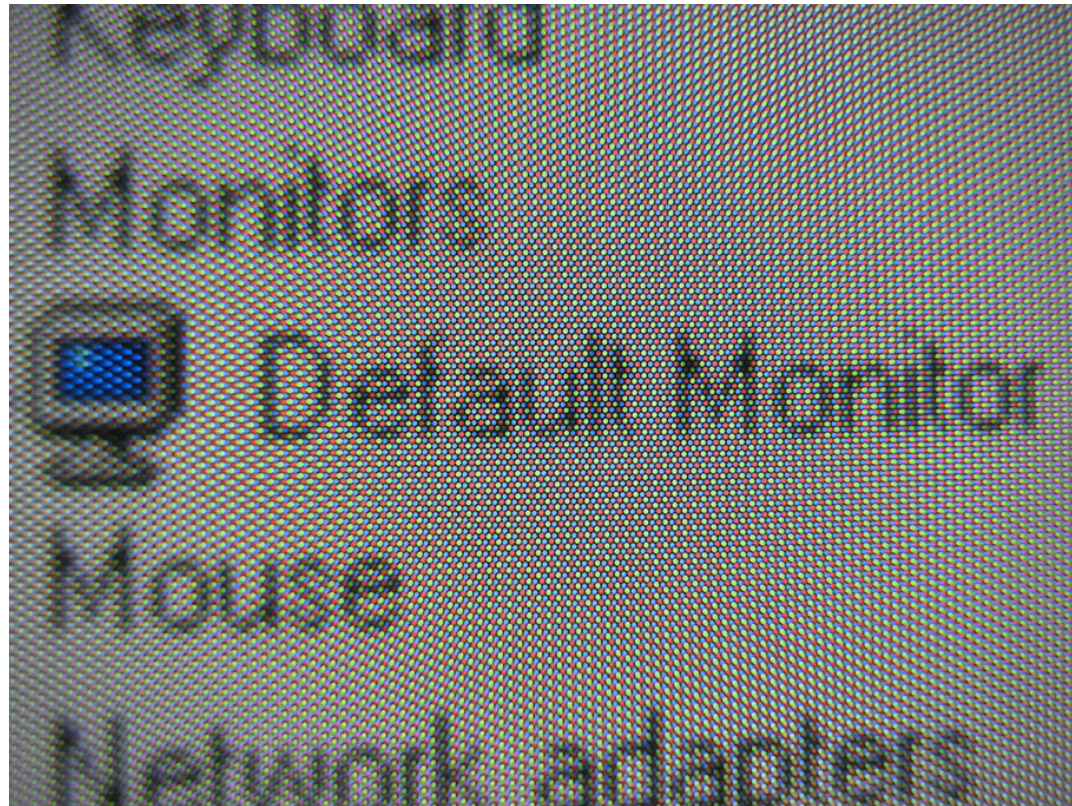
Optic array specifies geometry of environment



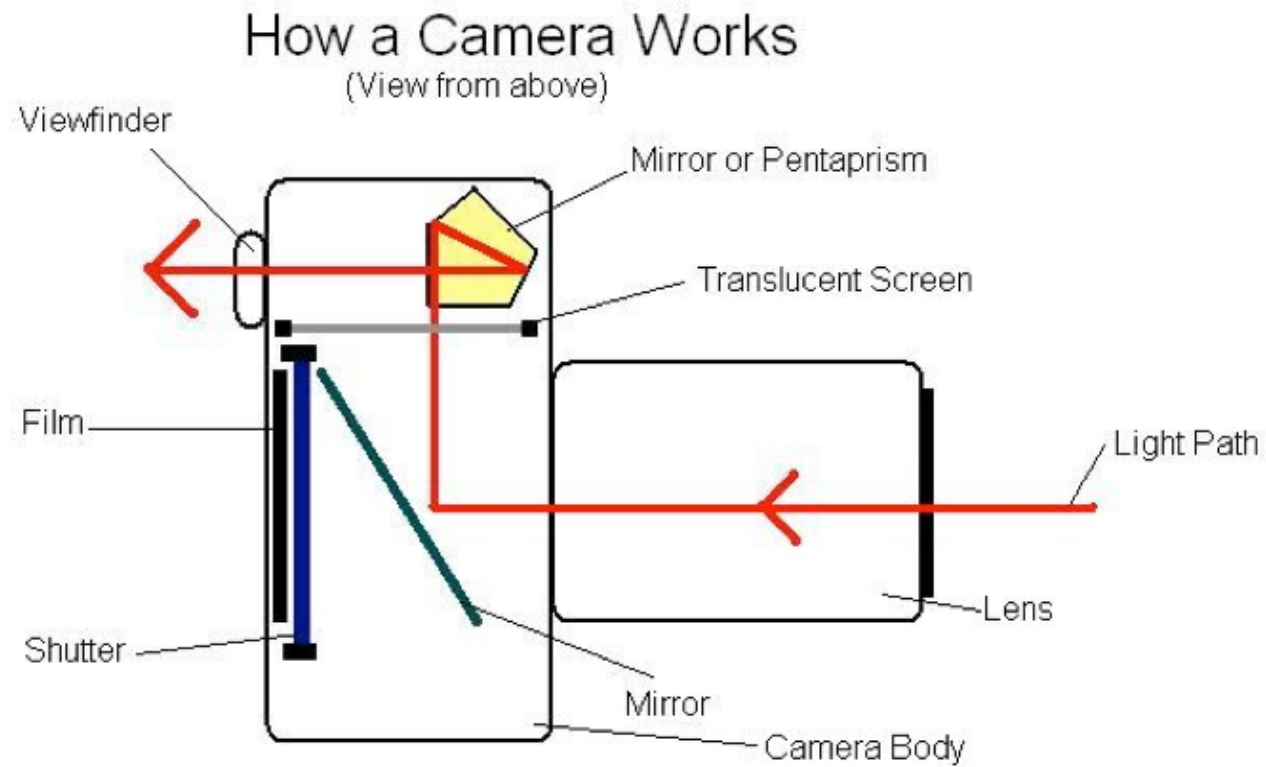
Color == categories of wavelength

- Eyes categorize wavelength into relative intensities within wavelength bands
- RGB ~ **Red**, **Green**, **Blue**
 - Long, medium, short wavelengths
- *Color is a neural/psychological construct*

