



PERCIEVING OBJECTS

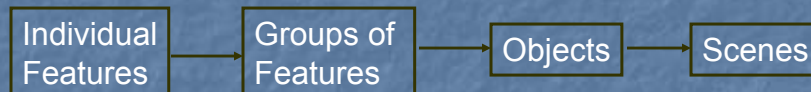
ICS 280: Visual Perception



Different Approaches



Physiological Approach

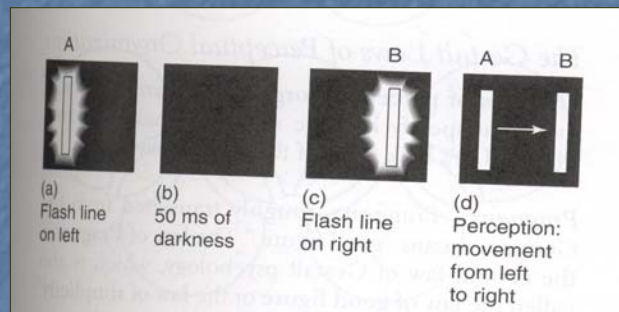


Psychophysical Approach

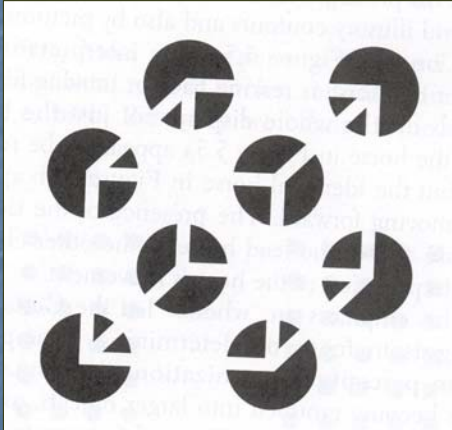
Gestalt Approach

- Gestalt psychology
 - Structuralism : Perception is created by combining elements called *sensation*
- But this cannot explain
 - Apparent Movement
 - Illusory Contours

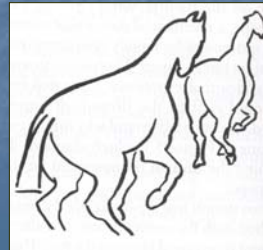
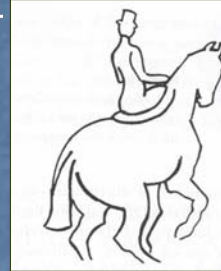
Apparent Movement



Illusory Contours



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Basic Philosophy

- The whole is different than the sum of its parts
- Six principles defining perception

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Gestalt Principles of Perceptual Organization

- Law of Simplicity
- Law of Similarity
- Law of Good Continuation
- Law of Proximity
- Law of Common Fate
- Law of Familiarity

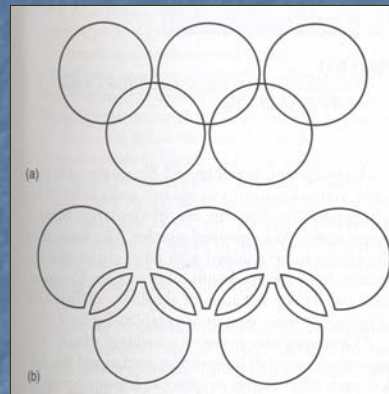
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Law of Simplicity

- Every stimulus pattern is seen in a way that is as simple as possible.



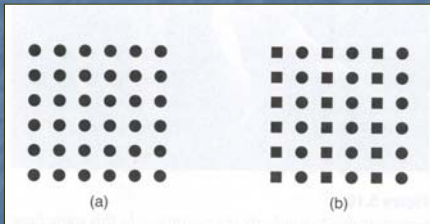
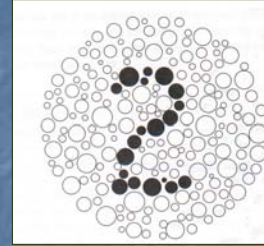
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Law of Similarity

- Similar things appear to be grouped together

Lightness



Shape

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Orientation

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Law of Good Continuation

- Points that when connected are seen as straight or smoothly curving lines tend to be seen as belonging together, and the lines tend to be seen in such a way that they follow the smoothest path.

