

The Art and Science of Depiction
Vision Solves Problems

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Plan

- Vision as an cognitive process
- Computational theory of vision
- Constancy, invariants

Intro to Visual Perception 2

Distal vs. proximal stimulus

- Distal stimulus: reality
- Proximal stimulus: retinal image

proximal stimulus (2D) Distal stimulus (3D)

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Vision as an inverse problem

- The distal stimulus is projected into a proximal stimulus

proximal stimulus (2D) Distal stimulus (3D)

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Vision as an inverse problem

- The distal stimulus is projected into a proximal stimulus
- How can we inverse this projection?

proximal stimulus (2D) Distal stimulus (3D)

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Unconscious inference (Helmholtz)

- Our vision system solves a problem
- Under-constrained problem
 - A visible point A' can correspond to an infinity of 3D points (A1, A2, A, A3...)

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Unconscious inference (Helmholtz)

- Our vision system solves a problem
- Under-constrained problem
- Assumptions on the scene

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The Ames room

- Invalid assumption
- Wrong conclusions

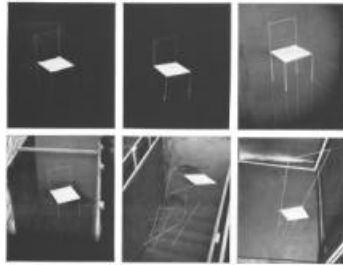


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Ames chair

- Different scenes
- Same projection
- We assume it is a chair



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Patrick Hughes

- Perspective painting on the inverse geometry

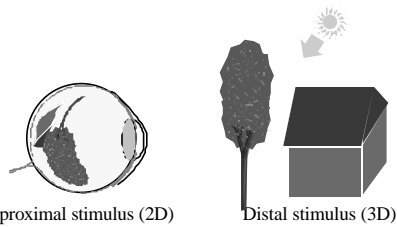


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The paradox of vision

- Available information: proximal stimulus
- Conscious information: distal stimulus

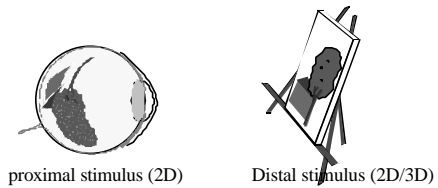


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The paradox of Pictures

- Distal vs. proximal
- Available information: proximal stimulus
- Conscious information: distal stimulus



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Pictures and inverse problem

- Can
 - Simplify analysis
 - Be a puzzle

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Plan

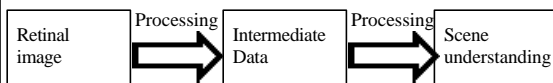
- Vision as an cognitive process
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- Constancy, invariants

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Vision as information processing

- Input: retinal image
- Output: 3D layout, object recognition, etc.



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Computational theory of vision

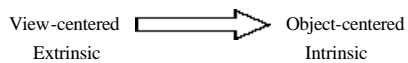
- Marr's stages (extended by Palmer et al.)
- Human and Computer Vision
- Classification of different kinds of processes
- Has proved fruitful in art studies

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Computational theory of vision

- Marr's stages (extended by Palmer et al.)
- Human and Computer Vision
- Classification of different kinds of processes
- Has proved fruitful in art studies



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Retinal image

- Intensity

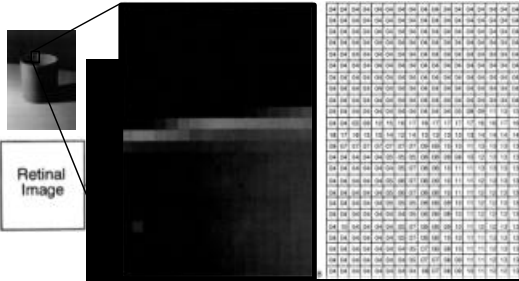


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Retinal image

- Intensity: hard to comprehend



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Retinal image

- Intensity

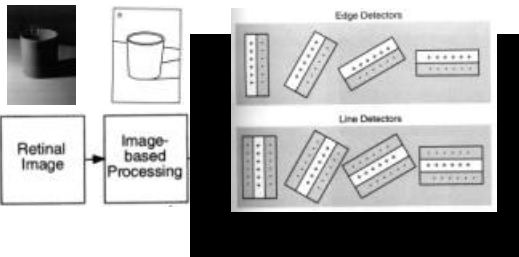


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Image-based (primary sketch)