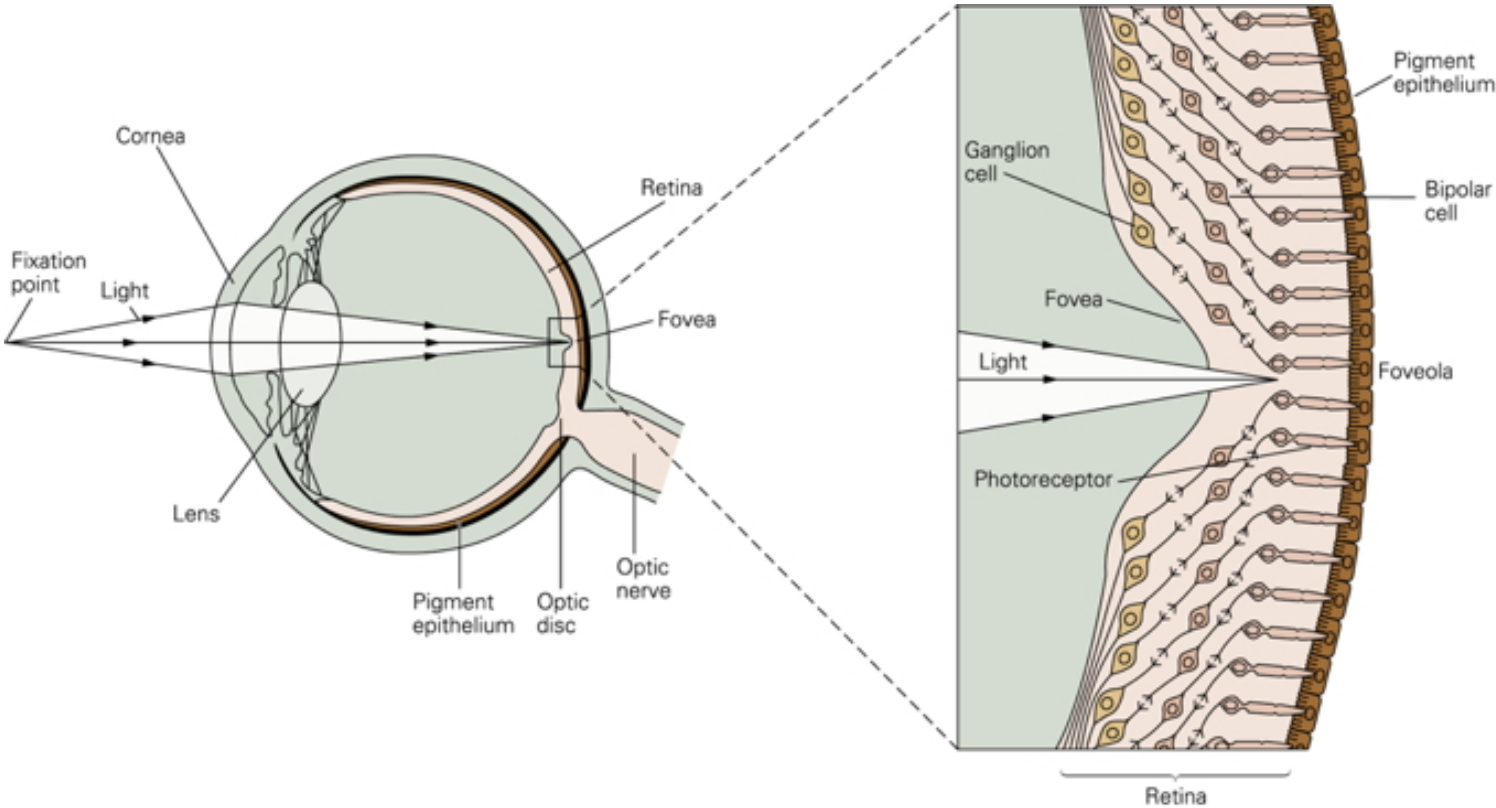
RGB monitors



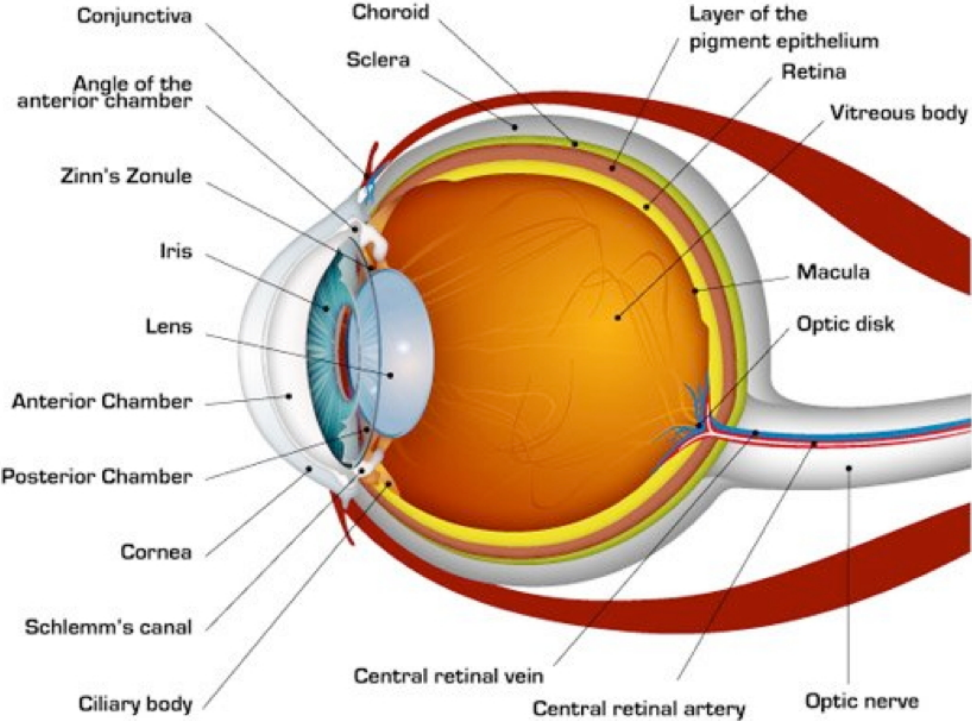
How a camera works



The biological camera



The biological camera



Parts of the eye

- *Cornea* - refraction (2/3 of total)
- *Pupil* - light intensity; diameter regulated by Iris.
- *Lens* - refraction (remaining 1/3; focus)

