Coding depth

The physiological basis for stereopsis
- How can cortical neurons process disparity information?
- Barlow, Blakemore and Pettigrew discovered cortical neurons that could code for retinal disparity.
- Their receptive fields were selective for the positions of the images on the two retinae.

- Individual neurons were “tuned” for different amounts and directions of disparity.

Hubel & Wiesel’s Depth-Sensitive Cortical Cells

Clinical tests for stereopsis
- Can be tested by ophthalmologist/optometrist
- Polaroid or red/green filters

- May have poor stereopsis due to vision problems
  - often due to binocular vision problems as a child
    - Strabismus (eye-turn)
    - Amblyopia (lazy eye)
    - Cataract

Size Perception, Perceptual Constancies, and Visual Illusions

Size Constancy
- The perception of size and the perception of distance are closely related.

- This relationship forms the basis for the phenomenon of size constancy. It allows for the accurate perception of real size despite changes in the size of the retinal image.

- In general, constancies are the visual system’s response to a continuously-changing retinal image.

- Constancies represent a mechanism that takes into account the fact that an object remains constant even though its image on the retina may change substantially.

- A failure in the constancy mechanism may produce an illusion.

- Several classes of constancy:
  - Size
  - Shape
  - Lightness
Size constancy
Why does someone walking away not appear to shrink?

Size constancy and size perception
- Refers to the tendency to see objects as their true size, despite changes in retinal image size
- Requires that distance of targets be taken into account
- Misplaced constancy can lead to visual illusions

Relationship between size perception and perceived distance:
- Generate afterimage on retina
- View afterimage against surfaces at different distances
- Note changed size of afterimage

This picture looks odd because the size and distance cues are in conflict

Size constancy:
- Given the size of the image on the retina (visual angle) and its distance, it is possible to compute the physical size of an object
- Size constancy is the mechanism that makes this computation
- Holway & Boring demonstrated the crucial importance of depth perception in an experiment

The Holway-Boring experiment:
- Observer views Test Disks located at different distances
- Task is to adjust size of Comparison Disk to match physical size of Test Disk

Test disks all set to subtend 1° of visual angle

Constancy scaling
- Richard Gregory proposed that size judgements in general were controlled by a constancy scaling mechanism
- In brief, this means that perceived size is a simple product of retinal image size and perceived distance
  \[ S = k(R \times D) \]
  where \( S \) = perceived size
R = retinal image size
D = perceived distance

19 Emmert’s law:
• Emmert was first to note that afterimage size changed with perceived distance
• This may now be considered as a specific example of constancy scaling

20 Size perception and visual illusions:
• A number of visual illusions may result from the misapplication of constancy scaling
  • Gregory has argued that the misjudgement of size is because the illusory figure contains information that activates the constancy scaling mechanism
  • Consequently, an object is seen as larger or smaller than it should be

21 Muller-Lyer Illusion:
• If the arrowheads are seen as internal and external contours, the closer, external corner should appear bigger

22 Ponzo illusion:
• The “classic” Ponzo illusion makes the upper line appear longer

23 Perceived depth in pictures has strong effect on perceived size

24 Magnitude of the illusion tends to increase as more depth cues are introduced

25 Animals are also susceptible to depth illusions:
• Train animal to choose a pair of lines in which top one is longer
  • Show a pair of lines of equal length superimposed on railroad tracks vs lines on a control background
  • Animal chooses the illusory picture

26 The moon illusion:
• Moon (or sun) seems larger at the horizon than at the zenith
  • Recognised in classical times, many theories
  • Current most-accepted explanation in terms of apparent distance, although issue is still controversial
• **Assumption**: if two objects have the same retinal image size, the one that appears closer will look smaller

• That means horizon moon must look more distant

• Some evidence that horizon looks further away than zenith sky

29

• If zenith sky appears closer, then moon will seem to be smaller