Summary

Why object perception is hard
Mid-level vision
   Structuralism
   Gestalt
   Visual Pandemonium
Object recognition
   Structural description models
   Image description models
Face perception

How do we put parts together to form wholes?
The Structuralist Approach

Perceptions are the sum of atoms of sensation—bits of color, orientation, and so forth. In the structuralist view, perception is built up of the local sensations the way a crystal might be built up of an array of atoms.
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The Gestalt Approach

- According to Gestalt psychologists, the whole is different than the sum of its parts. Gestalt is a German word meaning configuration or pattern.

- Perception is not built up from sensations but is a result of *perceptual organization*

- Gestalt principles do not make strong enough predictions to qualify as “laws”
  - They are better thought of as *heuristics* - “best guess rules”
What is the most *likely* cause of the image that is landing on my retina?

The committee model of perception:
Cues balance and interact with each other to influence our percepts – a “bag of tricks”
The Gestalt committee – how to perceptually organize objects
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The Gestalt laws of perceptual organization

**Similarity:** Similar things appear to be grouped together.

![Diagram of Gestalt laws](image-url)
The Gestalt laws of perceptual organization

**Similarity:** Similar things appear to be grouped together.
The Gestalt committee – how to perceptually organize objects

The Gestalt laws of perceptual organization

**Proximity** – (nearness) things that are near to each other are grouped together
The Gestalt committee – how to perceptually organize objects

- Similarity
- Proximity
- Common fate
- Symmetry
- Parallelism
- Synchrony
- Connectedness/Common region
- Good continuation
**Good continuation:** Points that, when connected, result in contours. These contours follow the smoothest path.

![Diagram](image)

**The Gestalt laws of perceptual organization**

**Good continuation:** Points that, when connected, result in contours. These contours follow the smoothest path.

![Diagram](image)
Neurons in V1 seem to support ‘good continuation’

Improvement in visual sensitivity by changes in local context: Parallel studies in human observers and in V1 of alert monkeys
Kapadia, Ito, Gilbert, and Westheimer Neuron, 1995
The Gestalt committee – how to perceptually organize objects

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1 2 3 4 5 6 7 8 9

[Diagram showing visual grouping principles with an image of a street scene and a pattern of curved lines]
The Gestalt committee – how to perceptually organize objects

- Similarity
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The Gestalt laws of perceptual organization

Synchrony – elements occurring at the same time are seen as belonging together.

The Gestalt laws of perceptual organization

Common Fate – things that move together belong together
Combining Gestalt cues - 
Here there are two cues providing two simultaneous organizations within the same figure
Combining Gestalt cues - competition

**Proximity vs. Similarity** Which one wins?

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Combining Gestalt cues

Which cue wins depends on the stimulus …
Combining Gestalt cues

Gestalt laws are insensitive to some kinds of information
**Figure-Ground Segregation**

- Determining what part of environment is the figure so that it “stands out” from the background

**Figure-Ground Segmentation**

Figure is usually:
In the lower part of the display
Symmetric/parallel/Convex
Relatively small in area/Surrounded
Oriented vertically rather than obliquely
Figure-Ground Segregation

Elements located in the lower part of displays tend to be seen as figure.

Symmetry
Symmetry, Convexity, and Parallelism

Symmetry vs. Convexity

Figure 5.27
The black columns are symmetrical and the white columns are convex. Which are seen as figure (Kunzsa, 1979)?
Smaller and surrounded areas tend to be perceived as figure.

Figure-Ground Segregation - Neural Evidence from V1.

- Recordings from V1 in the monkey cortex show:
  - Response to area that is figure
  - No response to area that is ground
The committee model of perception:
Cues balance and interact with each other to influence our percepts – a “bag of tricks”

Related to the Gestalt rule of good continuation
Related to the Gestalt rule of good continuation
Related to the Gestalt rule of good continuation

Related to the Gestalt rule of similarity
Certain types of luminance cues signal figure
Related to the Gestalt cue for convexity?
How do we recognize objects that vary in their appearance and are viewed from many angles?

Visual input is extremely variable
Shape space is virtually infinite
How Do We Recognize Objects From Different Viewpoints?

Two competing theories:

- Structural description models
- Image description models

Structural-Description Models:

Recognition by Components (RBC)
Biederman (1985)

Geons (“Geometric Ions”)
Each geon is uniquely identifiable from most viewpoints *(viewpoint invariant)*.
Only 36 geons needed to make thousands of objects.
Objects can be identified if the geons can be identified:
- which geons are present?
- what is the spatial relation among geons?
Recognition by Components

- **Strengths**
  - Viewpoint invariant
  - Parts-based
  - May be able to deal with partial occlusion via feedback
  - Represent 3-D structure

- **Weaknesses**
  - Complexity of representation
  - Doesn’t easily represent subtle metric differences (e.g., distance between eyes)
  - Recognition is at the level of categories (chair vs. table) rather than individuals (my office chair vs. my kitchen chair)
How Does the Brain Process Information About Objects?

Figure 5.37 Psychophysical curve showing that a monkey is better at identifying the view of the object that was presented during training (arrow). The drop-off in performance for other viewpoints is an example of a lack of view invariance.
Image-Description Models

• Ability to identify 3-D objects comes from stored 2-D viewpoints from different perspectives
  
  – For a familiar object, view invariance occurs
  – For a novel object, view invariance does not occur
  
  • This shows that an observer needs to have the different viewpoints encoded before recognition can occur from all viewpoints

Face Perception
Figure 4.24 (a) Greeble stimuli used by Gauthier. Participants were trained to name each different Greeble. (b) Brain responses to Greebles and faces before and after Greeble training. (a: From Figure 1a, p. 569, from Gauthier, I., Tarr, M. J., Anderson, A. W., Shadlen, M., & Gore, J. C. (1999). Activation of the middle fusiform “face area” increases with experience in recognizing novel objects. Nature Neuroscience, 2, 568-573.)

Who’s your granny?
Who’s your granny?

Pareidolia (payr.eye.DOH.lee.uh) n. The erroneous or fanciful perception of a pattern or meaning in something that is actually ambiguous or random.
On Mars

On the Moon
On (Google) Earth

In smoke and fire and snow
In smoke and fire and snow

October 16, 2007: Is this Pope John Paul II waving from beyond the grave? Vatican TV director says yes.
This fiery figure is being hailed as Pope John Paul II making an appearance beyond the grave.
The image, said by believers to show the Holy Father with his right hand raised in blessing, was spotted during a ceremony in Poland to mark the second anniversary of his death.

In rocks
In trees

On food.
Do cars have faces?

Adaptation to faces
Adaptation to faces
Adaptation to faces
Identity Aftereffects

The identity of the middle image is ambiguous

pre-adapt
adapt

post-adapt
adapt

post-adapt
Adaptation to gender
Adaptation to ethnicity

Adaptation to expression
Tuning for:

- Configuration
- Gender
- Ethnicity
- Emotion
- Attractiveness
- Weight?
We probably have a continuum of selectivity for face processing – “It’s a face” -- “It’s Jennifer Aniston”

The way a face looks to us depends on who we've been looking at recently!

There are large individual differences in face processing, including people with prosopagnosia.

For more on prosopagnosia, see http://www.faceblind.org/