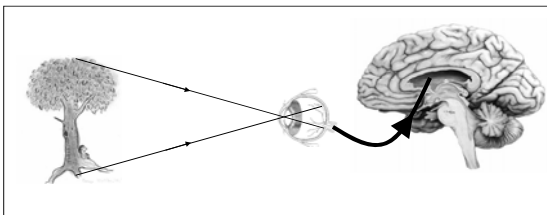


PAM3012
 Digital Image Processing for
 Radiographers
 Visual Perception

In This Lecture

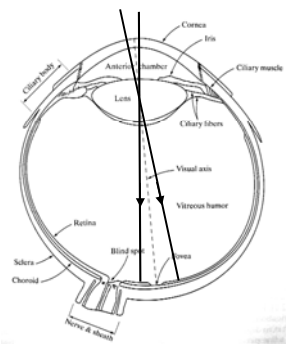
- Elements of visual perception
- Mechanics of the human visual system
- Structure of the eye
- Image formation in the eye
- Brightness adaptation and discrimination

Elements of Visual Perception



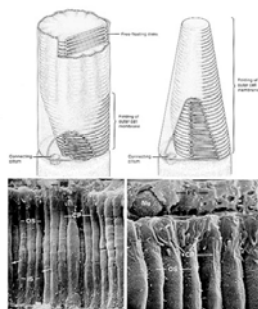
Structure of the Human Eye

- Lens focuses light on to photoreceptive area (retina)
- Photoreceptors convert light into electrical impulses that are decoded by brain



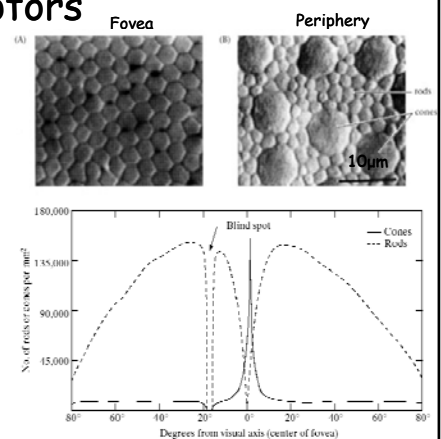
Photoreceptors

- Rods & Cones
- Convert light into nerve signal that is transmitted to the brain via the optic nerve.
- Rods - Dim light vision - SCOTOPIC vision
- Cones - Bright light vision - PHOTOPIC vision



Photoreceptors

- Distribution of receptors across retina
- 200,000 cones mm⁻² at fovea
- Size?



Photoreceptors

Rods

- One type

Cones

- Three types
 - Red (R)
 - Green (G)
 - Blue (B)

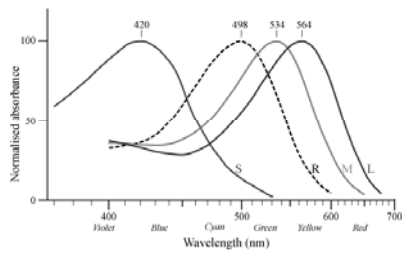


Image Formation in the Eye

- Lens in the eye is flexible
- Shape controlled by muscles
- To focus on distance objects
 - Muscles flatten lens
- To focus on close objects
 - Muscles allow lens to thicken

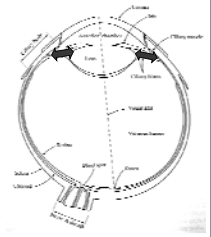


Image Formation in the Eye

- Centre of lens to retina is called *focal length*
- Varies from 17mm to 14mm
- Refractive power min to max
- Lowest refractive power when focusing on objects further than 3m
- Highest refractive power when focusing on near objects

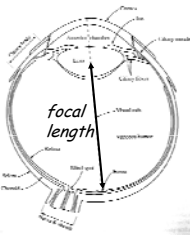
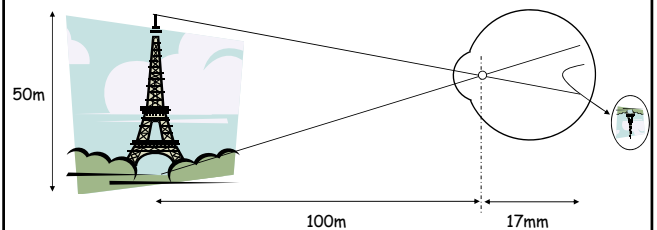


