

## PSY 250

### Defining and Measuring Variables

## Two Types of Research

- Correlation
  - Examines possibility of relationship between 2 variables
  - **Can't** infer causation
- Experiment
  - Manipulate one (or more) variable(s) and measure effect on another variable(s)
  - **Can** infer causation

## What is a variable?

- Any characteristic of the organism, environment, or experimental situation that can vary
- an event or behavior that can assume at least two values.

## Types of Variables

- Independent (IV)
  - the characteristic that is manipulated
- Participant/Subject (type of IV)
  - not manipulated by the researcher
- Dependent (DV)
  - measure of behaviour
- Confound
  - effect cannot be separated from the IV

## Participant characteristics

- Aspects of the participant, such as age, sex or personality traits, that are treated as if they are IV's.
- ***They are not IV's because they cannot be manipulated by the experimenter.***

## Types of IV's

- Physiological IV
  - Participants subjected to conditions that alter their normal biological state.
- Experience IV
  - Manipulation of the amount or type of training or learning
- Stimulus or environmental IV
  - An aspect of the environment that the experimenter manipulates.

## Selecting the DV

- When the researcher administers the IV, it is likely that several responses will occur. Which one should the researcher select?
- Assuming you have stated your hypothesis in general implication form, the "then" portion of the hypothesis will give you an idea of the general nature of your DV.

## Recording or Measuring the DV

- Correctness
  - Only correct responses are counted.
- Rate or Frequency
  - Rate of responding determines how rapidly responses are made during a specified time period.
  - The number of responses or events that occur within a specified time period is the frequency.
- Degree or Amount
- Latency or Duration

## Should You Record More than One DV?

- If you have the measurement capabilities, there is nothing to prohibit the recording of more than one DV.
- If recording an additional DV makes a meaningful contribution to your understanding of the phenomenon under study, then you should give it serious consideration.
- If recording another DV does not make a substantive contribution, then it is probably not worth the added time and trouble.
- Previous research can be used as a guide concerning whether you should consider recording more than one DV.

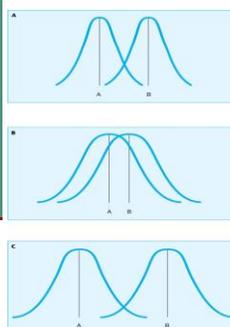
## Characteristics of a Good DV

- A DV is valid when it measures what the experimental hypothesis says it should measure.
- A good DV must be directly related to the IV and must measure the effects of the IV manipulation as the experimental hypothesis predicts it will.
- A good DV is also reliable.

## Extraneous and Confounding Variables

- Extraneous variables
  - Uncontrolled variables that can cause unintended changes between groups.
- Confounding
  - A situation in which the results of an experiment can be attributed to either the operation of an IV or an extraneous variable.

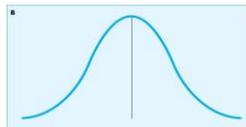
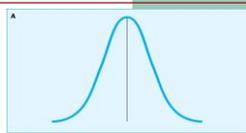
## Confounder Influences



- Figure A
  - no confounder present
- Figure B
  - the difference between two groups when a confounder is present and has moved the groups closer together
- Figure C
  - the difference between two groups when a confounder is present and has moved the groups farther apart.

## Nuisance Variables

- Either characteristics of the participants or unintended influences of the experimental situation that make the effects of the IV more difficult to see or determine.
  - Nuisance variables increase the spread of scores within a distribution; they do not cause a distribution to change its location.



## Controlling Extraneous Variables

- The experimenter must exercise control over both extraneous variables and nuisance variables so the results of the experiment are as meaningful (no extraneous variables present) and clear (minimal influence of nuisance variables) as possible.

- Joan wants to know whether the presence of other people influences altruistic behavior. In one situation she has a confederate posing as homeless and asking people for money when no one else is around. In another situation, people are asked for money on the crowded campus quad. The amount of money donated is recorded in each case.

- Karen is interested in peoples' comfort levels on elevators as the number of people in the elevator increases. She has her participants ride in an elevator, and then immediately rate their anxiety levels. Some people ride in an elevator with only one person, some with four other people, and some with seven other people. She finds that anxiety rises as the number of other people in the elevator increases

- Andy surveys classmates to get their grade point averages and their SAT scores, then determines that the two measures are correlated

## Theories

- Statements about the mechanisms underlying a particular behavior.
- Help organize and unify different observations related to the behavior
- Generate predictions about behavior

## Hypothetical constructs/concepts

- Hypothetical attributes or mechanisms that help explain and predict behavior in a theory
- E.g. motivation, self-esteem
- Can influence and be influenced by external behaviors

## Operationally Defining Variables

- Can measure behaviors associated with constructs
  - E.g. performance on IQ test to measure intelligence
  - Use conventional measures
  - Carefully weigh options
- Experimental operational definition
  - independent variable
- Measured operational definition
  - dependent variable

## Operationally Defining Variables

- Bridgman (1927) suggested that researchers should define their variables in terms of the operations needed to produce them.
- E.g. aggression = hitting, insulting
  - Frequency of above behaviors
- Such definitions allow others to replicate your research and are called **operational definitions**.