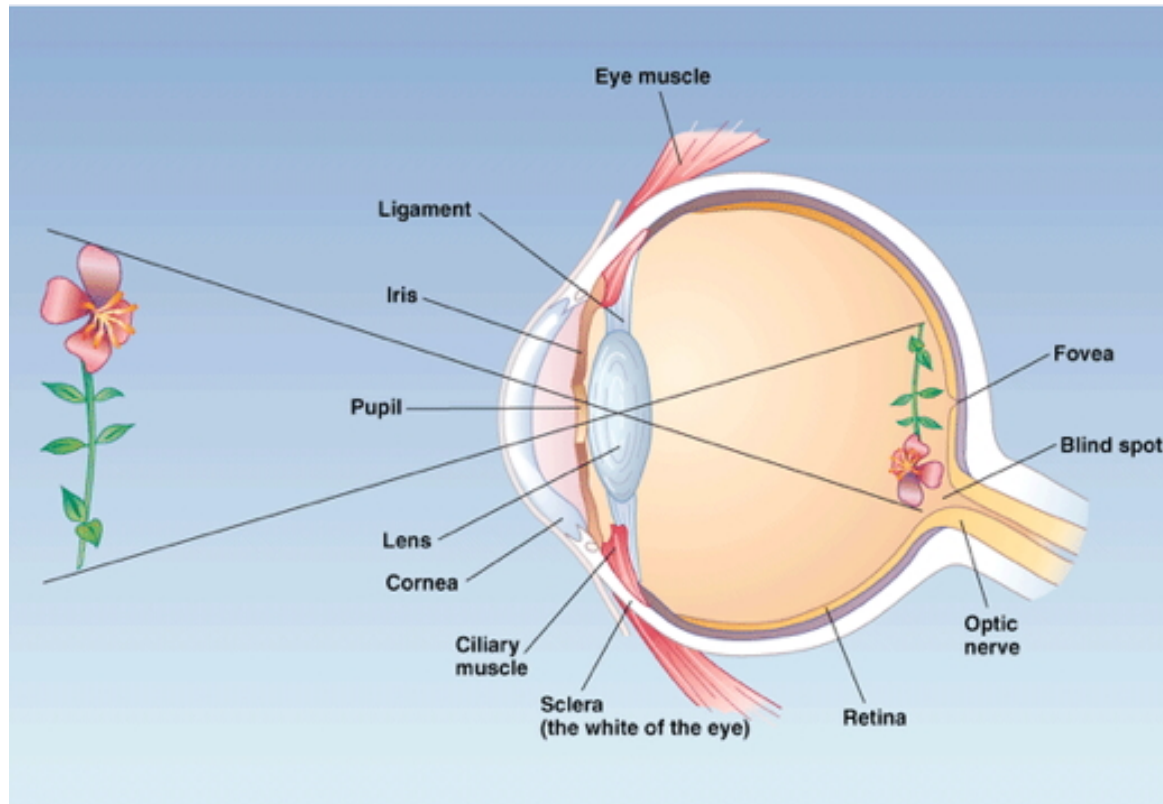
Parts of the eye

- *Retina* - light detection
 - ~ skin or organ of Corti
- *Pigment epithelium* - regenerate photopigment
- *Muscles* - move eye, reshape lens, change pupil diameter

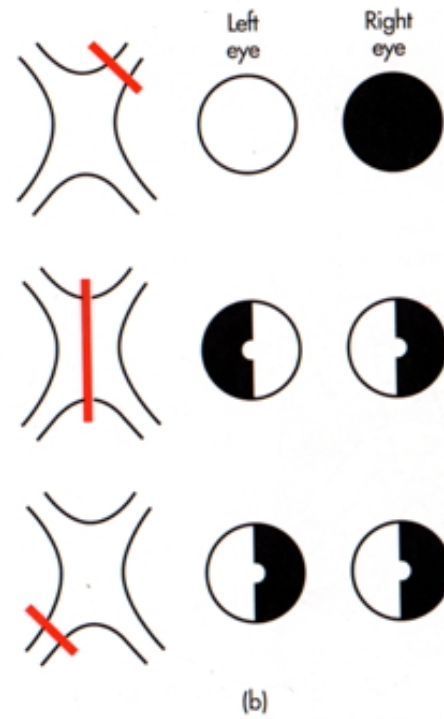
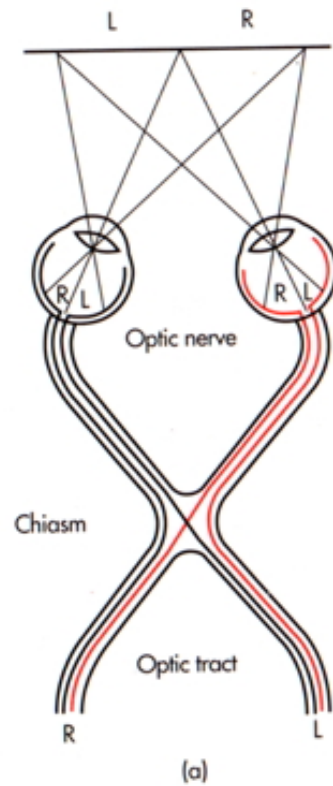
Eye forms image on retina

- Image inverted (up/down)
- Image reversed (left/right)
- Point-to-point map (*retinotopic*)
- Binocular and monocular zones

