

# Psychophysics and Psychometrics

Chung & Hyland (2012) *History and  
Philosophy of Psychology*. **Pages 37-40, 109-  
118**

# Psychophysics and Psychometrics

- In this lecture you will learn about
  - Psychophysics - measurement of physical sensation
  - Psychometrics - Questionnaire scale construction

# Psychophysics

- Originally known as sensorypsychophysiology
- The aim was to measure sensory experience
  - i.e., experience from sound, sight, touch, hearing, or temperature
  - What is the relationship between a sensation (e.g., weight and perception (e.g., heaviness)?

# Psychophysics - basic concepts

- Threshold (Latin word *limen*) of which there are two kinds
  - absolute threshold (also called stimulus threshold and often abbreviated to RL from the German *Reiz Limen*. This is the difference between something being there and not there.
  - Difference threshold (also called just noticeable different - JND - or DL from *Differenz Limen*. Example: Weber's (1934) 'compass test' of spatial discrimination. Mapping the sensitivity of skin in different parts of the body

# Psychophysics - basic concepts

- Point of subjective equality (PSE) when two stimuli are perceived as equal

# Psychophysical methods for determining thresholds

- 1. Method of limits
  - You adjust from below and above the threshold until the participant notices a change
- 2. Method of adjustment
  - The participant adjusts up and down until it is at the threshold
- 3. Method of constant stimuli
  - participant presented with a random array of stimuli - point at which 50% detected is threshold

# Example of method of limits

12	N		N		
13	N		N		N
14	N		N		N
15	Y	N	N	N	Y
16		Y		Y	
17		Y		Y	
18		Y			

# Weber's law

Weber noticed that the DL (difference threshold) increased with the stimulus intensity - and this happened for all sensory modalities

e.g., the JND of 20 Kilos is more than the JND for 1 Kilo

Weber found that the JND/stimulus size was constant - and Fechner called this *Weber's fraction*



# Fechner

Fechner gave Weber's fraction a mathematical form:

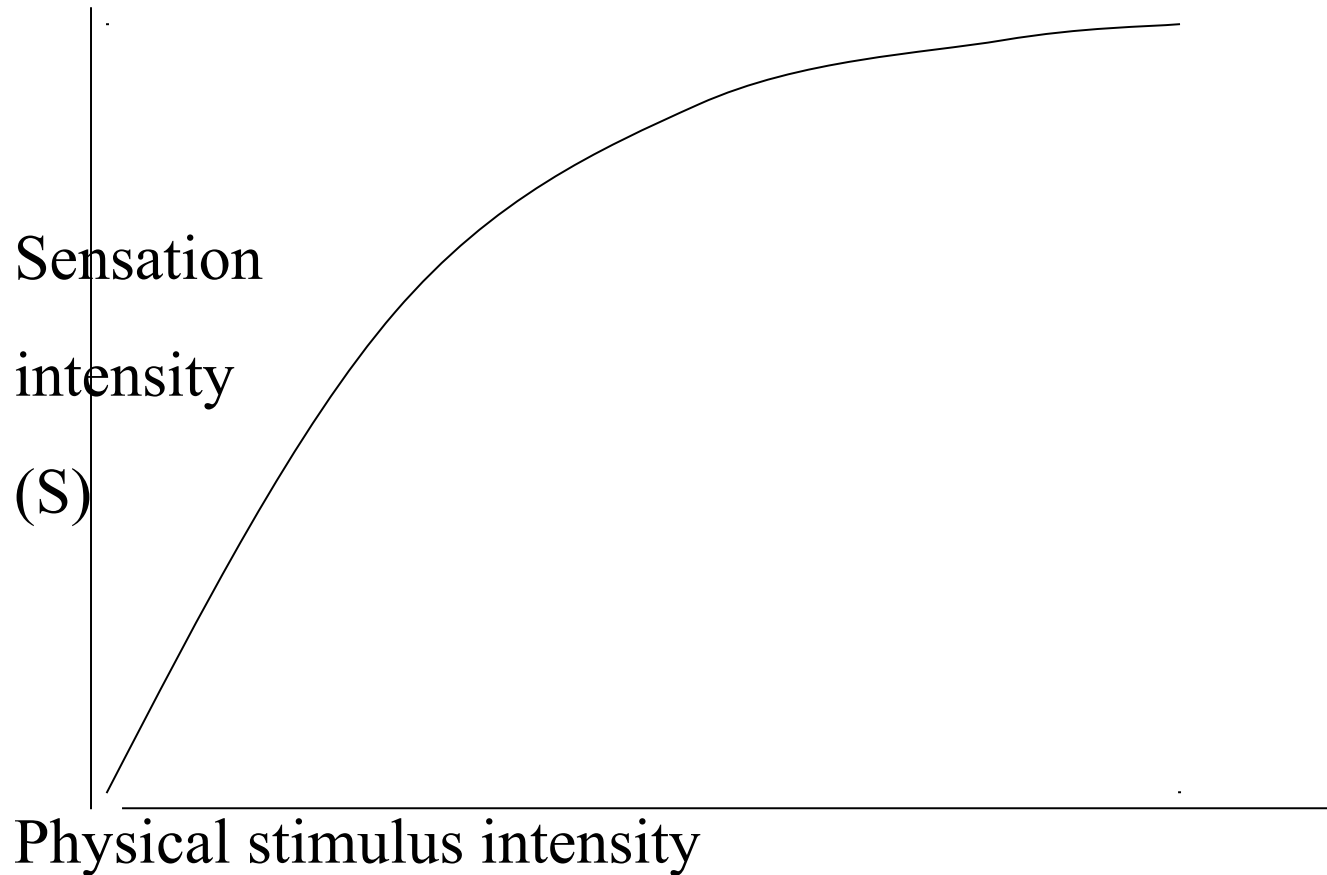
$$\frac{\delta R}{R} = \text{a constant}$$

