Human Vision

SPATIAL ORIENTATION IN FLIGHT
Limitations of the Senses

Visual Sense **Nonvisual Senses**

SPATIAL ORIENTATION IN FLIGHT
Limitations of the Senses

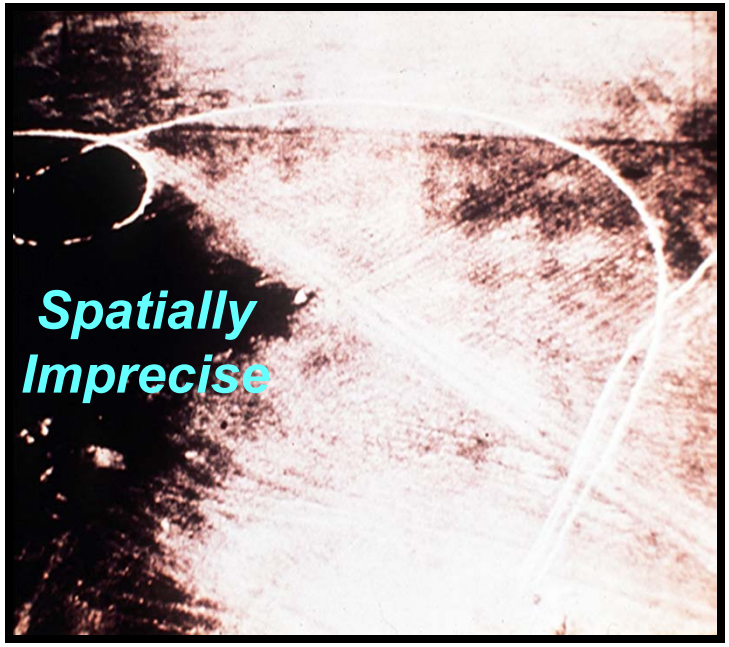
Visual Sense

Nonvisual Senses

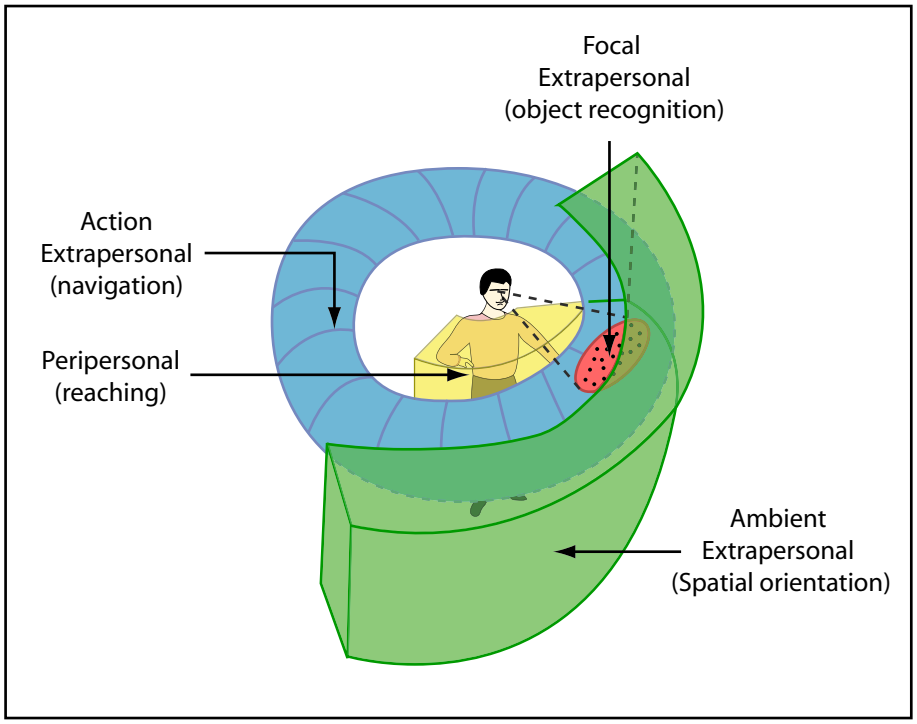
SPATIAL ORIENTATION IN FLIGHT
Limitations of the Senses

Visual Sense

Nonvisual Senses



VISUAL ORIENTATION
3-D Neurobehavioral Model



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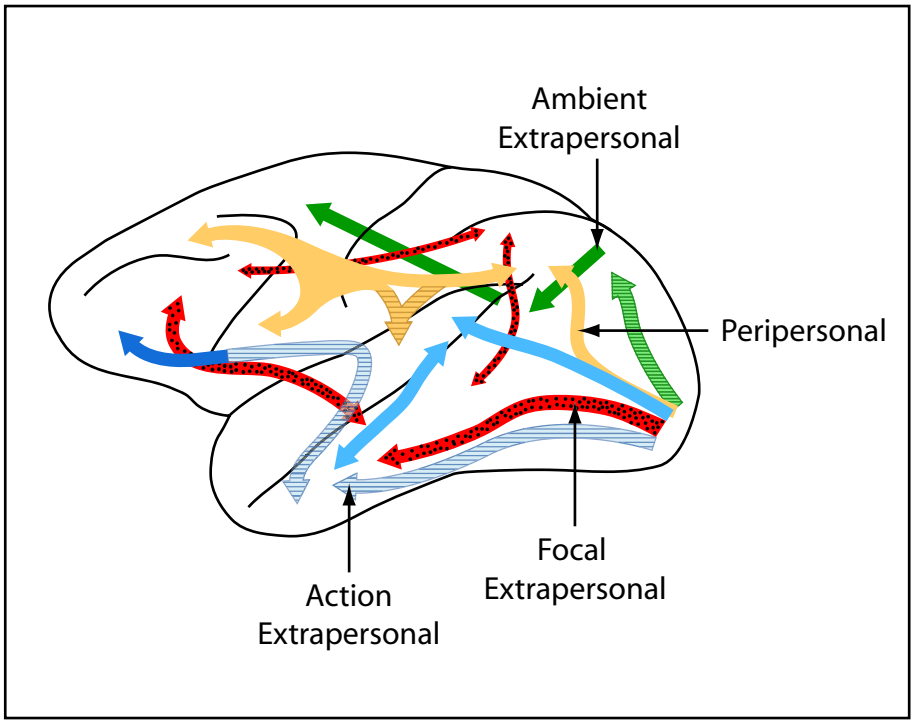

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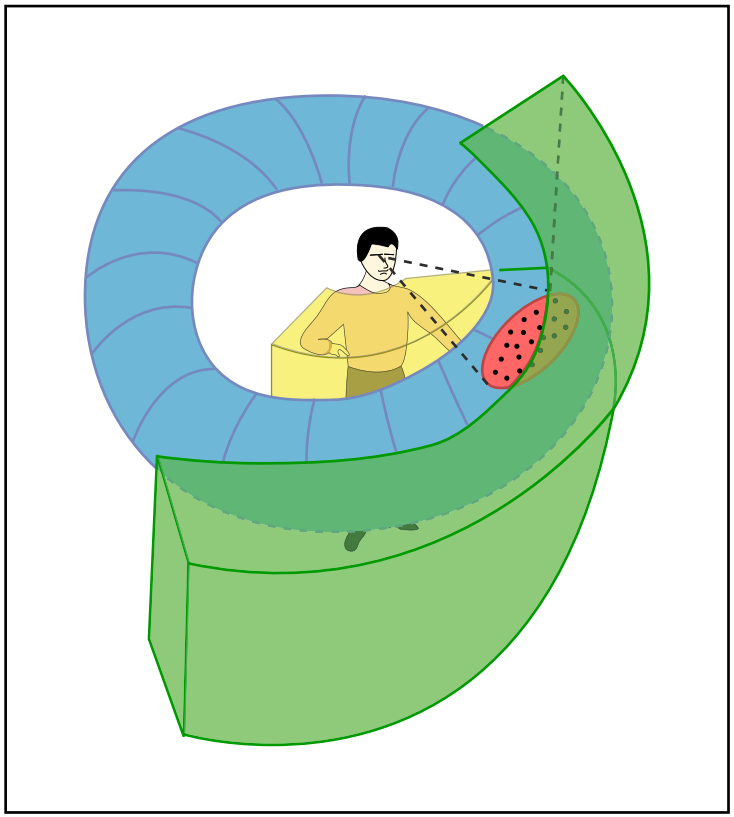
VISUAL ORIENTATION
The Two Visual System Hypothesis



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VISUAL ORIENTATION
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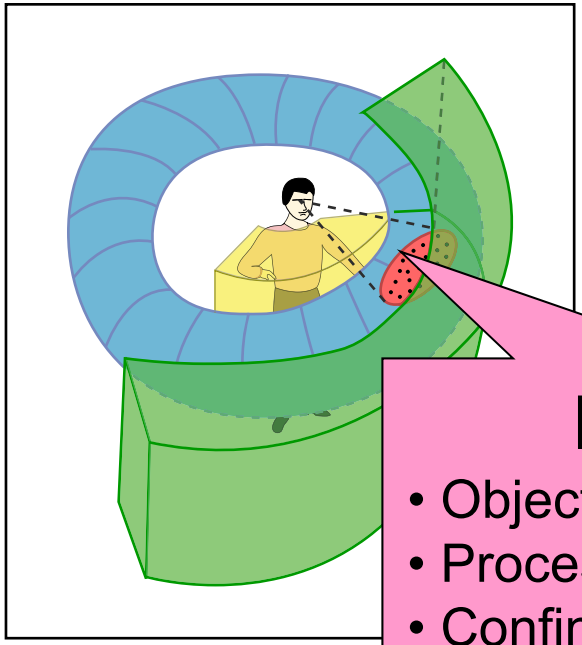

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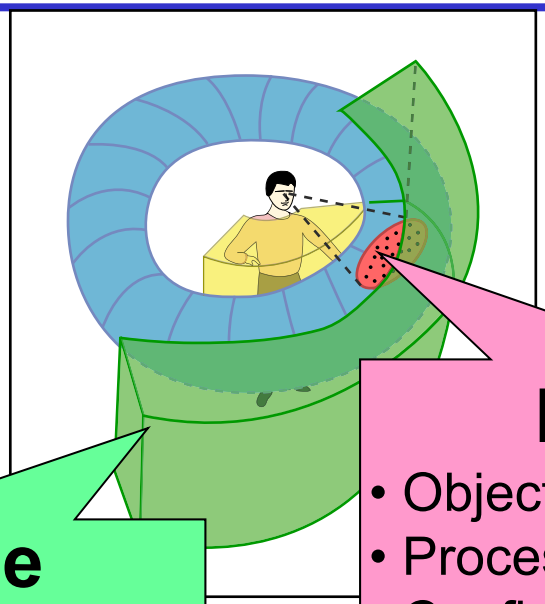
Focal Mode

- Object recognition ("*What*?")
- Processes fine visual details
- Confined to central visual field
- Conscious processing (attention demanding)
- "Synthetic" spatial orientation

VISUAL ORIENTATION
The Two Visual System Hypothesis



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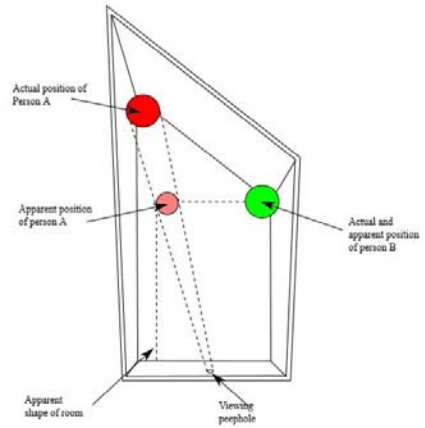
Ambient Mode
- Spatial orientation ("*Where*?")
- Uses coarse visual inputs
- Involves entire visual field
- Preconscious processing (little attention required)
- "Natural" spatial orientation

Focal Mode
- Object recognition ("*What*?")
- Processes fine visual details
- Confined to central visual field
- Conscious processing (attention demanding)
- "Synthetic" spatial orientation

VISUAL ORIENTATION
Alterations of The Ambient Visual Frame

Distortion -- *The Ames Room*



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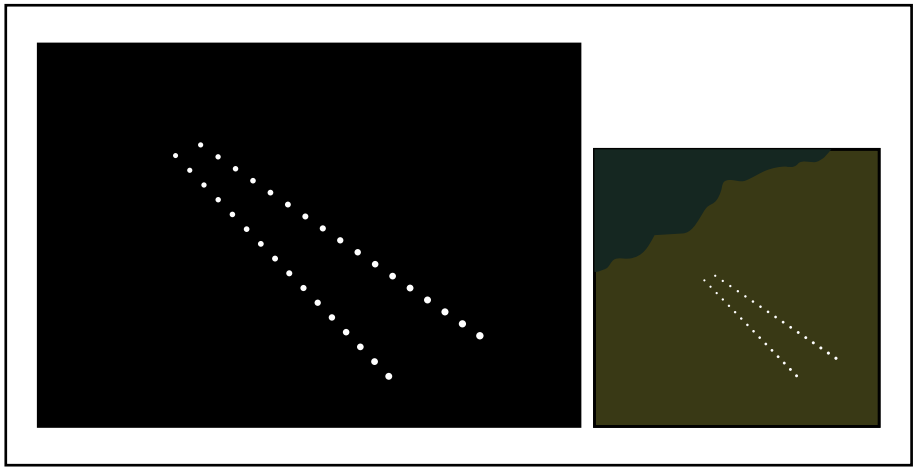
Absence -- *The "Black Hole" Approach*