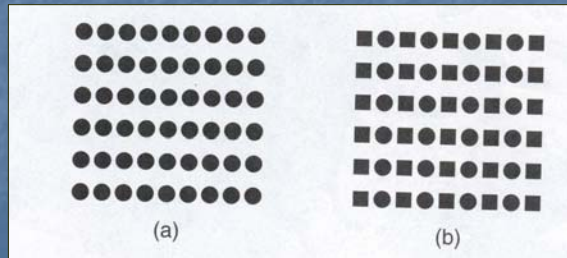


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Law of Proximity or Nearness

- Things close together appear to be grouped together
- Overcomes law of similarity in this example



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Law of Common Fate

- Objects moving in the same direction appear to be grouped together



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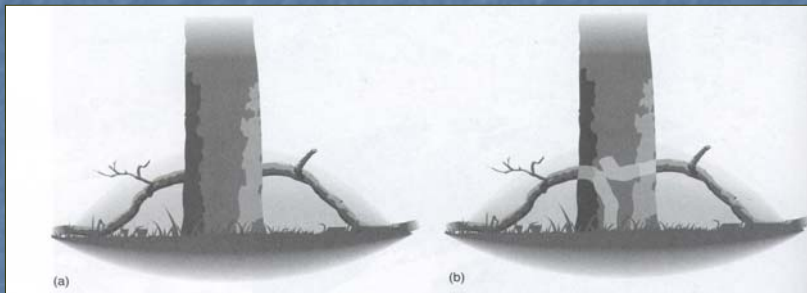
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Law of Familiarity

- Objects appear to be grouped if the groups appear to be familiar or meaningful.



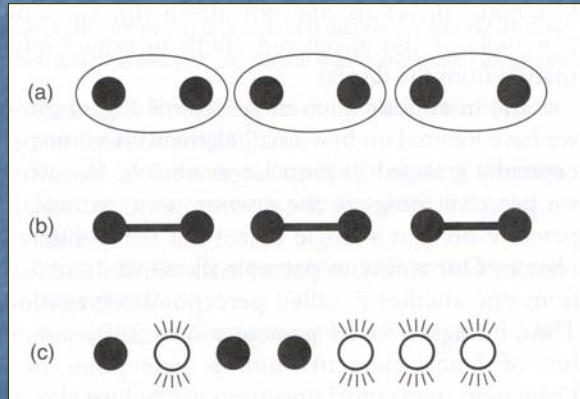
Heuristic and not Algorithm





Palmer-Irvine Principles of Perceptual Organization

- Common Region
- Element Connectivity
- Synchrony



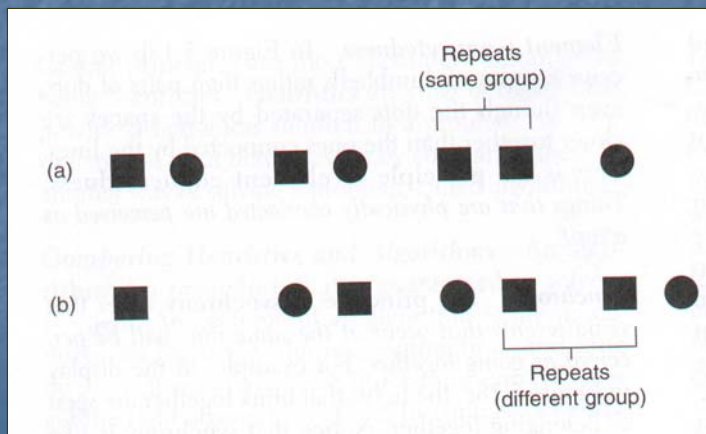
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Quantitative Measure of Grouping Effects

- Repetition Discrimination Task

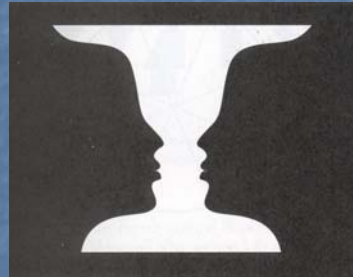


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Perceptual Segregation

- Gestalt Theory
- Reversible figure ground
 - Figure more object like
 - Figure seen as being in front of ground
 - Ground is uniform region behind figure
 - Separating contours appear to belong to figure

