9.63 Lab. in Visual Cognition

Fall 2009

(Some) Paradigms of Perception

What is a paradigm?

- An experimental method that is appropriate for studying particular phenomena.
- Questions to ask for a paradigm:
- (1) What questions or issues does the paradigm emphasize ? (goal of the paradigm)
- (2) What assumptions/hypothesis underlie the paradigm?

The Study of Perception

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- The Perceptual Process -- how it is studied:
- Imagine that you have been given a science project:
- Design a device that can locate, describe, and identify all objects, in the environment, including their distance from the device and their relationships to each other.

Some questions about Perception

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- What is the difference between perceiving something and recognizing it?

- Perception: Conscious sensory experience. Electrical signals that represent something (eg. seeing a tiger) are somehow transformed into your experience of seeing a “tiger”

- Recognition: Our ability to place an object in a category, such as "tiger," that gives its meaning.

Some questions about Perception

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- How can we measure perception?
- How are physiological processes involved in perception?
- How can physiological responses to perceptual stimuli be studied in the human brain?
- Perception does not just happen but is the end result of complex processes, many of which are not available to your awareness

Importance of Perception

- Precise measurements of perceptual capacities have enabled us to:

  Describe normal perception

  Describe the perceptual losses that occur because of aging, disease, or injury

- Need to understand perception in order to design devices to restore perception (within limits)

- Also important for understanding the perceptual demands encountered in daily life

The perceptual process

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- Top-Down and Bottom-Up Processing
- Processing that begins with the information received by the receptors is called bottom-up processing
- Processing that begins by considering the effect of the knowledge a person brings to the perceptual situation is called top-down processing

How do we study perceptual processes?

- **Psychophysical** level of analysis
  How a person's perception is related to stimulation in the environment
  Focuses on the relationship between the stimulus and perception
  Term *psychophysics* was introduced by Gustav Fechner in 1860
  Refers to quantitative methods for precisely measuring relationships between the stimulus (physics) and perception (psychology)

- **Physiological level** of analysis
  How a person's perception is related to physiological processes that are occurring within the person
  Focuses on the relationship between the stimulus and physiology

- **Cognitive** Influences on Perception
  How the knowledge, memories, and expectations influence perception

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Variables of Psychophysical Studies

- Dependant variables: observers are asked to make 1 of two kinds of judgments about stimuli that have been presented.

  If only one stimulus is presented, an absolute judgment is required. Absolute judgments can be simple statement about the presence of absence of a signal (“Yes, I saw it”, “No, I did not see it”) or a direct estimate (“how width was the line?”) or a relative judgment (“ A is larger than B”).

- Independent variables: Often magnitude (e.g. changing the intensity of a tone) and quality (e.g. the frequency of pitch).

- Control variable: The observer’s willingness to make a particular response. This attitude must remain constant from trial to trial (the criterion).

Threshold Measurements

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- The absolute threshold of stimulus detection -- point of intensity of stimulus at which it can be detected

- The difference threshold : DL is the smallest difference between two stimuli that a person can detect ("how different must two stimuli be before they can reliably be distinguished")

Threshold Methods

- How strong a signal must be to cross the threshold of perception?

- At first the answer may be obvious: all we have to do is slowly increase the intensity of a stimulus, such as tone or dim light until the observer responds “yes, there it is”.

- But when we try to repeat this process, the point at which an observer detects the stimulus changes from trial to trial. To deal with this variability, one method developed is known as the method of limits