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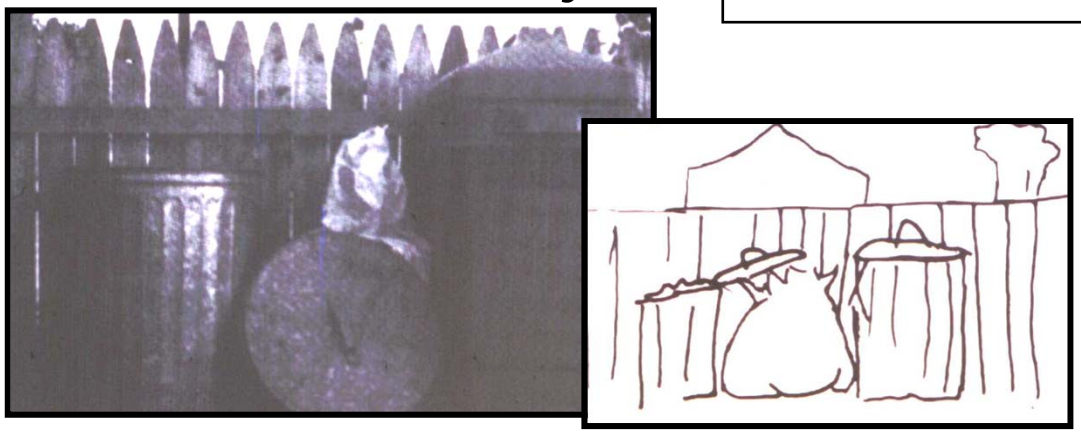
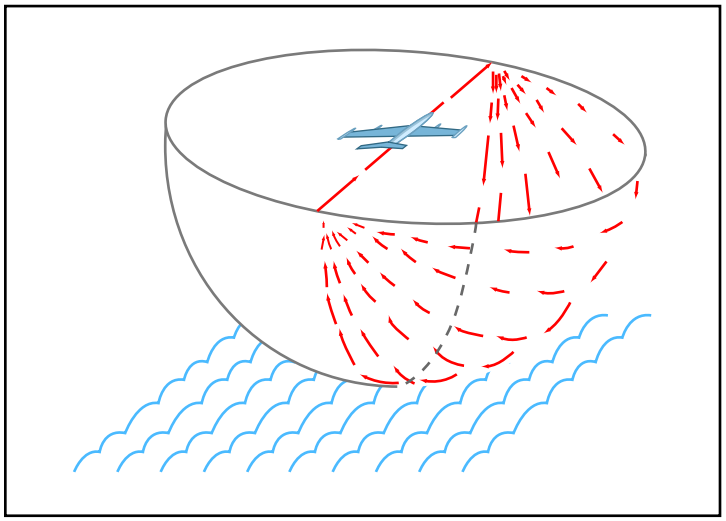
Distortion -- *Memory*



VISUAL ORIENTATION
Ambient Visual Effects (Self-Motion)

Characteristics of Vection

- **Requires large retinal area (including periphery)**
- **More dependent on background visual field**
- **Relies on moving textures (sluggish response, low frequency)**
- **Can occur with optically degraded stimuli**



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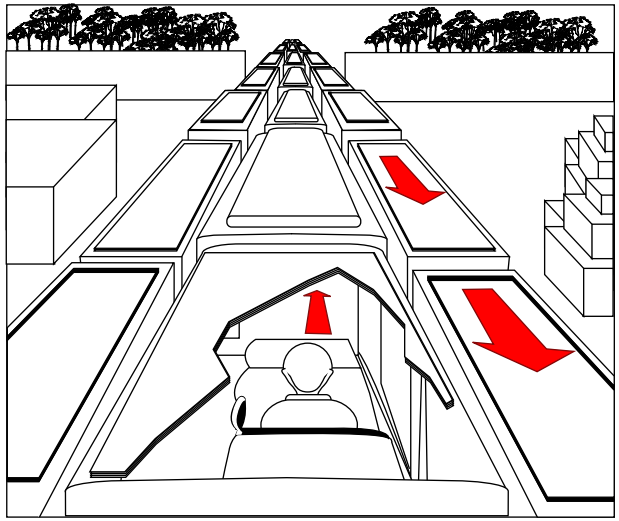

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VISUAL ORIENTATION
Ambient Visual Effects (Self-Position)

Characteristics of Field-Dependence

- **Similar visual requirements as vection (e.g., reliance on background field, can tolerate optical degradation)**
- **Tilted scenes produces changes in perceived visual vertical, gravitational vertical and posture**
- **Other position effects (luminance gradients, depth)**

Rod-and-frame

VISUAL ORIENTATION
Ambient Visual Effects (Self-Position)

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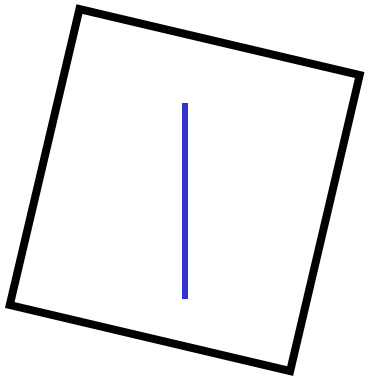

Rod-and-frame

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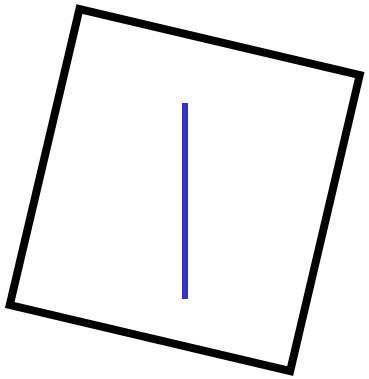

Rod-and-frame

Postural Effects

VISUAL ORIENTATION
Ambient Visual Effects (Self-Position)

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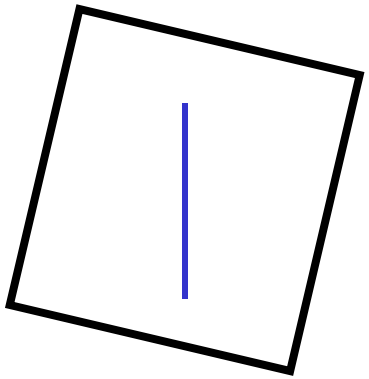
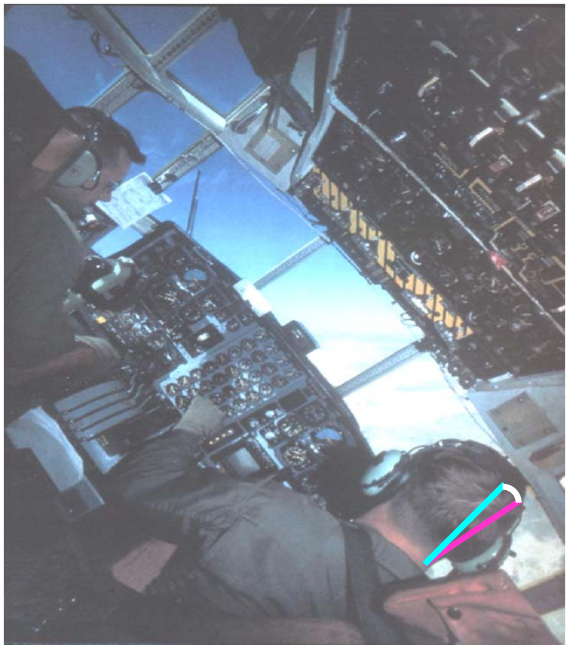


Rod-and-frame

Postural Effects



Optokinetic-Cervical Reflex

VISUAL ORIENTATION
Ambient Luminance Gradients

Luminance Gradients

- Light-to-Dark Gradient Important in Judging Visual Vertical
- Gradient Inversions Caused by
  - Low Sun Angles
  - Clouds
  - Terrain Shadowing
  - Lunar Reflections
- Can Result in Inversion Illusions

VISUAL ORIENTATION
Ambient Luminance Gradients

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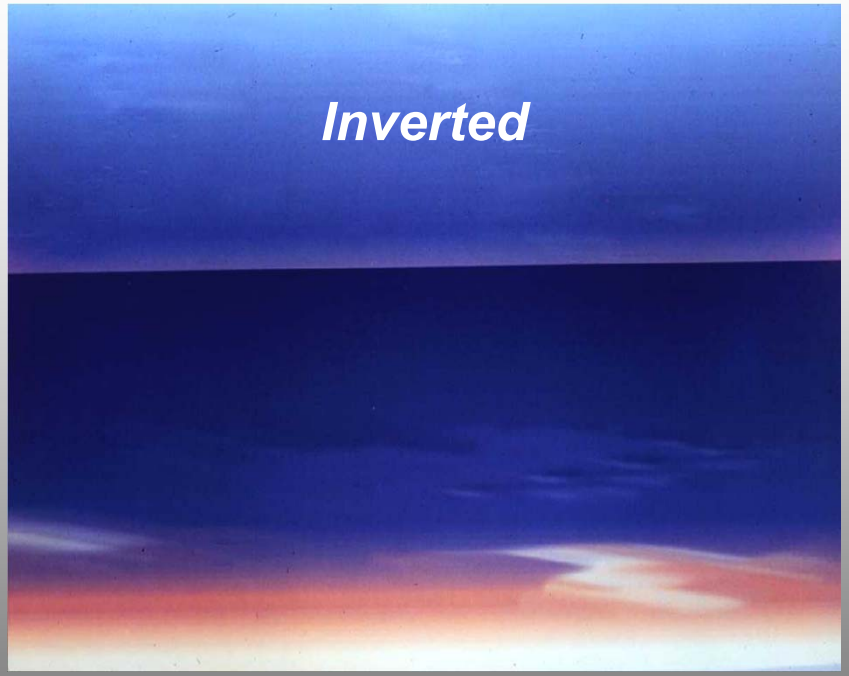

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VISUAL ORIENTATION
Ambient Visual Cues to Depth

Ambient Depth Cues

- Linear perspective/foreshortening
- Gradient of texture
- Motion parallax
- Illumination
- Aerial perspective

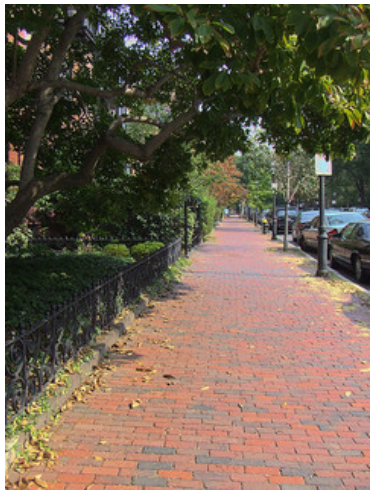
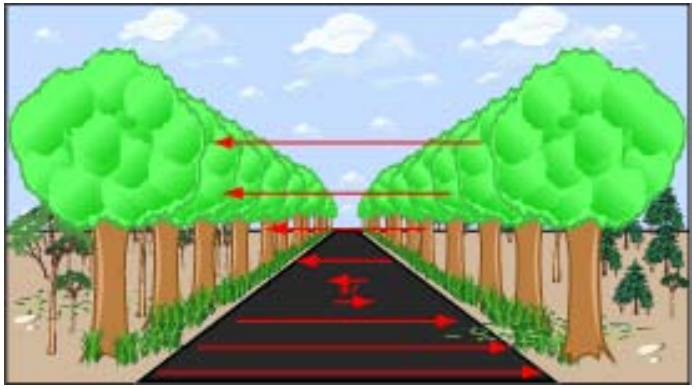


Image courtesy of Patrick M. on Flickr.

Linear perspective



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Motion parallax

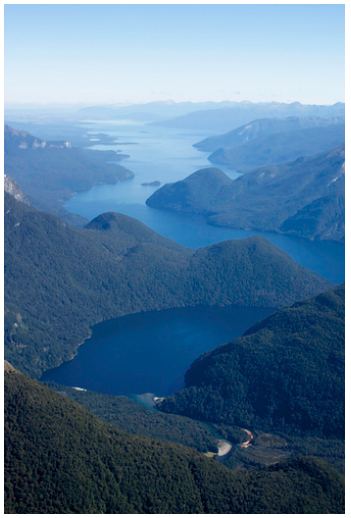

Image courtesy of Cameron Chamberlain on Flickr.

Aerial perspective

VISUAL ORIENTATION
Ambient Visual Cues to Depth

Linear Perspective & Gradient of Texture

Image courtesy of Patrick M. on Flickr.