Through a series of mathematical exercises he changed this to

$$S = k \log R$$

Where R is the stimulus magnitude (German word Reiz),  $\delta R$  is the amount of change needed to detect a difference (I.e. JND), and S is the psychological sensation

# Fechner's law can be expressed as a graph



# Psychophysics versus Psychometrics

- What happens if there is no physical stimulus?
- Psychophysics - if there is a physical stimulus
- Psychometrics if there isn't
  - but psychometrics can be related to psychophysical techniques

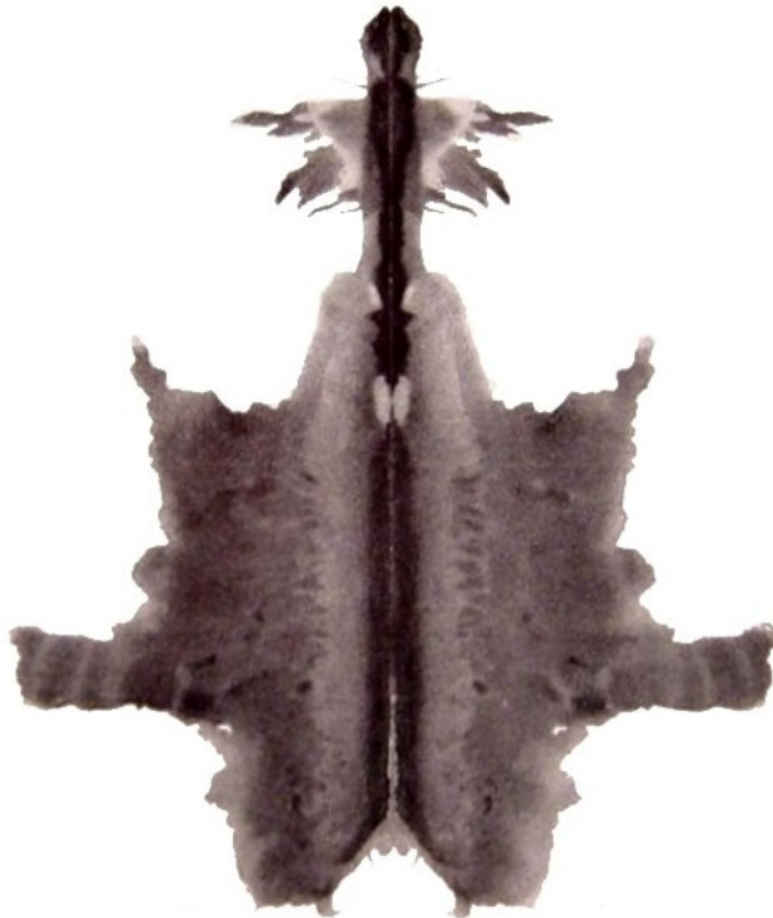
# From psychophysics to psychometrics

- Note: Fechner's first publication was on experimental aesthetics
- Example: A scale of beauty
- Imagine five paintings, and participants select the most beautiful painting
- Painting A      45% preference
- Painting B      25% preference
- Painting C      15% preference
- Painting D      10% preference
- Painting E      5% preference

# 3 Types of psychometric tests

- Individual tests (questionnaire)
  - people tested individually - used for intelligence tests, also tests of attitude and aptitude
- Group tests (questionnaire)
  - tested in groups - e.g., army batteries, group attitude testing etc
- Projective tests
  - people write stories and so reveal their motivations

# Rorschach test



# Thematic apperception test



# Measuring attitude

- Two methods of developing an attitude questionnaire
- Thurstone method
- Lickert method



# Thurstone method (1)

1. Choose a subject about which you want to measure attitude
2. Create a list of attitude statements
3. Ask judges to rate each statement on how positive or negative to the subject. E.g.