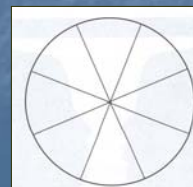
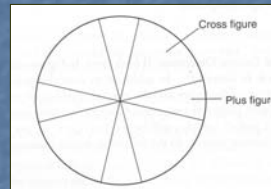


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Factors Determining Figure and Ground

- Figure
 - Symmetry
 - Smaller Areas
 - Horizontal or Vertical

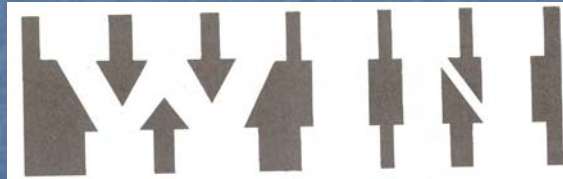


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Visual Perception

Factors Determining Figure and Ground

- Figure
- Familiarity



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Modern Research

- Role of Contours
 - Likelihood of Occurrence
- When does segregation occur?
 - Popular belief
 - First segregation, then recognition
 - Later proved
 - Recognition and segregation may happen in parallel

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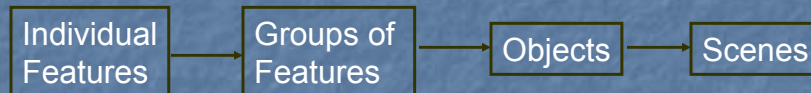
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Perceiving Objects



Physiological Approach



Psychophysical Approach

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How Objects are Constructed?

- Marr's computational Model
- Feature Integration Theory (FIT)
- Recognition-by-Components Theory (RBC)

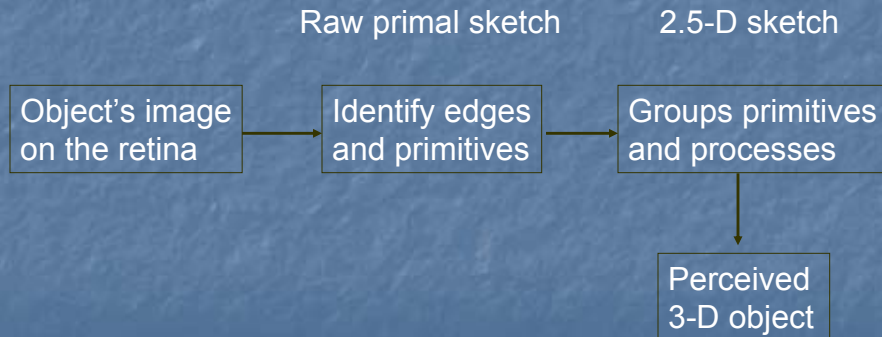
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Marr's Theory of Object Construction

■ Computational Approach

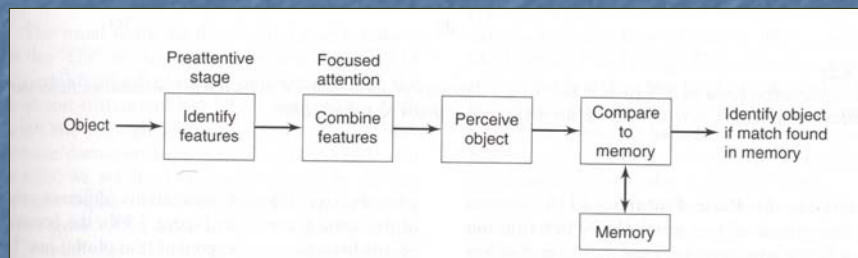


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Feature Integration Theory (FIT)