VISUAL ORIENTATION
Ambient Visual Cues to Depth

Ambient Depth Cues

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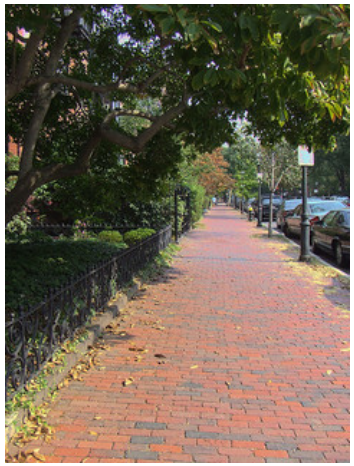

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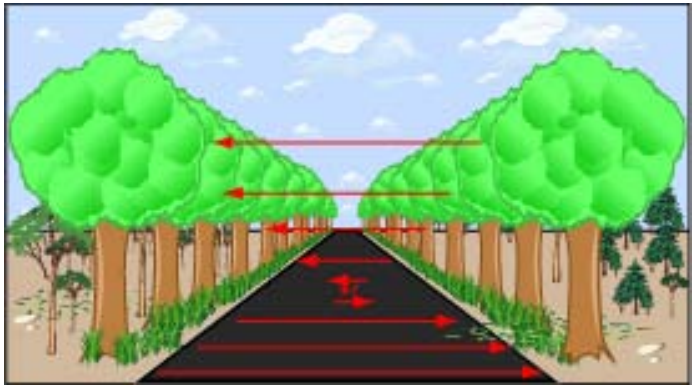
Linear perspective



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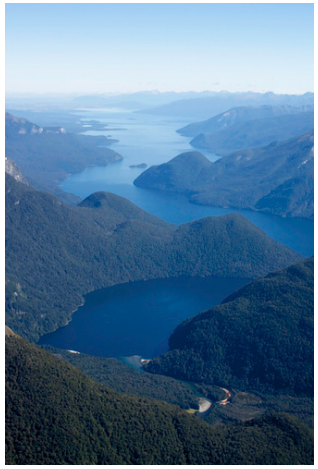
Motion parallax



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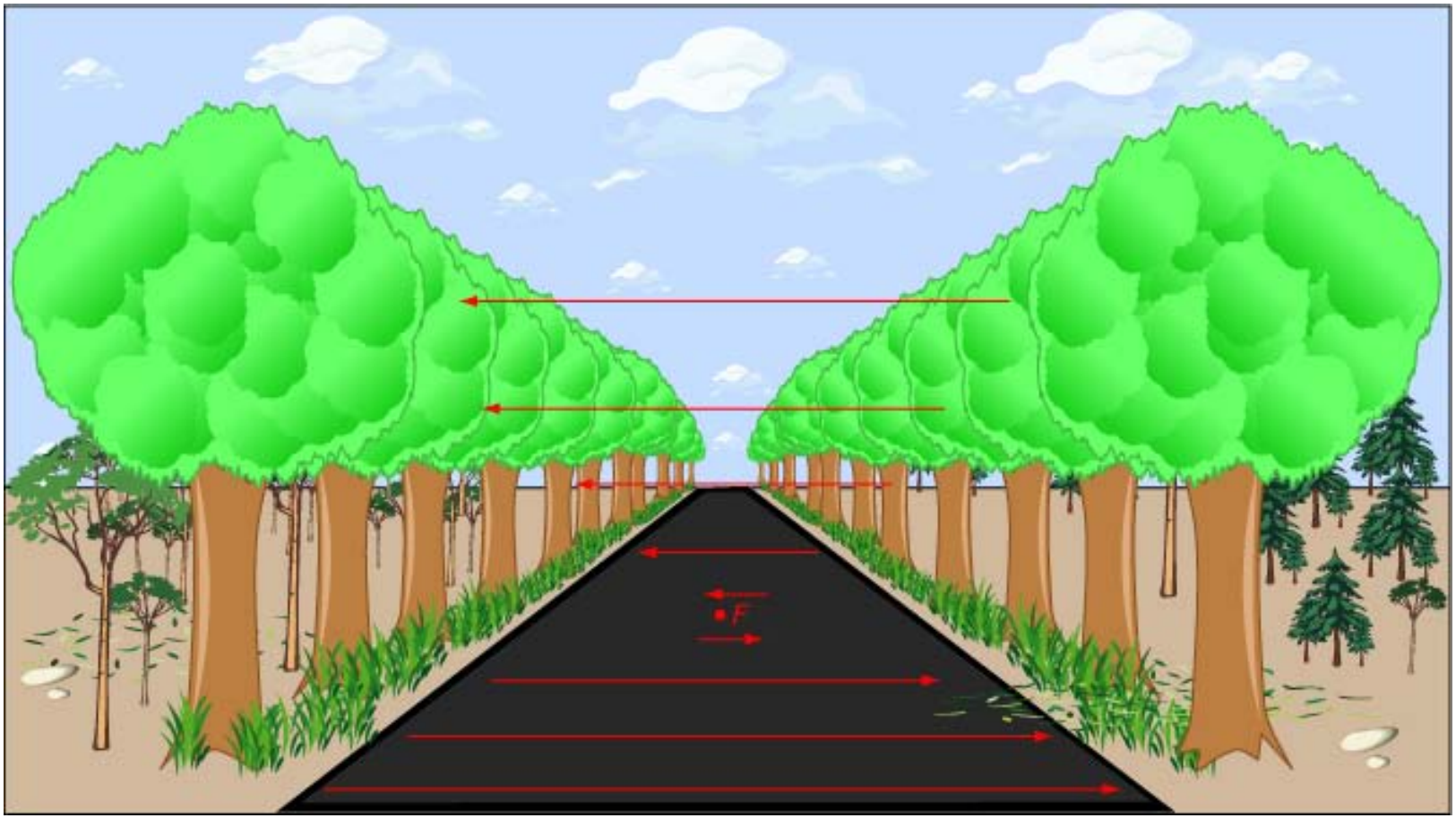
Aerial perspective

VISUAL ORIENTATION
Ambient Visual Cues to Depth

Motion Parallax



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VISUAL ORIENTATION
Ambient Visual Cues to Depth

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Image courtesy of Patrick M. on Flickr.

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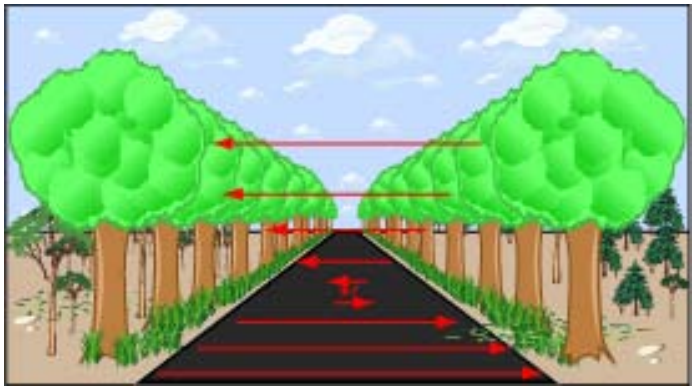

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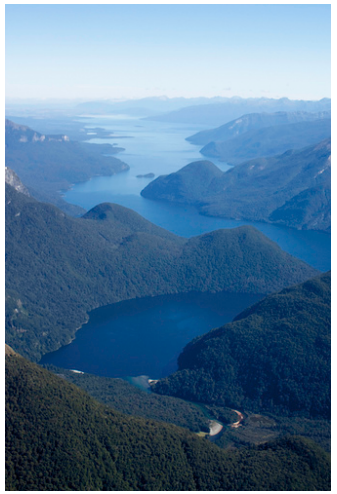
Motion parallax



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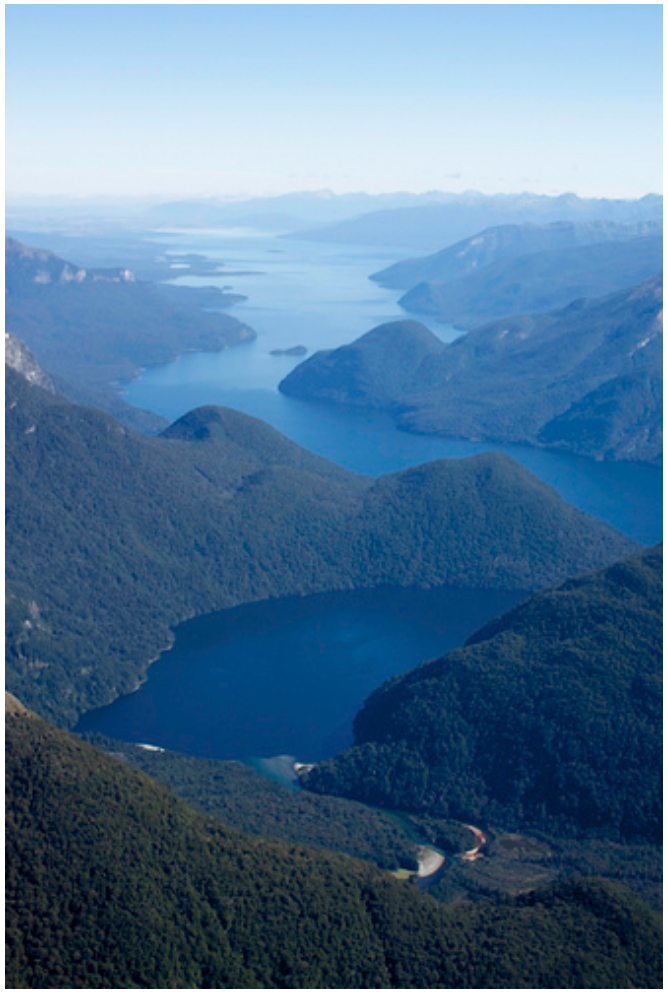
Aerial perspective

VISUAL ORIENTATION
Ambient Visual Cues to Depth

Aerial Perspective



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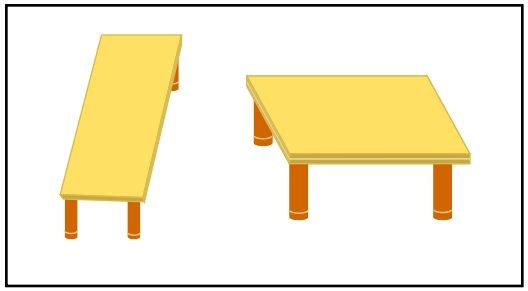
VISUAL ORIENTATION
Focal Visual Effects

Size and Shape Constancies

Rigidity is considered to be a fundamental property of objects; therefore, deviations in the size and shape of ground objects are perceived as changes in our orientation relative to the ground



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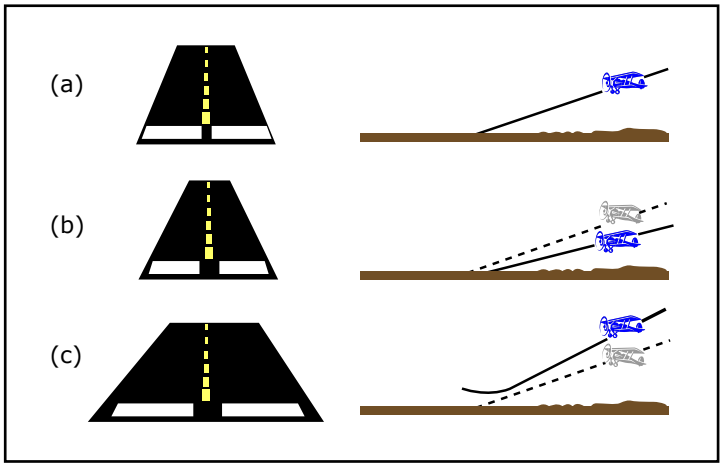

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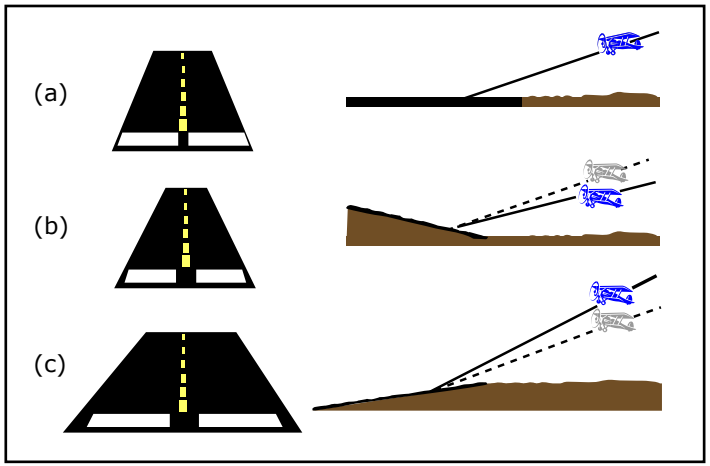
Size Constancy



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Shape Constancy

VISUAL ORIENTATION
Focal Visual Effects

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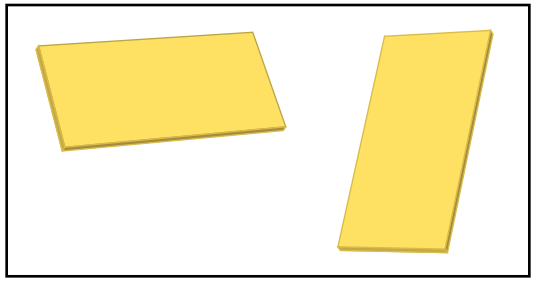

