

PERCEIVING DEPTH AND SIZE

Visual Perception

DEPTH

Cue Approach

- Identifies information on the retina
- Correlates it with the depth of the scene
- Different cues
- Previous knowledge

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Depth Cues

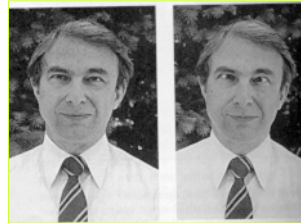
- Oculomotor
- Monocular
- Binocular

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Oculomotor Cues

- Convergence
 - Inward movement for nearby objects
 - Outward movements for farther objects
- Accommodation
 - Tightening of muscles that change the shape of the lens



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Monocular Cues (Pictorial)

- | | |
|-------------------|---------------------------|
| ■ Occlusion | ■ Atmospheric perspective |
| ■ Relative height | ■ Linear perspective |
| ■ Cast shadows | ■ Texture gradient |
| ■ Relative size | ■ Movement-based cues |
| ■ Familiar size | □ Motion Parallax |
| | □ Deletion and accretion |

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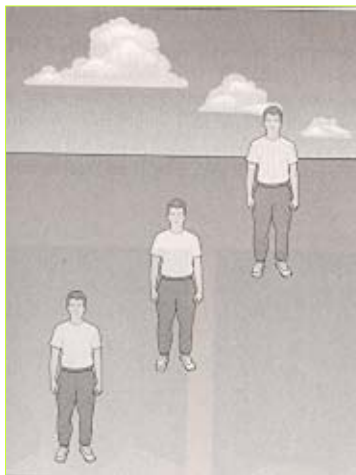
Occlusion



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Relative Height



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Conflicting Cues



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Cast Shadows



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Relative Size



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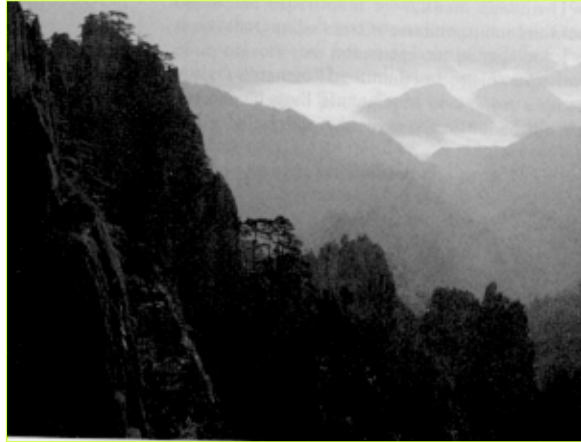
Familiar Size



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Atmospheric Perspective



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Linear Perspective Texture Gradient



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Presence of Ground

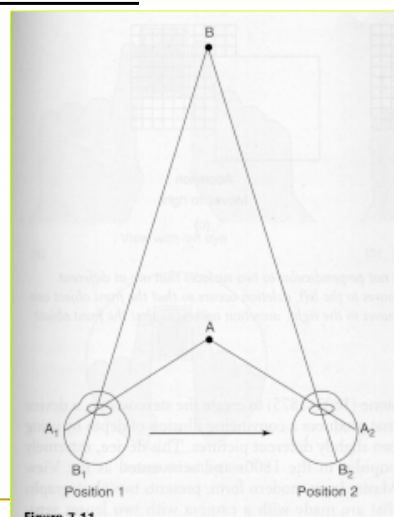
- It helps in perception
- Removal of ground causes difficulty in perception

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Motion Parallax

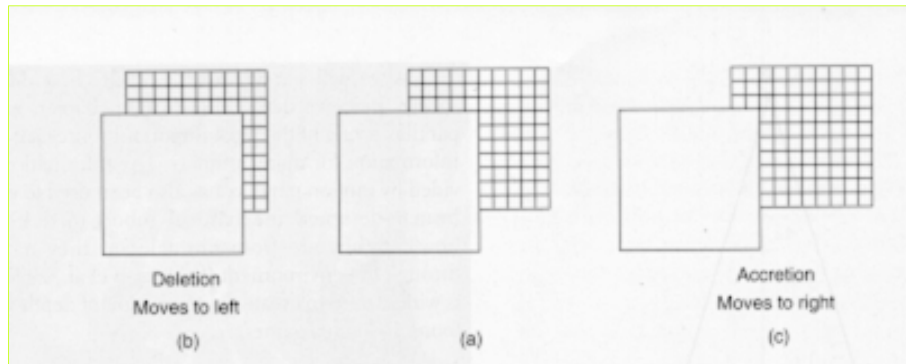
- Further points have lesser parallax
- Closer points move more



