PERCEIVING DEPTH & SIZE
CHAPTER 10

TASK OF PSYCHOLOGIST

- To answer questions like:
  - How does the **2-D projection** of light onto the retinas of the eyes give rise to the phenomenal experience of a **3-D world**?
  - Why don't people appear to shrink in size when they walk away?

- ***These are accomplished by a variety of depth cues.***

DEPTH PERCEPTION THE CUE APPROACH

- **THE CUE APPROACH:** focuses on the cues in the retinal image that are related to depth.

- We learn the connection among the various cues and depth through our _____

  _____in the environment.

  - The association becomes _____.

- Supported by ***cultural differences*** in depth cues:
  - **Turnbull (1961) and Kenge**

  - **Hudson (1960)**

What cues allow us to make judgments regarding distance of various objects in the scene?

- **3 TYPES OF CUES**

  - Oculomotor:

  - Binocular

  - Monocular

Oculomotor Cues

- **Convergence** - inward movement of the eyes when we focus on _____
  - We can feel this inward movement of our eyes.
- **Accommodation**: The change in the _____ that occur when we focus on objects at various distances.
  - We feel the tightening of the eye muscles that change the shape of the lens.
- **These are useful for close ranges**

Monocular Cues

- These require _____.
- They include _____.

Pictorial Cues

- **Pictorial Cues:** Depth information that can be depicted in a 2-D picture.
- **Perspective Convergence (Linear Perspective):** perception of depth from _____.
- **Occlusion** (Interposition): when one object _____
- **Relative size** - If 2 objects are of equal size, the more distant one will produce a _____.
- **Cast Shadows**: Shadows from nearer objects occlude objects that are farther away.
- **Relative Height:** objects that are higher in the field of vision are more distant (below the horizon).
  - Objects above the horizon that are lower in the field are seen as being farther away.
- **Familiar Size**: Our knowledge of _____ influences depth perception.

- **Texture gradients** - textures _____ and appear more closely packed with increased distance.

- **Atmospheric Perspective**: Distant objects are _____ and have a blue tint.
    - This is useful over great distances

MOVEMENT-PRODUCED CUES

- **Motion Parallax:** effect of relative differences in speed of movement of objects across retina due to distance from viewer.
    - e.g., watching out the window of moving vehicle
    - Near objects travel a _____ across the retina and therefore appear to move _____ across our visual field.
    - Far objects travel a _____ across the retina and therefore appear to move much _____ across the observer's visual field.

- **Deletion and accretion** - objects are covered or uncovered as we _____ relative to them.

Binocular Cues

- Cues that are derived from _____

- **Binocular Disparity:** arises from the fact that our 2 eyes view the visual world from _____ because our eyes are _____.

- The perception of depth based on binocular disparity involves **2 stages:**
    - First, the difference in the images on the two retinas is determined.
    - Second, this difference is transformed into the perception of depth called **Stereopsis.**

- **Binocular disparity** gives good depth reading for objects up to **30 feet away**.

Corresponding Retinal Points

- **Binocular Disparity** – differences between the 2 eyes can be described via Corresponding Retinal Points.

- **Corresponding Retinal Points**: Points in each retina that

- **Horopter**: is an _____ that passes through the _____ _____. Any point that is on this circle falls on the corresponding points on the 2 retinas.
- Objects that **do not fall on the horopter**, but are in the visual field, fall on the _____(disparate) points.

- The angle between these points is called the _____.
- The ***farther*** the object is from the horopter the _____.

Charles Wheatstone (1802-1875)

- Developed the _____based on the principle of binocular disparity.

- The **stereoscope (view Master**) produces the illusion of depth by using

- Camera with two lenses separated by the same distance as the human eyes.

How can we test whether depth perception is caused by disparity, pictorial cues, or a combination of both?

- **Random-dot stereogram (Julesz, 1971):** These are images that

- They are constructed by shifting a square-shaped section of the dots, in one of the pictures, to the right creating disparity.

- When the patterns are presented to the left and right eyes via a stereoscope, Ss perceive a _____ above the background.

The Correspondence Problem

- **The Correspondence Problem:** In order for the visual system to calculate disparity it must _____. How does the visual system do this?

- The visual system may match the images from the left and right retina on the basis of specific features.

- This may not work for objects like _____.

- As of today, there is _____ as how we perceive depth in the random-dot stereograms.

The Physiology of Depth Perception

Tsutsui et al. (2002; 2005) Experiment

- Monkeys matched texture gradients that were 2-D pictures and 3-D stereograms.
- Recordings from a neuron in the parietal lobe showed:
    - Specific cells responded to _____
    - These cells responded to _____
    - These same cells responded to _____
    - Thus same cell tuned to respond to _____

Disparity Information in the Brain

- **Disparity Selective Neurons or Binocular Depth Cells**: Cells in the _____ that respond best to stimuli that fall on points separated by a specific angle of disparity on the 2 retinas.

- **Zero Disparity Neurons**: respond best to _____ disparity between the retinas.

