The Ecological View of Perception

Lecture 14

Ecological View of Perception

James J. Gibson (1950, 1966, 1979)
Eleanor J. Gibson (1967)

- Stimulus provides information
- Perception involves extracting this information
- Direct Perception (Direct Realism)
  – All information needed for perception is supplied by the stimulus
  – No need for “higher” cognitive activity
  – Learn to extract relevant information
    - Exploration of object
    - All information is available “in the light”

Applications of Ecological View

- Motion Perception
  - Is the Object Stable or Moving?
- Depth Perception
  - Is the Object Near or Far?
- Perception of Plasticity
  - Is the Object Rigid or Flexible?

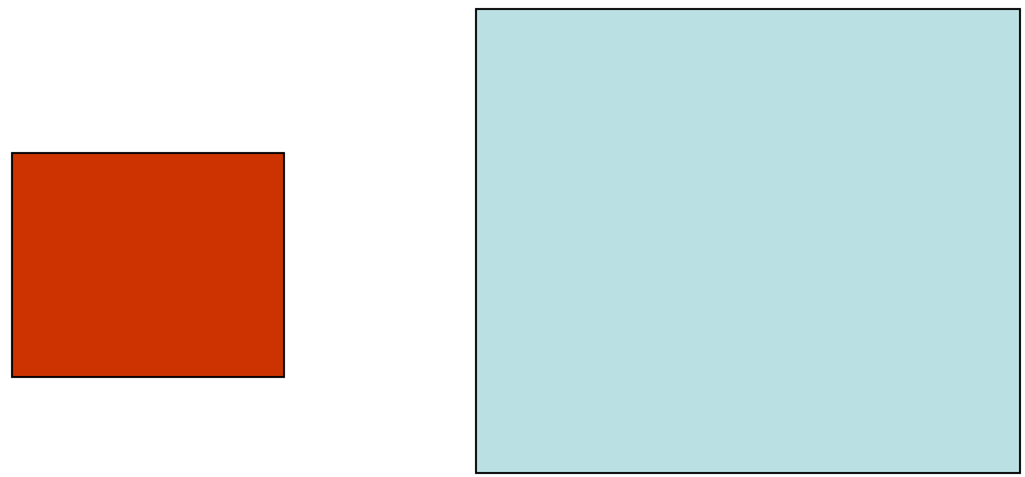
The "Stimulus" in Ecological Perception

- Distal Stimulus
  - Object of Regard
- Surrounding Stimulus Field
  - Environmental Context
    - Exteroceptive Stimuli
  - Information from Perceiver's Body
    - Proprioceptive Stimuli

Cues for the Perception of Motion

- Successive Covering, Uncovering

Covering and Uncovering: Watch the Red Square



Cues for the Perception of Motion

- Successive Covering, Uncovering
- Movement of Image Across Retina
  - Holding Head and Eyes Steady

Movement of the Retinal Image: Focus on the Cross And Hold Your Head and Eyes Steady

+ O

Cues for the Perception of Motion

- Successive Covering, Uncovering
- Movement of Image Across Retina
  - Holding Head and Eyes Steady
- Egomotion
  - Head/Eye Movements
    - Alter placement of retinal image

Egomotion:
Focus on the Cross, then
Track the Circle with your Eyes
Don’t Move Your Head!

\+ O

Egomotion:
Focus on the Cross, then
Track the Circle by Moving Your Head
Don’t Move Your Eyes!

+ O

An Exercise in Carwatching

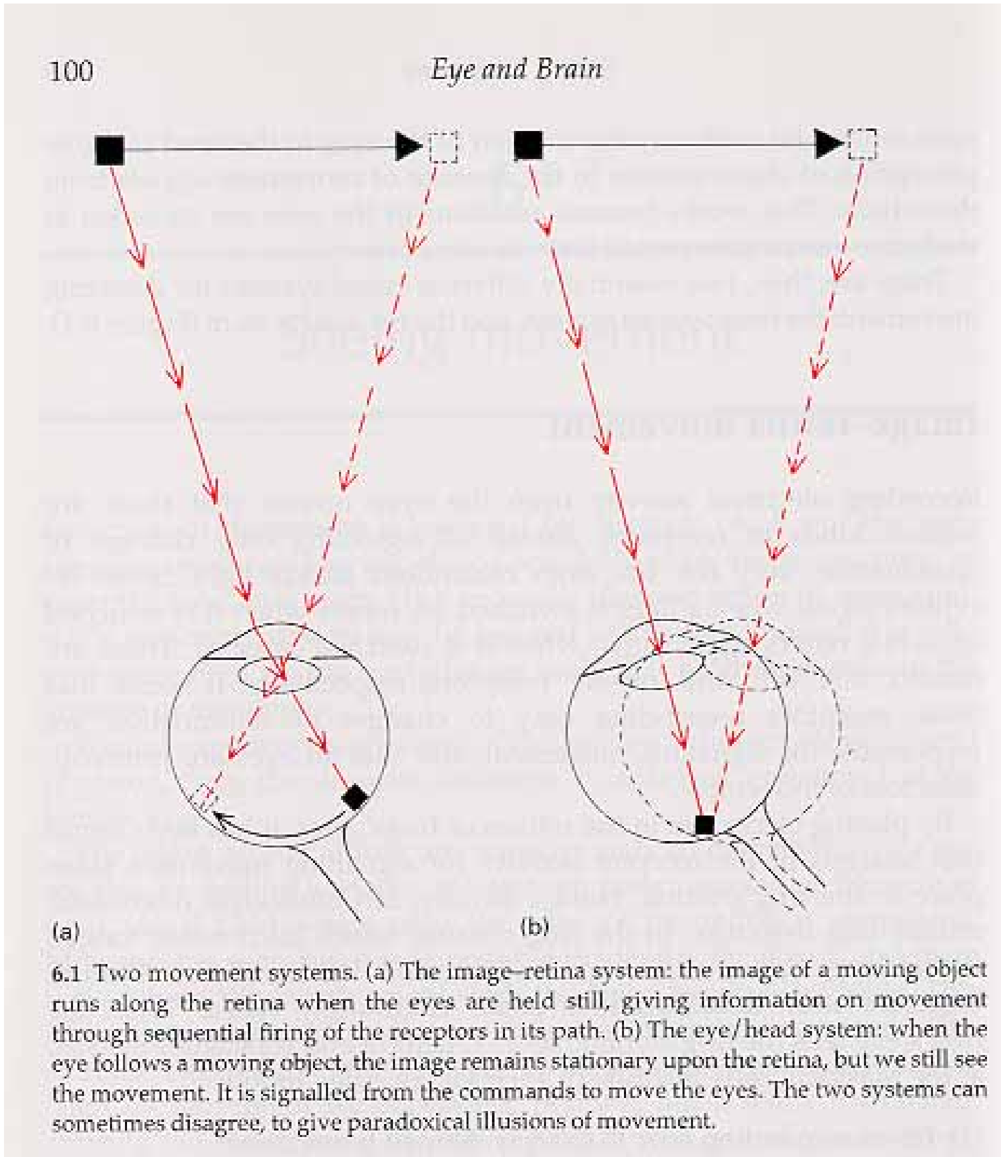
- Fixate on target across the street
- Wait for Car to Pass
  - Covering and Uncovering
  - Movement of Retinal Image
- Follow Passing Car
  - With Eyes, Holding Head Steady
  - With Head, Holding Eyes Steady

Two Systems for Perceiving Motion

Gregory (1966)

Image-Retina System

Eye/Head System



100 *Eye and Brain*

(a) (b)

6.1 Two movement systems. (a) The image–retina system: the image of a moving object runs along the retina when the eyes are held still, giving information on movement through sequential firing of the receptors in its path. (b) The eye/head system: when the eye follows a moving object, the image remains stationary upon the retina, but we still see the movement. It is signalled from the commands to move the eyes. The two systems can sometimes disagree, to give paradoxical illusions of movement.

Conflicting Signals: The World Moves

Cover one eye with your hand.

Focus other eye on the cross.

Then *gently* push on your open eye with your finger.

+

The Information for Motion: *Discrepancy*

- Information provided by image-retina system
  - Movement of image across retina
- Information provided by the eye/head system
  - Movement of eyes, head, body

Image-Retina and Eye-Head Systems

After Coren, Porac, & Ward (1976)

Target	**Action of Eye**	**Retinal Image**	**Command to Eye (Head)**	**Perception of Motion**
		Image-Retina System		
Moving	Stationary	Moves	None	Yes
		Eye-Head System		
Moving	Tracks	Stationary	Yes	Yes
Stationary	Moves	Moves	Yes	No
Stationary	Pushed	Moves	None	Opposite Direction
Stabilized	Moves	Stationary	Yes	Same Direction

Binocular Cues for the Perception of Distance

- Convergence
  - Eyes turn inward when focusing on object
  - Angle of vectors indicates distance
    - up to 30-40 feet

