HUMAN VISION SYSTEM

RETINA, COLOUR THEORIES AND PERCEPTION

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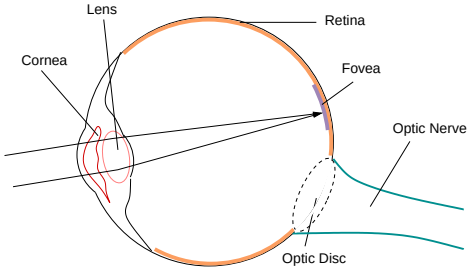
OVERVIEW

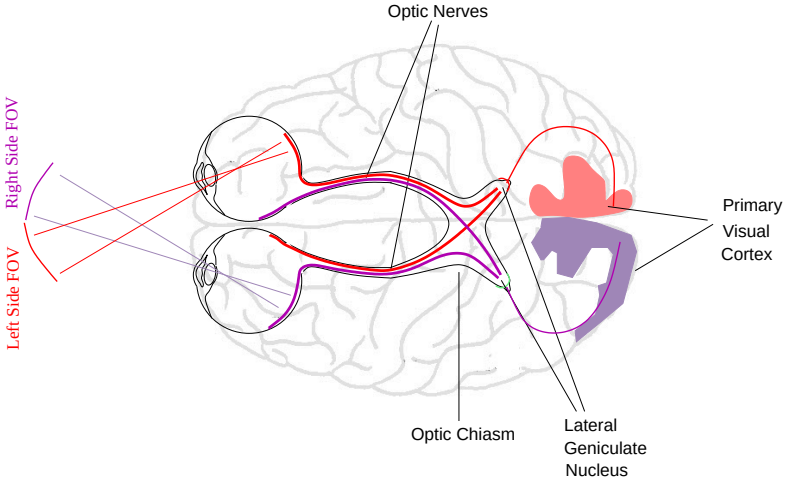
- Human Vision System
- Structure of the Retina
  - fovea and optic disc
  - rods and cones
- Trichromatic Theory
- Opponent Colour Theory
- Modern Colour Theory
- Summary

HUMAN VISION SYSTEM

- Human vision system comprises *eye* and *brain*
- The eye *senses* a spectrum; the brain *interprets* it as a colour
- *Optical pathway* carries the signals from the eye to the brain

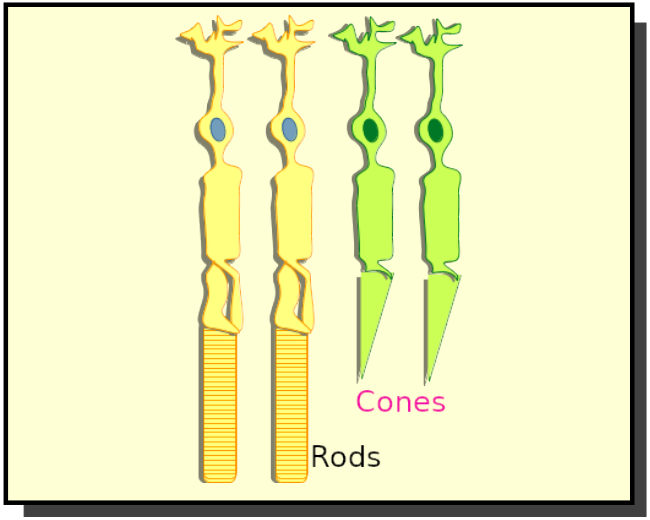


Human Eye



THE RETINA

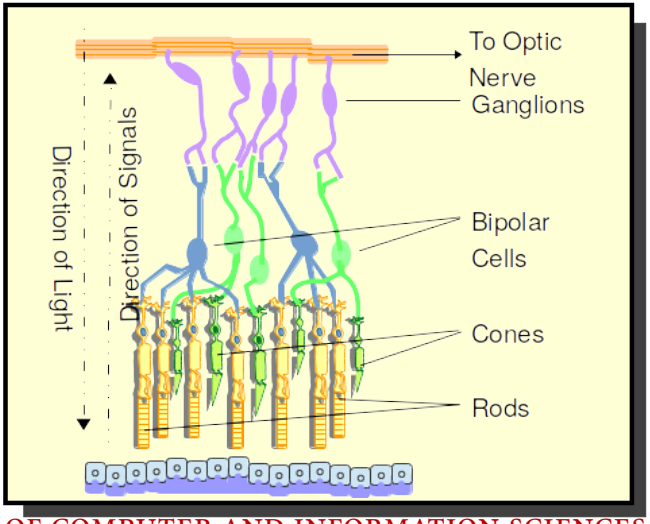
- Image of a scene falls on the retina
- Retina is a complex, multi-layered surface
- *Rod* and *Cone* cells 'see' the image
- Rods are sensitive to overall brightness



- Cones see colours and come in three varieties
- S cones see short wavelengths, M see medium wavelengths, and L sense long wavelengths
- Cones are smaller than rods and require bright light to work

THE RETINA ...