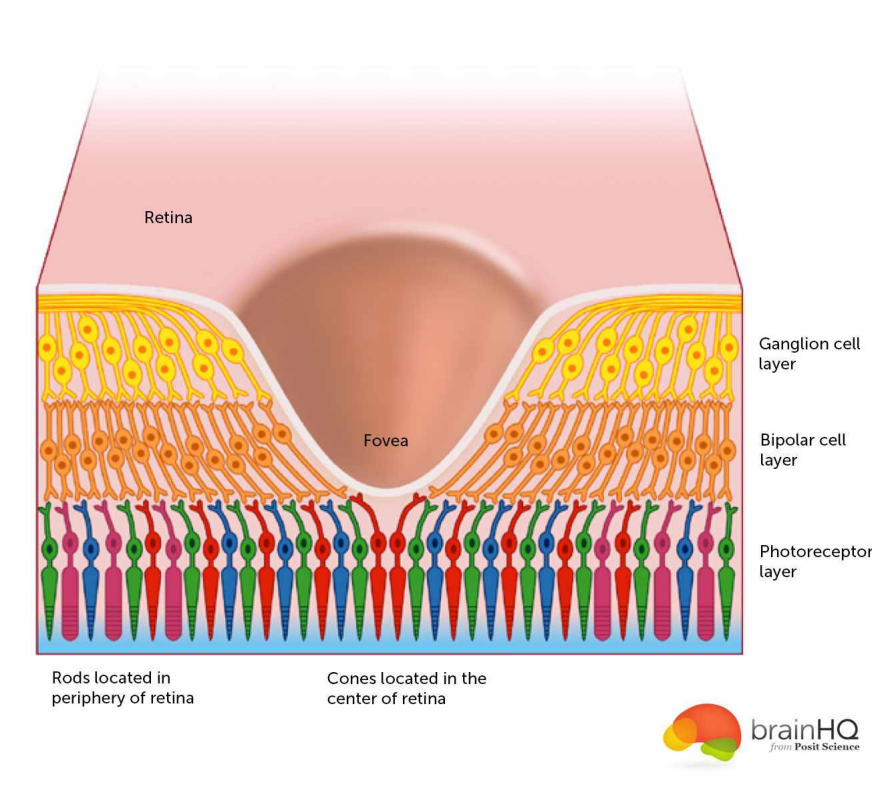
Retinal image



Eyes views overlap



The *fovea*

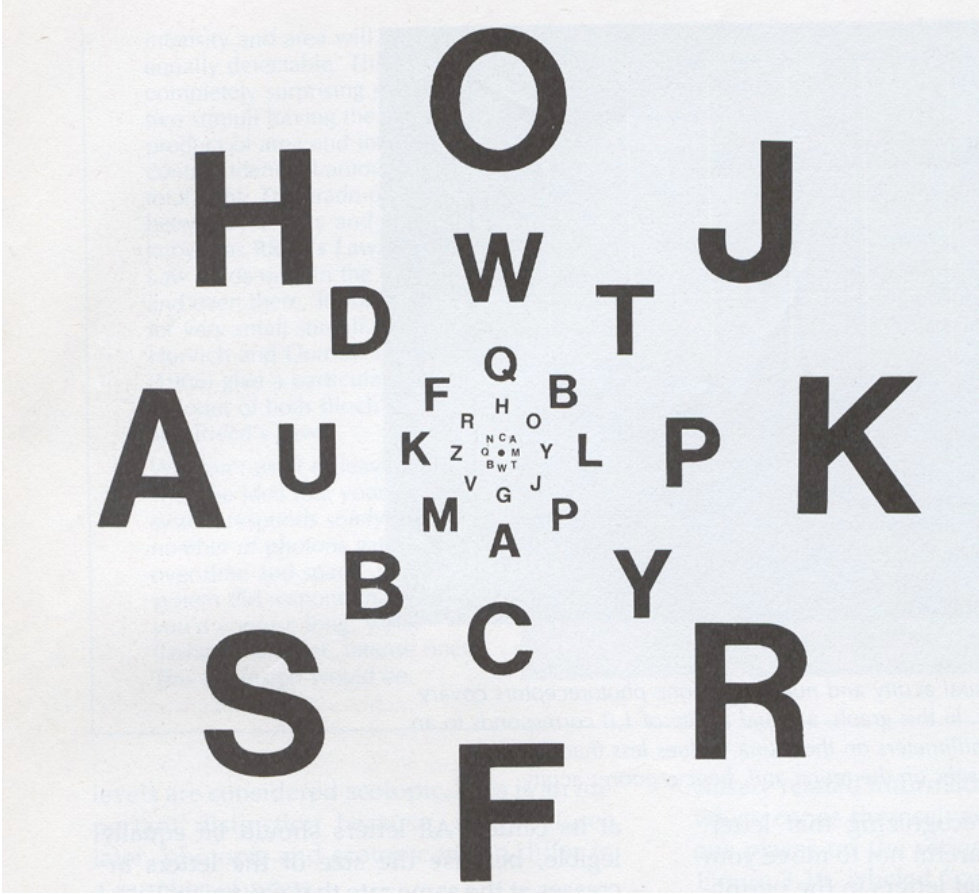


<http://www.brainhq.com/sites/default/files/fovea.jpg>

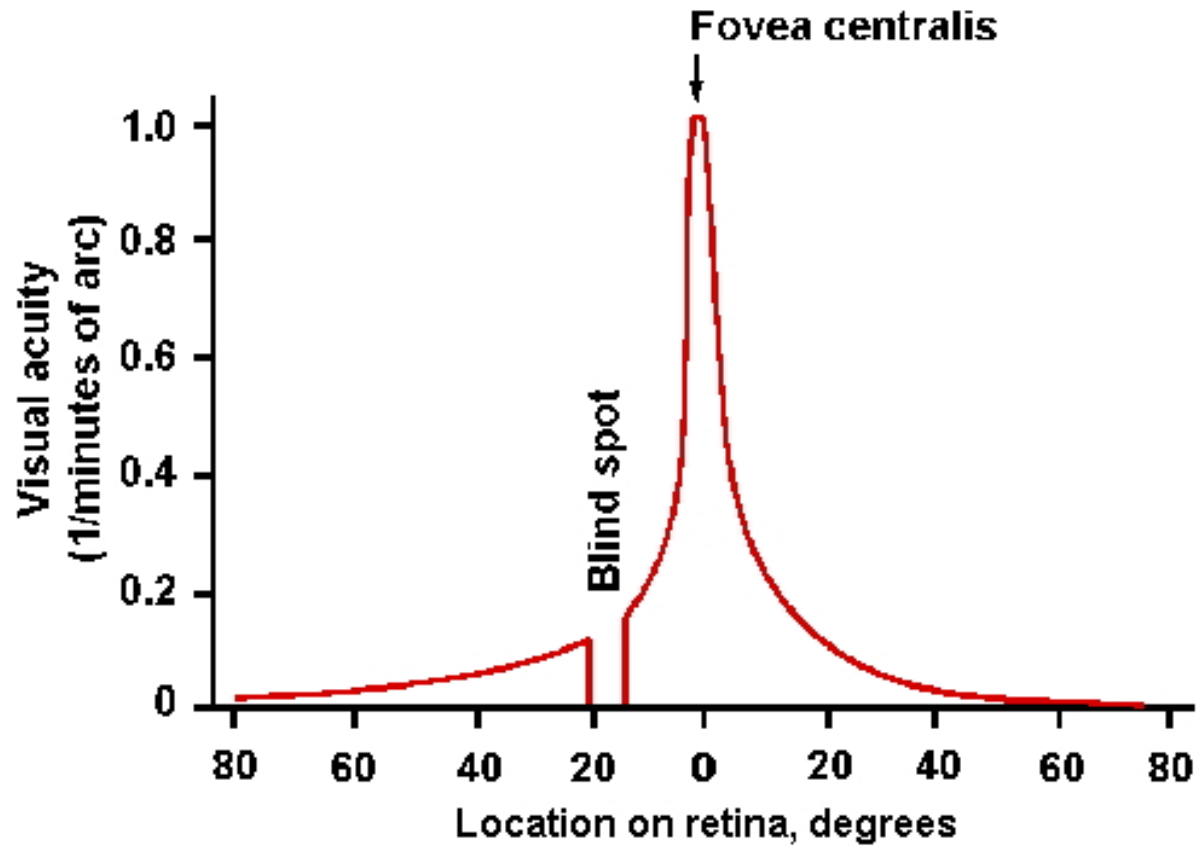
The fovea

- Central 1-2 deg of visual field
- Aligned with visual axis