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Deletion and Accretion



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Binocular Cues

- Binocular disparity and stereopsis
- Corresponding points
 - Correspondence problems
- Disparity information in the brain

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Binocular Disparity and Stereopsis

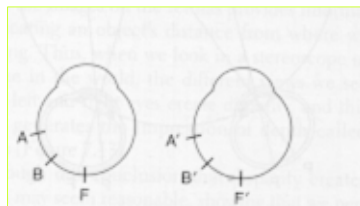
- Binocular disparity
 - Difference in the images of the two eyes
- Stereopsis
 - Disparity is transformed into perception of depth
- Discovery of stereoscope in 1800s



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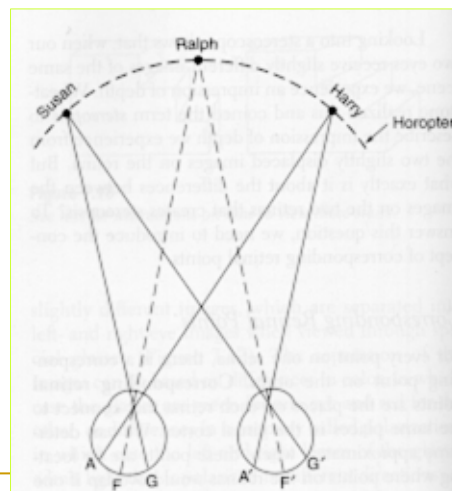
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Corresponding Retinal Points



Corresponding Points

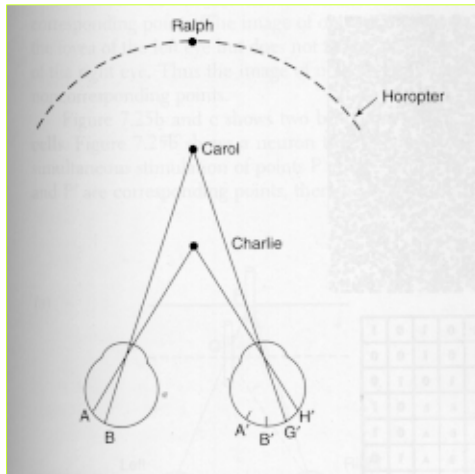
Points on horopter are images at corresponding points of the two eyes



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Corresponding Retinal Points



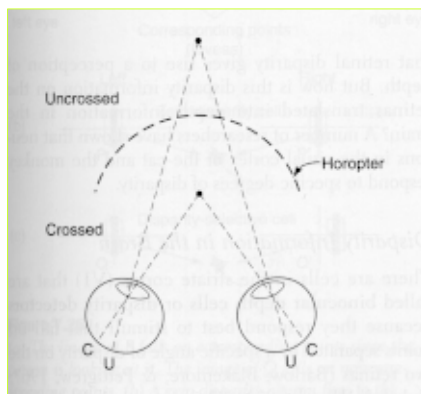
Disparity is defined by the angle between the image of a point and the corresponding point of its image on the other eye subtended from focus

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Crossed and Uncrossed Disparity

- For points in front of the horopter
 - The image is on the outer side of the retina from the image of a point on horopter
- For points behind the horopter
 - The image is on the inner side of the retina from the image of a point on horopter



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Disparity in Brain

- Striate cortex has binocular depth cells or disparity detectors
- Disparity selective cells
- Also selective about crossed or uncrossed disparity
- However, important is to solve the correspondence problem
 - Matching images of the same point on two different eyes
 - Only after this we can find the disparity

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How do they work together?

Depth information	0-2 meters	2-30 meters	Above 30 meters
Occlusion			
Relative size			
Accommodation and convergence			
Motion			
Disparity			
Height			
Atmospheric perspective			

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Depth perception in other species

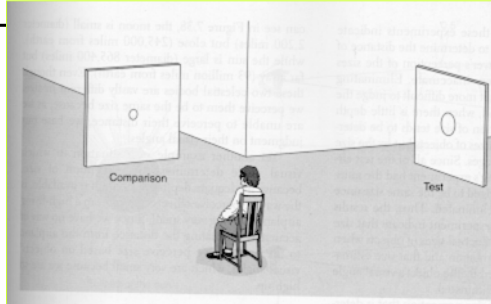
- Frontal Eyes needed for binocular disparity
 - Rabbits etc cannot use disparity for depth
 - Pigeon has 35 degree overlap

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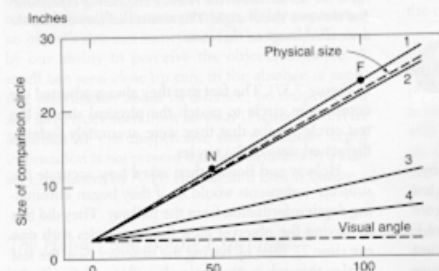
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SIZE