■ Preattentive Stage

- Detects features

■ Focused Attention Stage

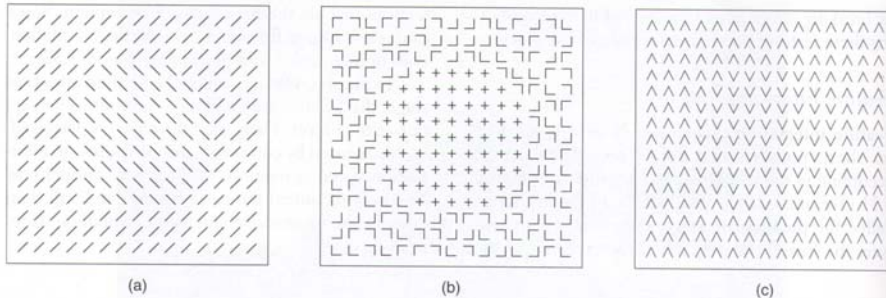
- Features are combined to perceive the object

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FIT : Preattentive Stage

- Pop-out boundary
 - Different Orientation
 - Different Value

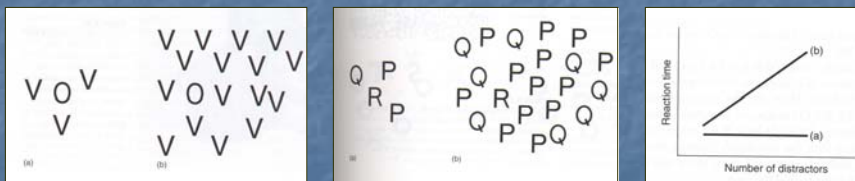


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FIT : Preattentive Stage

- Visual Search Detection Time
 - Constant with increase in number of distractors if target has pop-out features
 - Increases with increase in number of distractors if target has no pop-out features
 - Have to scan each distractor and eliminate



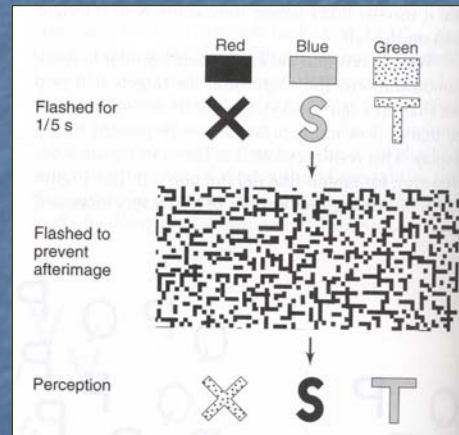
Similar to Saliency

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FIT : Preattentive Stage

- Independent features
- No association with objects
- Same observation from physiology

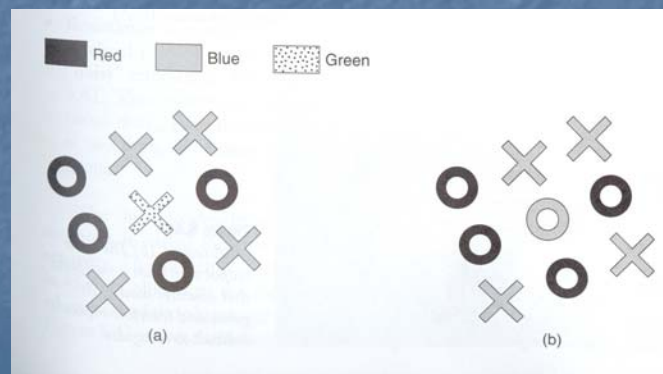


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FIT : Focused Attention Stage

- Attention is essential for combining features
- Same result from physiology

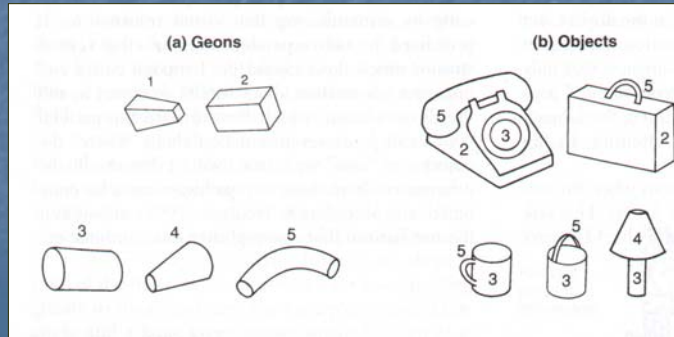


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Recognition-by-Components (RBC)

