Object vision (Chapter 4)

Lecture 8

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Chapter 3 Leftovers
Adaptation: the Psychologist’s Electrode (recap)

Adaptation: the diminishing response of a sense organ to a sustained stimulus

• An important method for deactivating groups of neurons without surgery

• Allows selective temporary “knock out” of group of neurons by activating them strongly
Effects of adaptation on population response and perception

Before Adaptation

Stimulus presented = 0 degree stimulus

unadapted population resp to 0 deg

Stimulus presented =
Effects of adaptation on population response and perception

Before Adaptation

Then adapt to 20°

Stimulus presented = /
Selective adaptation alters neural responses and perception

After Adaptation

Stimulus presented = $

\text{Orientation of line (degrees)}$

perceptual effect of adaptation is repulsion away from the adapter
Selective adaptation for spatial frequency: evidence that visual system contains neurons selective for spatial frequency
Adaptation that is specific to spatial frequency (SF)

1. adapt
Adaptation that is specific to spatial frequency (SF)

1. adapt

2. test

frequency of adapter
Adaptation that is specific to spatial frequency (SF)

1. adapt

2. test

3. percept
Adaptation that is specific to spatial frequency AND orientation

1. adapt
Adaptation that is specific to spatial frequency AND orientation

1. adapt

2. test
Adaptation that is specific to spatial frequency AND orientation

1. adapt

2. test

3. unadapted percept!
Orthodox viewpoint:

• If you can observe a particular type of adaptive after-effect, there is a certain neuron in the brain that is selective (or tuned) for that property

THUS (for example):

There are no neurons tuned for spatial frequency across all orientations, because adaptation is orientation specific.
Selective Adaptation to Faces
Selective Adaptation to Faces
The Development of Spatial Vision

• how can you study the vision of infants who can’t yet speak?

Read in book!
The Development of Spatial Vision

- how can you study the vision of infants who can’t yet speak?

I. preferential-looking paradigm
- infants prefer to look at more complex stimuli
The Development of Spatial Vision

• how can you study the vision of infants who can’t yet speak?

2. visually evoked potentials (VEP)
- measure brain’s electrical activity directly

SENSATION & PERCEPTION 2e, Figure 3.32
The Development of Spatial Vision

young children: not very sensitive to high spatial frequencies

**Visual system is still developing:**

- Cones and rods are still developing
- Retinal ganglion cells still migrating and growing connections with the fovea
- fovea: not fully developed until 4 years of age
Summary (Chapter 3B)

- spatial frequency sensitivity & tuning
- V1 receptive fields, orientation tuning
- Hubel & Weisel experiments
- simple vs. complex cells
- cortical magnification
- cortical columns
- adaptation
- infant vision / visual development
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Perceiving and Recognizing Objects
Q: How do we recognize objects?

• **retinal ganglion cells** and **LGN**: “spots”

• **V1**: “edges” or “bars”

How to go from “spots” and “edges” to objects?
Relevant brain areas:

• **Extrastriate cortex** - general term for regions outside V1
  - V2, V3, V4, Inferotemporal Cortex, etc.
Introduction

What do you see?
What do you see?
What do you see?
How did you recognize that all 3 images were of houses?

How did you know that the 1st and 3rd images showed the same house?

This is the problem of *object recognition*, which is solved in visual areas beyond V1.
Unfortunately, we still have no idea how to solve this problem.

Not easy to see how to make Receptive Fields for houses the way we combined LGN receptive fields to make V1 receptive fields!
**Viewpoint Dependence**

**View-dependent model** - a model that will only recognize particular views of an object

- template-based model

**Problem:** need a neuron (or “template”) for every possible view of the object - quickly run out of neurons!
**Middle vision:**

- *after* basic features have been extracted and *before* object recognition and scene understanding

  - Involves perception of edges and surfaces
  - Determines which regions of an image should be grouped together into objects
Finding edges

- How do you find the edges of objects?
- Cells in primary visual cortex have small receptive fields
- How do you know which edges go together and which ones don’t?
Computer-based edge detectors are not as good as humans

- Sometimes computers find too many edges
Computer-based edge detectors are not as good as humans

- Sometimes computers find too few edges
“Kanizsa Figure”

**illusory contour:** a contour that is perceived even though no luminance edge is present
• **Gestalt**: In German, “form” or “whole”

• **Gestalt psychology**: “The whole is greater than the sum of its parts.”

• Opposed to other schools of thought (e.g., structuralism) that emphasize the basic elements of perception

  **structuralists:**
  • perception is built up from “atoms” of sensation (color, orientation)
  • challenged by cases where perception seems to go beyond the information available (e.g., illusory contours)
Gestalt Principles

Gestalt grouping rules:

a set of rules that describe when elements in an image will appear to group together
**Good continuation**: A Gestalt grouping rule stating that two elements will tend to group together if they lie on the same contour.

![Diagram](image)
Good continuation: A Gestalt grouping rule stating that two elements will tend to group together if they lie on the same contour.
Gestalt Principles

Gestalt grouping principles:

- Similarity
- Proximity
Dynamic grouping principles

- **Common fate**: Elements that move in the same direction tend to group together

- **Synchrony**: Elements that change at the same time tend to group together

(See online demonstration: book website)

Figure/Ground Segregation: Face/Vase Illusion

“ambiguous figure”
Gestalt figure–ground assignment principles:

• **Surroundedness**: The surrounding region is likely to be ground

• **Size**: The smaller region is likely to be figure

• **Symmetry**: A symmetrical region tends to be seen as figure

• **Parallelism**: Regions with parallel contours tend to be seen as figure

• **Extremal edges**: If edges of an object are shaded such that they seem to recede in the distance, they tend to be seen as figure
• **Accidental viewpoint:** produces a regularity in the visual image that is not present in the world

• **Visual system will not adopt interpretations that assume an accidental viewpoint!**
• non-accidental viewpoint

“typical” viewpoint: interpretation won’t change if you move the camera a little bit
another accidental viewpoint
(when “good continuation” goes bad)
Accidental Viewpoints

• Believable 3-d figure:
Accidental Viewpoints

• Unbelievable figure

You could build a 3D object that would lead to this 2D image, but would need to take the picture from a very specific viewpoint.
Impossible triangle
(Perth, Australia)
Impossible triangle
(Perth, Australia)
Accidental Viewpoints
(street art)
...one more argument against Naive Realism:

**Speed Bumps of the Future: Children**
Speed Bumps of the Future: Children

“the girl’s elongated form appears to rise from the ground as cars approach, reaching 3D realism at around 100 feet, and then returning to 2D distortion once cars pass that ideal viewing distance. Its designers created the image to give drivers who travel at the street’s recommended 18 miles per hour (30 km per hour) enough time to stop before hitting Pavement Patty—acknowledging the spectacle before they continue to safely roll over her.”

- Joseph Calamia (Discover magazine blog)

“It’s a static image. If a driver can’t respond to this appropriately, that person shouldn’t be driving.…”

- David Duane, BCAA Traffic Safety Foundation

http://tinyurl.com/358r46p
Benard Pras - French sculptor

**Nonaccidental feature**: features that do not depend on the exact (or accidental) viewing position of the observer

- **T junctions**: indicate occlusion
- **Y junctions**: indicate corners facing the observer
- **Arrow Junctions**: corners facing away from observer

- these features are still present if object is shifted, scaled or rotated by a small amount