Smoking is an important pleasure in life

Smoking is harmful to smokers

Smoking is harmful to other people

Positive to  
smoking

Negative to  
smoking

1 2 3 4 5 6 7 8 9 10

# Thurstone method (2)

OK, you now have several statements about your attitude subject which have been rated by judges.

1. Take the mean position for the judges rating for each item - rejecting any items that have wide discrepancies (why?)

2. Now, and only now are you ready to give the scale to the participants whose attitude is to be measured. Ask participants whether they agree or disagree with each item. **Note: a binary choice.**

3. Attitude score is the point of change between agree and disagreed with items

# Lickert method for measuring attitude (1)

1. Choose a subject about which you want to measure attitude
2. Create a list of attitude statements. *So far the same as for the Thurstone method*
3. Now, you don't need to get judges to rate items. The reason is that you ask participants to judge items on a 7- point scale, not a binary scale

# Lickert method for measuring attitudes (2)

1. Smoking is an important pleasure in life

Disagree -3 -2 -1 0 1 2 3 Agree

2. Smoking is harmful to smokers

Disagree -3 -2 -1 0 1 2 3 Agree

3. Smoking is harmful to other people

Disagree -3 -2 -1 0 1 2 3 Agree

Add up total from scores (a lot easier, and so a commonly used method ...but

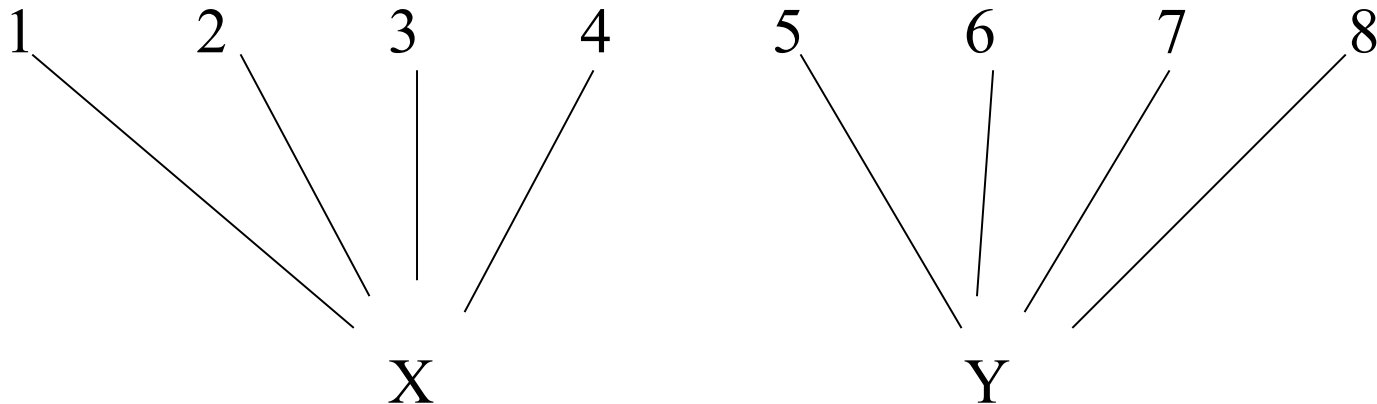
# Lickert method - points to watch

1. Make sure you have a range of items - it is less easy to be sure about this than the Thurstone method
2. You need a method for checking that an item is understood in a consistent way - otherwise it is an unreliable - this is something that Thurstone does anyway (This is usually done through item analysis, but see later)

# The concept of latent variables

Latent variables, are hypothetical constructs that determine response to items in a questionnaire.

Example of factor analysis to discover latent variables - examining inter-correlations



# Factor analysis

- Developed by Charles Spearman
- Book: The abilities of man 1927
- Follows earlier work by Binet and others who were trying to develop scales measuring ability.

# Questionnaires should be reliable and valid

- **Reliability** - do you get the same result if you test on a subsequent occasion?
- Test-retest reliability
- Spilt halves
- Internal consistency
- Practical consequence of poor reliability



# Validity: does the test measure what you say it is measuring? - 3 kinds

- Criterion validity
  - Does the scale measure the same thing as some other criterion or ‘gold standard’
- Content validity
  - Does the content of the scale reflect the subject to be assessed
- Construct validity
  - Does the scale measure some hypothetical construct?

# Examples of factor analysis in practice

- Intelligence testing - the concept of 'g'
  - Suggested by Spearman, and then a large influence in education
- Personality testing - the five factor theory
- Cattell's theory
- Big one and two factor theory