- Volumetric Primitives
 - Geons
- Principle of componential recovery



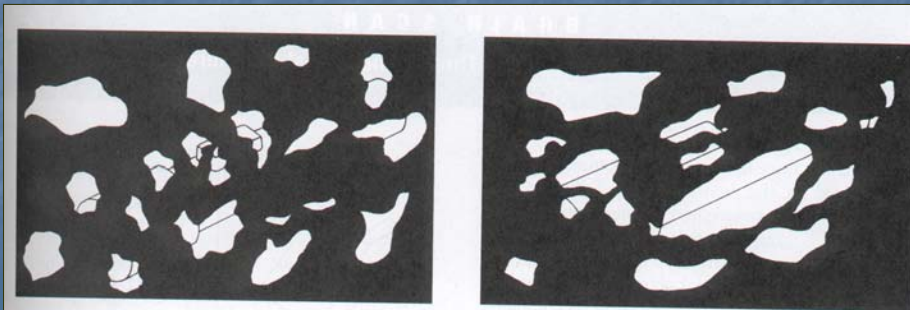
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ception

Properties of Geons

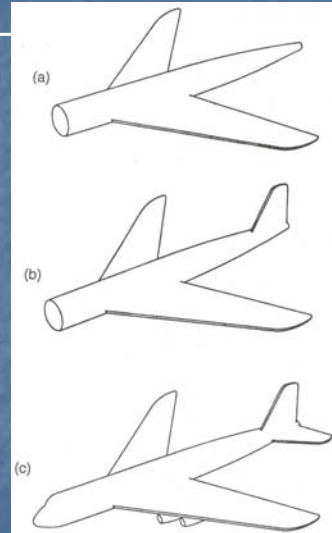
- View invariance
- Discriminability
- Resistance to visual noise

Cannot be mathematically enforced. Not very formal. Problem of any psychophysical study. No hard quantification.



RBC theory

- + Can identify objects based on a few basic shapes
- - Cannot help us detect the finer details which causes difference



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Comprehensive Model

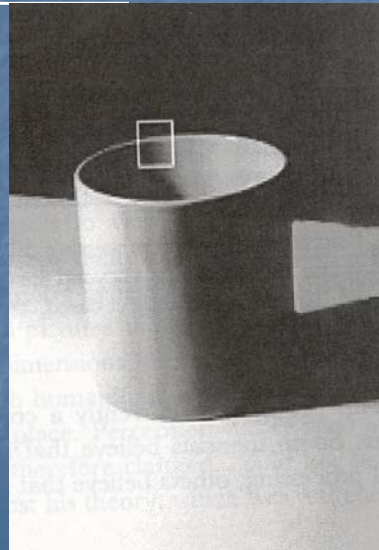
- Image Based Stage
- Surface Based Stage
- Object Based Stage
- Category Based Stage

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Image Based Stage

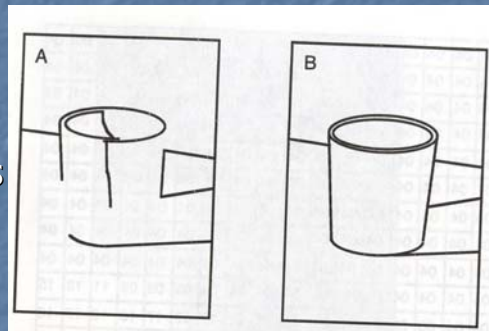
- Retinal Image
- Local feature detection



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Image Based Stage

- Retinal Image
- Local feature detection
 - Edges, Corners, blobs
 - Raw primal sketch
- Global relationship between them
 - Full primal sketch
 - Difficult



*Similarity with Marr's
Primal Sketch*

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Image Based Stage

- *Primitives*
 - 2D structure of image intensities
 - Features like edges, blobs, corners etc
- *Geometry*
 - Two dimensional
- *Reference Frame*
 - Retinal

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Surface Based Stage

- Find intrinsic property of surfaces in the real world
- Surfaces in 3D world as opposed to 2D primitives
- Visible surfaces from which light reflect to our eye
- *Intrinsic Images*

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Surface Based Stage

- Represented by 2D planar elements in 3D
 - 3D surface can be represented by infinite 2D planar elements
 - Properties
 - Distance from viewer
 - Slant
 - Shading (as color or texture)
 - Like a 2D rubber sheet wrapped on the face of the visible surfaces.

