Chapter 5: Perceiving Faces and Objects

Summary

Why object perception is hard
Mid-level vision
   Structuralism
   Gestalt
   Figure-Ground
   Occlusion
Object recognition
   Structural description models
   Image description models
Face perception
The Challenge of Object Perception

• Objects can be hidden or blurred
  – Occlusions are common in the environment

• The reasons for changes in lightness and darkness in the environment can be unclear – shadows cause huge differences in illumination

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The Structuralist Approach

• Approach established by Wundt (1830-1920)
  – States that perceptions are created by combining elements called sensations
  – Popular in mid to late 19th century

Wundt studied conscious experience by examining its structure or components parts (sensations, feelings) using individuals who were trained in introspection. This "school of psychology" became known as structuralism.
Structuralism could not explain 'apparent motion'.

It seems that the visual system 'looks' for regularity and patterns. We often 'see' or infer structure when it's not actually there.
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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"

The following 'laws' describe heuristics for how elements in a scene tend to group together:

The Gestalt laws of perceptual organization

Pragnanz: Every stimulus pattern is seen in such a way that the resulting structure is as simple as possible.

Similarity: Similar things appear to be grouped together.
The Gestalt laws of perceptual organization

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

The Gestalt laws of perceptual organization

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

The Gestalt laws of perceptual organization

**Good continuation:** Points that, when connected, result in contours and these contours follow the smoothest path.
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 laws of perceptual organization

Proximity – (nearness) things that are near to each other are grouped together

The Gestalt laws of perceptual organization

Proximity vs. Similarity Which one wins?

The Gestalt laws of perceptual organization

It depends…
The Gestalt laws of perceptual organization

**Common Fate** – things that move together belong together

**Uniform connectedness** – a connected region of visual properties is perceived as a single unit

**Common region** – elements in the same region tend to be grouped together

**Synchrony** – elements occurring at the same time are seen as belonging together.
The Gestalt laws of perceptual organization

Meaningfulness or Familiarity: Things are more likely to form groups if the groups appear meaningful or similar.

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.

Bev Doolittle (1985)
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 trees

On food.

Do cars have faces?

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Figure-Ground Segregation

- Determining what part of the 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
- Convex
- Relatively small in area
- Oriented vertically rather than obliquely

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

Area

Smaller areas tend to be perceived as figure.
Vertical and horizontal components tend to be perceived as figure.

Smaller areas (the black shapes) tend to be perceived as figure.
Symmetry vs. Convexity

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

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Shape and object perception
How Does the Brain Process Information About Objects?

How Do We Recognize Objects From Different Viewpoints?

Two competing theories:
- Structural description models
- Image description models
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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 (RBC)

Example of Geons Used and Representative Objects That Can be Constructed from the Geons' Shapes. (From Biederman, 1982)

Figure 5.35 (a) It is difficult to identify the object behind the mask because its geons have been obscured.
(b) Now that it is possible to identify geons, the object can be identified as a flashlight.
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)

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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

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.
Booth and Rolls, 1998

The neuron’s responses are similar within each object across viewpoints.

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Face Perception

Neurons in FFA also reflects to what you consciously see.
Grill-Spector et al. (2004)

- Fusiform Face Area (FFA) in each participant was identified with fMRI.
- On each trial, participants were shown either:
  - A picture of Harrison Ford’s face
  - A picture of another person’s face
  - A random texture
  - All stimuli were shown for 50 ms followed by a random-pattern mask
- Participants were to indicate what they saw (Harrison Ford, another face, or a texture pattern).
Grill-Spector Experiment - continued

- For trials that only included Harrison Ford's face, results showed that FFA activation:
  - Was greatest when picture was correctly identified as Ford
  - Was less when picture was identified as other object
  - Showed little response when there was no identification of a face
Identity Aftereffects

The identity of the middle image is ambiguous

Adaptation to faces

pre-adapt
Adaptation to gender

Adaptation to ethnicity

Adaptation to expression
• Insert slide about distributed vs. sparse processing

Quiroga et al. Nature 2005

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., Skudlarski, P. L., & Gore, J. C. (1999). Activation of the middle fusiform “face area” increases with experience in recognizing novel objects. Nature Neuroscience, 2, 568-573.)
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/

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