What is perception good for?

- We often receive **incomplete** information through our senses. Information can be highly **ambiguous**
- Perceptual system must resolve ambiguities by drawing inferences from a large set of perceptual cues and conceptual knowledge of the world
Primary and Secondary Visual Cortex (V1 and V2)

- Retinotopic maps
- Receptive fields:
  - On-off cells; Off-on cells
  - Simple cells
- Lateral inhibition

Retinotopic maps in V1

Retinotopic mapping: locations on retina are mapped to cortex in orderly fashion. Note: more of visual cortex is dedicated to foveal vision

Stimulus pattern
Response in monkey primary visual cortex (V1) measured by radio-active tracers

Revealing retinotopic maps with fMRI

From: Geoff Boynton, SALK institute
**Receptive Fields**

- The receptive field (RF) of a neuron is the area of retina cells that trigger activity of that neuron.

**On-off cells and off-on cells:**

- Simple cells (bar detectors)

**Hierarchical organization** of the brain: by aggregating responses over several on-off cells, the brain can detect more complicated features (e.g., bars and edges).

**There is some evidence for cells that recognize faces**

*Bruce, Desimone & Gross (1981)*

**Illusory Contours**

- One can see a square even though there is no square → illusory contour
- Bar detectors in visual cortex are activated by partial contours.
- Higher areas assemble lines into objects. The visual system fills in the lines in the corners.

**Mach Bands and Lateral Inhibition**

*What is seen* → *Stimulus*
Lateral Inhibition

- Lateral inhibition sets up competition between neurons so that if one neuron becomes adept at responding to a pattern, it inhibits other neurons from doing so.

**DEMO APPLETS:**
- http://www.psychology.mcmaster.ca/4i03/demos/lateral-demo.html
- http://serendip.brynmawr.edu/bb/latinhib_app.html

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Throwing Away Information

**The Craik-Cornsweet-O'Brien illusion**

(a) A gray rectangle is shown with a special edge in the middle. The rectangle seems to be divided with a lighter region on the left and darker region on the right. If you look closely, you will see that actually the two regions are not uniform. There is a gradual transition in each side, producing a sharp change from light to dark in the middle. (b) This is the same figure as in (a), but with the middle region covered by a black rectangle. Now you can see that the gray regions are actually the same. Try putting your finger over the middle of (a) to reveal the illusion.

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Functional Specialization

- Spatially different areas are functionally specialized for processing visual attributes such as shape, color, orientation, and direction of motion.

  - **Achromatopsia** (damage to V4)
    - cortical color blindness all color vision is lost and the world appears in shades of gray. And in achromatopsia, unlike as in blindness caused by damage to the eyes or optic nerve, even memory of color is gone
  
  - **Akinetopsia** (damage to V5 or MT)
    - or motion blindness—the loss of the ability to see objects move. Those affected report that they perceive a collection of still images.

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Sensory Binding Problem

- If spatially different areas are functionally specialized for processing visual attributes such as shape, color, orientation, and direction of motion….

- then how does the brain then “bind” together the sensory attributes of an object to construct a unified perception of the object?

  ➔ Binding Problem

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Binding Problem

- Visual Field: 
  - Red
  - Green
  - Horizontal
  - Vertical

- Visual Cortex: 
  - Red
  - Green
  - Horizontal
  - Vertical
Face Recognition

We detect faces when the configurations of features are present.

Is Face Recognition Special?

- Arguments have been made for both functional and neuroanatomical specialization for face processing (different from objects)

- Sources of evidence:
  - Behavioral experiments
  - Brain injury
  - Brain imaging

Neuropsychological evidence

- Face specific deficits found in prosopagnosia

- Subjects can identify most objects, but are impaired at recognizing faces

- Can name faces from touch and verbal descriptions so prosopagnosia is not a naming deficit ➔ visual pattern recognition problem

- Is it specific to faces or any difficult recognition problem?

Brain Imaging Evidence

- In humans, face perception is uniquely associated with activity in the fusiform face area located in the fusiform gyrus in the inferior temporal lobe

- This finding is more robust in the right vs. left hemisphere.
Visual Expertise?

• Gauthier and colleagues suggest that faces are special because we have become experts at within-category discriminations

• Claims that becoming an expert at "Greeble" discrimination involves the fusiform face area, as do other types of within-category discrimination (e.g. model car collectors)

• Experiment: perhaps fusiform area can be trained to recognize novel objects. Greeble learning experiment. Over 10 hours on naming Greeble objects

Result

• After learning, the “face area” has become the Greeble area

What about real-world experts?

• Fusiform area is active for objects that you are an expert in

Evaluation

• Maybe faces are not processed so differently from objects. Depends on your level of expertise with objects.

• Fusiform gyrus can be activated by objects with which we have expertise

• Configural processing also occurs with familiar objects
Perceptual Grouping and Gestalt Laws

Law of Good continuation. This is perceived as a square and triangle, not as a combination of strange shapes.

Law of Similarity. Items that look similar will be perceived as belonging to the same form.

Law of Proximity. Items that are nearby are grouped together.

Common Fate

Johansson point light displays

From: Emily Greenstein

Collection of point light displays:
http://www.montana.edu/~asl disproportion/blended.html

Figure–Ground Segregation

• An ambiguous drawing which can be seen either as two faces or as a goblet.

Filling in the Gaps

Filling in the Gaps

Memory contents:
1. Two small rectangles. (d) A black rectangle is added. The interpretation changes so that now the figure looks like a long white rectangle instead of the two short ones. The black rectangle is seen as excluding part of a single white one. (b) The two small rectangles have gaps. One interpretation is: again, one long white rectangle is partially excluded by an invisible shape. (c) When more lines are added, the invisible rectangle is visible: you see a "subjective" or "primary" contour.