Psychophysics

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Outline

- How Do We Measure Perception?
  - Psychophysics
- Methods for Detection & Discrimination
  - Method of Constant Stimuli
  - Method of Limits
  - Staircase Method

Wednesday

Monday

- Signal Detection Theory
- Methods for Scaling
  - Indirect Scaling
  - Magnitude Estimation
  - Cross-Modality Matching
- What about Identification?

How Do We Measure Perception?

Fechner

- Psychophysics
  - The study of the relationship between physical stimuli in the world and the sensations about them that we experience
- What are we measuring?
  - Detection
  - Discrimination
  - Scaling
  - Identification

Real World Applications

- Although psychophysical procedures are used for the measurement of sensation, they can be applied to any situation in which an accurate assessment of subjective experience is required
  - Testing the senses
    - Is my hearing normal?
    - Do I need glasses?
  - Determining the skills needed for a job
    - Is visual acuity or fast reaction times more important in a pilot?
  - Designing better equipment
    - How loud should an ambulance siren be?

Measurement Issues

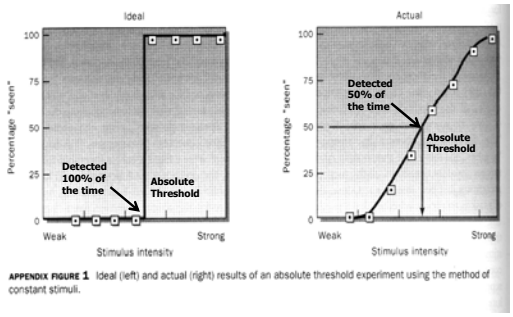
- Detection
  - How do we measure whether you've detected a stimulus or not?
    - Absolute Threshold
      - Boundary between detectable and undetectable stimuli

- Discrimination
  - How do we measure whether you can tell the difference between two stimuli?
    - Just Noticeable Difference (jnd)
      - Minimum amount a stimulus must be changed to produce a noticeable difference

Method of Constant Stimuli

- The experimenter selects a set of stimuli
  - Stimuli range from well above to well below the assumed threshold
- The stimuli are presented one at a time
  - Each stimulus is presented multiple times
  - The stimuli are presented in various orders
- The participant responds
  - "yes" when they detect the stimulus
  - "no" when they can't detect the stimulus

Results



APPENDIX FIGURE 1 Ideal (left) and actual (right) results of an absolute threshold experiment using the method of constant stimuli.

Method of Limits

- Present a stimulus that is clearly detectable or undetectable
  - If detectable
    - Present a series of stimuli that are less intense
      - Descending trial
  - If undetectable
    - Present a series of stimuli that are more intense
      - Ascending trail
- Run multiple ascending and descending trials
- Stop trial when the participant's response shifts
  - yes to no or no to yes

Results

Ascending Trials

	Trial Number							
Intensity	1 ↓	2 ↑	3 ↓	4 ↑	5 ↓	6 ↑	7 ↓	8 ↑
105	Y						Y	
104	Y		Y		Y		Y	
103	Y		Y		Y		Y	
102	Y		Y		Y		Y	
101	Y		Y		Y		Y	
100	Y	Y	Y	Y	Y		Y	
99	Y	N	Y	N	Y	Y	Y	
98	N	N	Y	N	N	N	N	Y
97		N	N	N		N		N
96		N		N		N		N
95		N		N				N
Crossover	98.5	99.5	97.5	99.5	98.5	98.5	98.5	97.5

Results

Descending Trials

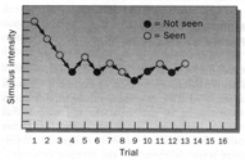
Trial Number

Intensity	1 ↓	2 ↑	3 ↓	4 ↑	5 ↓	6 ↑	7 ↓	8 ↑
105	Y						Y	
104	Y		Y		Y		Y	
103	Y		Y		Y		Y	
102	Y		Y		Y		Y	
101	Y		Y		Y		Y	
100	Y	Y	Y	Y	Y		Y	
99	Y	N	Y	N	Y	Y	Y	
98	N	N	Y	N	N	N	N	Y
97		N	N	N		N		N
96		N		N		N		N
95		N		N				N
Crossover	98.5	99.5	97.5	99.5	98.5	98.5	98.5	97.5