*Similarity with Marr's
2.5D representation*

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Surface Based Stage

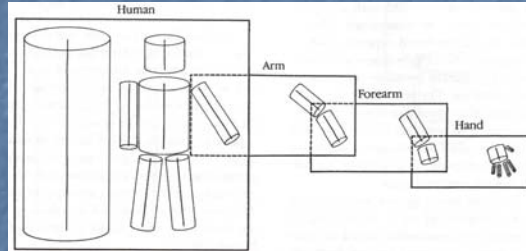
- *Primitives*
 - 2D planes embedded in 3D
- *Geometry*
 - Three dimensional
- *Reference Frame*
 - Viewer dependent

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Object Based Stage

- We have some 3D definition
 - Otherwise, surprised when hidden surfaces got exposed
- Two types of representation
 - 2D patched in 3D
 - 3D volume elements
 - Hierarchical



*Similarity with
Recognition by
Components*

Object Based Stage

- *Primitives*
 - 2D planes embedded in 3D
 - Volumes
- *Geometry*
 - Three dimensional
- *Reference Frame*
 - Object dependent



Category Based Stage

- Categorization
- Identification
- Cognitive Science
- Deals with knowledge in perception
- How it helps us survive

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Relationship to Graphics

- OpenGL triangular rendering
 - 2D triangle mesh embedded in 3D
 - Triangle is smallest planar 2D elements
- Volume Rendering
 - Uses volumes as primitives
- Image based Rendering
 - Depth Images analogous to surface based representation
 - That is why a view dependent rendering scheme is adopted
 - Since no object based information, difficulty in handling occlusion

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Role of Intelligence in Object Perception

- Ambiguous Stimulus
 - Inverse Projection Problem



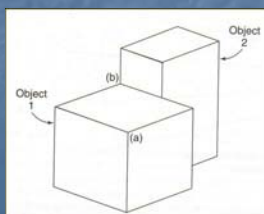
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Role of Intelligence in Object Perception

- Ambiguous Stimulus
 - Inverse Projection Problem
- Objects not separated
- Occlusion
- Ambiguity in lightness

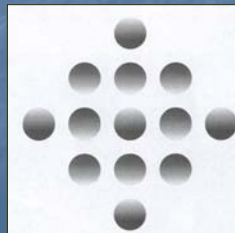
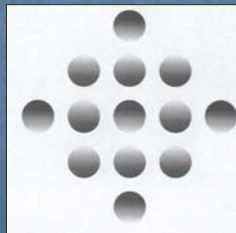
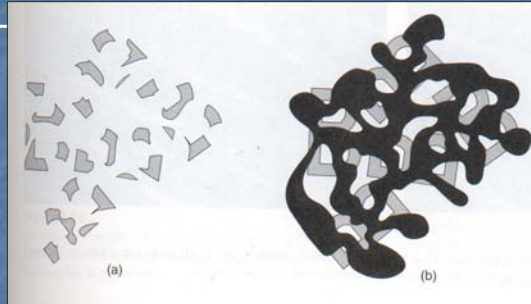


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Intelligence Heuristics

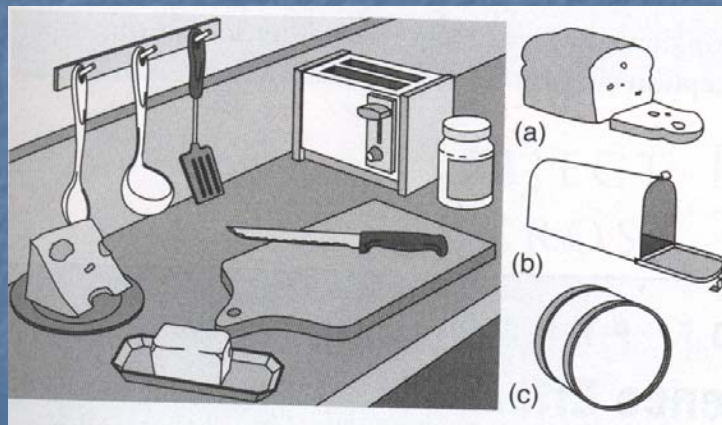
- Occlusion
- Light from above



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Top Down Processing



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