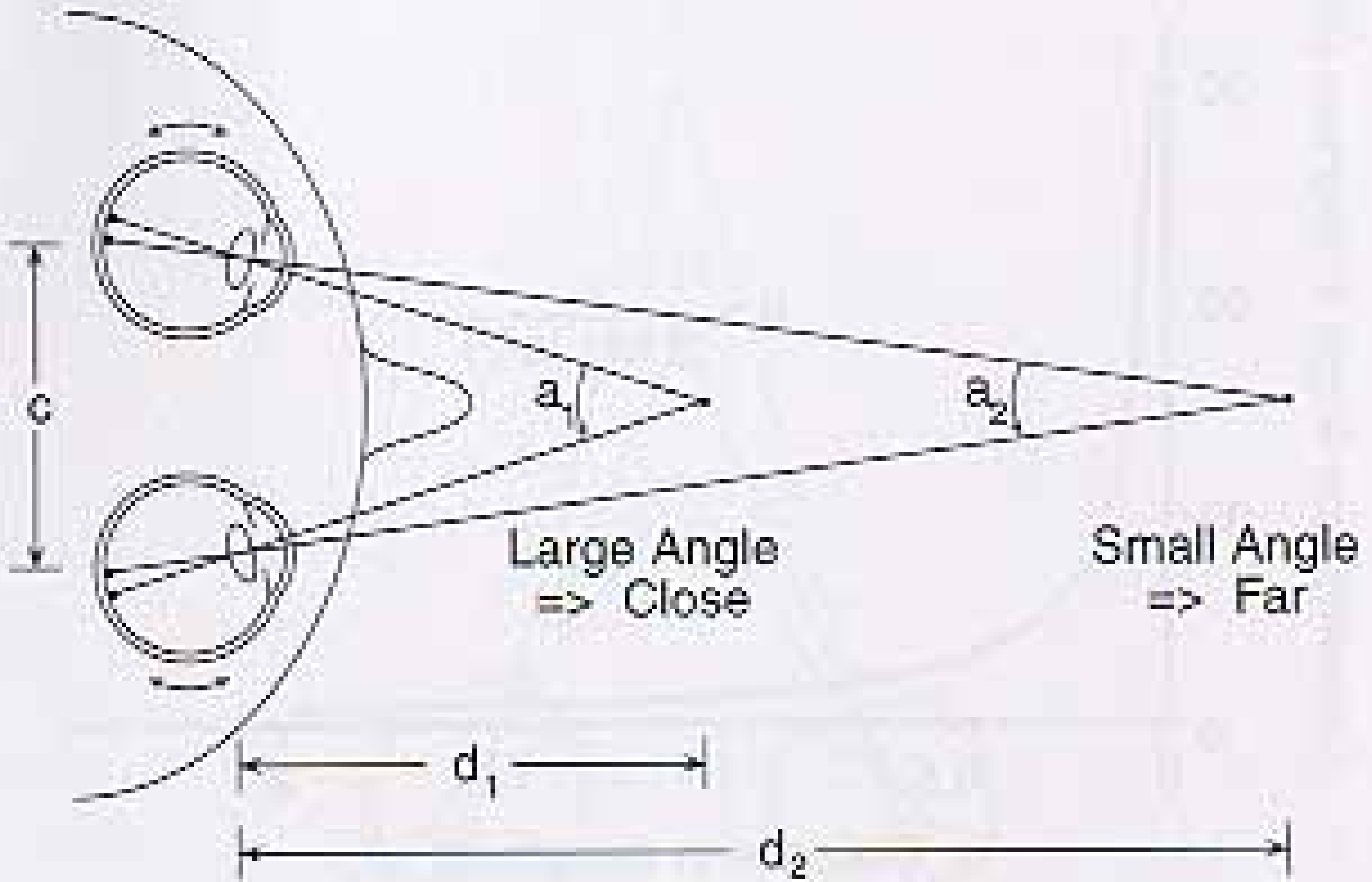


Figure 5.2.2 Depth information from eye convergence. The angle of convergence between the two eyes (a) varies with the distance to the object they fixate: smaller angles for objects far away (a_2) and larger angles for objects nearby (a_1).

Palmer, *Vision Science*

Binocular Cues for the Perception of Distance

- Convergence
- Retinal (Binocular) Disparity
  - Eyes Separated by 2-3 Inches
    - Each receives somewhat different image of object
  - Stereoscopic Vision
    - 2-Dimensional images on retina
    - Fused into 3-dimensional image in brain

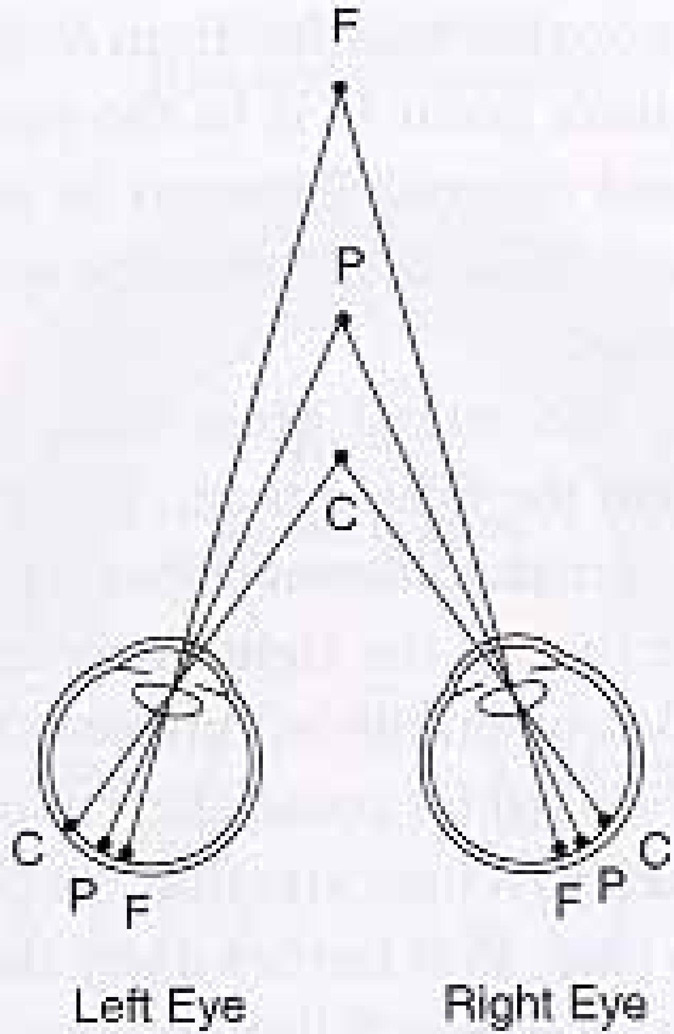


Figure 5.3.2 Crossed versus uncrossed binocular disparity. When a point P is fixated, closer points (such as C) are displaced outwardly in crossed disparity, whereas farther points (such as F) are displaced inwardly in uncrossed disparity.

Palmer, *Vision Science*

Different Images: The World Moves

Hold your left index finger at full arm’s length.

Hold your right index finger at half arm’s length.

Close your right eye.

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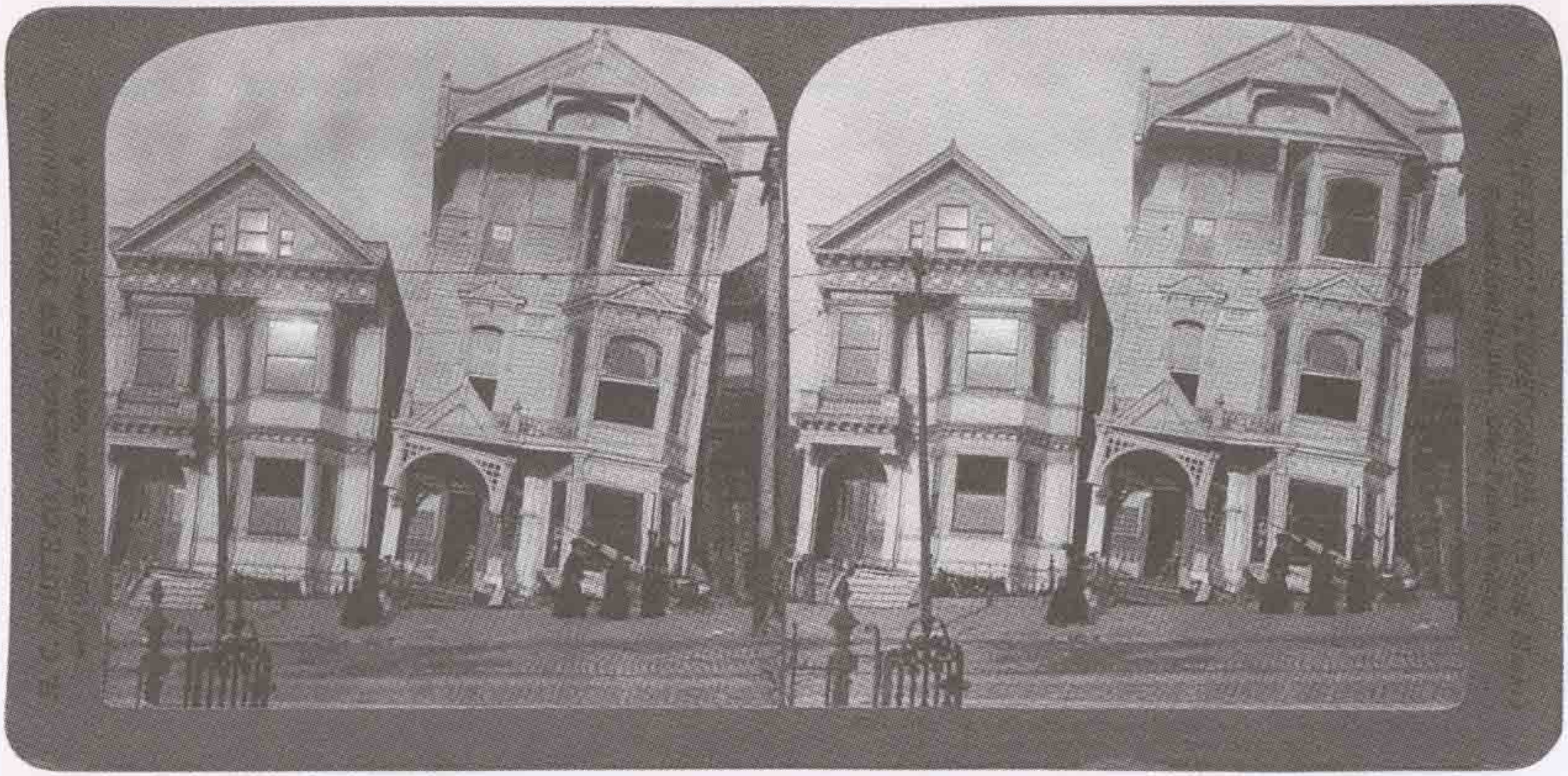
Align your two fingers using your left eye.

Both should coincide with cross above.

Then close your left eye and open your right eye.

The Stereoscope



H.C. White Co., *After the Earthquake—Frame Houses Tumbled from Their Foundations, San Francisco Disaster,* 1906; Collection Prints and Photographs Division, Library of Congress, Washington, D.C.

Monocular Cues for the Perception of Distance

- Accommodation
  - Lens bulges to focus on near objects
  - Lens flattens to focus on distant objects

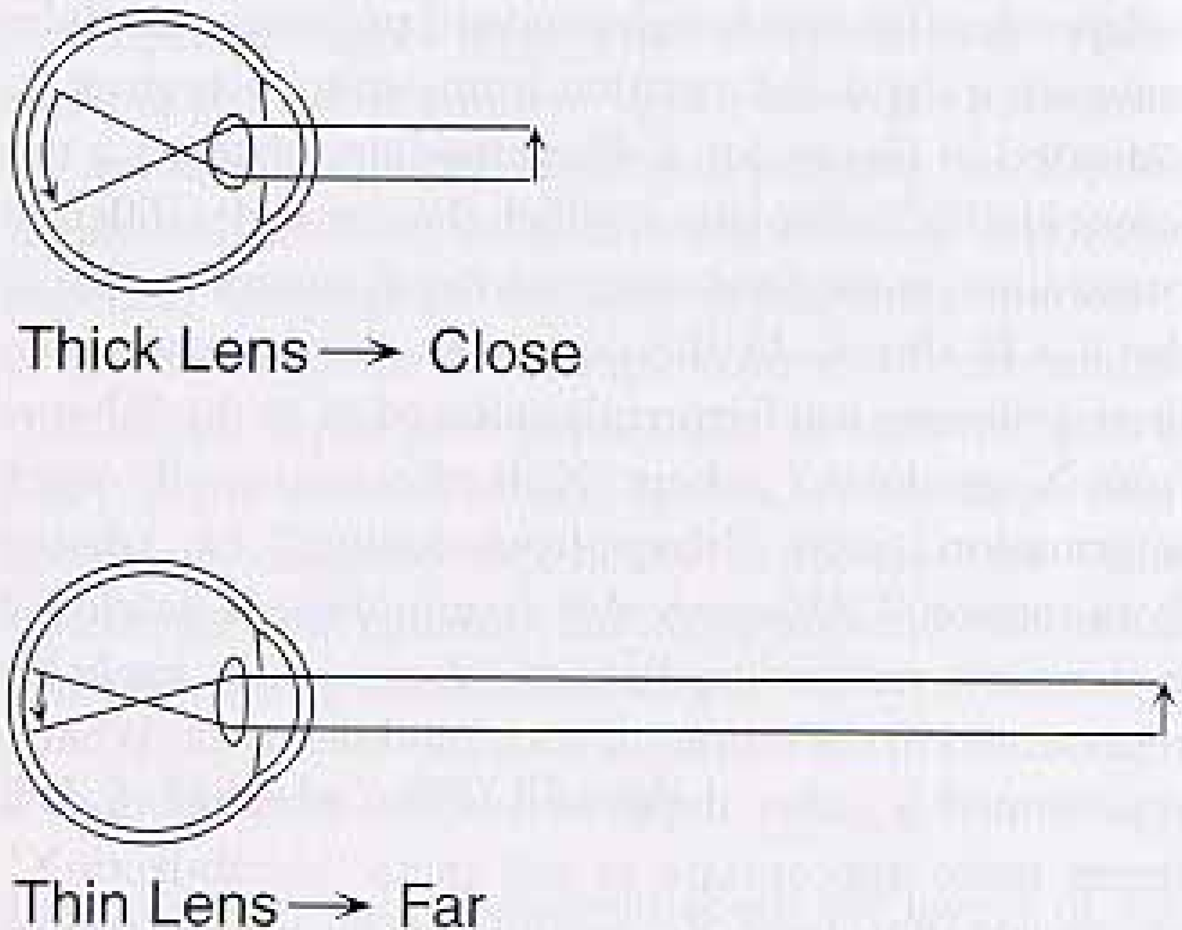
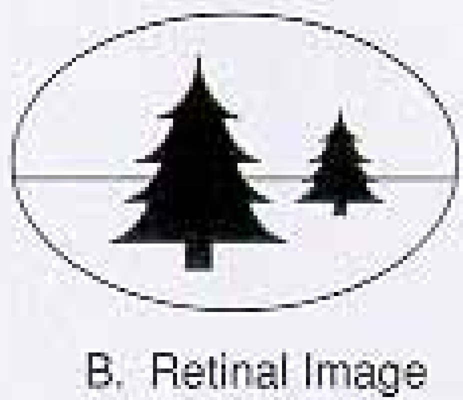