Selective Rearing Studies (cats): Blake & Hirsch (1975)

- **Monocular Rearing**: Kittens were deprived of binocular cues for the _____ of life by alternating their vision between the _____.
    - **few binocular neurons**
    - **did not respond to binocular cues**
    - **Sensitive Period**:

- **Conclusion**: eliminating binocular neurons eliminates _____.
- **Strabismus**
- **Stimulus Deprivation Amblyopia**

PERCEIVING SIZE

- Distance and size perception are interrelated

Holoway and Boring Experiment - Method

- The Ss sits at the intersection of **2 hallways**
- There is a **luminous circle** in each hallway
- Comparison circle, that is always _____ away
- Test circle, ranges from _____ away
- The S must adjust the diameter of the comparison circle to match the test circle.
- All of the stimuli (circles) cast exactly the _____ and therefore the _____.
- Visual angle depends on both the _____ and the _____ from the observer.
- Part 1 of the experiment provided observers with depth cues.
  - Judgments of size were based on _____
- Part 2 of the experiment - gradually reduced the depth cues available (e.g., Ss closed one eye or looked through a peephole).
  - When depth information is eliminated or reduced, size estimates are strongly influenced by _____.

Real-World Examples

- **eclipse:** small close moon appears to be same size as the large far away sun.
- **high-flying airplanes**
- Because our depth cues for these objects are _____ we perceive the size of these objects based on their _____ which is _____ because they are so high in the sky.

Size Constancy

- **Size Constancy:** compensate for distance of object from perceiver and thus object's perceived sized stays relatively constant.

- **Size-Distance Scaling**: our perception of size is based on a constancy-scaling mechanism that supplements the information available on the retinas by taking an object's distance into account.

- **S = K(R x D)**

  - **S =**
  - **K =**
  - **R =**
  - **D =**

  - The changes in distance and retinal size balance each other

- **Emmert's law:** The father away the afterimage appears, the _____ it will seem.

  - Thus, perception of size does not depend on retinal size alone, it is affected by _____.

  - Staring at an image _____. This bleached area determines the retinal size of the after image and remains constant no matter where you are looking.

- This can be explained by **S = K(R x D)**

  - R remains _____, but D _____ with distance of projection surface.

MOON ILLUSION

- When the moon is on the **horizon it looks bigger** than when it is higher in the sky.

Explanations

- **Apparent Distance Theory**: An object on the horizon is viewed across a filled space of terrain, which contains many _____ and therefore should appear farther away than an object elevated in the sky.

MOON ILLUSION: Explanations (Continued)

- Key to this theory is that both the horizon and elevated moons have the same _____ and therefore the moon that appears more distant will also appear larger: **S = K(R x D)**

- **Support:** Ss estimate the distance to the horizon as being greater than the distance to the sky.

- **Angular Size-Contrast Theory**: The moon appears smaller when surrounded by _____.

  When the moon is on the horizon it has less sky surrounding it and so it appears larger.

CROSS-CULTURAL DIFFERENCES IN DEPTH AND SIZE PERCEPTION
Are pictures seen in the same way in different cultures?

- Are pictures a universal means of communication which transcend culture or language?

- **Hudson (1960):** noted that some South African Bantu workers had difficulties in interpreting depth cues in pictures. Such cues are important features of 2-dimentional representations (pictures).

- Hudson constructed a test of three-dimensional picture perception to test many different tribal and linguistic groups in Africa. He used 3 depth cues in these pictures.

- Ss were shown the pictures and were asked: "What do you see?" "What is the man doing?" and "which is nearer, the antelope or the elephant?"

- Results: "both the children and the adults found it _____ in the pictorial material. The difficulty varied in extent but appeared to persist through most educational and social levels."

MULLER-LYER ILLUSION

- **<u>Cross-Cultural Differences in the perception of the Muller-Lyer Illusion</u>:**
- Environments around the world differ in their degree of _____
    - In most urban, technically advanced societies, houses are constructed on _____, which involve **perpendicular and right-angle dimensions**.
    - In other environments such as **Oceanic and many African cultures**, **walls and roofs** may be _____ and straight lines and angular intersections may be few.
- **<u>Segall, Campbell, & Herskovits (1966)</u>** administered several optical illusions to children and adults from the Philippines, Africa, and the US.
- The researchers hypothesized that people who live in carpentered environments would have the greatest difficulty seeing the lines as equal.
    - This is because through experience with right angles they have learned that outward pointing finlike perspective is often associated with edges that are farther away and inward with those that are closer.

DEVELOPMENT OF DEPTH PERCEPTION: THE VISUAL CLIFF

- Devised by Eleanor Gibson and Richard Walk (1960) to test depth perception.
- Glass surface, with checkerboard underneath at different heights

- Mom stands across the gap
- Babies aren't afraid until about the age _____.
- How do you test depth perception of an infant who can't crawl using a visual cliff?
- **<u>Joseph Campos (1978, 1982)</u>**