- *Retinal ganglion cells* pushed aside
- Highest *acuity* vision == best for details

Acuity varies across fovea



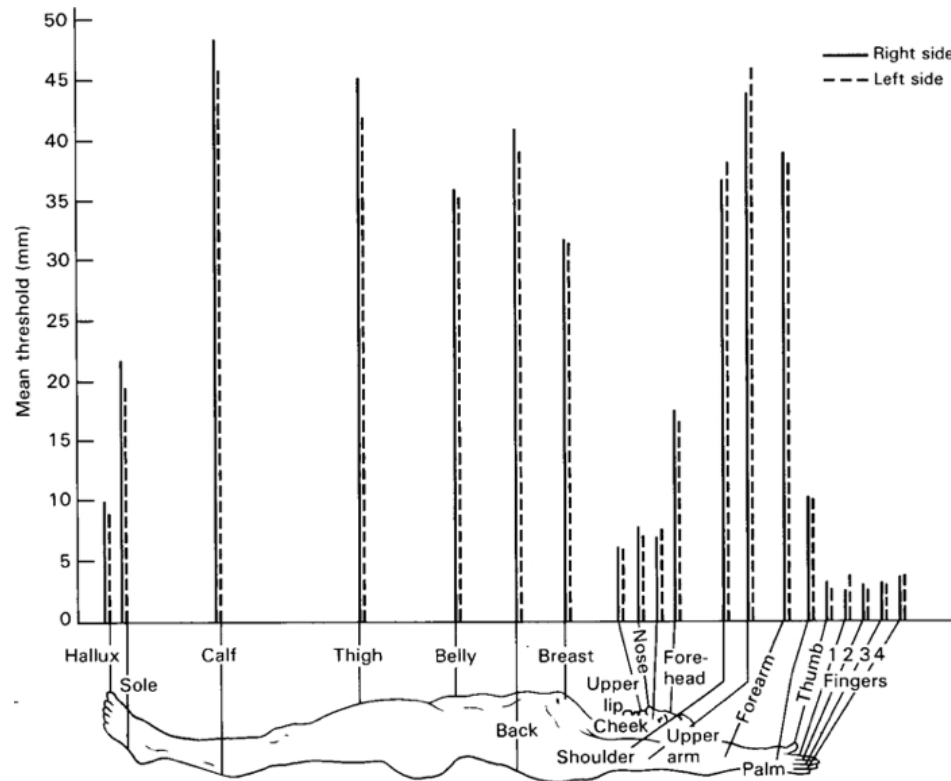
Acuity varies across fovea



http://michaeldmann.net/pix_7/blndspot.gif

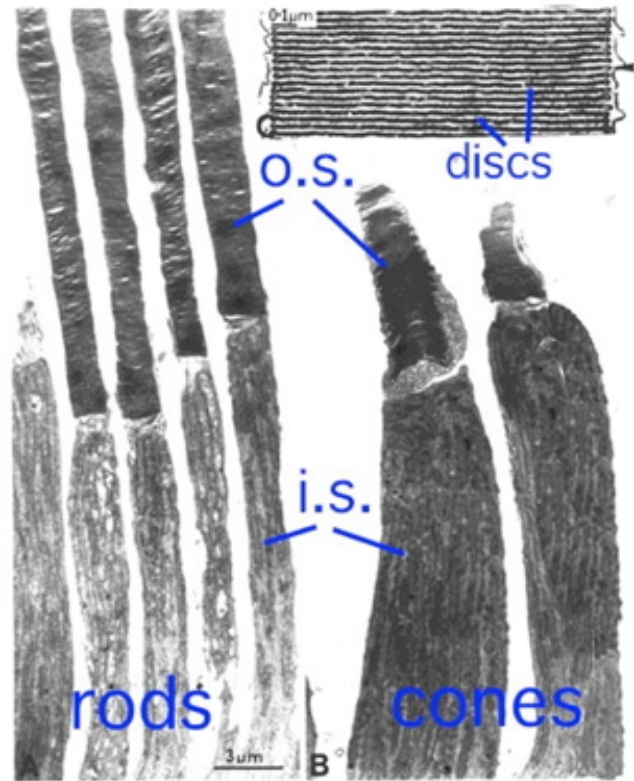
What part of the skin is like the fovea?