Figure 5.2.1 Depth information from lens accommodation. The lens of a human eye changes shape to focus the light from objects at different distances: thin for objects far away and thick for ones nearby.

Palmer, *Vision Science*

Monocular Cues for the Perception of Distance

- Accommodation
- Relative Size (the size-distance rule)
  - Distance constant, object size = f(image size)
  - Size constant, object distance = f(1/image size)



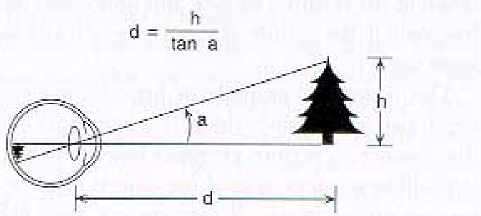


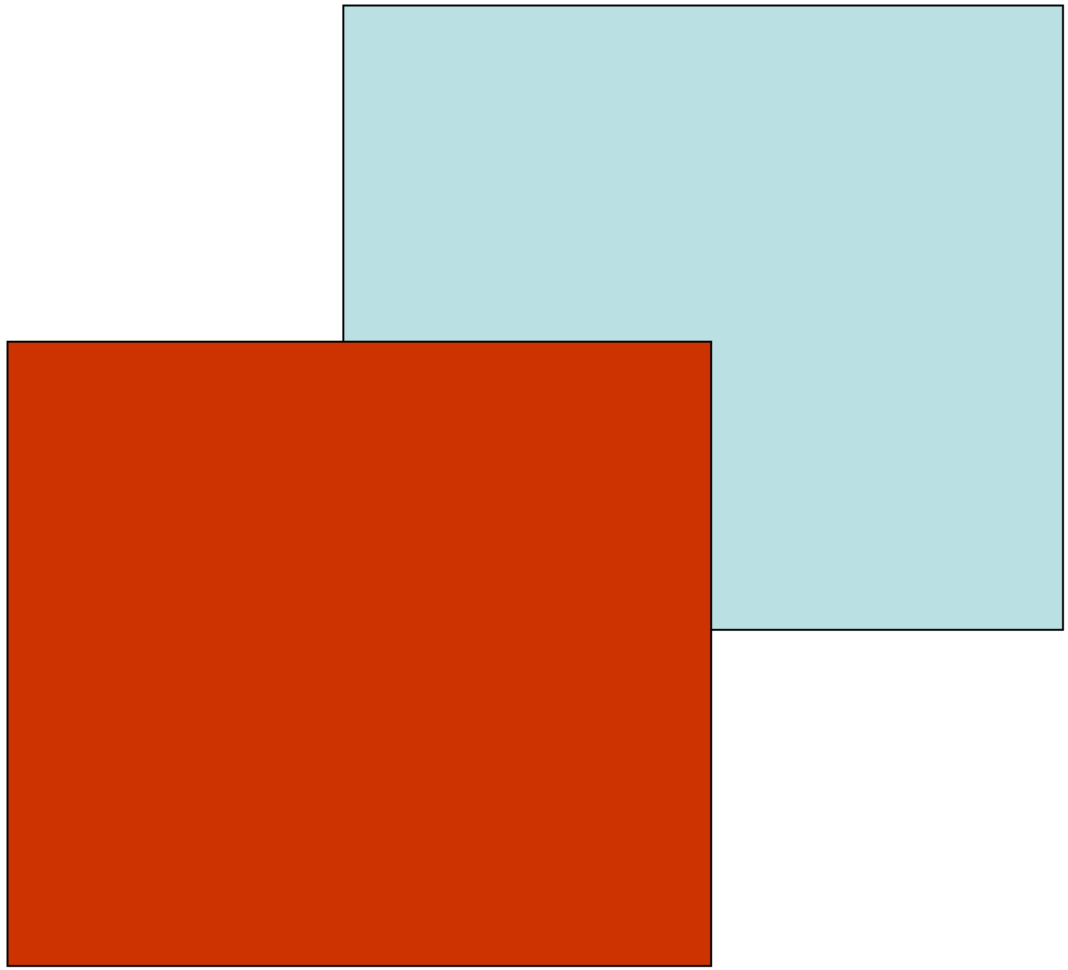
Figure 5.5.9 The size-distance relation. The viewing geometry of perspective projection shows that the distance to an object can be determined from its size (*h*) and the tangent of its visual angle (*a*).

Figure 5.5.8 Relative size. If two otherwise identical objects are viewed at different distances, the farther object projects a smaller image onto the retina. The relative size of such objects can therefore provide information about relative depth.

Palmer, *Vision Science*

Monocular Cues for the Perception of Distance

- Accommodation
- Relative Size
- Superposition (Interposition)
  - Nearby object cuts off view of more distant object



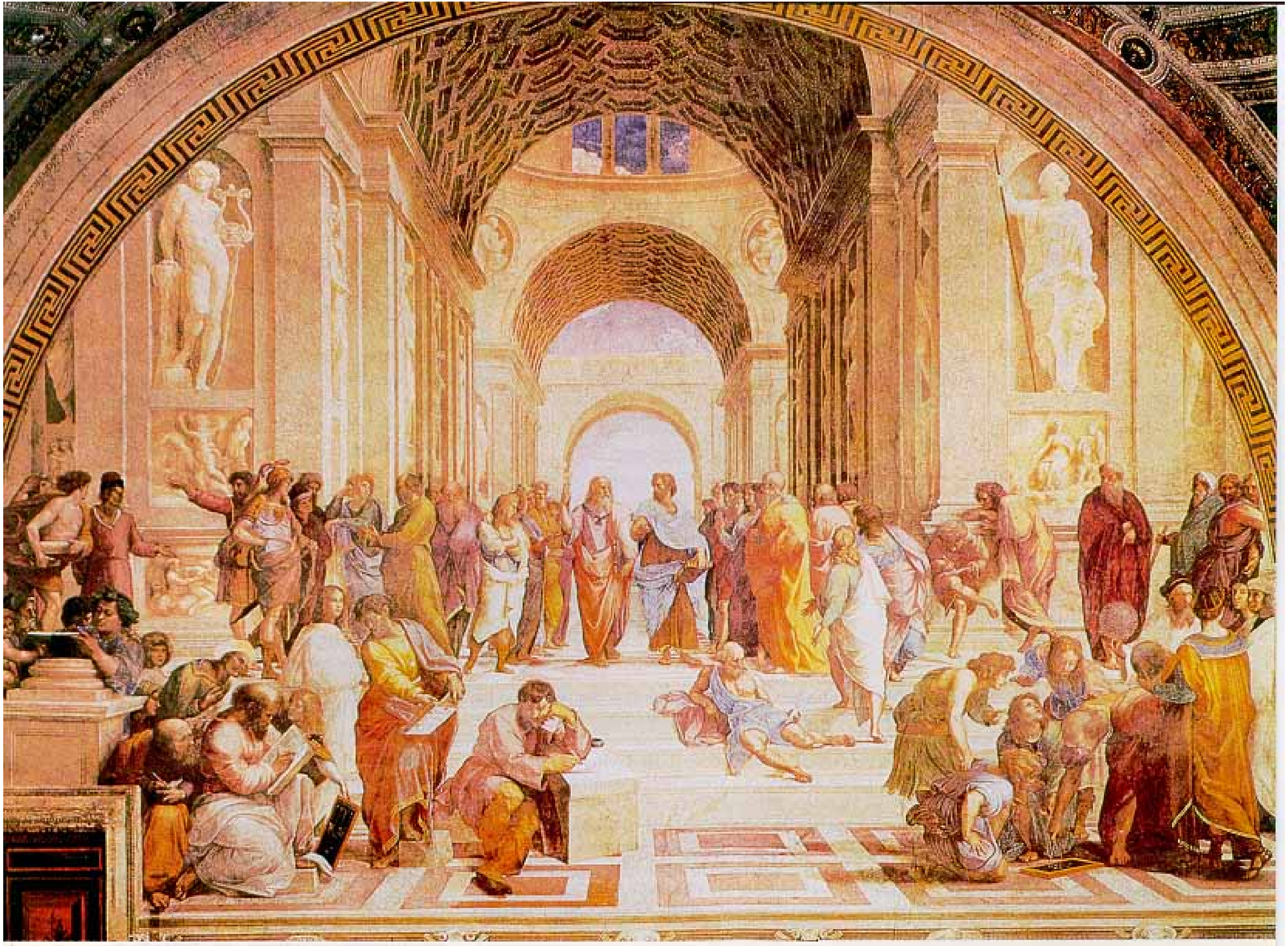
Magritte
Carte Blanche
(1965)

National Gallery of Art

Monocular Cues for the Perception of Distance

- Accommodation
- Relative Size
- Superposition
- Linear Perspective
  - Vanishing Point

Madonna with Child (13th c.)
Wikipedia



Raphael, “The School of Athens” (1510)