Method of Limits

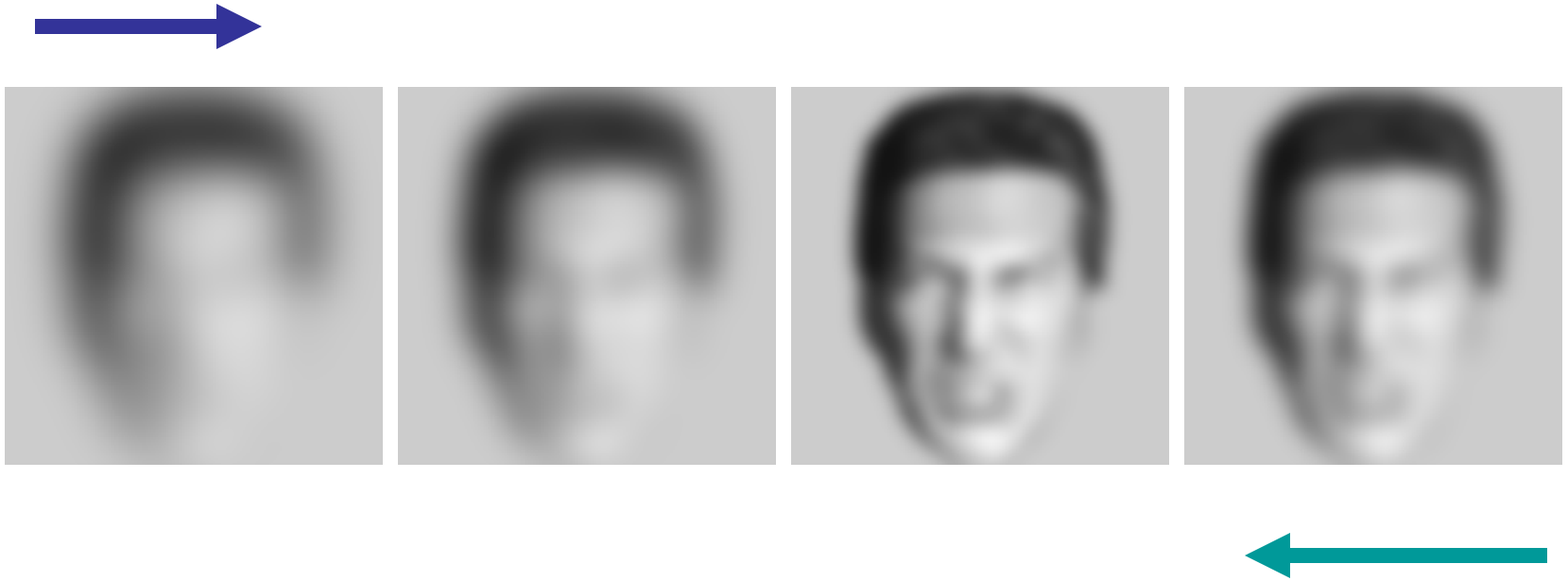
Using the method of limits to determine an absolute threshold.

Stimulus intensity	Response				
	↓		↓		
200			Yes		
180	Yes		Yes		
160	Yes		Yes		
140	Yes	Yes	Yes		
120	Yes	No	No	Yes	
100	Yes	No		No	
80	No	No		No	
60		No		No	
40		No		↑	
20		No			
		↑			
					Mean
Threshold	90	130	130	110	115

Note: In the first series of trials, the experimenter starts with a strong stimulus and decreases its intensity until the observer can no longer detect it. The threshold is the mean of the stimulus intensities that yield the first "no" response and the last "yes" response. In the next series of trials, a weak stimulus is increased in intensity until it is detected. It is customary to start each series at a different stimulus intensity to make it less likely that the observer's responses will be influenced by the length of a series. Stimuli are in arbitrary units-that is, the intensities ranging from 20 to 200 could represent weight or anything else that might vary in intensity.

Figure by MIT OpenCourseWare.

Blur face and emotion



Staircase Method: A new version of the method of limits

Using the staircase method to determine an absolute threshold

Stimulus intensity		Response		
	↓			
180	Yes			
160	Yes			
140	Yes	Yes	↓	Yes
120	Yes	No	No	↑
100	Yes	No		
80	No	↑		
		Threshold = 124		

Figure by MIT OpenCourseWare.

The staircase method concentrates responses around the threshold.
For the first trial, it is similar to the method of limits. Once an estimate of the threshold is obtained, the staircase method does not present stimuli that are far from this estimate.

Contrast Sensitivity Function: Thresholds of visual perception

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The contrast sensitivity function: our window of visibility. Any object whose Spatial frequencies and contracts fall within the yellow region will be visible. Those outside the yellow region are outside the window of visibility.

Magnitude Estimation

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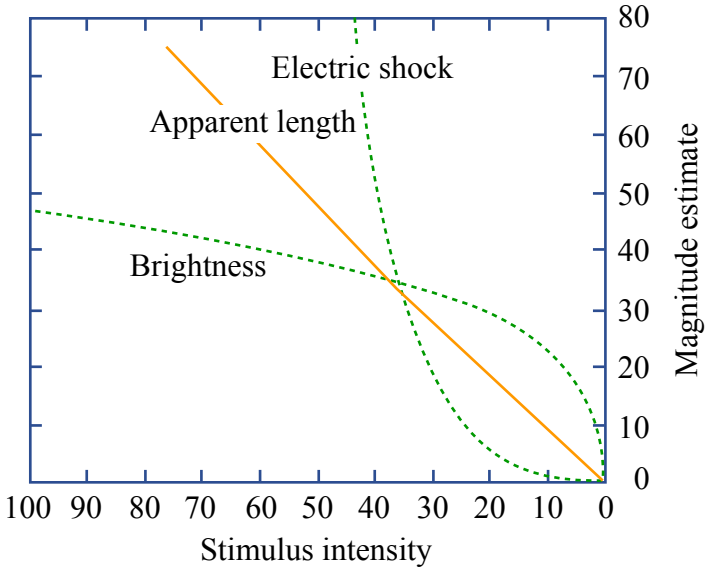
- Classical psychophysical methods were developed to measure absolute and difference thresholds
- What about perceptions that occur above threshold ?
- Perception in everyday experience are often above threshold: We can easily see and hear what is happening around us.
- To measure these above-threshold perceptions, we use a technique called magnitude estimation
- If we double the intensity of a tone, does it sound twice as loud?
- If we double the intensity of a light, does it look twice as bright?
- "magnitude estimation" (also called "scaling") is a technique that accurately measures this relationship

