Cogs 160: Neural Coding in Sensory Systems
Cogs 272: Computational Models of Sensory Coding

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Department of Cognitive Science
Spring, 2010

Today

- Grading (Cogs 160)
- Academic honesty
- Week 2: rescheduled class times
- Syllabus
- Introduction
- Cogs 272 only: logistics
Grading

- Participation (reading, discussion): 25%
- Mini thought essays (1 page, weekly): 75%
Academic Honesty

- Do your own writing!
- Plagiarizing will not be tolerated
Week 2: Rescheduled Classes

Cog 272: Wed 5-6 PM, April 7, 2010
Syllabus

Each week: overview (Tue), research paper (Thr)

Week 1: Retina
Week 2: LGN & V1
Week 3: V4
Week 4: MT & LIP
Week 5: Hair cells
Week 6: Auditory cortex
Week 7: Olfactory bulb & cortex
Week 8: Barrel cortex
Week 9: Multimodal integration
Week 10: Sensorymotor interaction: oculomotor system
Perception is an Illusion
(Sometimes closer to reality than others)
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Checker-shadow illusion:
The squares marked A and B are the same shade of gray.

Edward H. Adelson
Perception is an Illusion
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Edward H. Adelson
Perception is an Illusion
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Every reduction of some phenomenon to underlying substances and forces indicates that something unchangeable and final has been found. We are never justified, of course, in making an unconditional assertion of such a reduction. Such a claim is not permissible because of the incompleteness of our knowledge and because of the nature of the inductive inferences upon which our perception of reality depends.

-- Hermann Ludwig Ferdinand von Helmholtz
The Facts of Perception, 1878
Some Questions We Will Explore

- What are some limitations of sensory perception?
- How are they consequences of neural representation?
- How are they overcome/minimized by neural coding/computation?
Introduction to the Visual System

Sagittal view
Introduction to the Visual System

Horizontal view
The Eye and the Retina

Light is focused by the cornea and the lens onto the retina, a thin layer of neural tissue at the back of the eye which contains photoreceptors. Photoreceptors transduce light into neural signals and pass their signals on to the brain.
Rods and Cones

Fovea

Periphery
Distribution of Cones & Rods
Perception is an Illusion
(Sometimes closer to reality than others)
Three Types Cones
Anatomy of the Retina

- Pigmented cell
- Rod
- Cone
- Horizontal cell
- Amacrine cell
- Bipolar cell
- Ganglion cell
Basic Anatomy of a Neuron
Action Potential

- Closed channel
- Open channel
- Direction of propagation of impulse
- Resting and temporarily unable to fire
- Active state
- Resting

Cell body

Na⁺
Action Potential

- Spikes are all-or-none, discrete, stereotyped events.
- A certain threshold-level input must be achieved in order to produce a spike. Below that, no spikes.
- Refractory period: after a neuron has fired an action potential, it cannot fire another until some time has passed.
- The firing rate of the neuron (e.g., spikes per second) represents information about stimulus intensity within each neuron.
- Response latency (precise timing) also encodes information
Retinal Ganglion Cells

Left cell is ON-center/OFF-surround.
Right cell is OFF-center/ON-surround.
Hermann Grid
Hermann Grid

Response of an ON-center/OFF-surrond retinal ganglion cell

Response at Intersection

\[
(8)(1) - (8)(1/16)(4) - (8)(1/16)(4) = 8 - 1 - 2 = 5
\]

Response off Intersection

\[
(8)(1) - (8)(1/16)(2) - (8)(1/16)(6) = 8 - 3/2 - 1 = 5 1/2
\]
Mach Band

Diagram showing stimulus intensity and neural response intensity along with corresponding retinal cells.
Retinal Image is Flipped
Visual Field in Each Eye

Left eye visual field

Right eye visual field

blind spot
vertical meridian
horizontal meridian
fixation point
fovea
optic disc
Visual Field Representation in the Cortex

Eye and Brain

optic chiasma

lateral geniculate body

area striata
Visual Field Representation in the Cortex
Cogs 272: Logistics

- Two Cogs 160 lectures, one review, one primary research
- Slides, discussion Q’s, & essay assignment due Mon (this Wed)
- Participate in discussions, but be considerate of audience
- Grade essays (due Tue), return by Friday
- Critique each other’s lectures (one paragraph/lecture)
- Thur 7-8 journal club: prepare slides, lead discussion
## Schedule

<table>
<thead>
<tr>
<th>Date (topic):</th>
<th>160, 272, food</th>
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</thead>
<tbody>
<tr>
<td>Week 1 (Retina):</td>
<td>Jake, Ben, Angela</td>
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<tr>
<td>Week 2 (LGN &amp; V1):</td>
<td>Vicente</td>
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<td>Week 3 (Extrastriate visual cortex):</td>
<td>Doug</td>
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<td>Week 4 (MT &amp; LIP):</td>
<td>Crane</td>
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<td>Week 5 (Audition I):</td>
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<td>Week 6 (Audition II):</td>
<td>Tomoki</td>
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<td>Week 7 (Olfaction):</td>
<td>Ben</td>
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<td>Week 8 (Somatosensation, barrel cortex):</td>
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<td>Week 9 (Multimodal integration):</td>
<td>Walter</td>
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<tr>
<td>Week 10 (Oculomotor system):</td>
<td>Pradeep</td>
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