“Raphael Rooms”, Vatican City

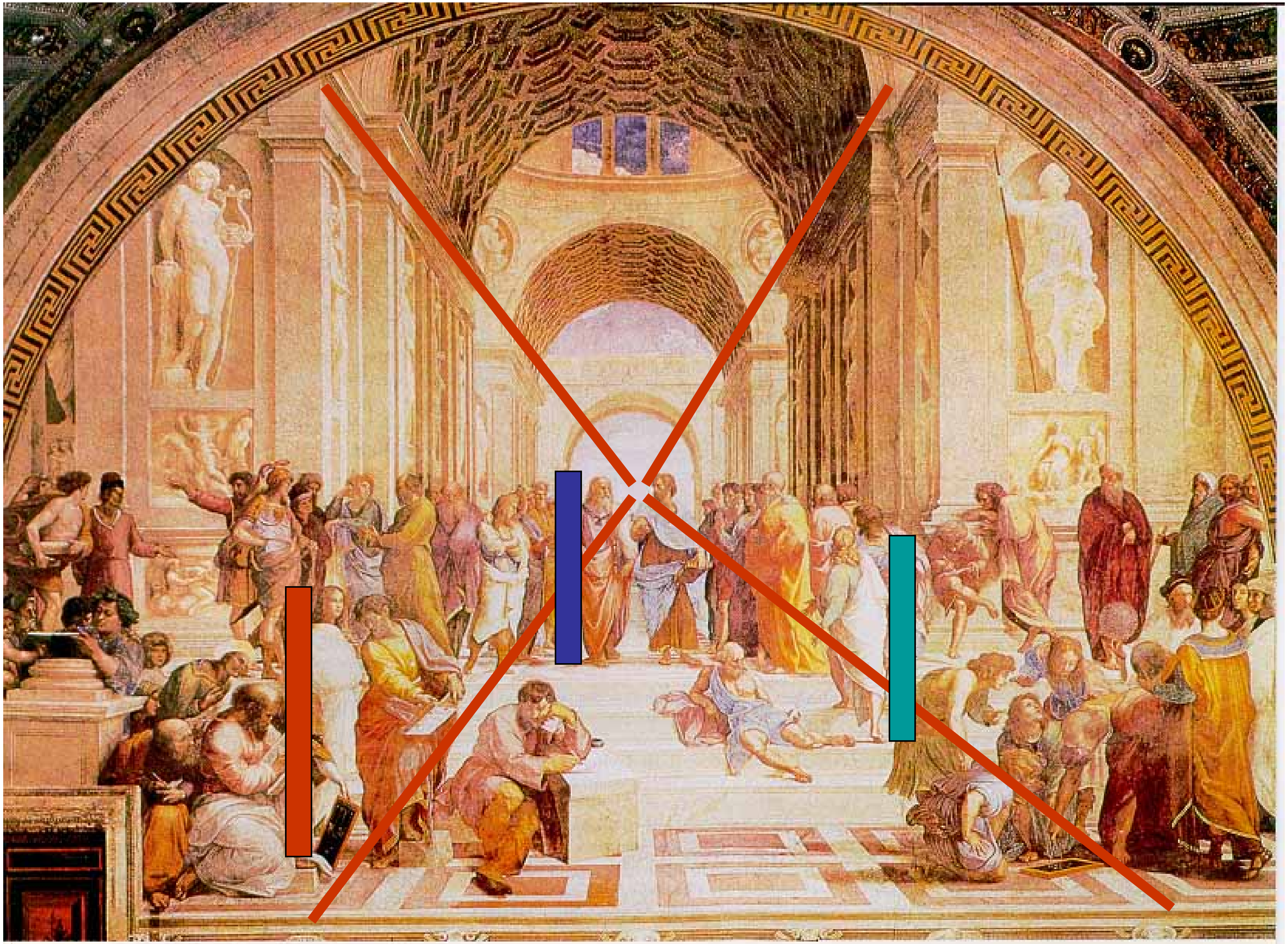
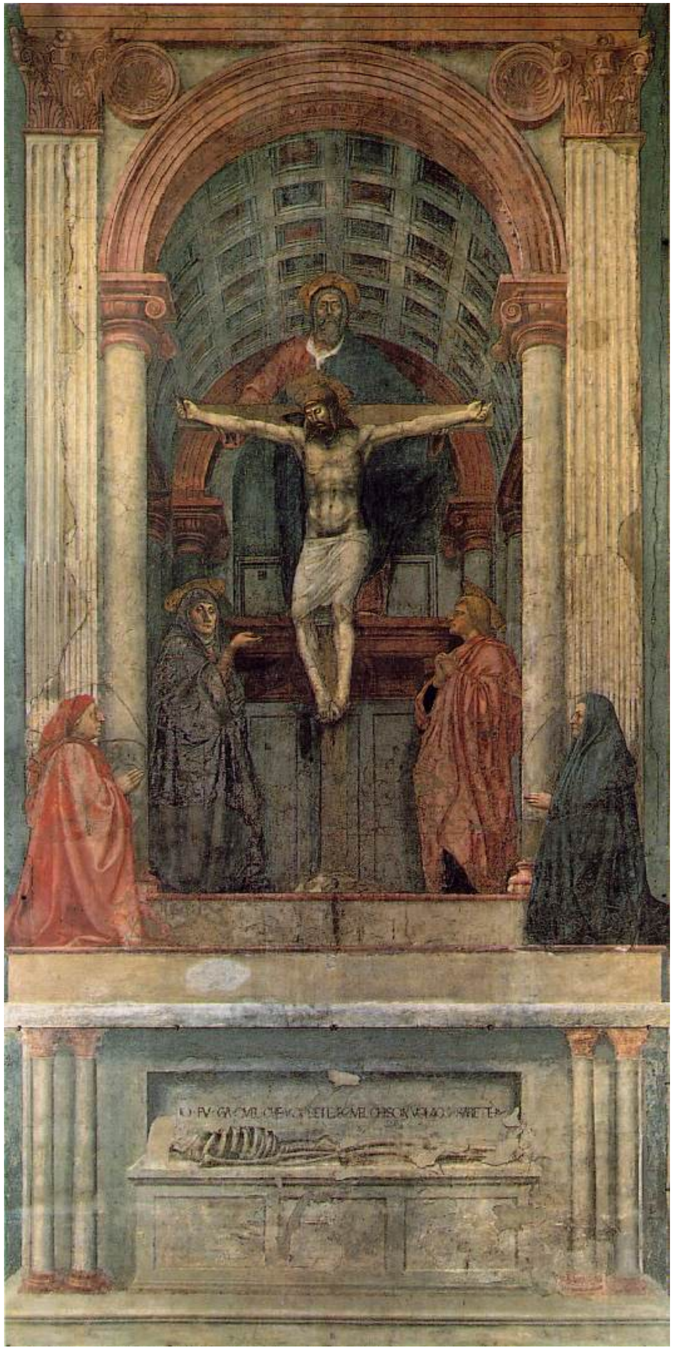


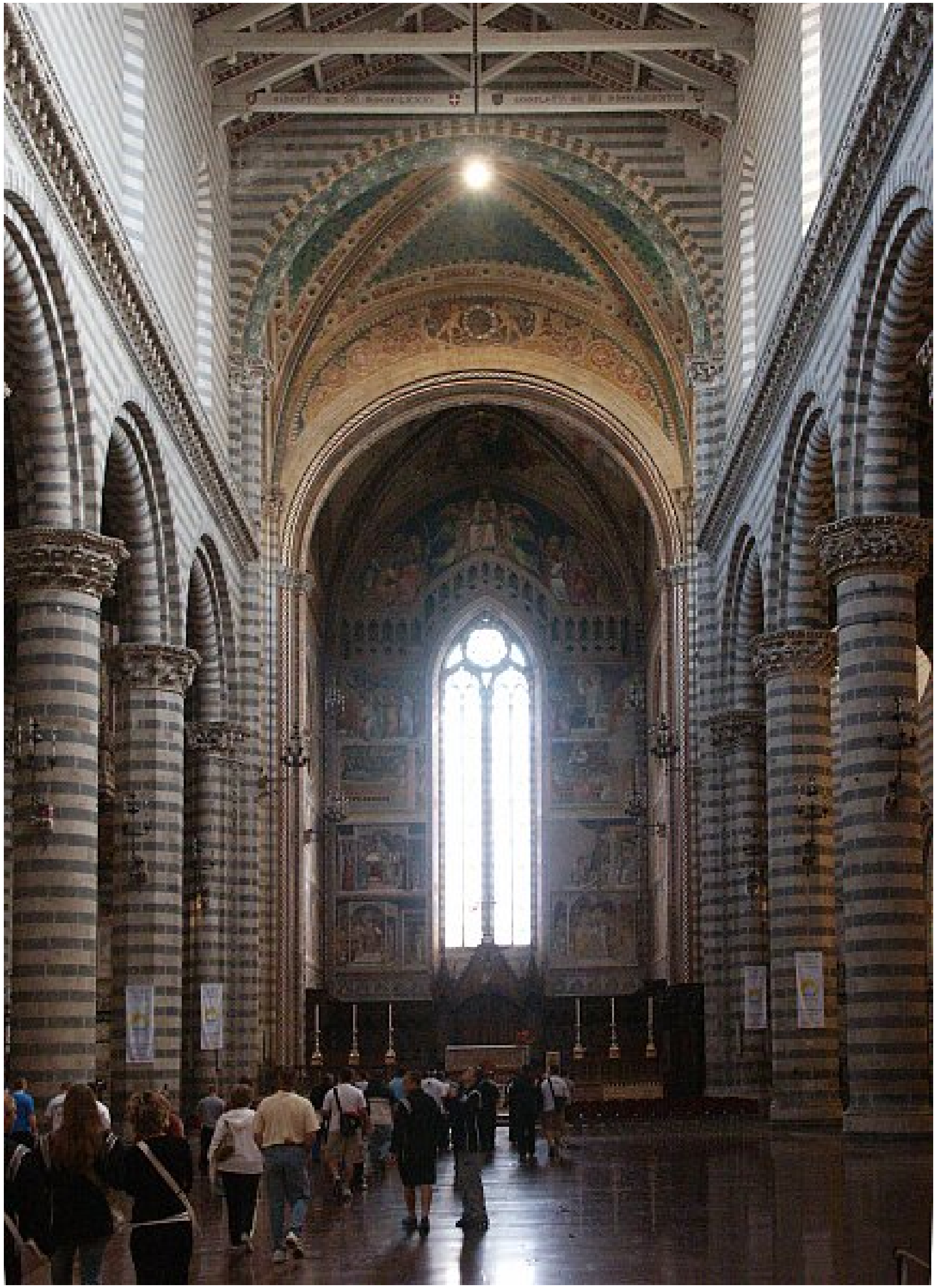
Figure 1. *The School of Athens*, Raphael's Renaissance masterpiece, demonstrates the artist's awareness of many of the visual cues used by the brain to determine the shape and depth of objects. Raphael creates the vivid perception of a three-dimensional scene through shading, texture and contour information, together with linear perspective. The painting depicts the major figures of Greek science, with Plato and Aristotle at the center, Euclid holding the compass, Ptolemy with the globe, and Pythagoras shown writing. Historically, the argument whether perception is driven by "top-down" or "bottom-up" processes originated with Plato and Aristotle, who convey their views by the directions of their pointing fingers. The argument extended to 19th-century psychology, in the debate between Helmholtz and the Gestalt school, and continues into current computational approaches to vision. (Reprinted with permission from the Vatican museums.)