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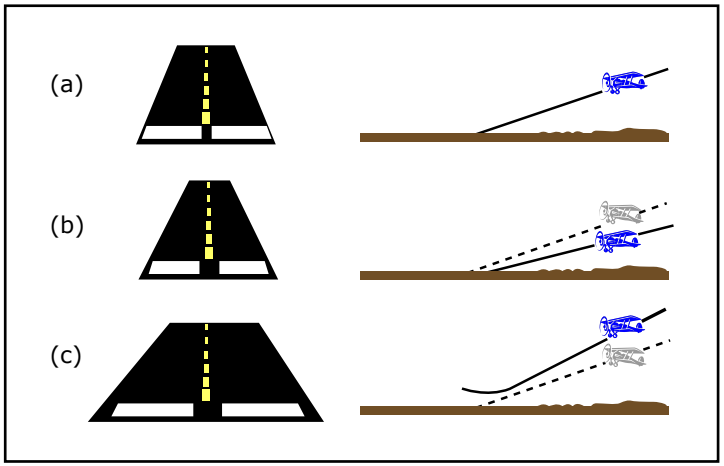

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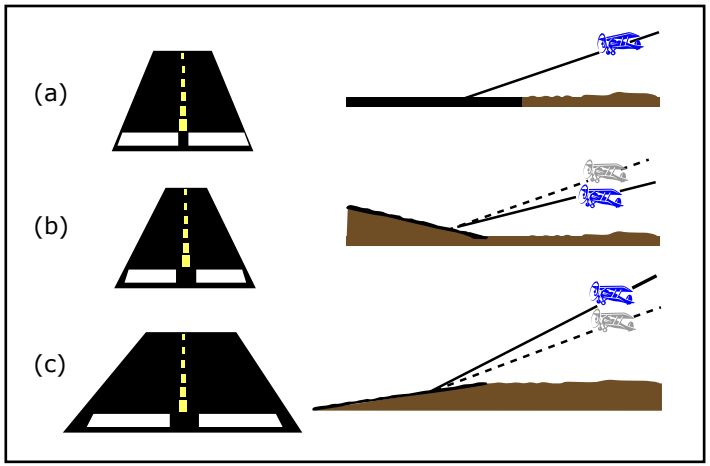
Size Constancy



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Shape Constancy

VISUAL ORIENTATION
Focal Visual Effects

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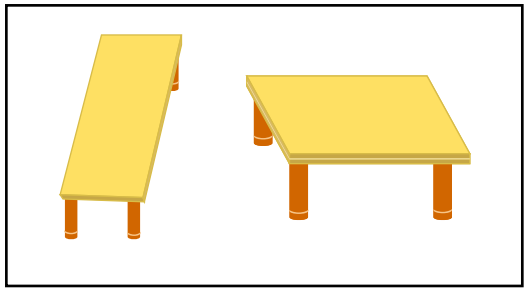

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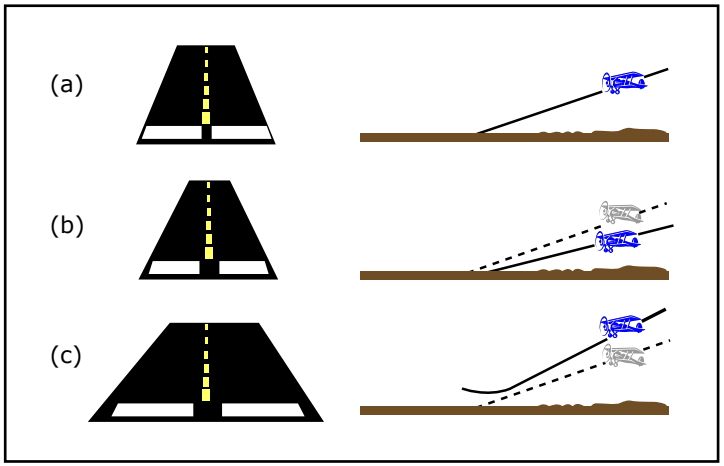

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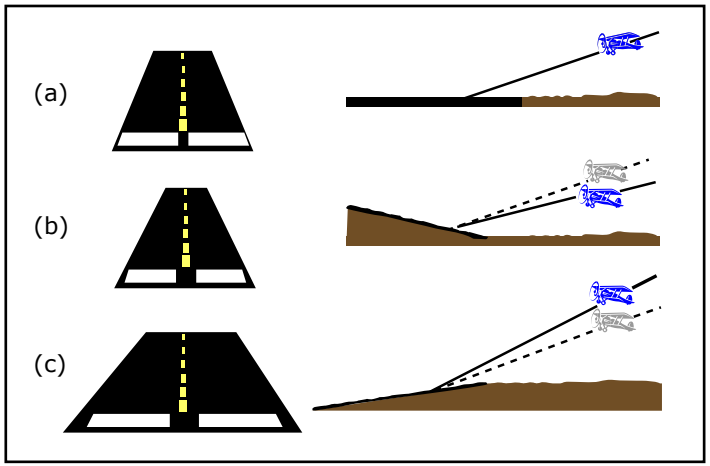

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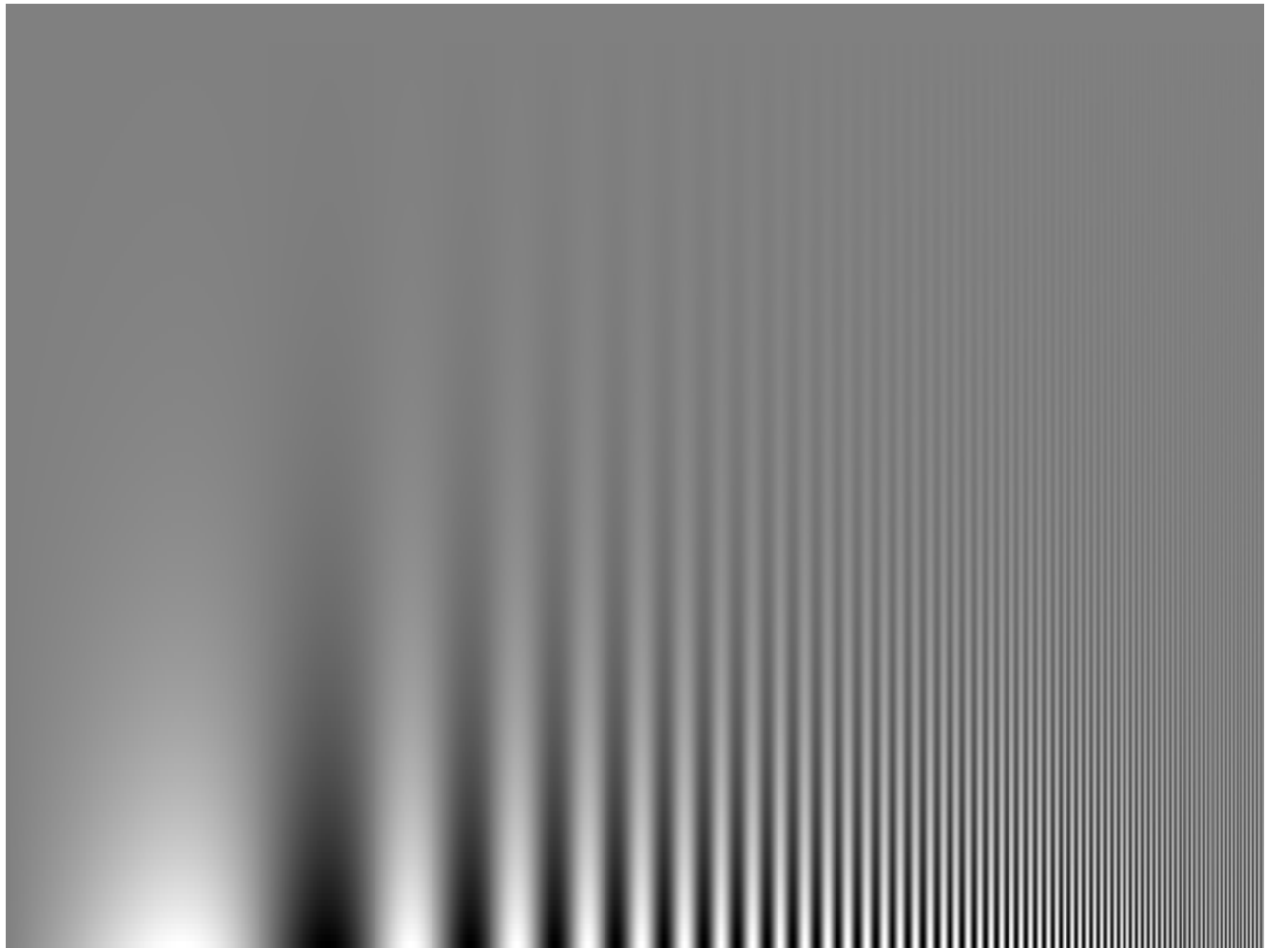
Shape Constancy

Contents

- Introduction
- Contrast & Frequency
- Visual Pathway, Visual Image
- Receptive Fields, Gestalt
- Color, Color deficits, after images
- Size of objects

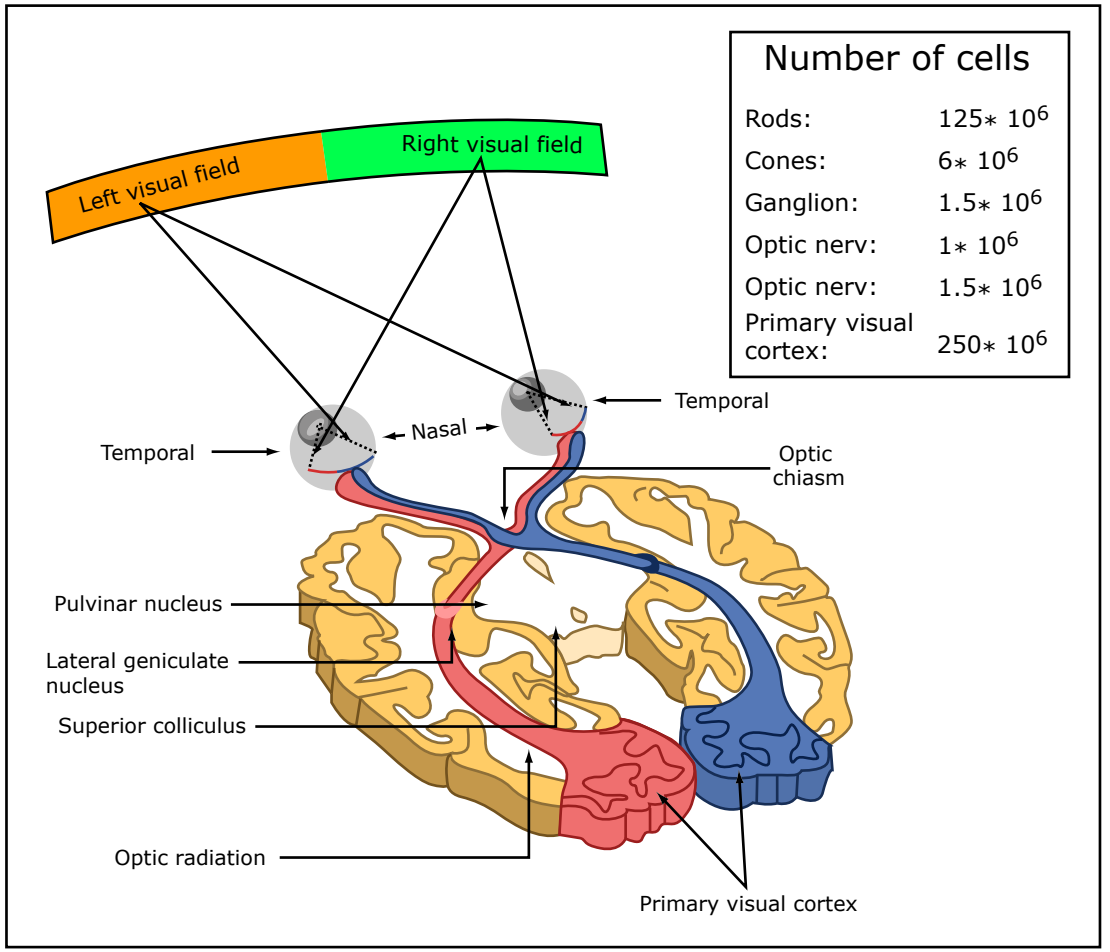
Spatial Frequency and Contrast



Optic nerve - from eye to brain

- Left visual field
  -> right brain side
- Right visual field
  -> left brain side

- Retina 11cm^2
- Optic nerve diameter 2mm
- **<u>convergence</u>**
  receptors ->ganglion
- **<u>divergence</u>**
  optic nerv -> visual cortex



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Rod and cone density

Image of rods and cones removed due to copyright restrictions.