Magnitude Estimation: Brightness perception

- Its simple:
- Experimenter presents a "standard" stimulus to the observer
  e.g. a light of moderate intensity, and assigns it a value of, say, 10
- Then presents lights of different intensities
- Observer is asked to assign a number to each of these lights that is proportional to the brightness of the light
- If the light appears twice as bright as the standard, it gets a rating of 20, half as bright, a 5; and so on

Magnitude Estimation: Brightness perception



Curves showing the relationship between perceived magnitude and stimulus intensity for electric shock, line length, and brightness. (Adapted from Stevens, 1962.)

Figure by MIT OpenCourseWare.

Brightness of Light:

- Shows that doubling the intensity does not necessarily double the perceived brightness

- Doubling the intensity causes only a small change in perceived brightness, particularly at higher intensities

- This result is called response compression

- As intensity is increased, the responses increase, but not as rapidly as the intensity

- To double the brightness, it is necessary to multiply the intensity by about 9

Adaptation method: The psychologist's electrode

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Selective adaptation

Adaptation: a reduction in response caused by prior or continuing Stimulation. Adaptation provides inside about the properties of the neurons

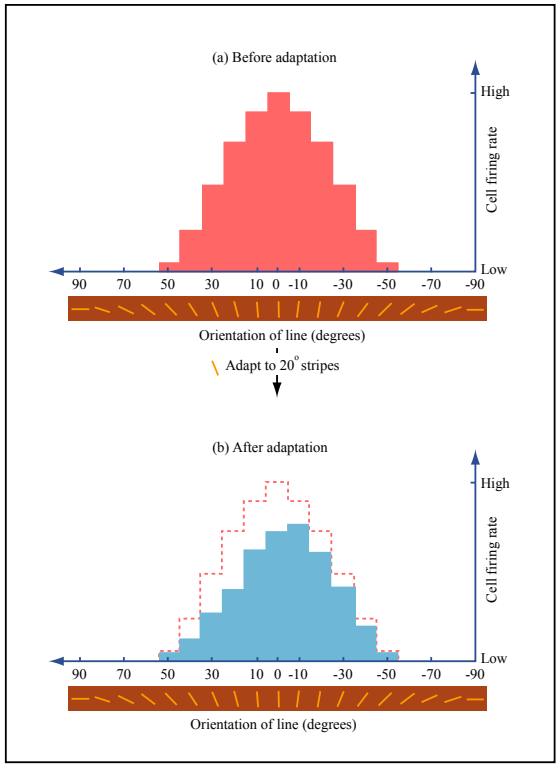

Figure by MIT OpenCourseWare.

In (a), before adaptation, illustration of the normal firing rate of cells tuned to orientations of 0 , 10, -10, 20, -20, etc. Then, suppose we expose the visual system to a 20 deg. grating for some time.

This adapting stimulus will cause the 20 deg. cells to be the most active and the extended activity will fatigue these cells. The adaptation procedure will also affect the other cells to some extent: the 10 and 30 deg. cells will be the next most fatigued, and so on.

In (b), it is shown what should happen if we present the Vertical grating again, after adaptation to the 20 deg. grating. Because the 0 deg. cells have been fatigued more than the - 10 deg. cells, the – 10deg. Cells are firing fastest.

As a result, we should perceive the vertical test stimulus Has being oriented 10 deg. to the left

Thorpe (1998): Detecting an animal among distractors

EEG response 150-160 msec after image presentation

Figure removed due to copyright restrictions.

http://suns.mit.edu/SUnS07Slides/FabreThorpe_SUnS07.pdf

Kirchner & Thorpe (2006)

Saccadic response 180 msec after image presentation

Figure removed due to copyright restrictions.

http://suns.mit.edu/SUnS07Slides/Thorpe_SUnS07.pdf

Evans & Treisman (2005): An RSVP task

Hypotheses: Performance should deteriorate when the distractors scenes share some of the *same features* with targets.

Is there an animal ? Is there a vehicle ?

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“People” were used as distractors for animal (target) and for vehicle (target)

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Figures removed due to copyright restrictions.

Features set like parts of head, body, hair are shared between animals and Human: this level of information may help recognition of animals in previous studies

Evans & Treisman: Results

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Features set like parts of head, body, hair are shared between animals and Human: this level of “part “information may help recognition of animals in previous studies

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