What part of the skin is like the fovea?



<http://jov.arvojournals.org/data/Journals/JOV/933499/jov-3-10-1-fig001.jpeg>

Photoreceptors detect light



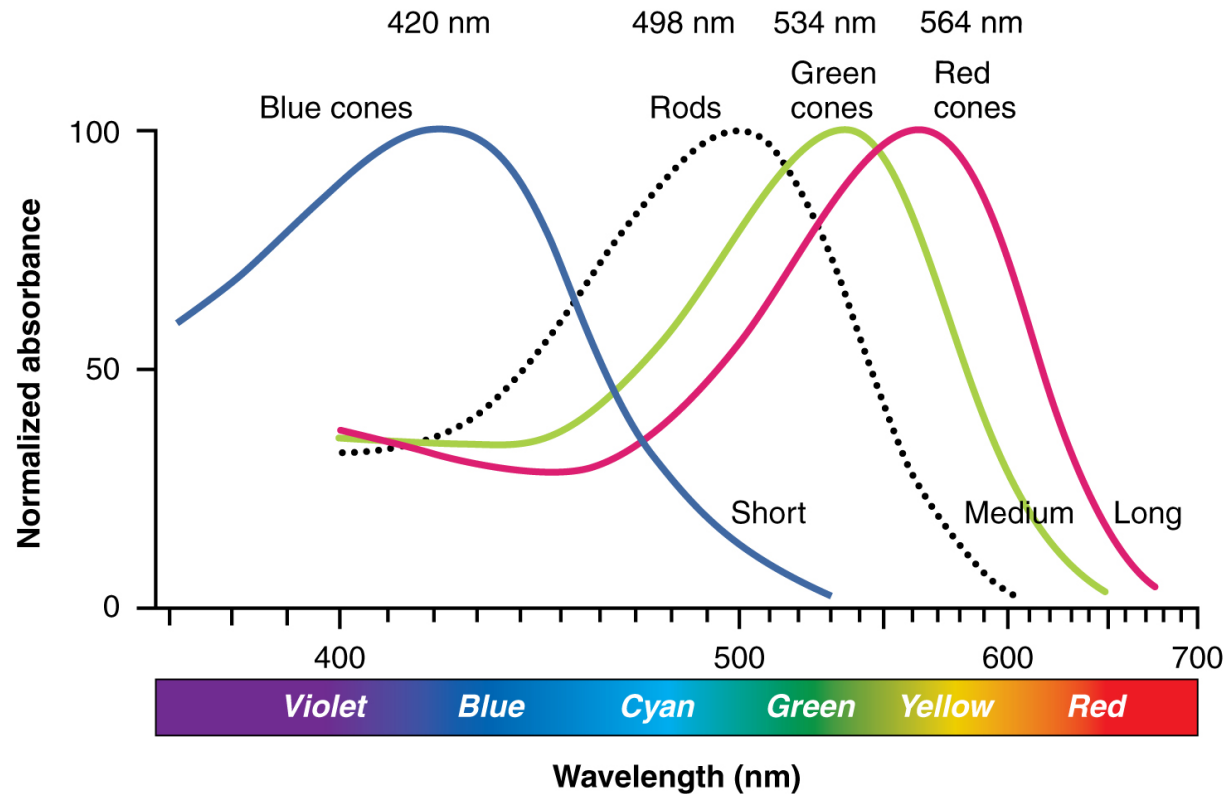
Photoreceptors detect light

- *Rods*
 - ~120 M/eye
 - Mostly in periphery
 - Active in low light conditions
 - One wavelength range

Photoreceptors detect light

- *Cones*
 - ~5 M/eye
 - Mostly in center
 - 3 wavelength ranges

Photoreceptors "specialize" in particular wavelengths



Anatomy & Physiology, Connexions Web site. <http://cnx.org/content/col11496/1.6/>, Jun 19, 2013.

How photoreceptors work

- Outer segment
 - Membrane disks
 - *Photopigments*
 - Sense light, trigger chemical cascade
- Inner segment
 - Synaptic terminal
- Light *hyperpolarizes* photoreceptor!
 - The *dark current*

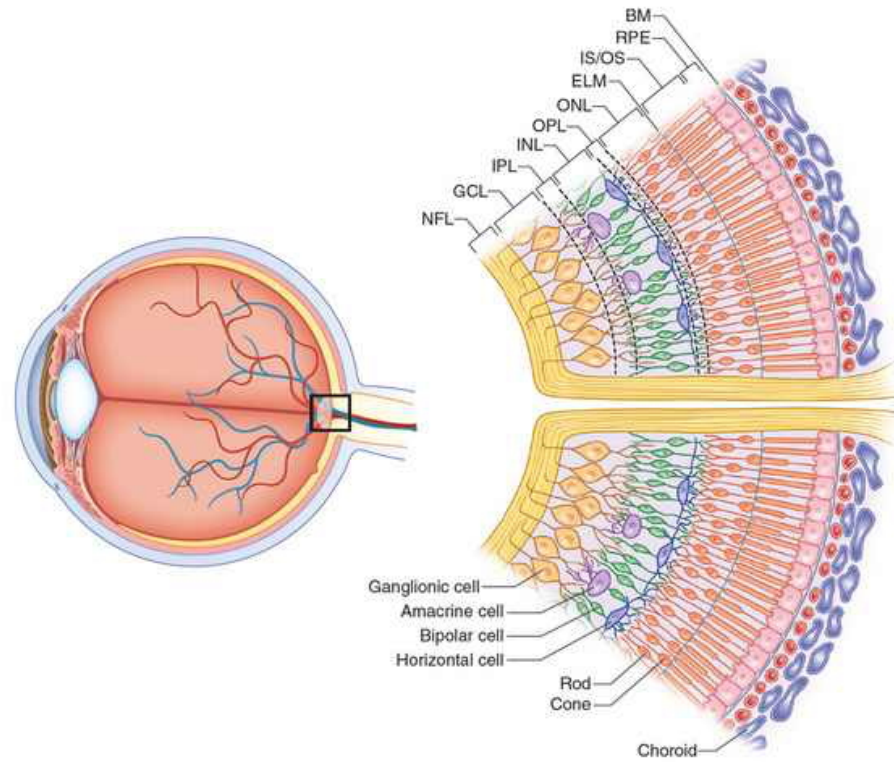
Retina

- Physiologically *backwards*
 - How?
- Anatomically *inside-out*
 - How?