- Contrast, edge detection

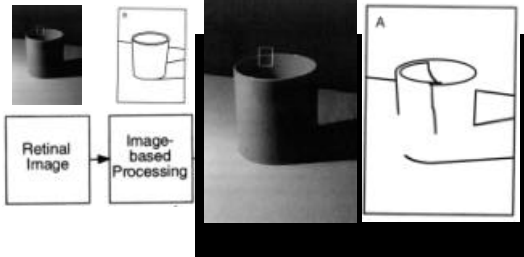


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Image-based (primary sketch)

- Contrast, edge detection
- Not so easy

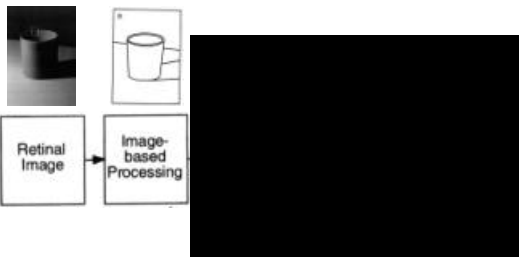


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Image-based (primary sketch)

- Contrast, edge detection

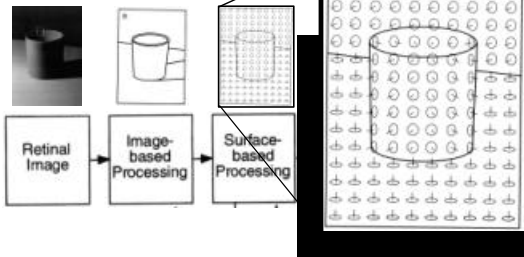


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Surface-based

- Visible surfaces, organization
- Distance, orientation



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Surface-based

- Visible surfaces, organization
- Distance, orientation

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Surface-based

- Visible surfaces, organization
- Distance, orientation

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Surface-based

- Visible surfaces, organization
- Distance, orientation

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Object-based

- 3D properties, structure
- Nature of the description highly discussed

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Category-based

- Recognition, category, function

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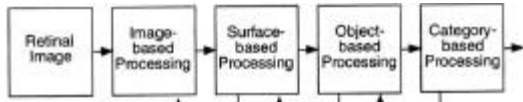
Feedback

- Bottom-up and top-bottom

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Scope of the theory

- Computer Vision
- Human Vision
- No direct correspondence in the brain
- Has proved fruitful conceptual tool



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Relation to children drawing

- First children draw what they know
 - Object-centered
- Then, what they see
 - View-centered



Age 5



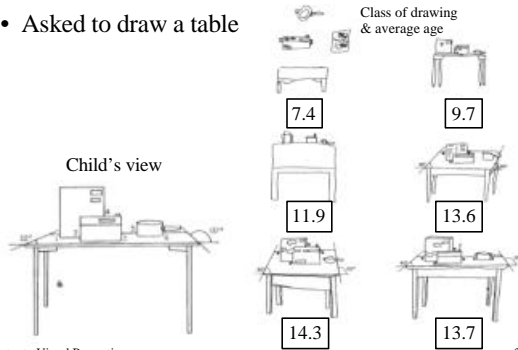
Age 9 (gifted!)

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Evolution of children's drawings

- Asked to draw a table

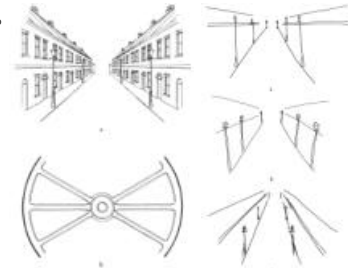


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What about adults?