Depends on depth estimation



- All depth cues present
- Closing one eye
 - No binocular cues
- Through a peephole
 - No monocular cues
- Adding drapes
 - No shading cues

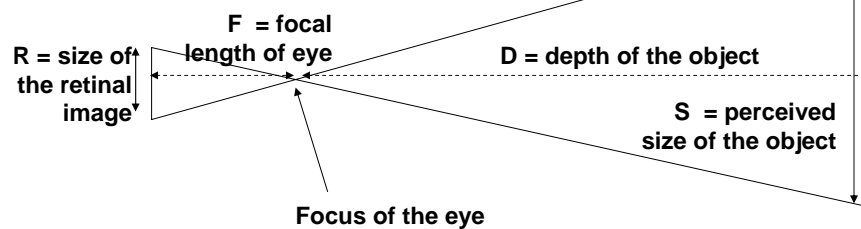


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Size Constancy

■ Size-distance Scaling

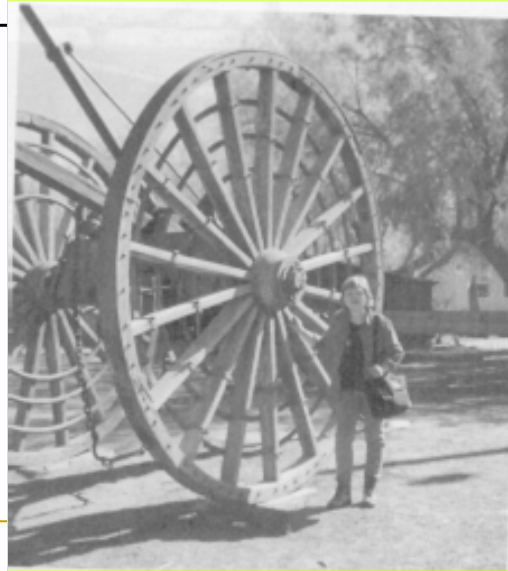
- $S = K(R \times D)$
- $K = 1/F$



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Relative size

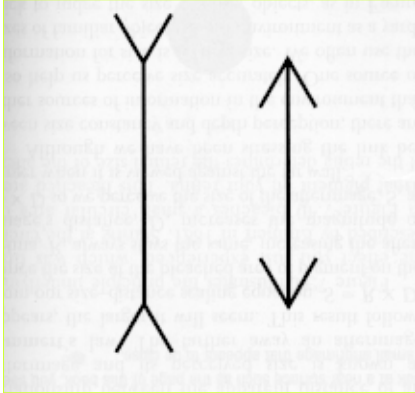


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Visual Illusions

Muller-Lyer Illusion



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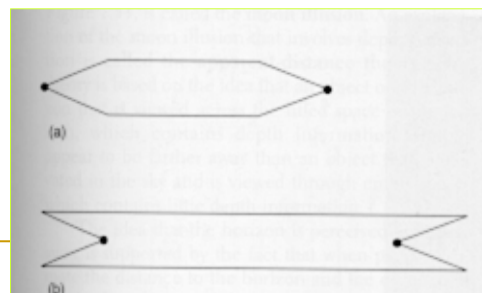
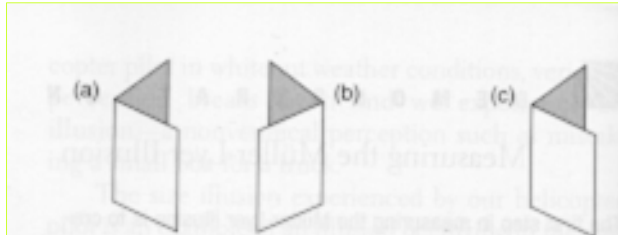
Explanation 1: Misapplied size constancy scaling



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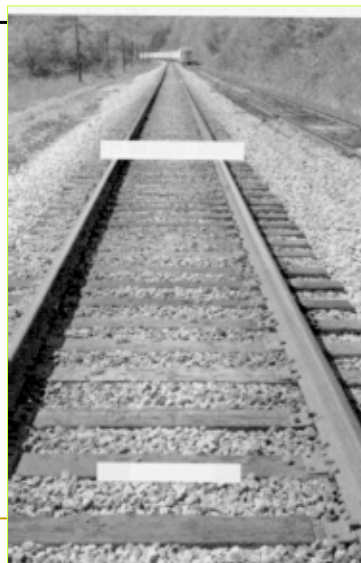
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Explanation 2 : Conflicting Cues Theory



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Ponzo Illusion



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Ames Room



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From: <https://www.youtube.com/watch?v=HmMmJgJmMgJ>