Masaccio,
“The Trinity”
(1427)

Basilica of Santa Maria Novella,
Florence



Orvieto Cathedral
(14th c.)

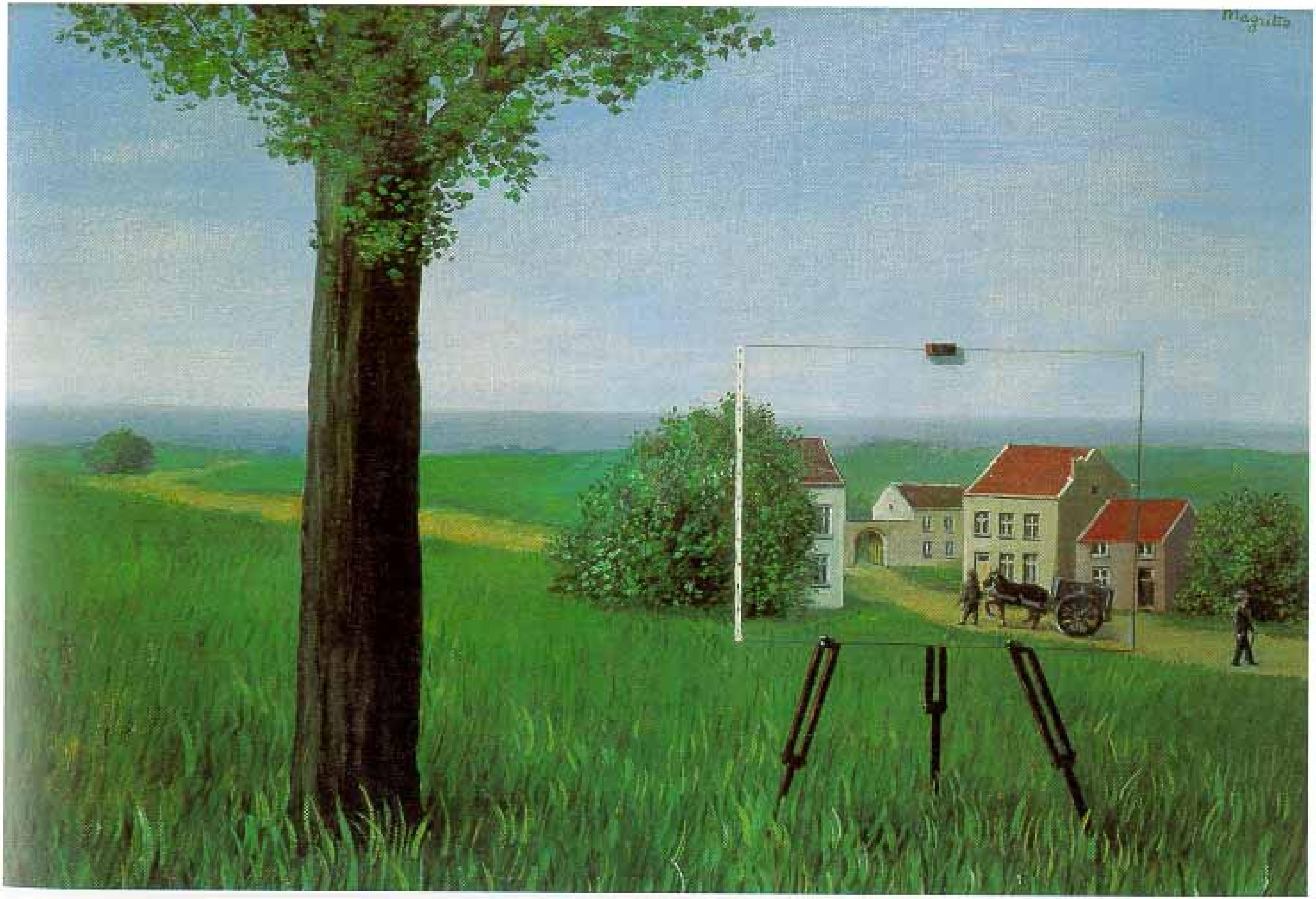


Basilica of Santa Maria Novella, Florence

(Alberti, 1458)

Magritte
The Human Condition
(1933)

National Gallery of Art



Magritte, *The Fair Captive (*1931)

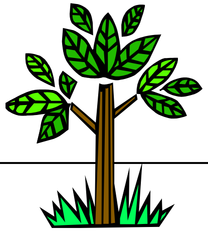
Hogarth Galleries, Sydney

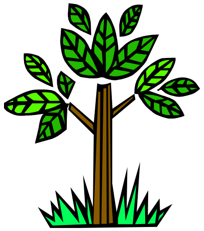
Magritte
The Promenades of Euclid
(1935)

Minneapolis Institute of Arts

Monocular Cues for the Perception of Distance

- Accommodation
- Relative Size
- Superposition
- Linear Perspective
- Elevation
  - distance from horizon





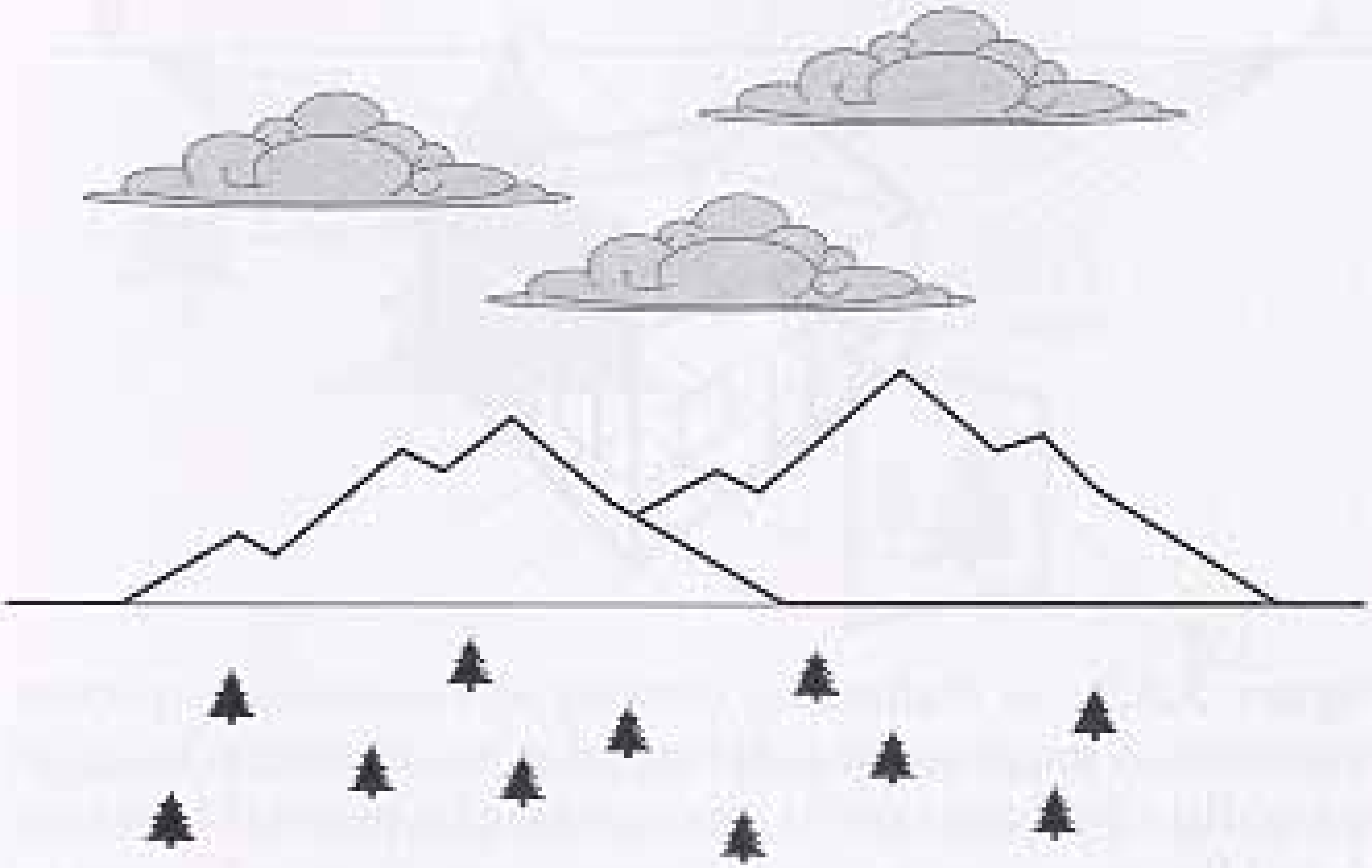


Figure 5.5.6 Position relative to the horizon. In perspective projection of a 3-D scene, objects on a level plane that are closer to the horizon are perceived as being farther from the observer.

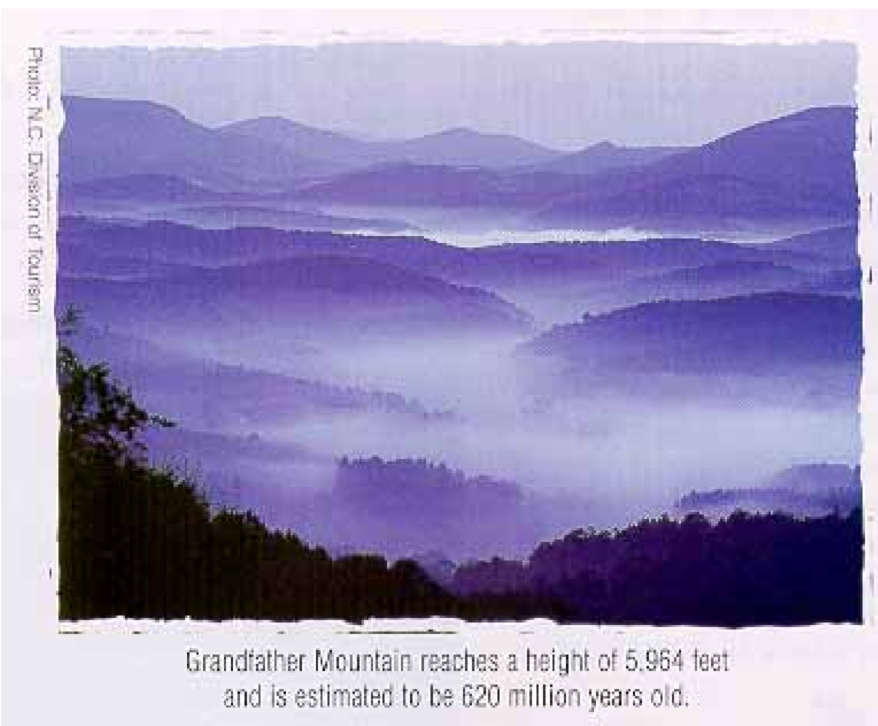
Palmer, *Vision Science*

Monocular Cues for the Perception of Distance

- Accommodation
- Relative Size
- Superposition
- Linear Perspective
- Elevation
- Aerial (Atmospheric) Perspective
  - Diffraction of Light by Dust, Moisture
  - “Bluing” of Distance

Blue Ridge Mountains

North Carolina Division of Tourism



Lake Atitlan, Guatemala

Photo by Thor Janson, courtesy of Susan McGovern

Atitlan: Chichicastenango

Magritte, *The Glass Key* (1959)