## Evaluating Operational Definitions

- Reliability
  - consistency, stability, "repeatability"
- Validity
  - Does procedure measure variable it is supposed to measure?
  - accuracy/truth, how "valid" is the measure
  - Often not one-to-one relationship between variable measured and measurements obtained
    - E.g. illness affects test performance

## Reliability

- Consistency and dependability
- Ranges from 0 to 1.0
- Want to have reliability between .80 and .90
- Assume each measurement includes error
  - Elements not due to variable of interest
  - E.g. mood, health affects IQ scores
  - Can calculate averages over large # of trials as with RTs

## Sources of Error

- Observer Error
- Environmental Changes
- Participant Changes

## Types of Reliability

- Test-retest Reliability
  - repeat the test/measure on two different occasions
  - good reliability indicates score is not susceptible to random daily changes
  - measure of temporal stability
  - Compute correlation between two sets of scores

## Types of Reliability cont.

- Alternate Form Reliability
  - performance on 2 versions of a test are correlated
  - measure of temporal stability

## Types of Reliability cont.

- Inter-item Reliability
  - measure of internal consistency
  - Test or questionnaire consisting of multiple items
  - Each item (or group of items) measures a part of the total construct
  - Split-Half Reliability
    - Split set of items in half, compute separate score for each half, evaluate degree of agreement between two halves

## Types of Reliability cont.

- Inter-rater Reliability
  - Simultaneous judgments
  - when scoring measure requires judgements
  - Consistency or degree of agreement between two judges

## Types of Validity

- Face Validity
  - Simplest, least stringent
  - Superficial, "face" value
  - Based on subjective judgment
  - Sometimes detrimental
- Content Validity
  - represents domain of concept or construct being measured

## Types of Validity cont.

- Criterion Validity
  - performance checked against some outside criterion
  - two types :
    - 1) Concurrent Validity
      - consistent with other, established measures of same variable
    - 2) Predictive Validity
      - accurately predict behaviour according to theory

## Types of Validity cont.

- Construct Validity
  - Most important aspect of validity
  - Define the construct
  - Measurements of variable behave same way as variable itself
  - Difficult and time-consuming to establish

## Types of Validity cont.

- Convergent and Divergent Validity
  - Form of construct validity taken together
  - Convergent
    - Show strong relationship between measures obtained by two different methods
  - Divergent
    - Demonstrating measurement of one specific construct, not combining two different constructs in same measurement process
    - Two distinct constructs produce unrelated scores

## Internal Validity

- IV producing the desired effect?
  - Could observed effect be due to some other factor?
- Need to control for confounds in order to achieve a high level of internal validity

## Relationship Between Reliability and Validity

- Reliability is a prerequisite for Validity
- But not necessary for measure to be valid in order to be reliable
- Readings can be reliable but not accurate
  - – watch that always keeps time 10 minutes fast

## Measurement

- Defined as the assignment of symbols to events according to a set of rules.

### Scales of Measurement

- the particular set of rules in assigning a symbol to the event in question.

## Scales of Measurement

- Nominal Scale
  - simple qualitative classification system
  - e.g., categorizing types of ice-cream
- Ordinal Scale
  - used when events can be rank ordered.
  - intervals separating the ranks do not have to be comparable
- Interval Scale
  - used when the events in question can be rank ordered and equal intervals separate adjacent events.
- Ratio Scale
  - takes the interval scale one step further by permitting the rank order of scores with the assumption of equal intervals between the ranks, but also assumes the presence of a true zero point.



## Qualitative Variables

- Separated into descriptive categories
- No mathematical properties
- Nominal
  - E.g. ethnicity
- Can have numerical value –Ordinal
  - E.g. Size, placement in competition, age groups in developmental study

## Quantitative Variables

- Meaningful numerical values
- Interval
  - E.g. Temperature
- Ratio
  - E.g. Blood alcohol level

## Discrete Variables

- Do not allow fractions
- Qualitative
- Nominal
- Ordinal
- Interval or Ratio if whole numbers
- Dichotomous
  - Two levels
  - E.g. yes and no, gender

## Continuous Variables

- Not restricted to whole numbers
  - Can include fractions
- E.g. Dollar Value, Weight
- Can vary anywhere within a range
- Only interval and ratio scales

## Modalities of Measurement

- Self-Report Measures
- Physiological Measures
- Behavioral Measures

## Other Aspects of Measurement

- Multiple Measures
- Sensitivity
  - Small effects – variable must be measured in units small enough to detect effect
  - Scale of measurement must have enough categories to allow discrimination among individuals
- Range
  - Ceiling and floor effects