Lecture 1: Vision

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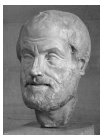
Vision

- Something we all take or granted
- *'Seeing is believing'*

Empiricist philosophy

•*Sensory evidence* as the source of knowledge

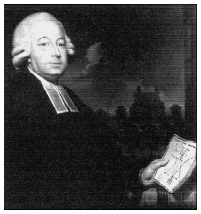
- John Locke
  - At birth, mind is a *blank slate*



- Aristotle
  - *Natural philosophy*

Empiricism in science

- Empiricist philosophy & development of scientific method



- The case of Maskelyne & Kinnebrook

Psychological Science in 21st C

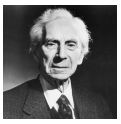
- The 'microscope / telescope' of science is reversed
- The 'observer' becomes the observed

Illusions

- Are visual illusions just an amusing oddity?
- But .. also – illusions of
  - memory
  - language
  - thinking
- Looking at something utterly familiar, as if encountering it for the first time

Vision and 'the computational paradox'

- Artificial Intelligence (AI)
  - Born in 1950's amid great optimism
  - Marvin Minsky - intelligent robots by 1980's ??



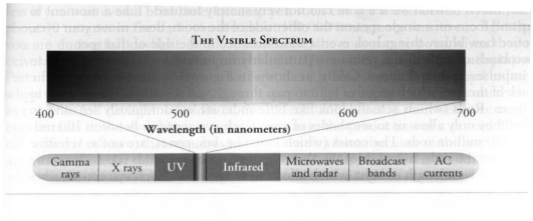
- An early AI program (*Logic Theorist)* out-performed Bertrand Russell !!

Vision and 'the computational paradox'

- Walking about, conversing and *seeing* turn out to be extremely complex
- By comparison, chess & theorems in logic are a walk in the park!
- Neuroscience - a ***lot*** of brain power is devoted to vision

Light

- Light is electromagnetic radiation
- Amplitude
  - An important (*but not the only*) determinant of perceived brightness
- Wavelength (frequency)
  - An important (*but not the only*) determinant of perceived colour

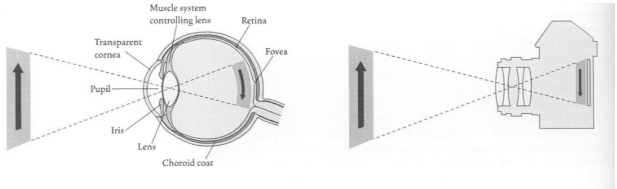


Light & other electromagnetic waves.

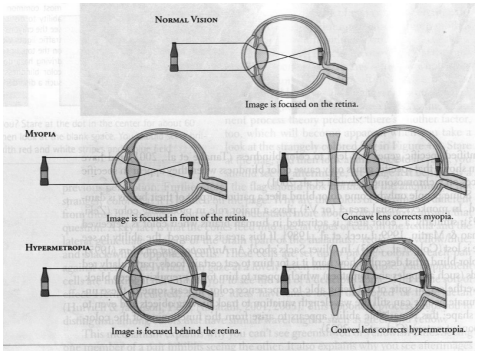
Eye is sensitive to only a tiny portion of the electromagnetic spectrum: about 360 to about 750 nm

Bees can 'see' ultraviolet

Is the eye like a camera?

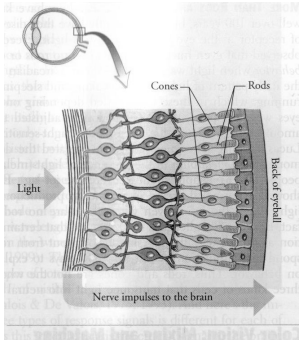


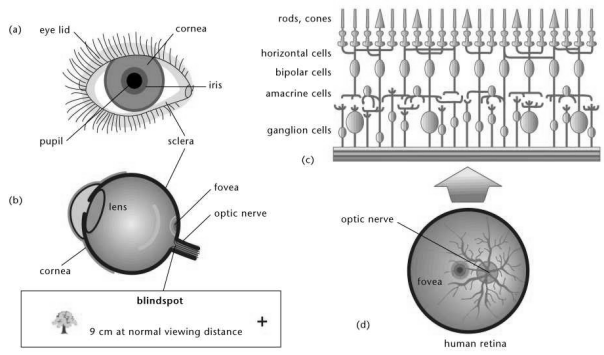
Visual problems



Rods and Cones:

the design of the retina is very odd !!





Structure of the retina & the blindspot

Structure of the eye

- The eye is a highly selective organ
- Fovea – specialised for perception of fine detail
  - Relatively small – just 1^o – 2^o in diameter
  - About area of thumbnail at arm's length
  - Blindspot is larger - about 5^o by 7^o

The blindspot

- If you close one eye, why aren't you aware of a visual gap at the location of the blindspot??
- Perceptual 'filling in' – V.S. Ramachandran

Sensitivity to light energy (brightness)

- Eye is sensitive to enormous range of brightness levels
  - Ratio of dimmest perceptible object to extremely bright object is about
  - 1: 100,000,000,000

Duplex theory of vision

- Cones
  - Specialised for daytime vision
  - Responsible for colour vision
  - Perception of fine detail – high acuity

Duplex theory of vision

- Cones
  - Retina contains about 6 million cones
  - Foveal vision – cones only
  - Density of cones decreases in peripheral vision

Duplex theory of vision

- Rods
  - Specialised for night vision
  - Difficult to discriminate colour at night (*achromatic* sensation)
  - Difficult to discriminate fine detail at night – poor acuity

Duplex theory of vision

- Rods
  - Retina contains about 120 million rods
  - There are **no** rods in fovea
  - Rods more plentiful in peripheral vision
  - Looking *'off the fovea'* (e.g. at stars)

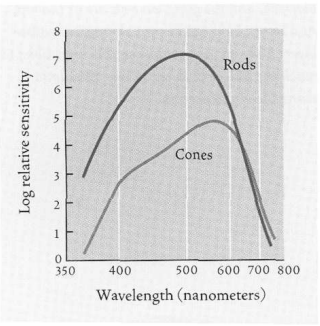
Duplex Theory of vision

- Photopic vision
  - Normal daylight
  - Seeing with cones
  - High acuity (fine detail), but low sensitivity

Duplex Theory of vision

- Scotopic vision
  - Dark adaptation (slow – about 30mins)
  - Seeing with rods
  - High sensitivity, but low acuity (loss of fine detail)

Rods and cones



Rods more sensitive overall. Maximally sensitive to light with wavelength of about 510nM (greenish)

Cones are less sensitive overall. Maximally sensitive to light with wavelength of about 560nM (yellowish)

Duplex theory of vision

- Purkinje shift
- Dark adaptation
  - Blues and greens look *relatively* lighter
  - Reds look *relatively* darker

Visual pigments

- Rods
  - Rhodopsin
  - Light sensitive chemical – light exposure causes photoreceptor to fire
- Cones
  - Three different visual pigments

Summing Up

- Reversing the microscope of science – 'the observer becomes the observed'
- The structure of the eye
- Duplex theory of vision