Menil Collection, Houston

Monocular Cues for the Perception of Distance

- Accommodation
- Relative Size
- Superposition
- Linear Perspective
- Elevation
- Aerial Perspective
- Texture Gradients

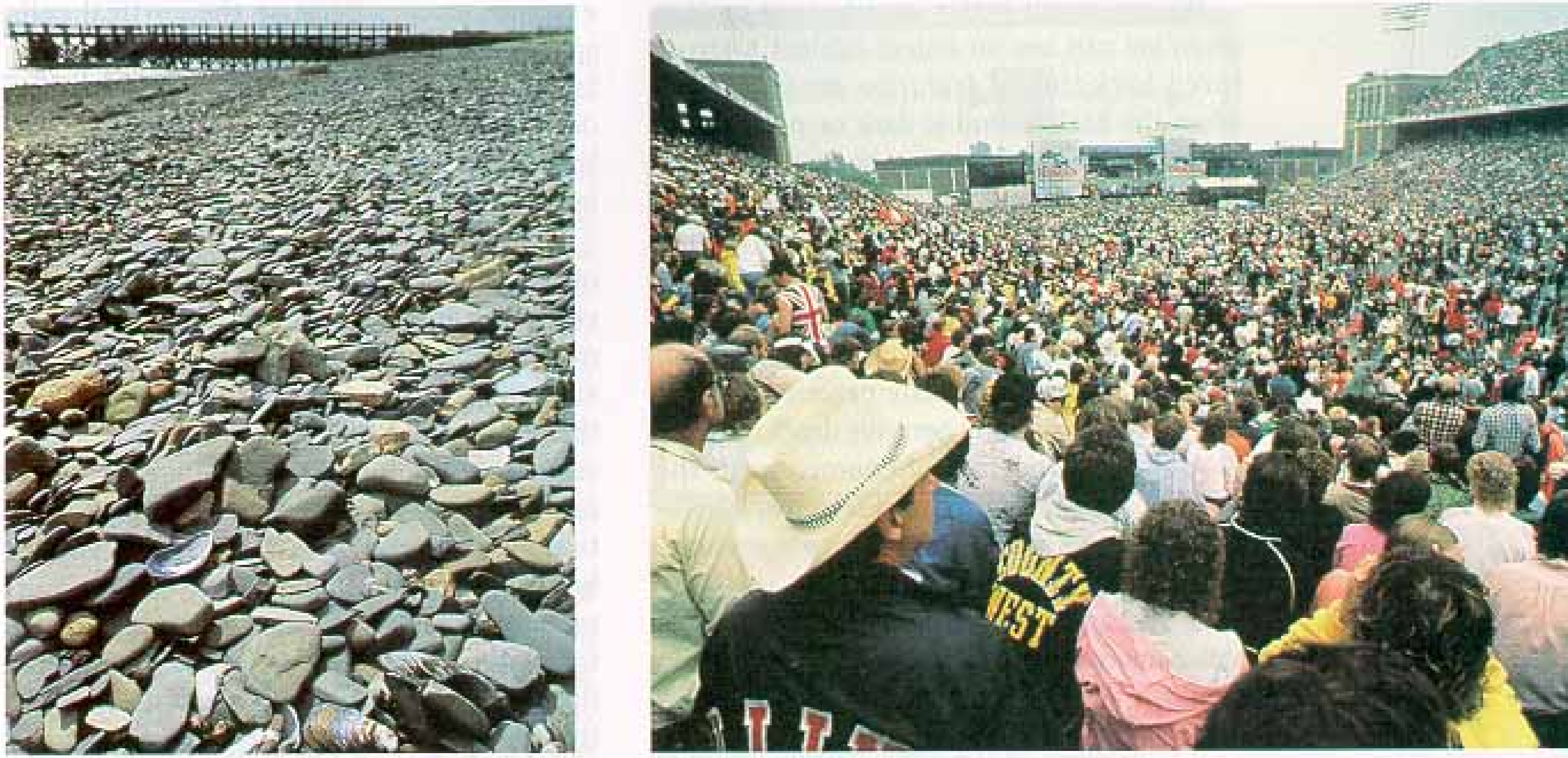


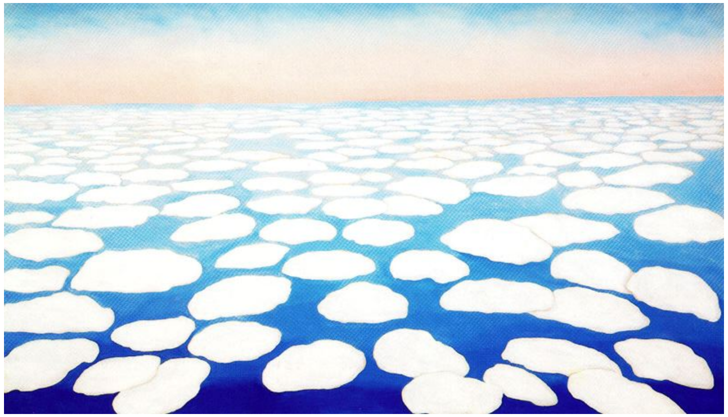
FIGURE 5-8

Examples of Texture Gradients *The elements that make up the textured surface (rocks on left, people on right) appear to be packed closer and closer together as the surface recedes.*

O’Keeffe, “Sky Above Clouds I” (1963)

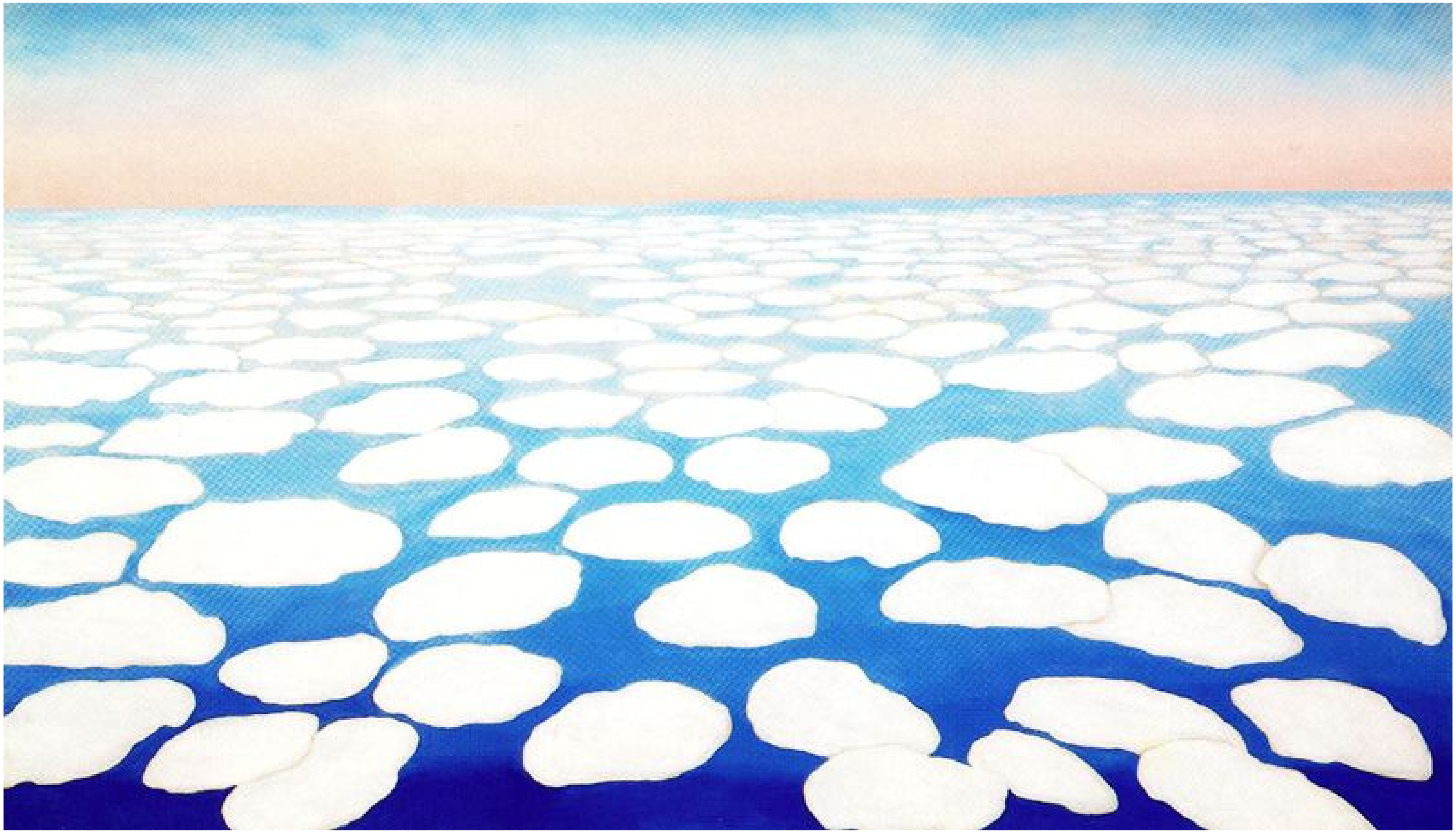
Georgia O’Keeffe Museum

O’Keeffe, “Sky Above Clouds I-IV” (1963-5)



O’Keeffe, “Sky Above Clouds II” (1963)

Private Collection



O’Keeffe, “Sky Above Clouds III” (1963)