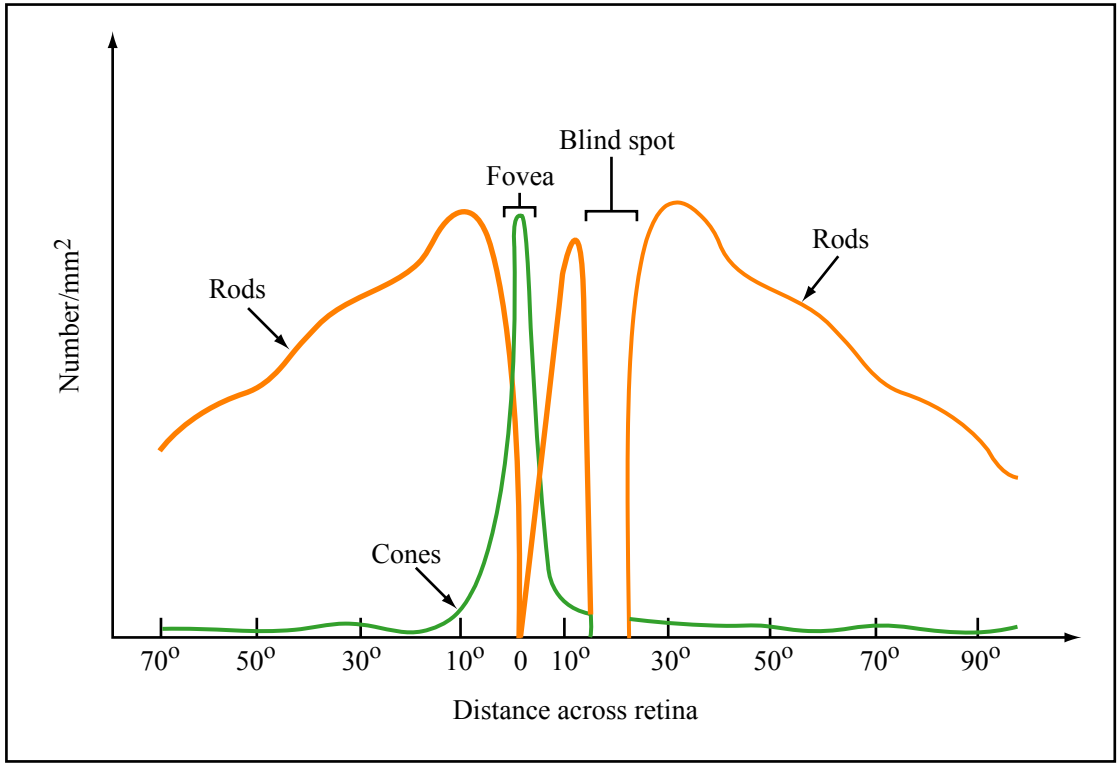


Image by MIT OpenCourseWare.

- On average 120 rods converge on 1 ganglion cell
- On average 6 cones converge on 1 ganglion cell

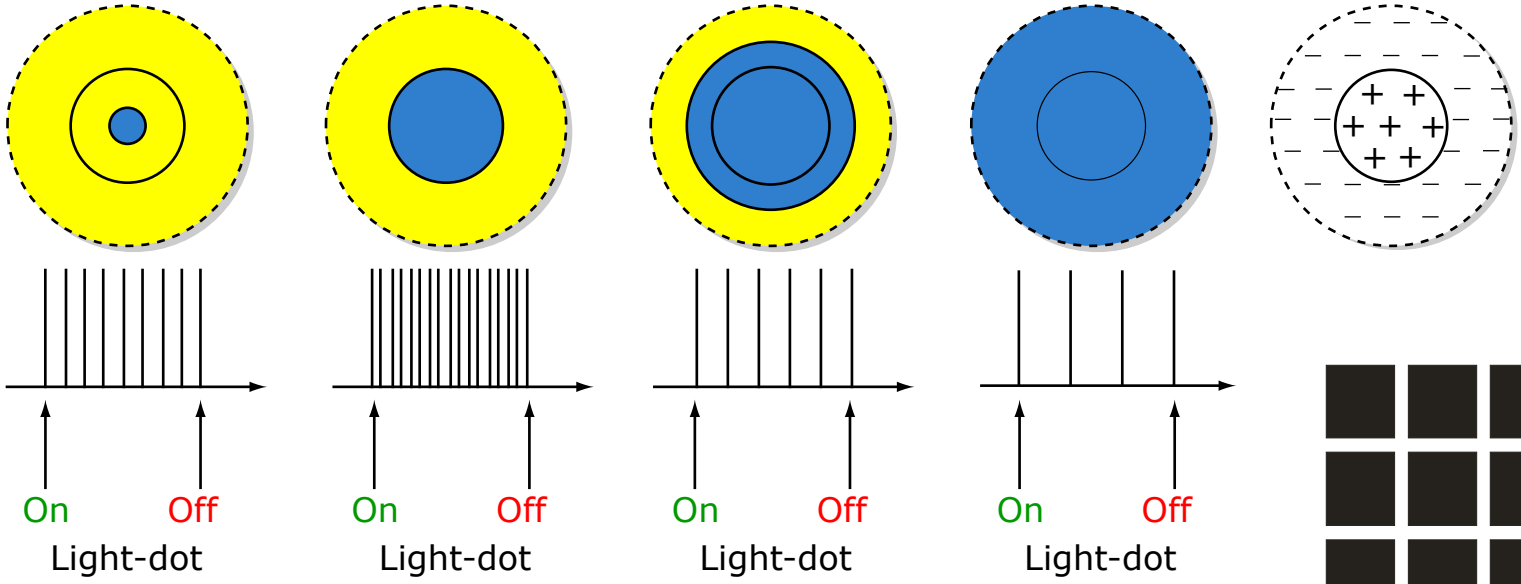
Image properties

- Image quality created by retina is not homogenous
- Color vision mainly in fovea
- Resolution decreases in periphery
  - Best resolution for color in the fovea
  - Best resolution for b/w 20° parafovela

Questions

- How come that we perceive such a nice and homogenous image of our surrounding?
- What happened to the blind-spot hole?
- Why do we perceive color in the periphery?

Receptive Fields



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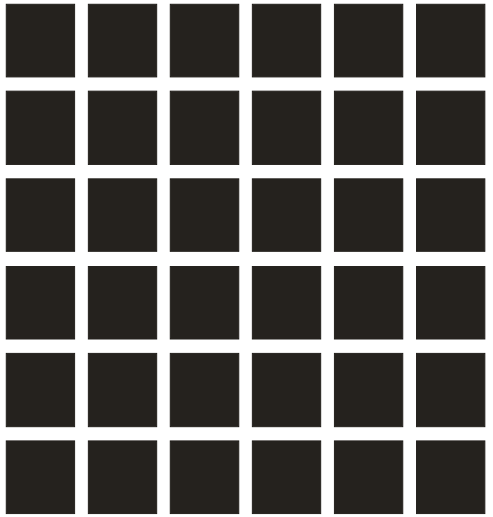

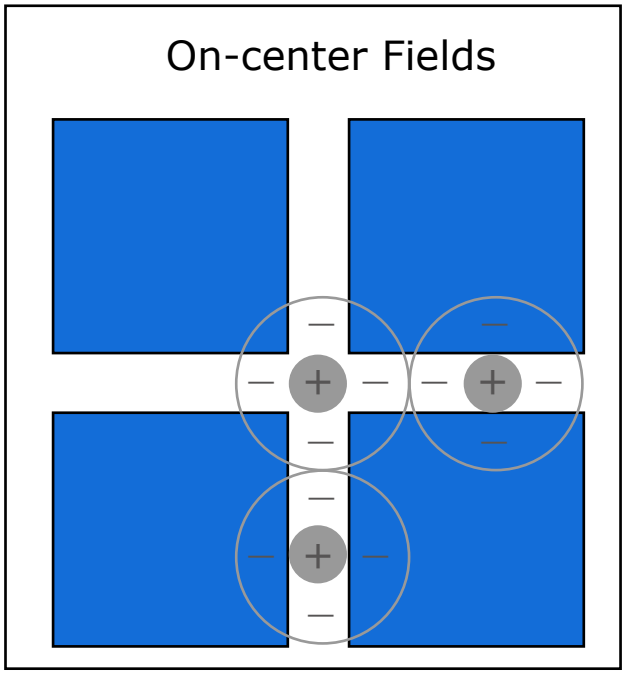

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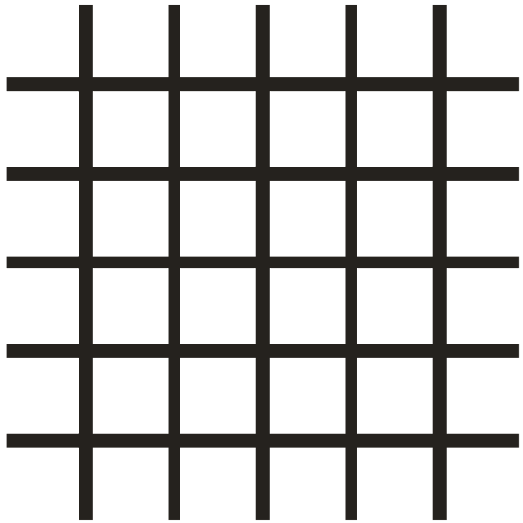
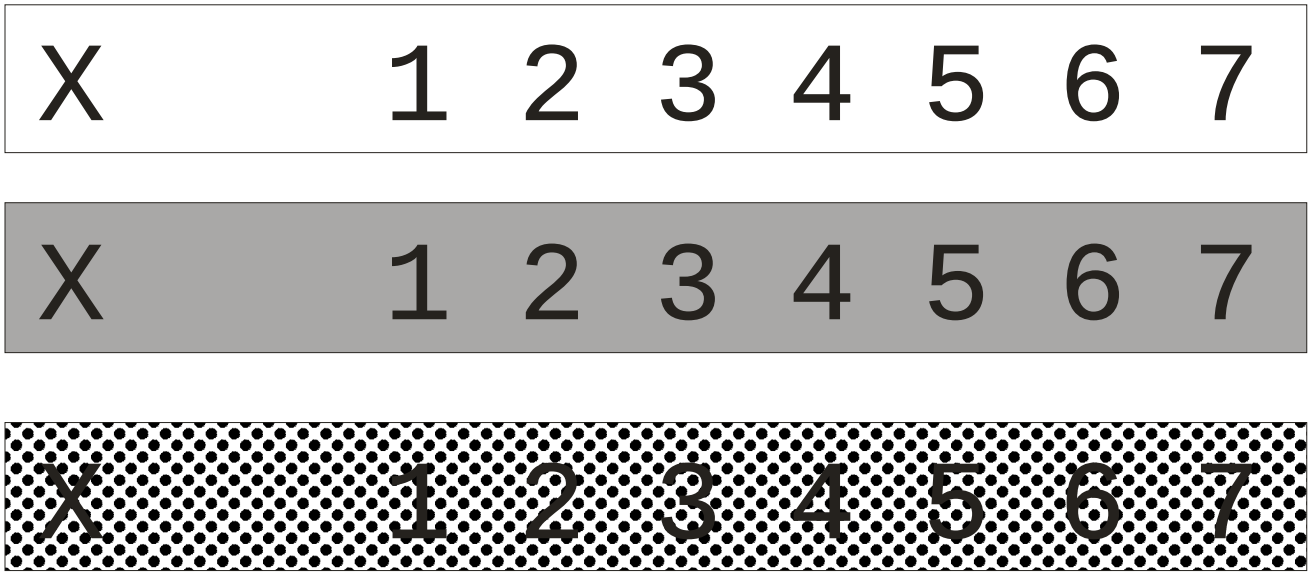


Filling the blind spot

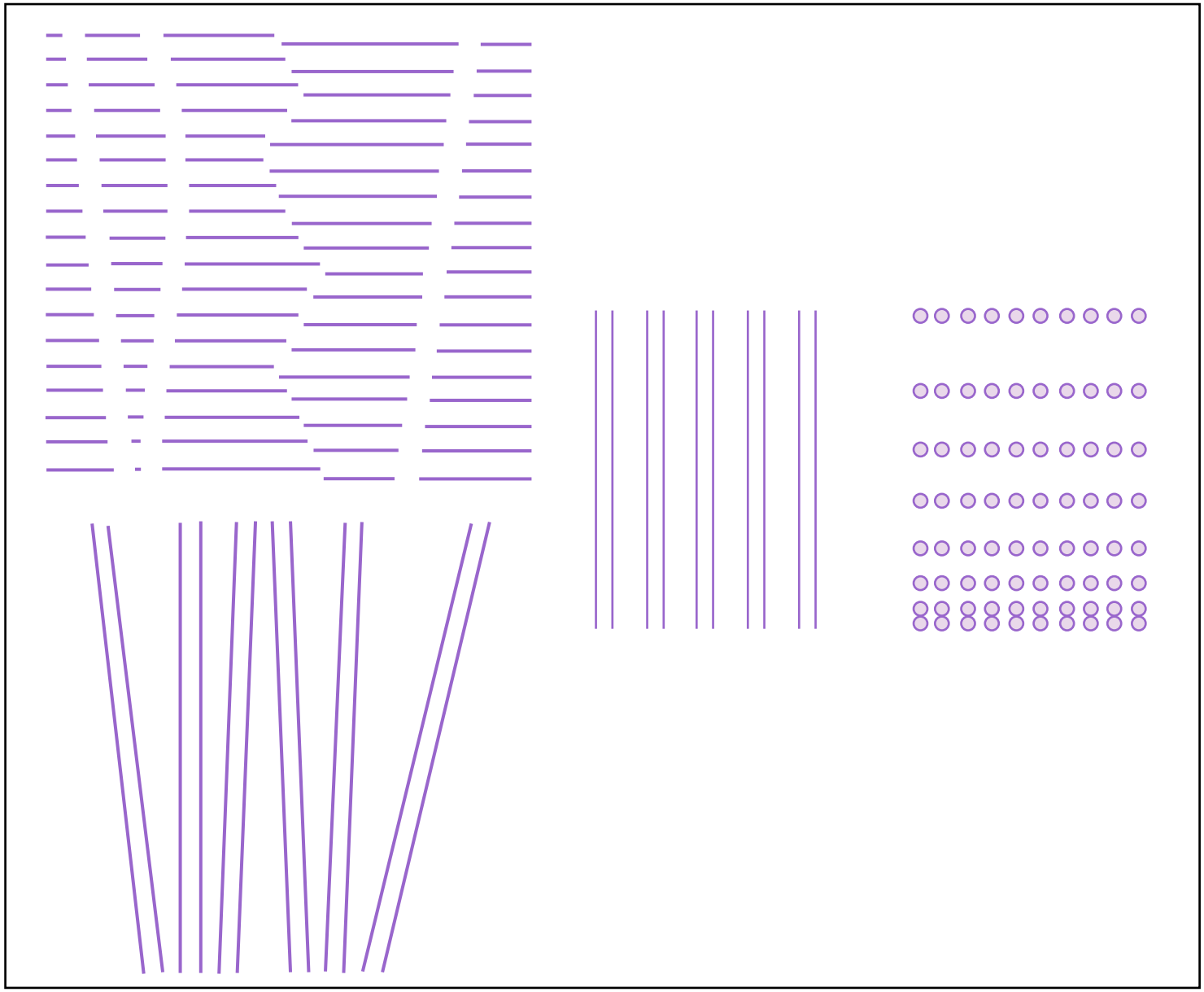


- Close your left eye and fixated with the right eye the X.
  Which number is missing? What is the color pattern at the psotion of the missing number?
- The blind spot is filled with the surrounding pattern.