- *Fovea* is the central region of the retina
- Fovea contains almost all the cones and very few rods
- There are nearly 10 times more L-cones than S-cones
- There are nearly 3 times more L-cones than M-cones



- Rods are distributed in a ring around fovea
- There are 10 times more rods than all cones combined
- *Optic Disc* is the region where retina meets the optic nerve
- Optic Disc does not have any light receptors: rods or cones

COLOUR PERCEPTION

Structure of the retina leads to many phenomena associated with human vision system

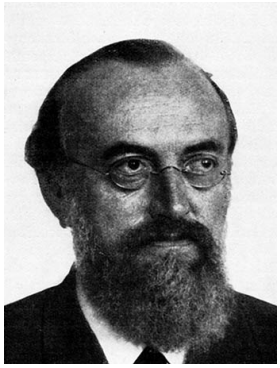
- We see colour only under bright illumination; this is called *Photopic Vision*
- Maximum colour detail is seen when object is directly in front
- We see many shades of green and very few blues
- Rods are more light sensitive; we see only in shades of black under low-light and this is called *Scotopic Vision*
- We need *averted vision* to see faint objects
- There is a *blind spot* in our vision

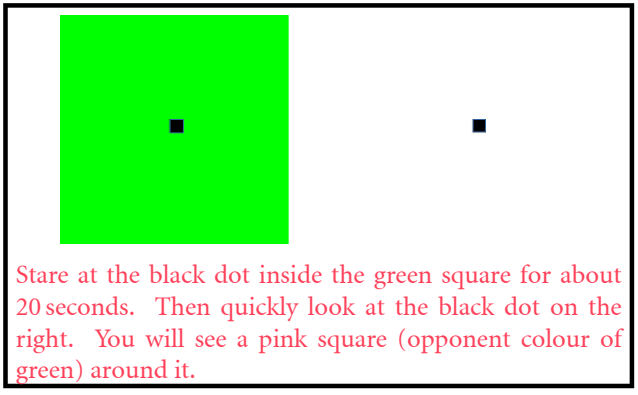
TRICHROMATIC THEORY

- Thomas Young, Hermann von Helmholtz and James Maxwell proposed the *trichromatic theory*
  - Every colour we see is obtained by adding different amounts of three primary colours: Red, Green and Blue
  - Inspired by the presence of S, M and L cones in the retina
- Demonstrated effectively by Maxwell using colour wheels and multi-colour projection (1861)
  - When the wheel on the right is spun fast, we see the purple colour shown

OPPONENT COLOUR THEORY

- Proposed by Ewald Hering in 1892 to explain certain phenomena
- We **never see** colours such as *bluish-yellow, yellowish-blue, greenish-red* and *reddish-green*
- *After-images* are seen in certain colour pairs





Stare at the black dot inside the green square for about 20 seconds. Then quickly look at the black dot on the right. You will see a pink square (opponent colour of green) around it.

- Three types of *bipolar* (- to +) colour responses
  - Luminance or black (-) to white (+)
  - Blue (-) to Yellow (+)
  - Green (-) to Red (+)

MODERN COLOUR THEORY

- Svaetichin proposed the modern theory of colour (1956) by combining aspects of trichromatic and opponent colour theories
- Colour perception occurs in three stages
  - Photoreceptors in the retina are trichromatic
  - Three signals are generated in the retina
    - Weighted average of S, M and L cone responses
    - Bipolar red-green signal by subtracting M-cone response from the other two
    - Bipolar blue-yellow signal by subtracting S-cone response from the other two
  - Three signals transmitted independently to the brain after low-pass filtering
- Brain interprets the signals as a specific colour

SUMMARY

- Human vision system comprises the eye and the brain
- Eye senses the spectrum and the brain interprets the sensed signals
- Rods and Cones are photoreceptor cells in the retina
- Rods give us low-light and cones, colour vision
- Modern colour theory, by Svaetichin in 1956, states that colour perception occurs in three stages
- Various vision phenomena can be accurately explained by the theory

END OF MODULE II