- Reproduce two drawing with similar angles
- Wheel:
 - Accuracy $\sim 5^\circ$
- Street:
 - Error: 32°

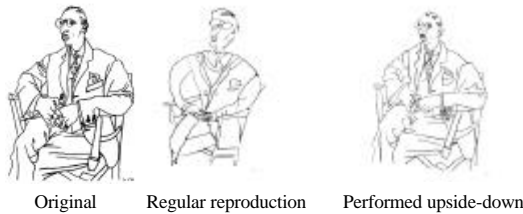


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Drawing reproduction

- From *Drawing on the right side of the brain*
- Reproduction of Picasso's portrait of Stravinsky

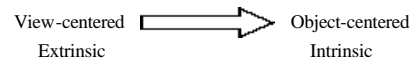


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Relation to pictures

- How we see pictures
- Different classes of pictures for different stages



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Relation to pictures

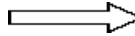
- Different classes of pictures for different stages
- Not a strict classification



View-centered
Extrinsic



Object-centered
Intrinsic



Relation to pictures

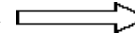
- Chinese painting refuse extrinsic, only essential
- No shadow



View-centered
Extrinsic



Object-centered
Intrinsic



Retinal image

- Impressionism



Retinal image

- Impressionism
- Photography



Image-based

- Line Drawing



Intermediate

- View-based
- Cues for surface-based feature extraction are enhanced
 - Depth cues
 - Orientation cues
- No subjective feature (e.g. lighting)



Intermediate

- View-based
- Cues for surface-based feature extraction are enhanced
 - Depth cues
 - Orientation cues
- More subjective feature (lighting)



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Higher level

- Primitive art
- Cubism
- Schema
- “What I know”

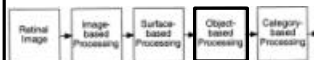
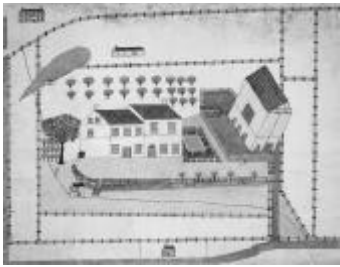


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Higher level

- Primitive art
- Cubism
- Schema
- “What I know”



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Higher level

- Primitive art
- Cubism
- Schema
- “What I know”



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Higher level

- Primitive art
- Cubism
- Schema
- “What I know”
- Not limited to picture



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Expressionism

- “What I feel”



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Relation with 2D/3D qualities

- Almost the opposite!
- 3D quality correspond to retinal image
- 2D quality arises from higher-level pictures
- Because of vision paradox
 - Distal is seen when proximal is shown

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Relation with 2D/3D qualities

- 3D quality but Retinal image



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Relation with 2D/3D qualities

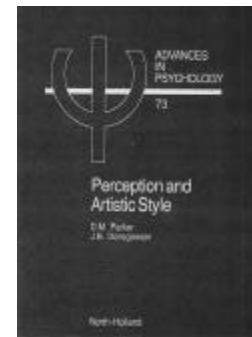
- 2D quality but Higher level



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Further reading



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Plan

- Vision as an cognitive process
- Computational theory of vision
- Constancy, invariants

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Constancy & Invariants

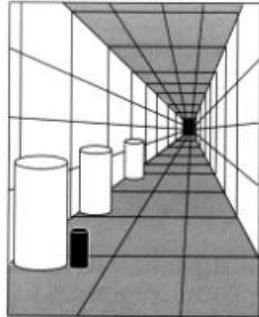
- We see intrinsic properties of objects
- They are “invariant” or “constant”
- Ecological advantage

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Visual angle vs. size

- We see cylinders with same size
- Valid most of the time



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Visual angle vs. size

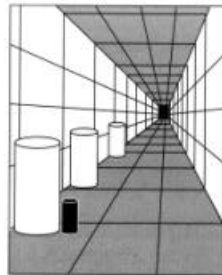
- Mirror experiment:
 - Draw your face on a mirror
 - Measure: the drawing is $\frac{1}{2}$ your face
 - However, you see “full size”

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Visual angle vs. size

- How do we do that?
 - Distance
 - Familiarity
 - Assumptions
- Here
 - Perspective
 - Position on ground plane
 - Similarity

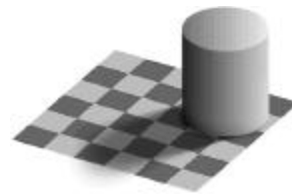


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Brightness vs. lightness

- Brightness: subjective amount of light
- Lightness: how “white”