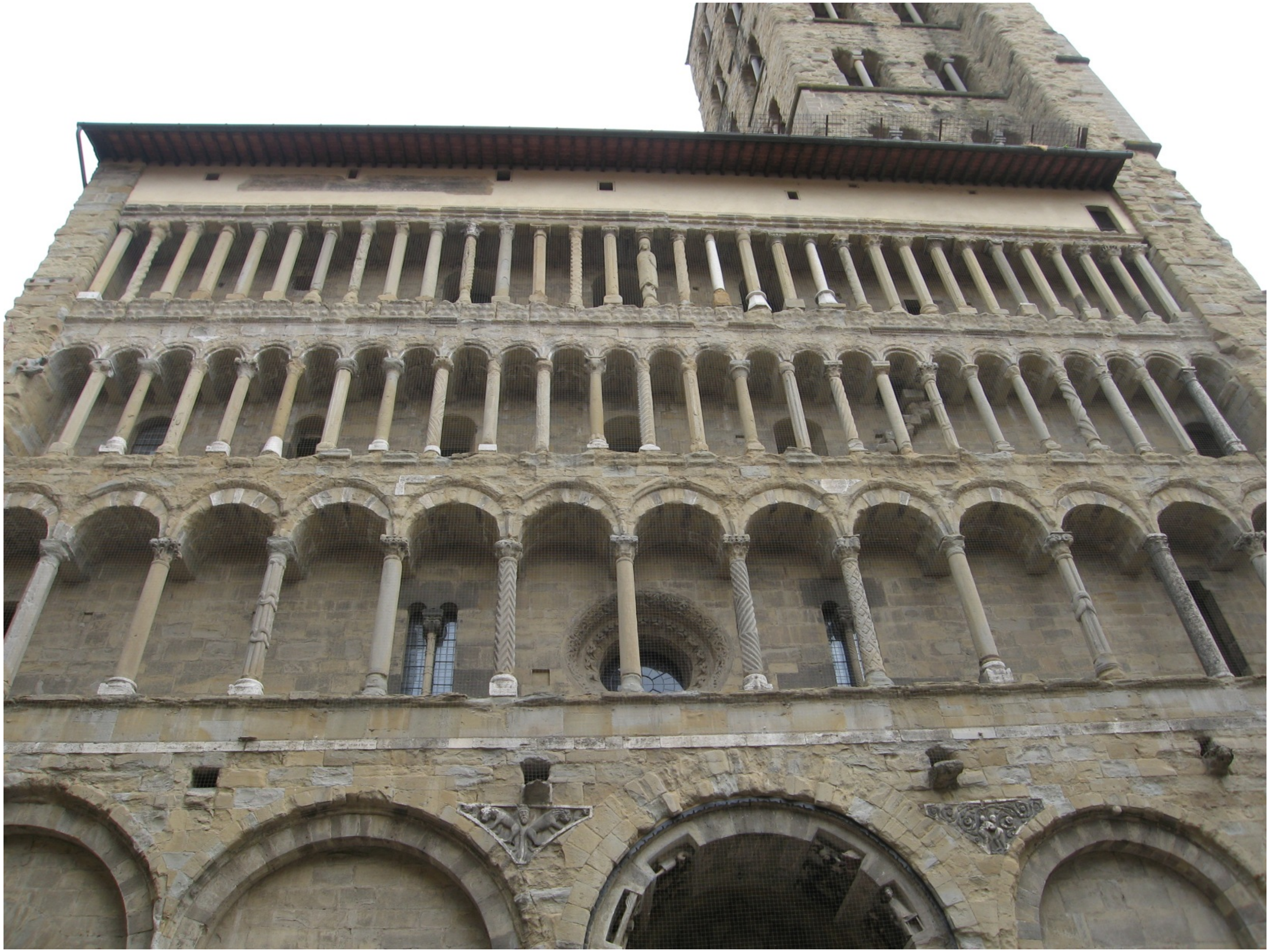
Private Collection

O’Keeffe, “Sky Above Clouds IV” (1965)

Art Institute of Chicago

Town Houses, Dublin

Duomo, Arezzo, Italy



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Monocular Cues for the Perception of Distance

- Accommodation
- Relative Size
- Superposition
- Linear Perspective
- Elevation
- Aerial Perspective
- Texture Gradients
- Shadowing
  - Relative positions of shadows
  - Distance with respect to light source

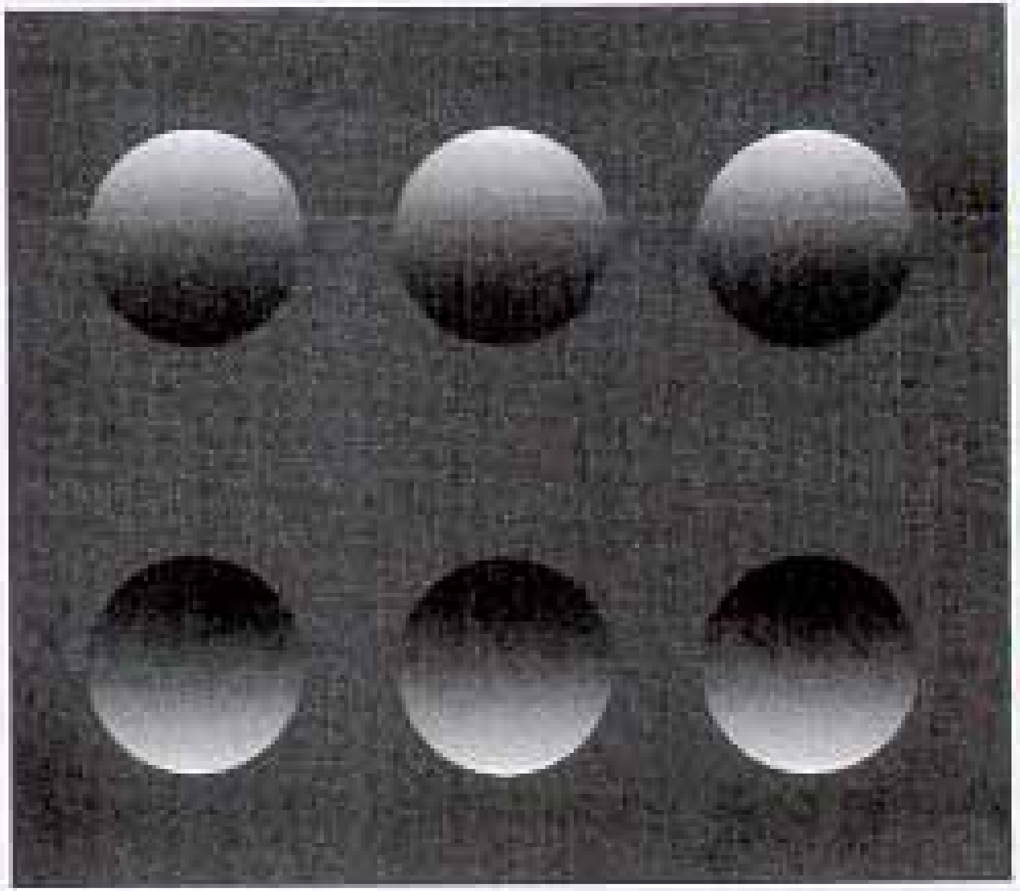
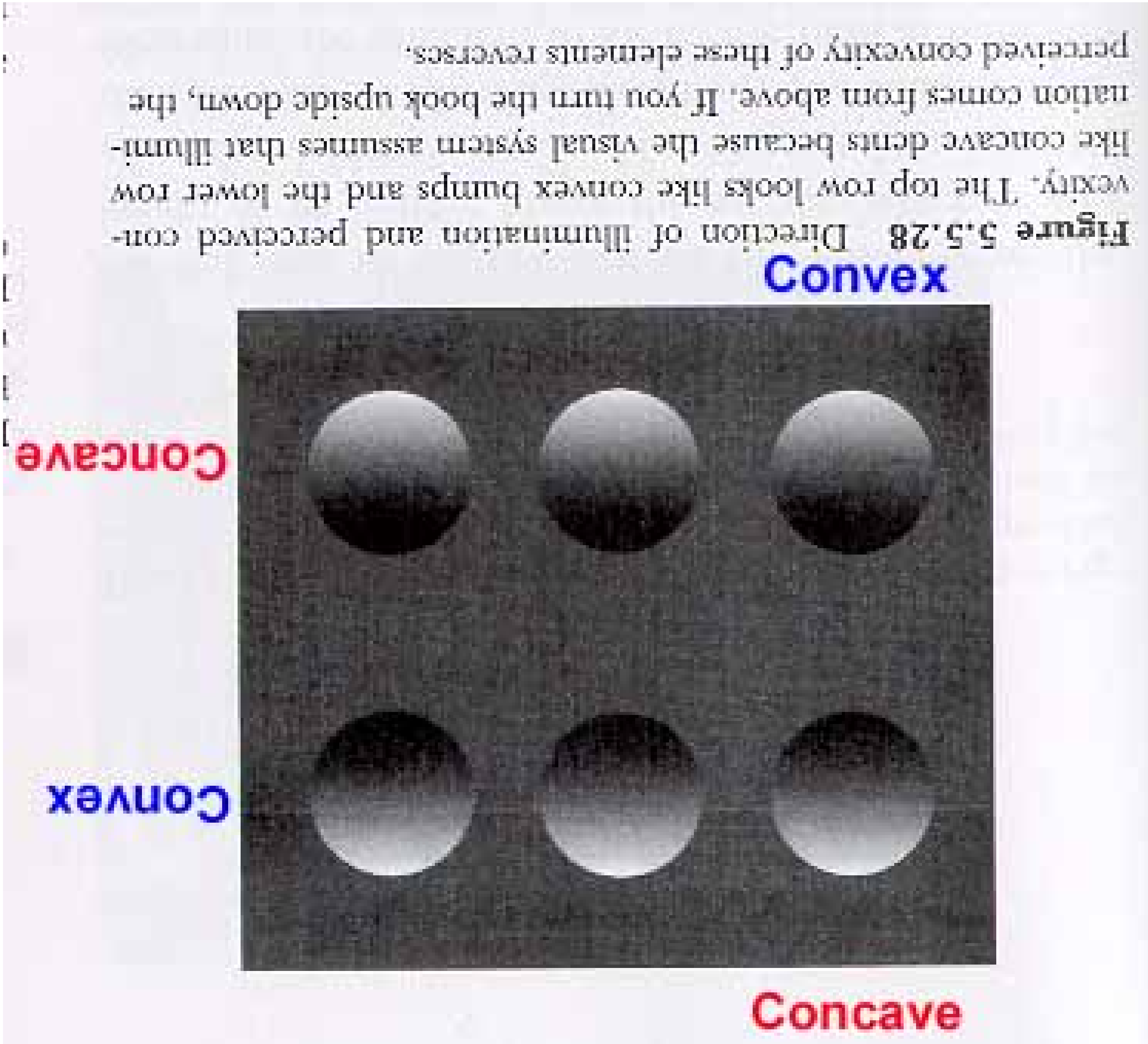
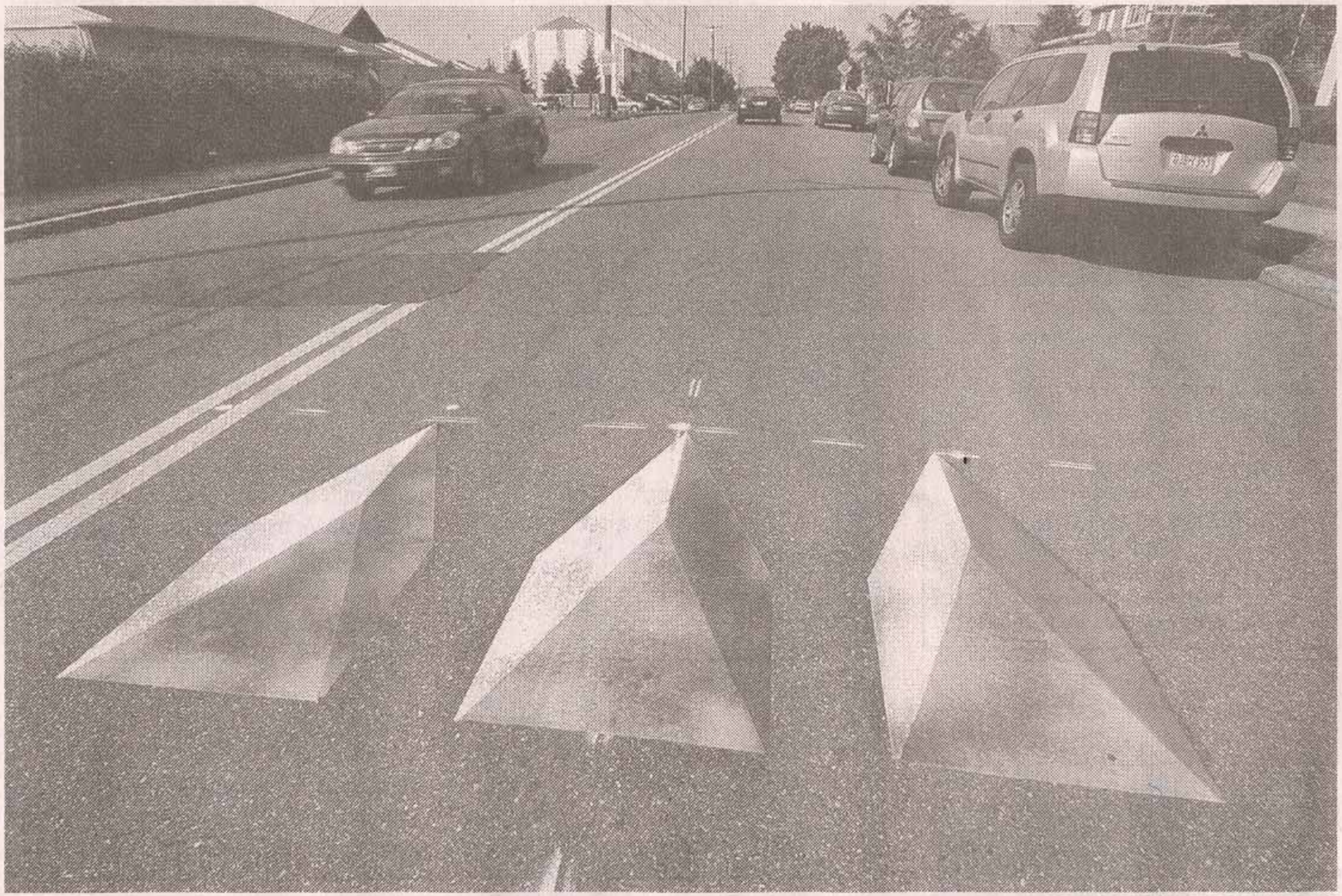