Retina

- Physiologically *backwards*
 - Dark current
- Anatomically *inside-out*
 - Photoreceptors at back of eye

Retinal layers

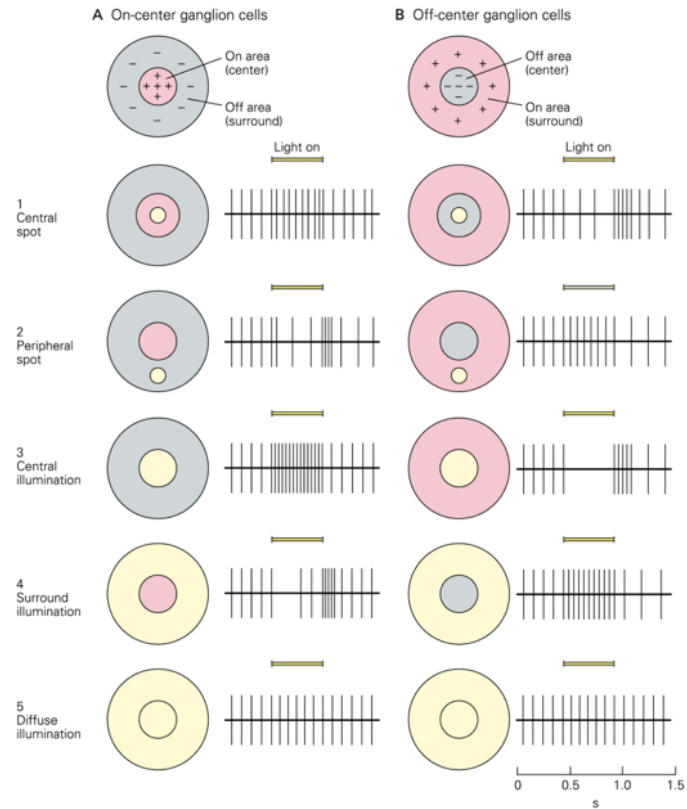


<http://www.retinareference.com/anatomy/>

Retinal layers

- From photoreceptors...
- To *Bipolar cells*
 - <-> and *Horizontal cells*
- To *Retinal ganglion cells*
 - <-> and *Amacrine cells*

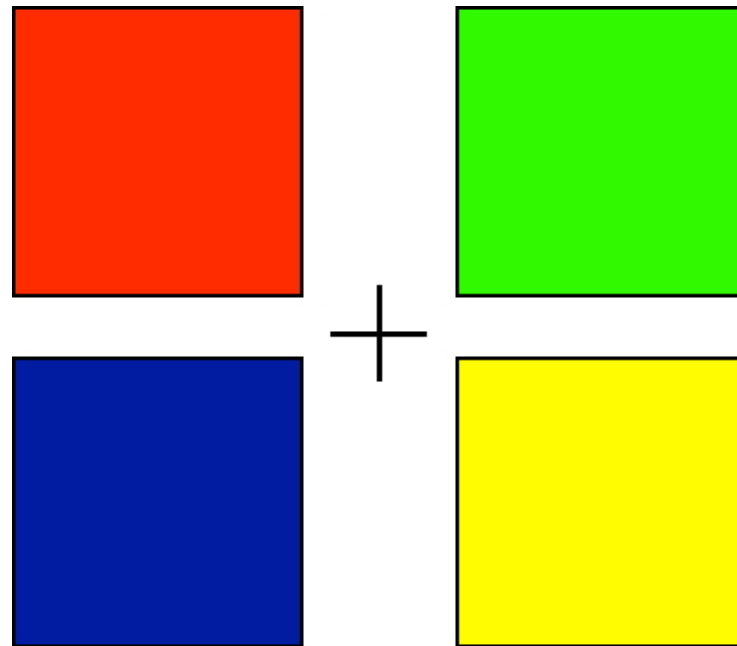
Center-surround receptive fields



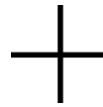
Center-surround receptive fields

- Center region
 - Excites (or inhibits)
- Surround region
 - Does the opposite
- Bipolar cells & Retinal Ganglion cells ->
- Most activated by "donuts" of light/dark
 - Local contrast (light/dark differences)