Staircase Method

- Present a stimulus that is clearly detectable or undetectable
  - If detectable
    - Present a series of stimuli that are less intense until no longer detectable
  - If undetectable
    - Present a series of stimuli that are more intense until detectable
- Switch direction whenever participant's response shifts
  - yes to no or no to yes

APPENDIX FIGURE 2 The results of a staircase experiment.

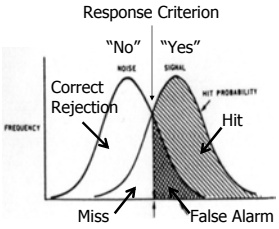


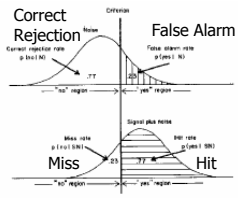
Signal Detection Theory

- These tasks are not done in a vacuum
  - Random internal & environmental noise
    - Is that just background noise or was that the stimulus I was supposed to perceive?
- Thus, thresholds for perception depend on
  - The observer's real threshold
  - The observer's response criterion
    - Strict / Conservative or few actual signals
      - Is that the man you saw rob the video store?
    - Lax / Liberal or many actual signals
      - Is that light speck on the x-ray abnormal growth?

Outcomes

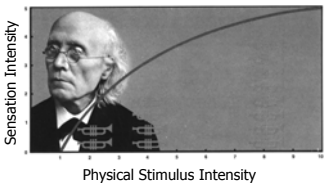
	Stimulus Present	Stimulus Absent
"Yes"	Hit	False Alarm
"No"	Miss	Correct Rejection





- Moving the response criterion will alter the outcomes
  - Strict / Conservative
    - Fewer false alarms
    - More misses
  - Lax / Liberal
    - Fewer misses
    - More false alarms

Scaling



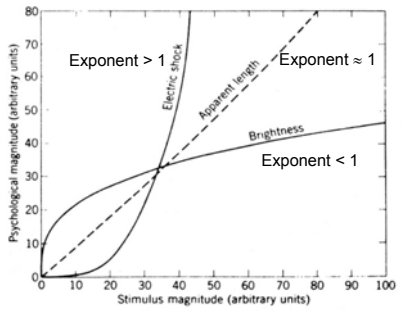
Fechner's law

- Indirect Scaling
  - Use discrimination ability as a basis of psychological scaling
    - Units are jnd (Just Noticeable Difference)

Magnitude Estimation

- Observers are asked to assign numbers to the magnitudes of sensations
  - How loud is this tone?
  - How black is this paint?
- Stimuli are judged in isolation
  - One at a time
  - Try not to pay attention to previous stimuli or previous responses
    - Just consider the current stimulus
- Restriction on responses
  - Must be a number larger than 0
  - Can use decimals or fractions

Results



Cross-Modality Matching

- Observers are asked to adjust the intensity of a stimulus on one sensory continuum until it matches the intensity of a stimulus on another sensory continuum
  - Make the tone as loud as the light is bright
  - Squeeze the grip as hard as the taste is salty
  - Make the weight as heavy as the shock is strong
- No numbers are involved
  - The data still conform to a power law

Identification

- Process of Identification
  - Which category or label in memory best fits the features of the present stimulus?
- To identify successfully
  - Information must be transmitted properly
    - But information is rarely transmitted perfectly
      - Remember the game "Telephone"?
    - Limited by our channel capacity
      - 7 +/- 2 bits of information
- Identification speed is affected by the number of alternatives
  - Hick's Law