Web site: http://tinyurl.com/visionclass (Class notes, readings, etc)

Location: Biolabs 2062

Time: Mondays 03:30 – 05:30

Lectures:
Faculty: Gabriel Kreiman and invited guests

Contact information:
Gabriel Kreiman
gabriel.kreiman@tch.harvard.edu
617-919-2530
Joseph Olson
josepholson@fas.harvard.edu
Office Hours: After Class. Mon 05:30-06:30

Lesion studies in animal models. Neurological studies of cortical visual deficits in humans. 

**Psychophysics of visual object recognition [Joseph Olson]**

Introduction to the thalamus and primary visual cortex [Camille Gomez-Laberge]

*Oct-10*

*Columbus Day. No class.*

Adventures into *terra incognita*. Neurophysiology beyond V1 [Hanlin Tang]

First steps into inferior temporal cortex [Carlos Ponce]

From the highest echelons of visual processing to cognition [Leyla Isik]

Correlation and causality. Electrical stimulation in visual cortex.

Theoretical neuroscience. Computational models of neurons and neural networks. [Bill Lotter]

Computer vision. Towards artificial intelligence systems for cognition [David Cox]

Computational models of visual object recognition. [Kreiman]

Psychophysics: The study of the dependencies of psychological experiences upon the physical stimuli that generate them

Basic measures:

- **Reaction time** — The time taken by subjects to perform a task or make a judgment can give an indication (or at least an upper bound) of how long the necessary psychological (and hence neural) processing takes.

- **Performance** — Often inversely related to reaction time. There are techniques for mitigating response biases.

- **Threshold** — Stimuli can be varied to determine the threshold for detection, discrimination, or some more complex psychological phenomenon.
• What are the theories / evidence / questions driving the motivation behind some psychophysics experiments of visual recognition?

  – Atoms of recognition
  – Gestalt (whole vs sum of the parts)
  – Context
  – Tolerance and Invariance to image transformations
  – Fundamental properties of visual system (e.g. speed)
Gestalt laws of grouping
Basic phenomenological constraints

- **Law of Closure** — The mind may experience elements it does not perceive through sensation, in order to complete a regular figure (that is, to increase regularity).
- **Law of Similarity** — The mind groups similar elements into collective entities or totalities. This similarity might depend on relationships of form, color, size, or brightness.
- **Law of Proximity** — Spatial or temporal proximity of elements may induce the mind to perceive a collective or totality.
- **Law of Symmetry (Figure ground relationships)** — Symmetrical images are perceived collectively, even in spite of distance.
- **Law of Continuity** — The mind continues visual, auditory, and kinetic patterns.
- **Law of Common Fate** — Elements with the same moving direction are perceived as a collective or unit.
Law of closure: perceiving objects as whole even if they are not complete

The mind may experience elements it does not perceive through sensation, in order to complete a regular figure (that is, to increase regularity)
Law of closure: perceiving objects as whole even if they are not complete.

The mind may experience elements it does not perceive through sensation, in order to complete a regular figure (that is, to increase regularity).
Law of similarity

The mind groups similar elements into collective entities or totalities. This similarity might depend on relationships of form, color, size, or brightness.
Law of proximity

Spatial or temporal proximity of elements may induce the mind to perceive a collective or totality.
Law of symmetry

http://isle.hanover.edu/Ch05Object/Ch05SymmetryLaw.html

• The Law of Symmetry is the gestalt grouping law that states that elements that are symmetrical to each other tend to be perceived as a unified group
Law of continuity

The mind continues visual, auditory, and kinetic patterns
Law of continuity

The mind continues visual, auditory, and kinetic patterns
Law of common fate
MIRCs
Minimal Recognizable Configurations
Holistic representation of faces

McKone et al, Frontiers in Psychology, 2013
Holistic representation of faces

A Thatcher illusion

Inverted

McKone et al, Frontiers in Psychology, 2013
Holistic representation of faces

Composite illusion

McKone et al, Frontiers in Psychology, 2013
Beyond pixels – Context matters
Tolerance to image transformations

- Scale
- Position
- Rotation (2D)
- Rotation (3D) – viewpoint
- Color
- Illumination
- Cues
- Clutter
- Occlusion
- Other non-rigid transformations (aging, expressions, etc)
Scale tolerance
One-shot learning for scale tolerance

Which one is it?
Position tolerance
Tolerance to viewpoint and illumination changes
Recognition from minimal features
Recognition of caricatures

Images: Hanoch Piven
Visual recognition depends on experience
Recognition of images flashed for ~100 ms (demo)
Visual recognition can be extremely fast

Is information integrated over time?

Singer and Kreiman, 2014
Rapid decay in recognition of asynchronously presented object parts

Brief asynchronies disrupt object recognition

Singer and Kreiman, 2014
The visual system has a very large capacity.
Pattern completion: Objects can be recognized from partial information
Amodal completion
Object recognition from partial information
Object completion task

Unmasked

Whole

Animal
Chair
Vehicle
Fruit
Face

response

500 ms

Partial

Animal
Chair
Vehicle
Fruit
Face

response

500 ms

33-150 ms

500 ms

500 ms
Object completion (unmasked condition)
Partial Information induces latencies
Backward masking

10 ms 20 ms 30 ms 40 ms 50 ms 100 ms 200 ms
Doubles?

http://www.francoisbrunelle.com/

Francois Brunelle
Object completion task (masking)

The diagram illustrates the object completion task with masking. It shows two conditions: Whole and Partial. In the Unmasked condition, the object is fully visible, while in the Masked condition, the object is partially masked. The response is recorded within a time frame of 33-150 ms after the object is presented.
Object completion (unmasked condition)

Unmasked

Masked

Whole

Partial

Performance

SOA

Whole

Partial

Performance

SOA
Further reading


Original articles cited in class (see lecture notes for complete list)
- McKone et al, Frontiers in Psychology, 2013