Figure and background

- The total visual input is organized into figures and background.
- The Gestalt-laws describe principles how figure and ground are separated.
- **Figures** are in front, have a border, connected, “things”.
- The **background** is behind the figure, withour border, uninterrupted, homogenous.

Gestalt-laws



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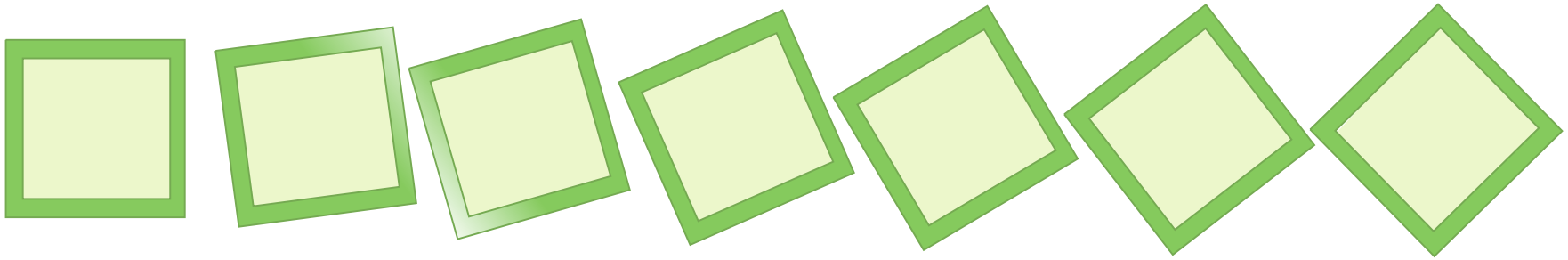
Perceptual categories



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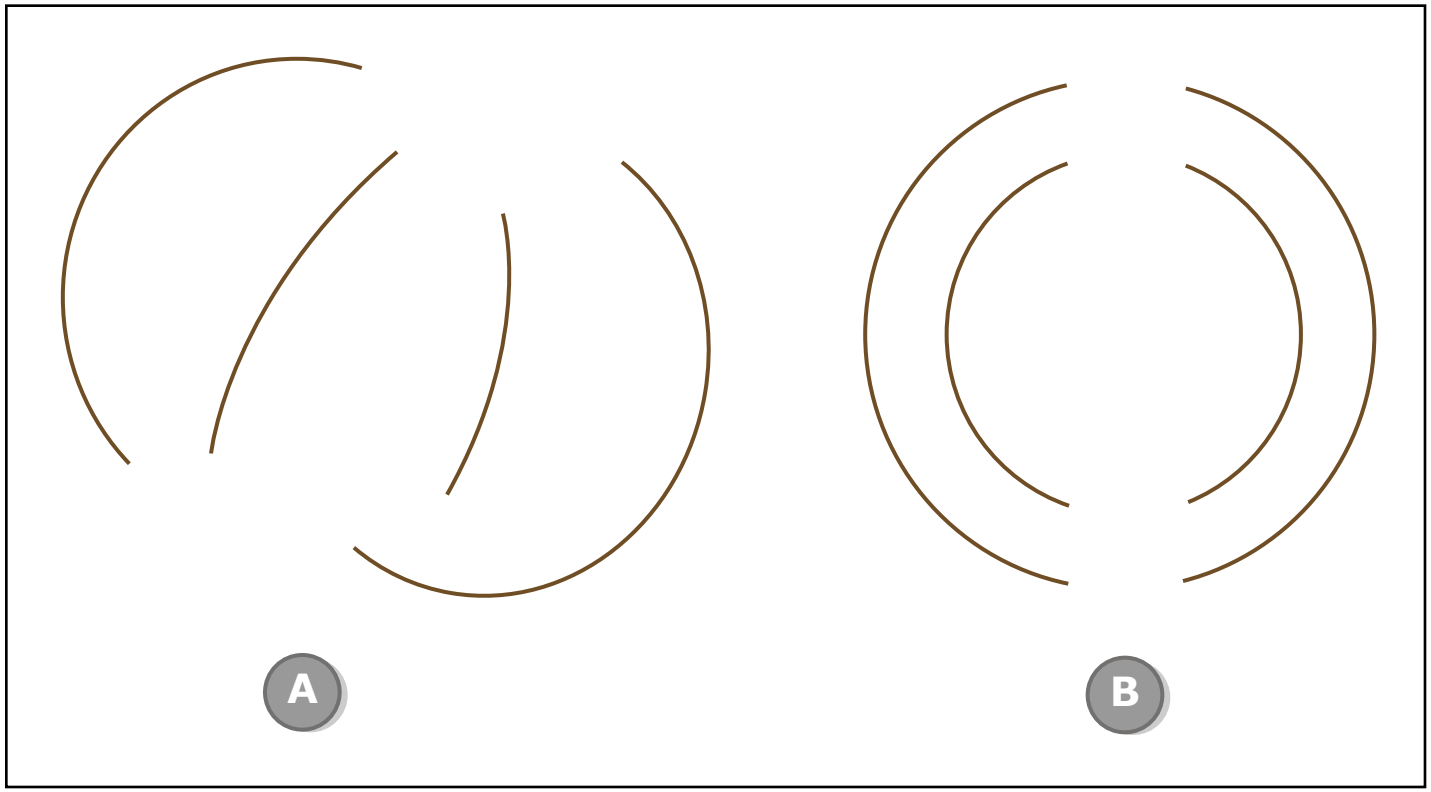
Square……Diamond

- The shapes in-between are neither square nor diamond.
- Our perception is organized in categories, even if the stimuli are continuos.

Perceptual categories: Reproducing shapes

- Figure in B is the drawing when the shape of the Figure A is given as a tactile stimulus (without vision).



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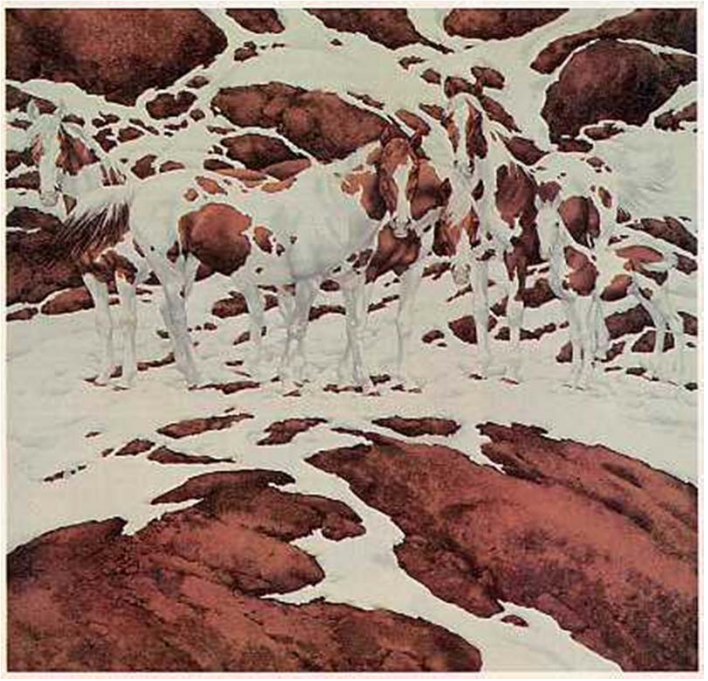
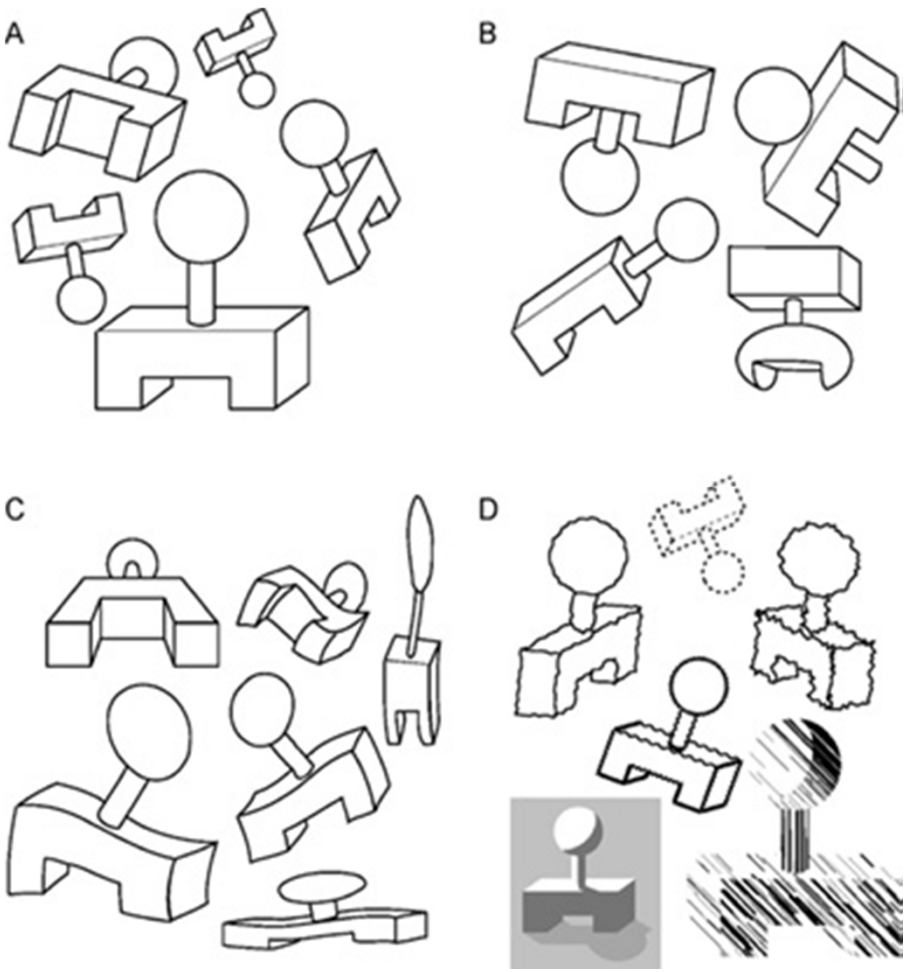
Emergence



- The dog is perceived as a whole, all at once.
- We do not construct the “dog” by first identifying its parts, e.g. combining feet, ears, nose, tail, etc.

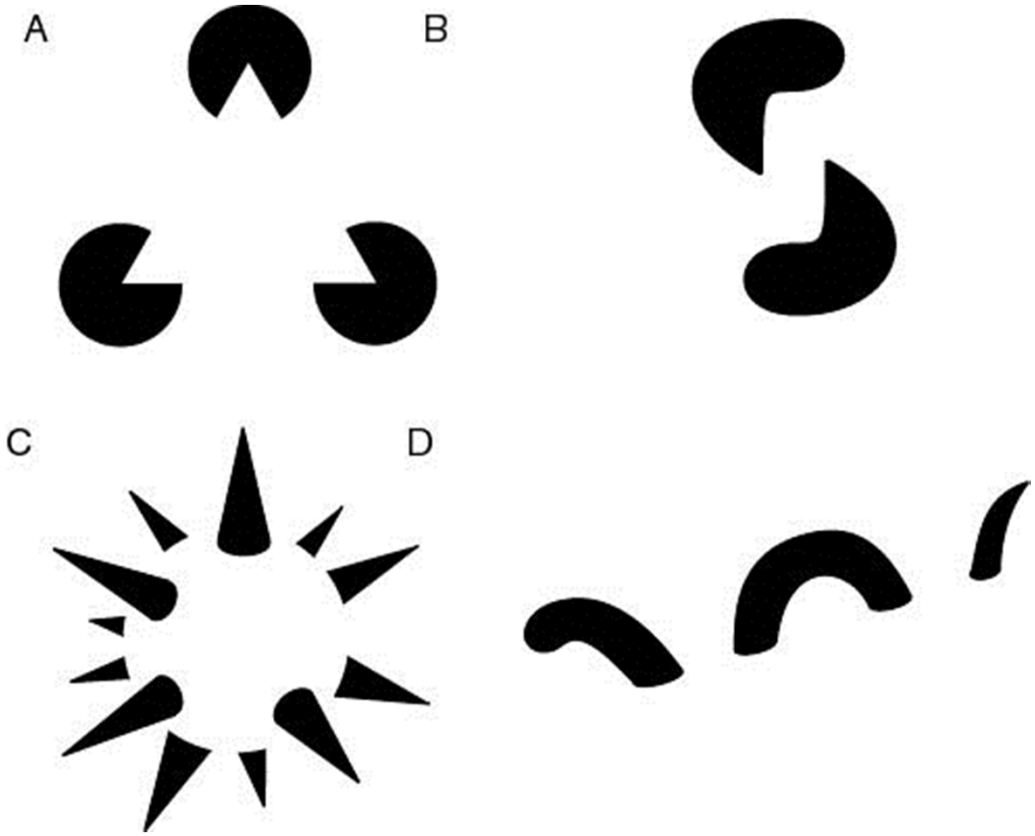
Invariance

- simple geometrical objects are recognized independent of rotation, translation, and scale, (and other deformations)
- Objects in A are immediately recognized as the same shape,
- are different from those in B,
- are the same as in C despite perspective and elastic deformations,
- and can be depicted using different graphic elements as in D.