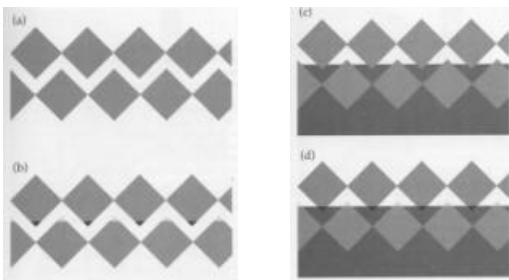


The white cells in shadow are as dark as the black illuminated cells

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Lightness constancy



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Lightness constancy

- Sargent
- White in light and in shadow



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Color constancy

- Chromaticity of light sources vary
- Chromatic adaptation
 - Similar to white balance on camcorder
 - Different films, filters



Objective colors under neon lighting With chromatic adaptation

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Constancy

- Size
- Lightness
- Color
- Position
- Orientation
- Shape

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Degree of constancy

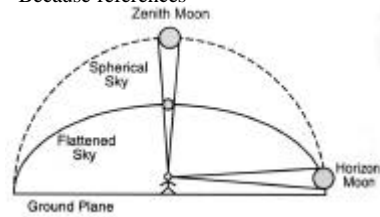
- Not always perfect
- Sometimes too much

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Degree of size constancy

- The Moon illusion
 - The Moon appears bigger on the horizon
 - Because it looks farther (Emmert's law)
 - Because references



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Degree of color constancy

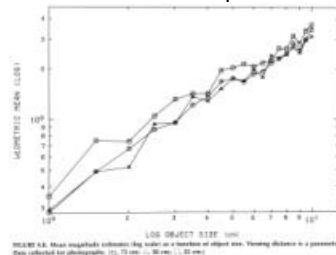
- Incandescent light looks warmer
- Sodium lighting looks yellowish
- Depends on intensity

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Constancy & Pictures

- Estimate size of depicted objects
- Different virtual viewpoints

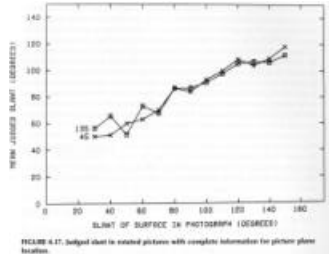


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Constancy & Pictures

- Estimate slant of depicted objects
- Different real viewing angles

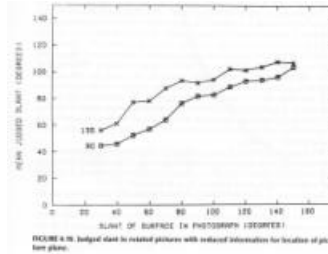


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Importance of frame

- Estimate slant of depicted objects
- Different real viewing angles, invisible frame

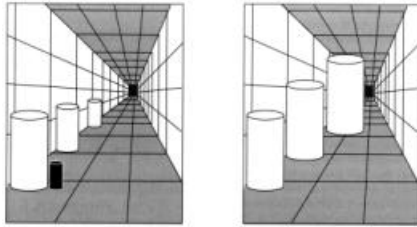


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Constancy & Pictures

- Hybrid constancy with respect to
 - Picture object
 - Depicted scene

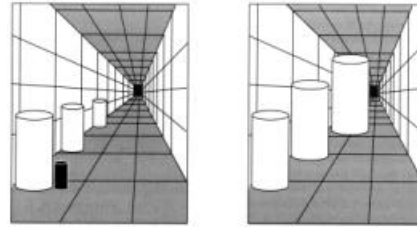


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Constancy & Pictures

- Hybrid constancy
- Problem
- Richness



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Degree of constancy

- Vermeer *Soldier and a Laughing Girl*
- Too good to be true: use of camera obscura



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Size constancy failure



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Size constancy failure



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Size constancy failure



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Breaking size constancy for symbol

- Middle-age
- Size = social importance



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Size constancy dissonance

- Surrealism (Magritte)



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Color constancy and pictures

- Chromatic adaptation with respect to picture object, not with respect to dicted scene



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Constancy & architecture

- Palazzo Spada in Rome (by Borromini)
- Short corridor
- Column size decreases
- Appears longer



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Constancy & Make Up



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Constancy & Lighting



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Next session

- Gestalt and picture organization
- Gaze movement and focal point

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Assignments

- Piranesi
 - Tutorial 1 to 4
- Reading
 - Art and Illusion, Gombrich
 - Summary 1 to 2 pages
 - 2 Discussion issues
- Feedback, 1 picture

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Discussion

- *The Man Who Mistook his Wife for a Hat*
- *The Colorblind Painter*
- Oliver Sacks



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