9.35 lecture
The Retina

The retina

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Rods and Cones

Question: How do you design a visual system that can respond to the high illumination levels that occur during daytime, and to the low light levels that occur at night?

Answer: The "*duplicity theory*" of vision (J. von Kries, 1896): *Use two different classes of photosensitive receptors that operate in different luminance regimes:*

- *Scotopic* vision: low-light, rod dominated
- *Photopic* vision: High light levels, cone dominated

Dark adaptation experiments

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Inhomogeneity of the retina

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Distribution of receptors in the eye

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Rod vs. cone vision

- Rod vision is more sensitive than cone vision
  - individual rods are more sensitive to light than individual cones.
  - there is higher convergence from rods to ganglion cells (120 to 1) than from cones to ganglion cells (6 to 1; in the fovea it's very often 1 to 1).
- Rod vision has lower acuity than cone vision
  - higher convergence from rods, i.e., larger integration area.

Rods also are slower, i.e., have longer integration time.

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Note: Cats are nocturnal, rod dominated, with "reflective tapetum" to give photons a second chance to be absorbed.

Three cone types (in humans)

"red" cones = "long wavelength" cones = L cones
"green" cones = "middle wavelength" cones = M cones
"blue" cones = "short wavelength" cones = S cones

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Principle of *univariance*: A receptor responds only to how much light is absorbed, not to its wavelength.
(The wavelength has to be "inferred" by the responses of the three cone types.)

—> Makes color TV and RGB monitors possible

Univariance: linear weighted sum (dot product)

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Again, large individual variation in the relative distribution of the different cone types:

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Beyond Receptors

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On-center and Off-center cells

(Images removed due to copyright considerations.)

Mach bands

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