Figure 5.5.28 Direction of illumination and perceived convexity. The top row looks like convex bumps and the lower row like concave dents because the visual system assumes that illumination comes from above. If you turn the book upside down, the perceived convexity of these elements reverses.

Palmer, *Vision Science*


Convex
Concave
Concave
Convex
Figure 5.5.28 Direction of illumination and perceived convexity. The top row looks like convex bumps and the lower row like concave dents because the visual system assumes that illumination comes from above. If you turn the book upside down, the perceived convexity of these elements reverses.

Illusory Traffic Control



MATT ROURKE/ASSOCIATED PRESS

However it may seem, this speed hump in Philadelphia is nothing more than flat pieces of plástic burned into the street. Municipal officials say the month-old program will soon be expanded.

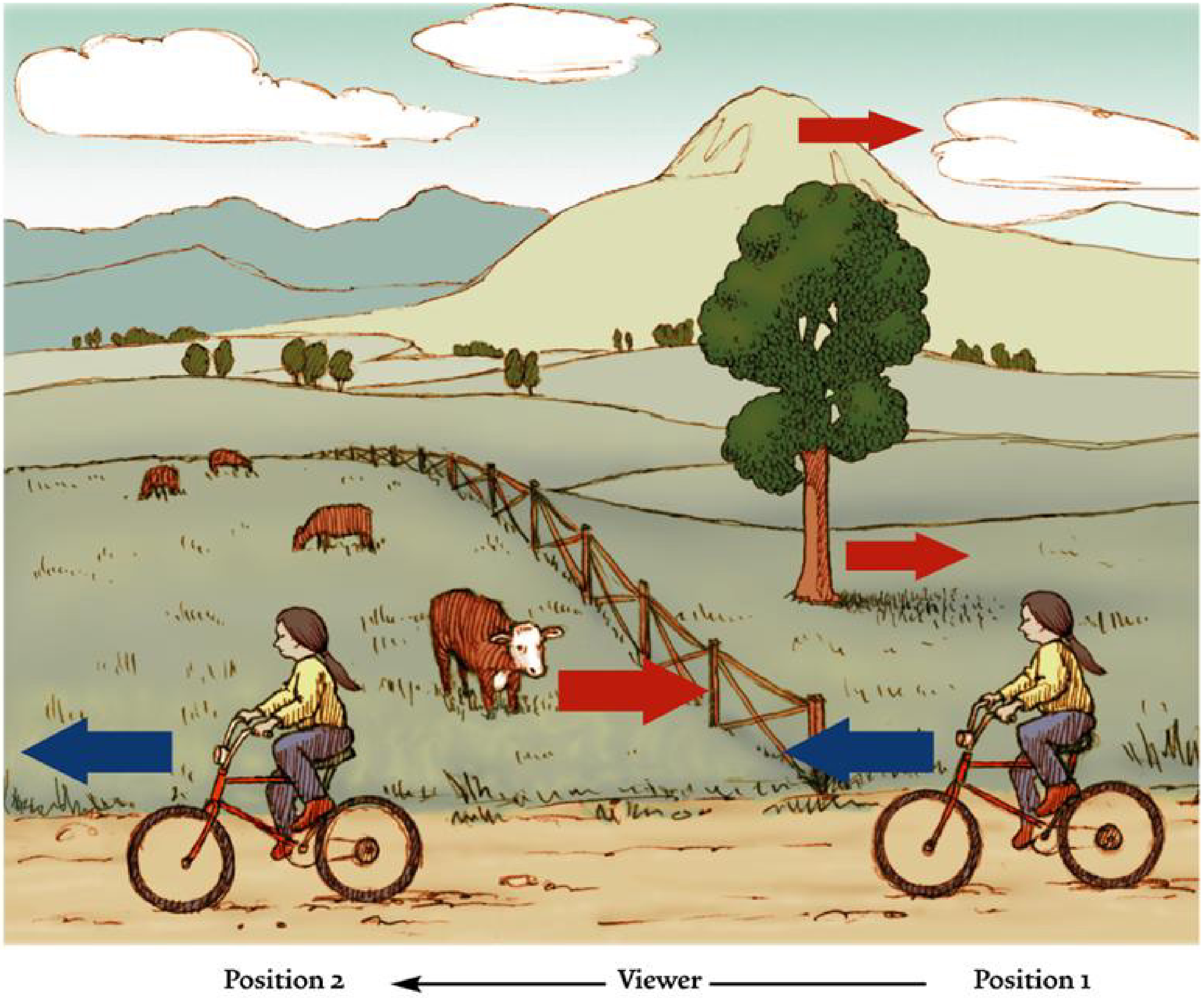
Pictorial Cues to Depth and Distance

- Relative Size
- Linear Perspective
- Elevation
- Superposition
- Texture Gradients
- Aerial Perspective
- Shadowing

Motion Cues to Depth and Distance

- Motion Parallax
- Optic Flow

Motion Parallax



Gleitman 6e

Motion Parallax:
The World Moves Again

Hold your left index finger at full arm's length.

Hold your right index finger at half arm's length.

Close your right eye.

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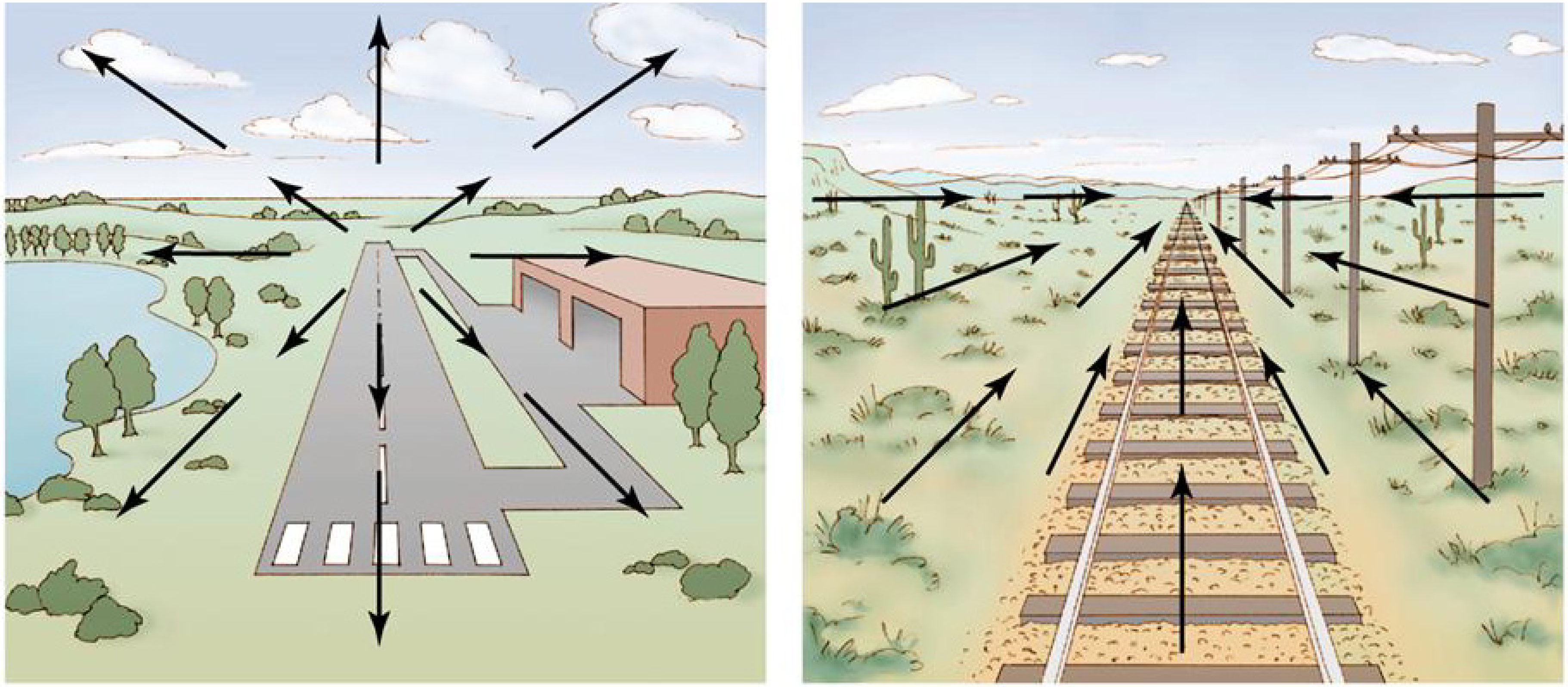
Align your two fingers using your left eye.

Both should coincide with cross above.

Then move your head back and forth

to the left and right.

Optic Flow



Gleitman 6e

Organization of Cues for Depth or Distance

	Binocular	**Monocular**
Ocular From Eyes	Convergence	Accommodation
Optical From Light	Retinal Disparity (Stereopsis)	Relative Size Linear Perspective Elevation Superposition Texture Gradients Aerial Perspective Shadowing Optic Flow Motion Parallax

Direct Perception
(Gibson's "Ecological View")

- All the Information Needed for Perception is Supplied by the Stimulus
  - The Whole Pattern of Proximal Stimulus Information Available in the Environment
- Perceptual Systems Evolved to Extract the Information Relevant for Perception
  - Part of Innate Biological Endowment
  - Little or No Learning, Memory
  - Little or No Reasoning, Judgment, Inference