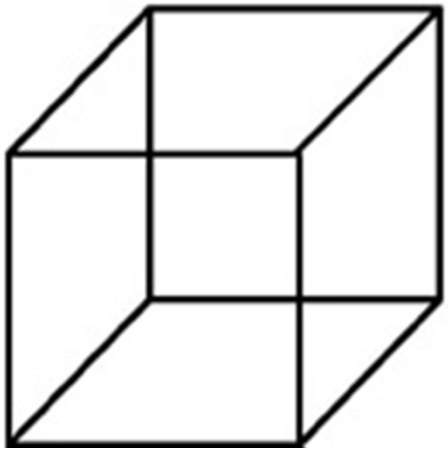


Reification

- The perceived object can contain more information as given by the sensory input. (e.g. ball in C)
- Mostly for spatial information.



Multistable perception

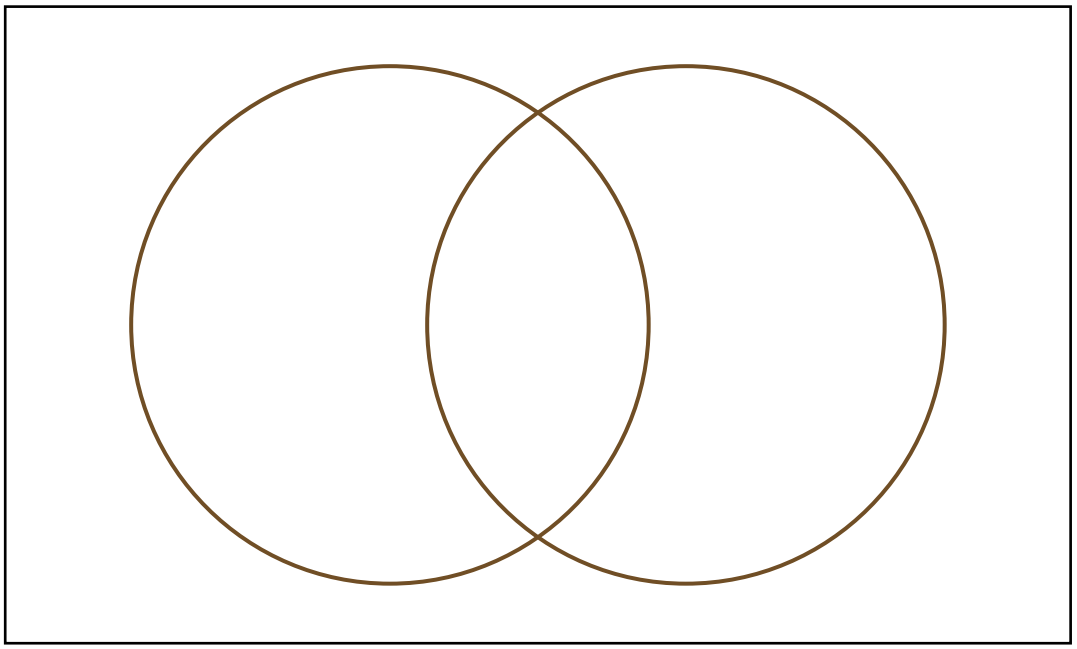


Necker cube

Rubin's Figure / Vase

- Ambiguous perceptual experiences (2 figures share a common border) lead to multistable perception. The experiences pop back and forth between two or more alternative interpretations.

What are the components?



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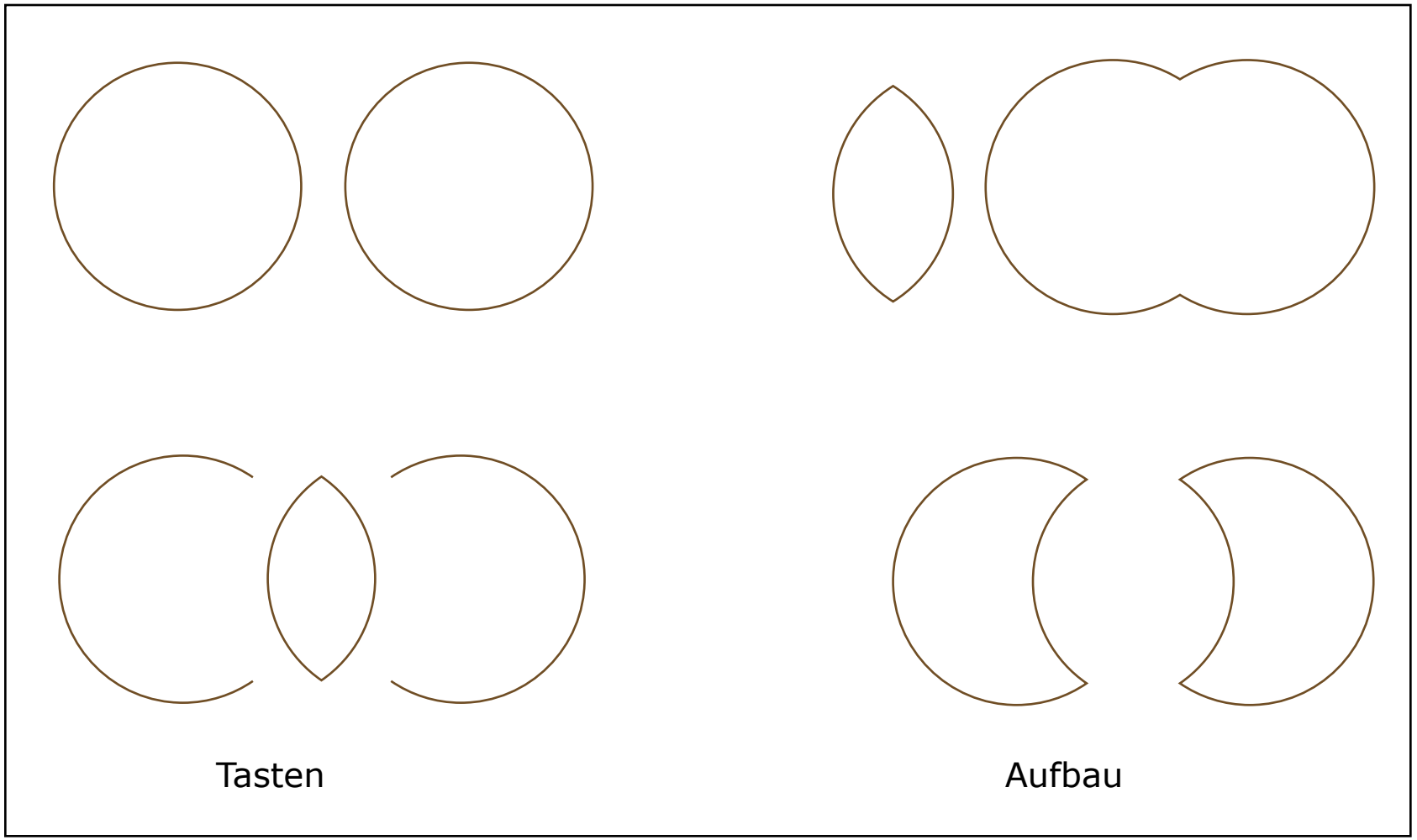
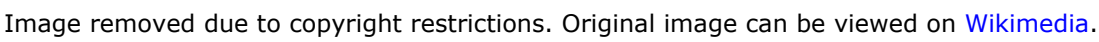
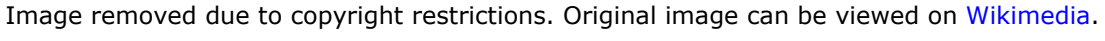
Some of the combinations



Color



- Wavelength - physics
- Color - perception



Color blindness

- Normal color vision is **trichormat**, 3 cone types are used.
- Dichromacy, most common Red-Green color blindness
  lacking or reduced long-wavelength or medium-wavelength cones
  (4-8% of the male population!)
  includes: Protanopia (rare), Deuteranopia (1% m), Protanomaly (1% m), Deuteranomaly (6% m)
- Monochromacy, complete inability to distinguish any colors
  cone monochromacy (only 1 cone type)
  rod monochromacy (only rods)

- Human Factors
  Color codes
  (Maps, Signals, etc)

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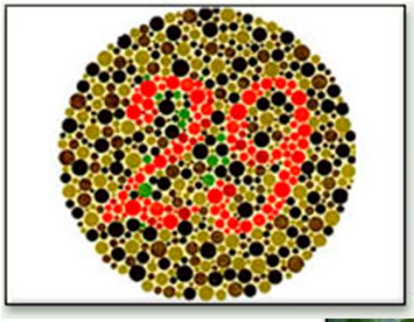
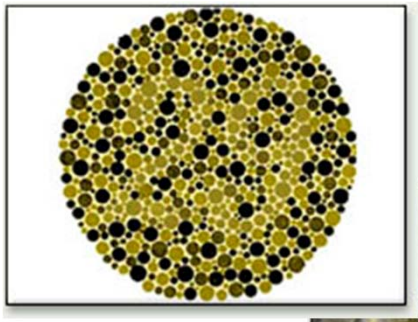
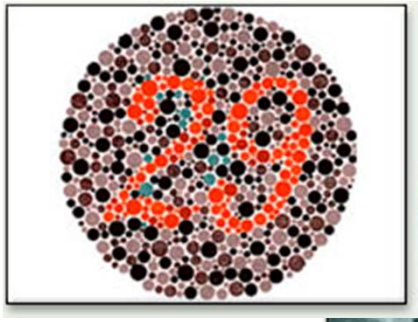
Color blindness - samples



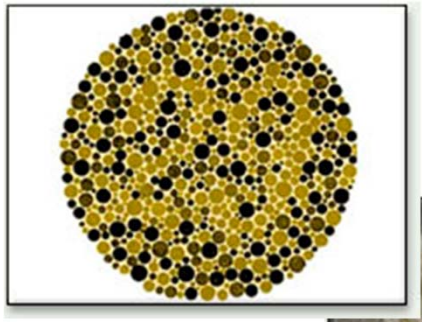
Trichormat
(all cones)



Protanopia
(L-cone)



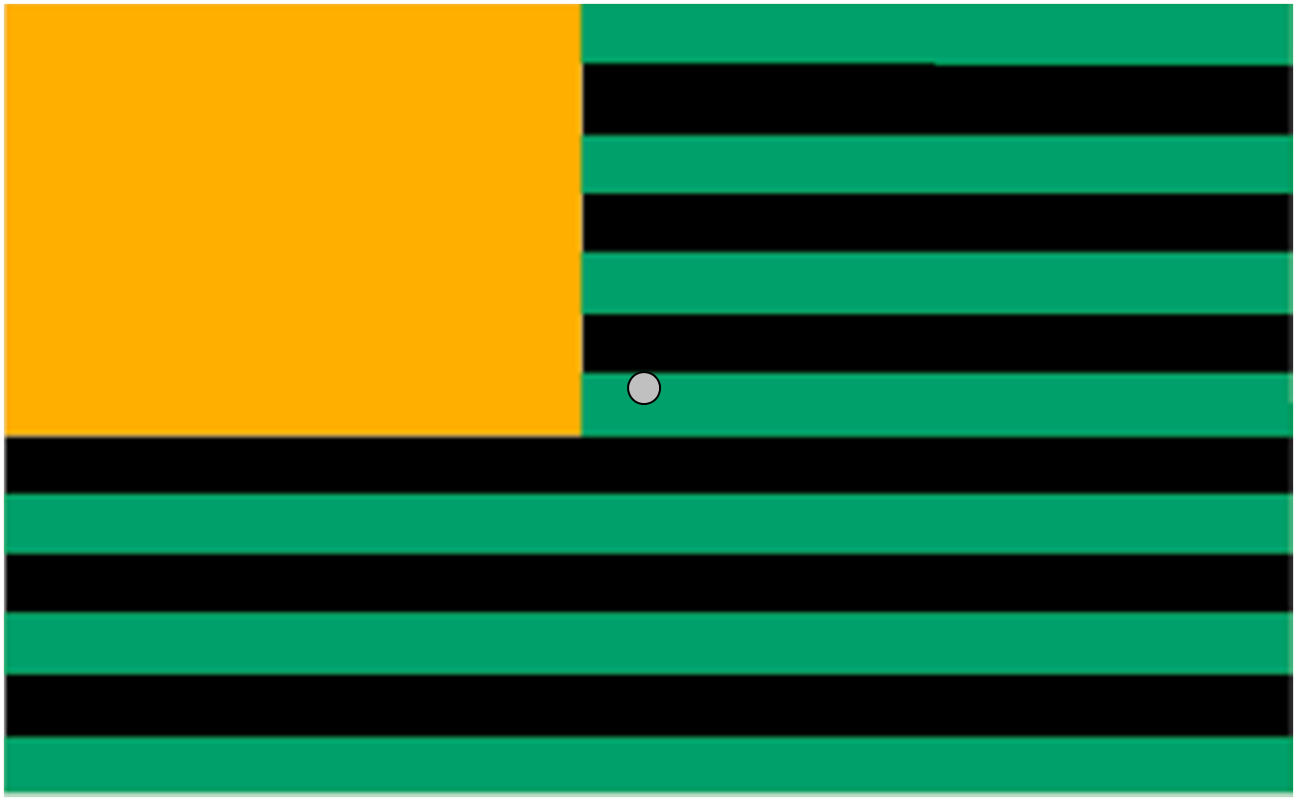
Tritanopia
(S-cone)