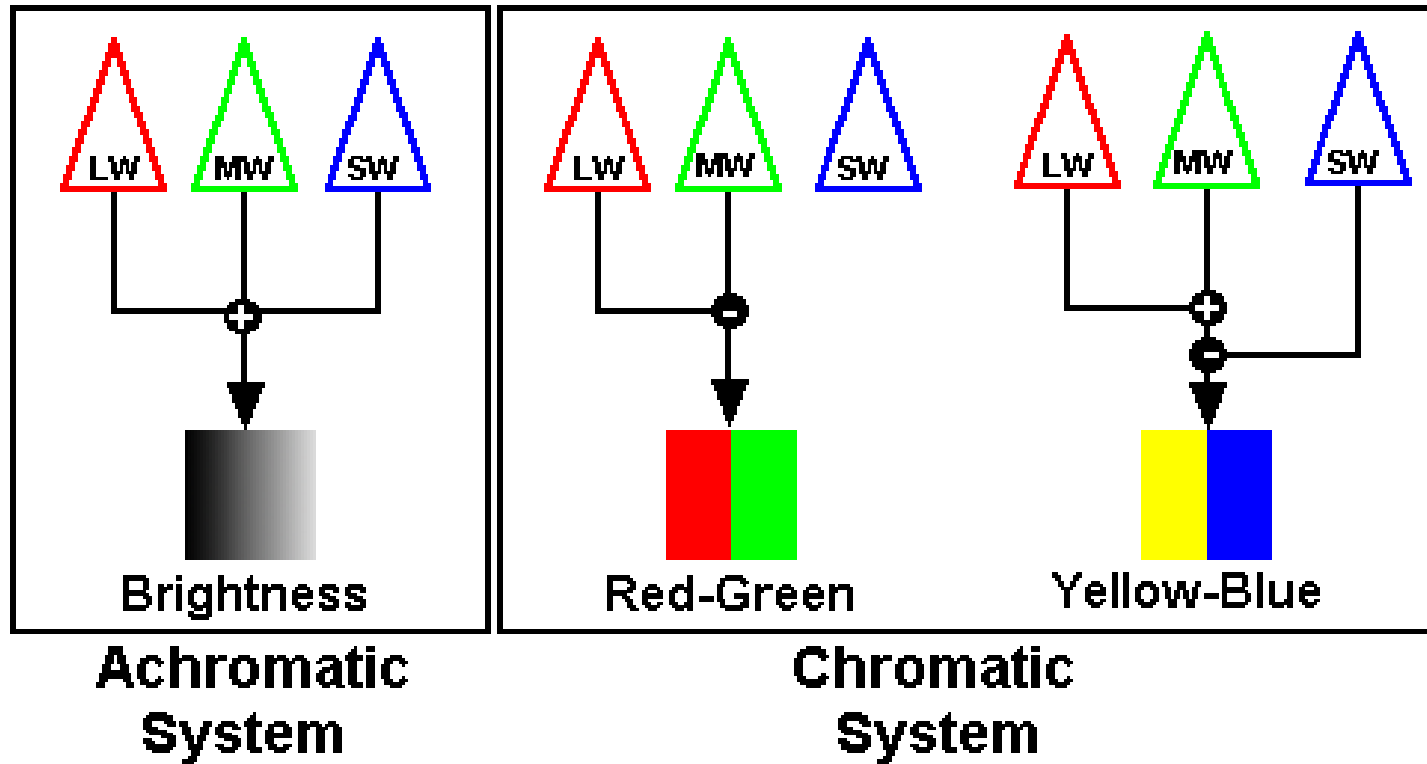
What's a reddish-green look like?



What's a reddish-green look like?



Opponent processing

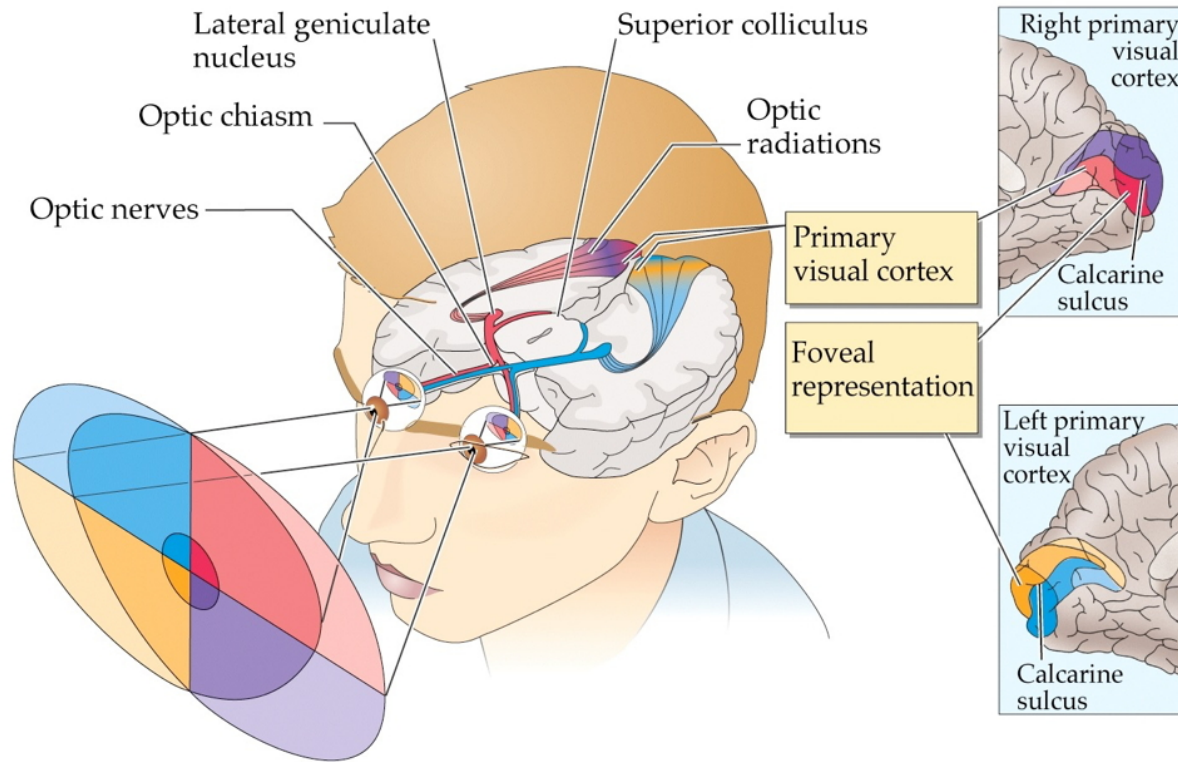


<http://www.visualexpert.com/sbfaqimages/RGBOpponent.gif>

Opponent processing

- Black vs. white (achromatic)
- Long (red) vs. Medium (green) wavelength cones
- (Long + Medium) vs. Short cones
- Can't really see reddish-green or bluish-yellow
 - "Oppose" one another at cellular/circuit level

From eye to brain



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From eye to brain

- Retinal ganglion cells
- 2nd/II cranial (optic) nerve
 - Optic chiasm (χ - asm): Partial crossing of fibers
 - Nasal hemiretina (lateral/peripheral visual field) cross
 - Left visual field (from L & R retinae) -> right hemisphere & vice versa
- *Lateral Geniculate Nucleus (LGN)* of thalamus (receives 90% of retinal projections)

From eye to brain

- Hypothalamus
 - *Suprachiasmatic nucleus* (superior to the optic chiasm): Synchronizes day/night cycle with circadian rhythms
- Superior colliculus & brainstem

Next time...

- Wrap up on vision
- Principles of action