Image Formation in the Eye

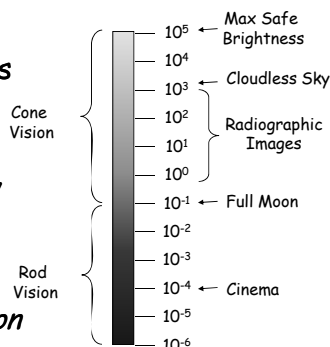
- Calculate the height of the image on the retinal



- Calculate the image size of the Eiffel Tower on the retina
- Calculate smallest resolvable separation at 100m

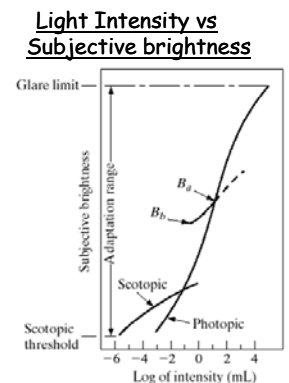
Range of Human Vision

- Visual system can adapt to an enormous range
- Can't operate over range simultaneously
- Accomplished by changing sensitivity
- *Brightness adaptation*



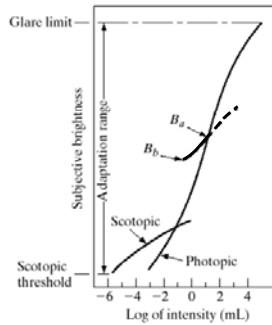
Subjective Brightness

- Perceived Intensity
- Logarithmic function of light received by eye



Brightness Adaptation

- Range of brightness's that can be discriminated simultaneously is small in comparison to total adaptation range
- For a given set of conditions the current sensitivity level of the visual system is called the *brightness adaptation level*.



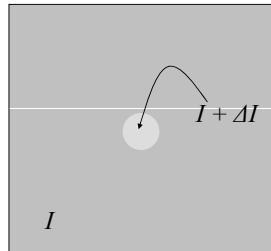
Bright Discrimination

- Digital Images are displayed as a discrete set of intensities
- Eyes ability to discriminate intensities at a given *adaptation level* is an important consideration when displaying images

Bright Discrimination

Classic Experiment

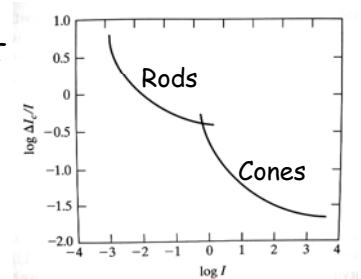
- *Weber Ratio*: $\Delta I_c / I$
- ΔI_c is the incremental illumination discriminable 50% of the time
- Small Weber Ratio represents "good" brightness discrimination



Bright Discrimination

- Plot $\log(\Delta I_c / I)$ as a function of $\log(I)$

- Constant ΔI . Vary I
- Discrimination is "poor" at low light levels
- Discrimination is "good" at high light levels



Brightness Discrimination

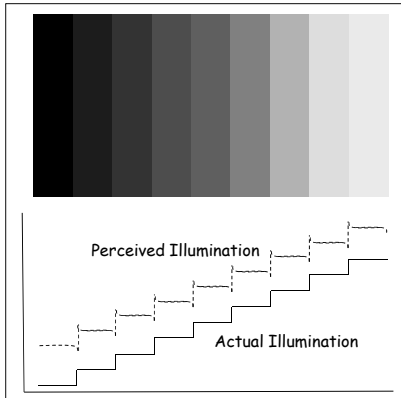
- If background is held constant & brightness of flashing spot is varied
- ΔI varied incrementally from never perceived to always perceived
- Typical observe can distinguish 12 - 24 intensity changes
- Related to number of intensities a person can see a point in monochrome image
- Does not mean that an image can be represented with such as small number of intensities...

Brightness Discrimination

- Two phenomena clearly demonstrate that perceived brightness is NOT a simple function of intensity...

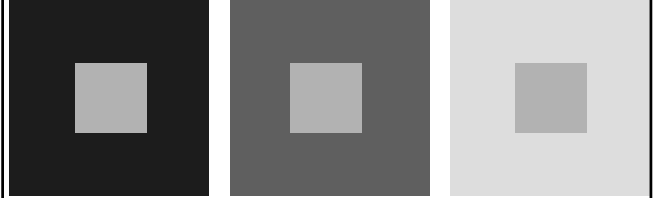
First Phenomenon

- Visual system tends to under or overshoot around the boundary of two regions of different intensity
- *Mach Bands*



Second Phenomenon

- *Simultaneous Contrast*



All the inner squares have intensity

Summary

- Elements of visual perception
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- Brightness adaptation and discrimination