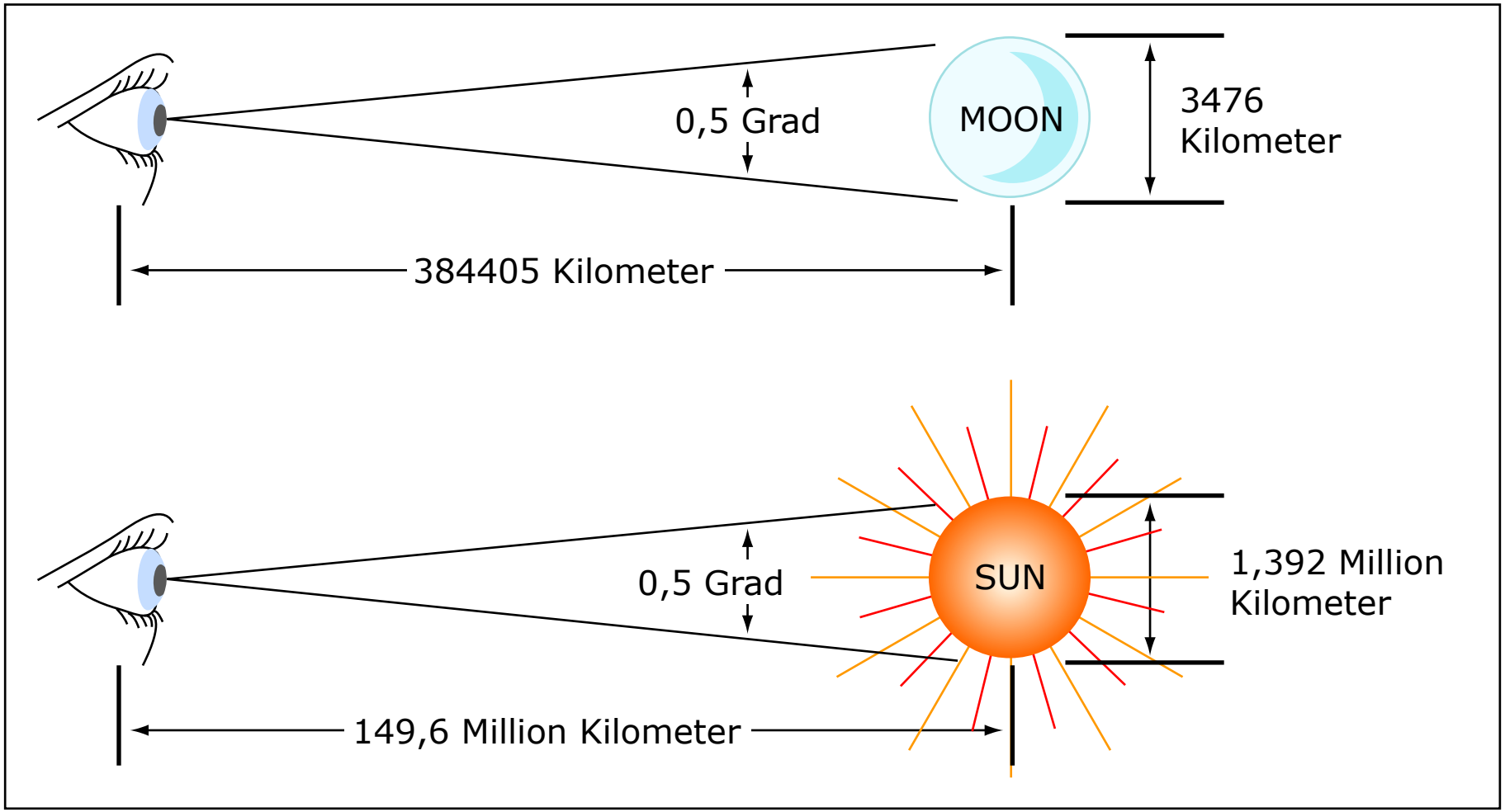
Deutanopia
(M-cone)

Color vision - after images 1

- Fixate center dot on flag for 1 minute, then look at a white surface



Color vision - after images 2



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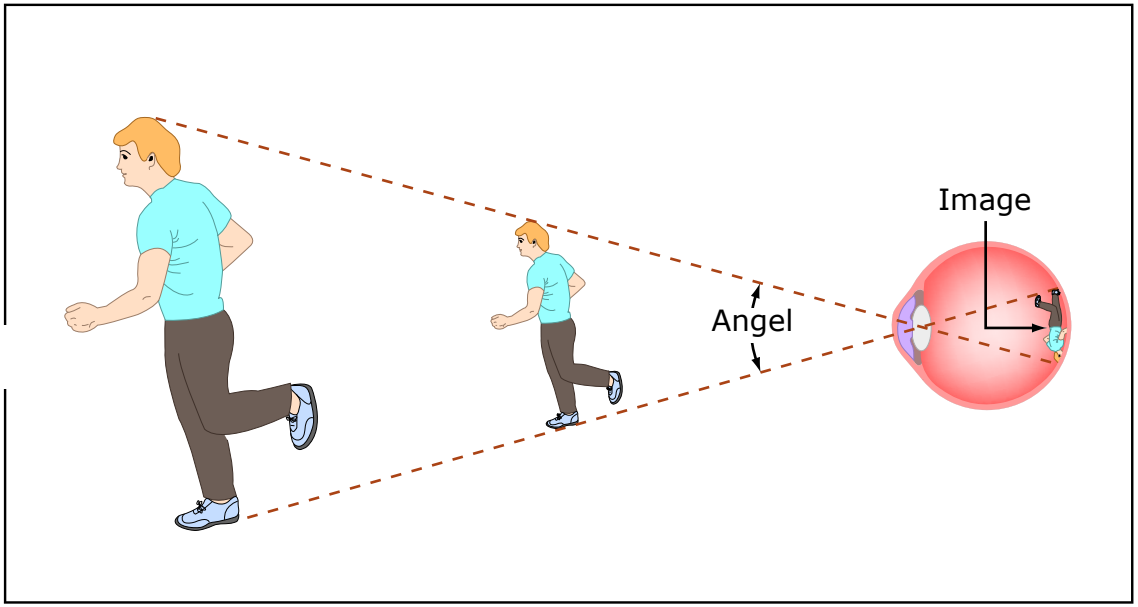
Perceived size

- How to estimate the distance of person?



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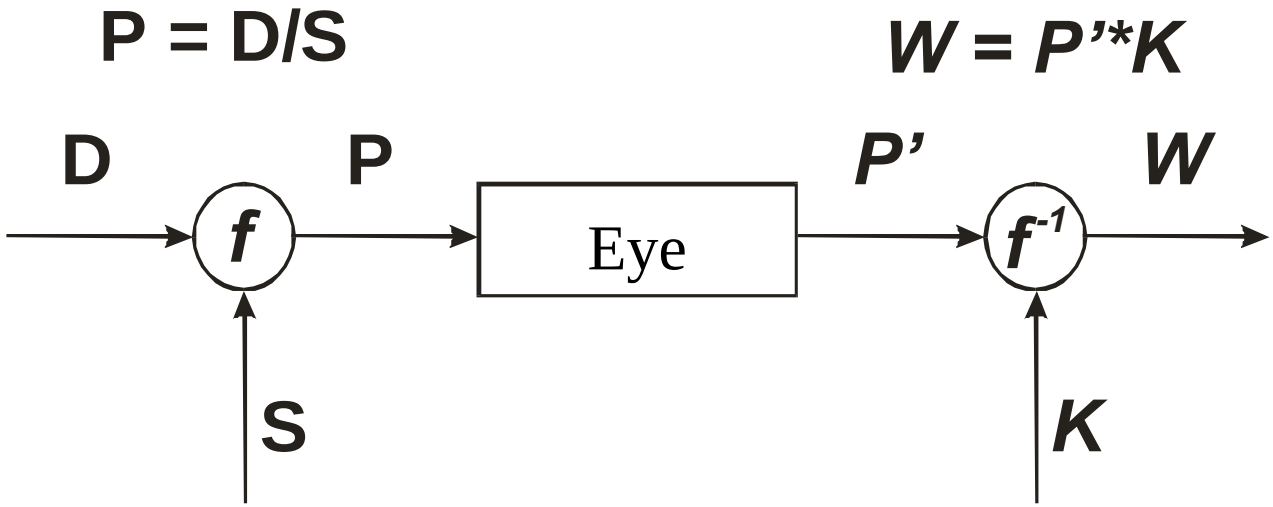
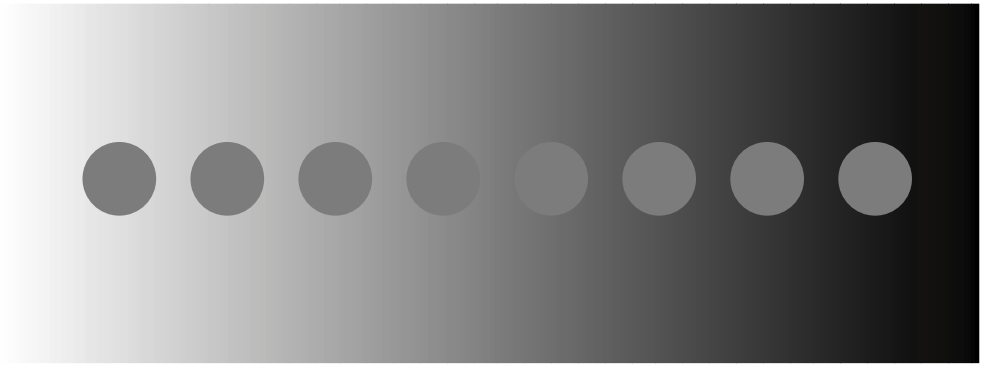


Additional Slides



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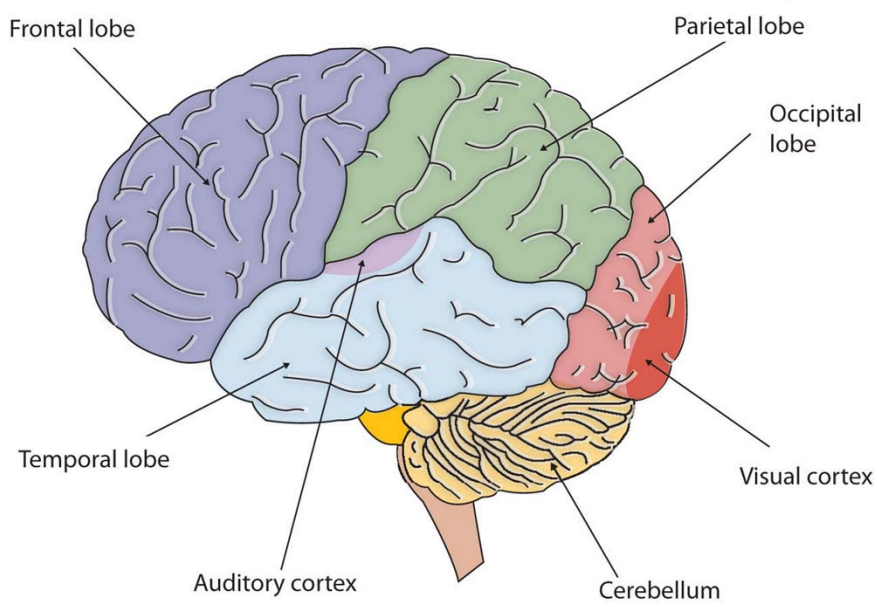
Major parts

- **Occipital lobe**: visual perception system

- E.g., visuospatial processing, discrimination of movement and colour discrimination



Adapted from Stangor, C. *Introduction to Psychology*. Flatworld Knowledge, 2010. Courtesy of Flatworld Knowledge.

Sensory Maps - Homunculus

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