

9.63 Laboratory in Cognitive Science

Fall 2005

Course 2b-

Variables, Controls

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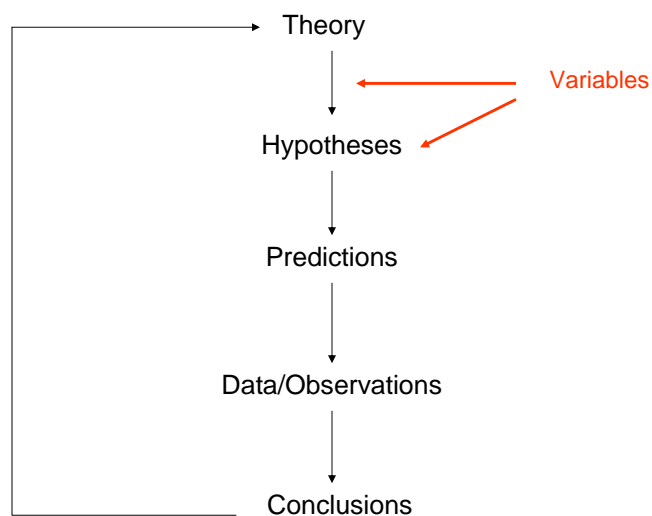
Scientific Thinking

- Science is:
 1. Empirical – Based on observations
 2. Objective – Observations and conclusions are clearly defined in ways that allow others to get the same results
 3. Systematic – Observations are organized in such a way that allows causal inferences
 4. Often based on theory
- The experimental method is an analytic process: a decomposition of a phenomenon.
- The choice of research question – and the theory it is testing – is the first and most fundamental step in cognitive science research
- Intuition can be wrong: Our perceptual and reasoning mechanisms may not always be accurate

Doing a research in science

- Goals of Cognitive Science Research
 - conducting sound research
 - critically evaluating research
- Sources of CogSci research
 - Theories
 - Practical problem
- Sources of research ideas
 - Observation
 - Experts
 - Literature search
- Steps in the Research Process
 - Get an idea
 - Formulate a testable hypothesis
 - Review the literature
 - Conduct pilot research
 - Complete the research
 - Conduct statistical tests
 - Interpret de results
 - Prepare an article

Research Path



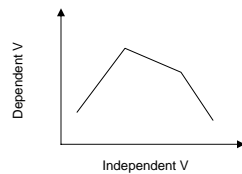
Experimental Research

- In experimental research, the researcher manipulates at least one **variable** and then measures at least one outcome.
- Manipulated variables are called independent variables
- Outcome variables are called dependent variables
- Independent Variable: the condition manipulated or selected by the experimenter to determine its effects on behavior (its effect on the response)
- Independent variable have at least two **levels**
- Dependant Variable: a measure of the subject behavior (basically the response). The response depends on the value of the independent variable.
- Variables that vary along with the independent variable are known as confounding variables

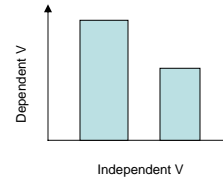
- In a perfectly run experiment, any difference between experimental groups on the dependent variable must be caused by the manipulated variable
 - Since only the manipulated variable differs between groups
- Experiments can, in principle, show causation
- However, still need theory to interpret the effects of a manipulation

Quantitative and Categorical Variables

- Quantitative variable varies in amount
- Qualitative variables varies in kind
- The distinction is very important for theories: why?
- The distinction is very important for making graphs



When do we use line graph?



When do we use bar graph?

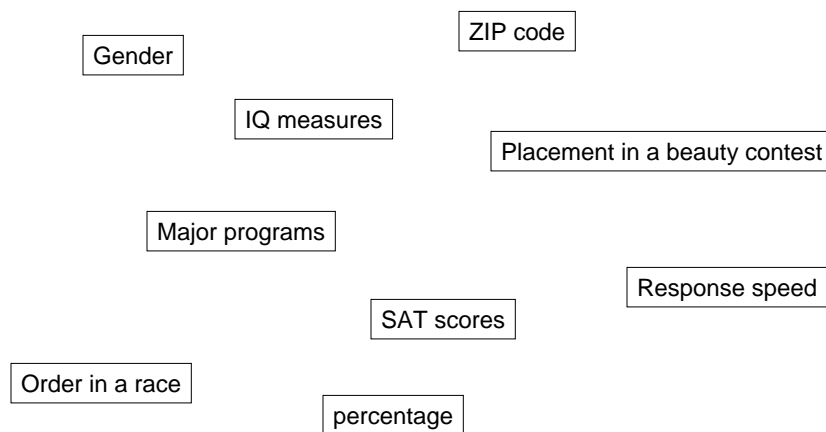
Measurements Scales

- Measurements scales can have 4 properties and the combination of these properties determine what is measured
- The properties are
- (1) differences (e.g. cold-warm, male-female)
- (2) magnitude (e.g. one attribute is greater than, less than or equal to another instance)
- (3) equal intervals between magnitude
- (4) a true zero on the scale

Measurements Scales and Properties

- Nominal scale: differences
- Ordinal scale: difference, magnitude
- Interval scale: difference, magnitude, interval
- Ratio scale: difference, magnitude, interval, meaningful zero

Variables and Scales



Nominal Ordinal Interval Ratio

Which measurements scales?

- Emotion (happy, angry, etc) ?
- Categories of famous people (singer, actor, politician) ?
- Caricatures of a face?
- Level of masculinity?
- Something is colder than something else?
- The degree of temperature of the object?
- Degree of clutter (more to low complex)?
- Distance of viewing a scene?
- Levels of depression?
- List of your 10 preferred CDs from most to the less?
- Length of a line?
- Your weight?

Nominal

Ordinal

Interval

Ratio

Why is that so important?

- Nominal and ordinal scale have specific statistics: non parametric statistics, based on the rank order of the data or on the sign of the differences between subjects.
- Interval and ratio scales allow you to perform most mathematical operations on them and inferential statistics (parametric statistics, like pearson correlation, t-test, ANOVA).
- Textbook: chapter 5: Table 5.1 page 126

Measurement Scales: Nominal Scale

- One that classifies objects or events into categories (according to their similarity or differences)
- No numerical or quantitative property
- A nominal scale is a classification system
- E.g. Type of fruits, names, being male or female
- Independent variables are often measured on nominal scales.

Measurement Scales: Ordinal Scale

- A measure that both assigns objects or events a name and arranges them in order of their magnitude
- A list of objects/stimuli arranged in order of preference ?
- Rule to assign numbers on an ordinal scale: the rank order of numbers on the scale must represent the rank order of the psychological attributes of the objects or events.
- On ordinal scale give the order of preference not the difference in preference among items

- E.g., list your 10 favorite CDs – 1-10.
- It may be that you like #1 and #2 about the same but like these much more than #3 – if so, the distance between 1 and 2 is not the same as the distance between 2 and 3

Measurement Scales: Interval Scale

- A measure in which the differences between numbers are meaningful; include both nominal and ordinal information.
- The rule for assigning numbers to events or objects on an interval scale is that equal differences between the numbers on the scale must represent equal psychological differences between the events or objects.
- IQ scores are measured on an interval scale since the interval between, say, 85 and 100 is the same magnitude as the interval between 100 and 115 (i.e., 1 standard deviation).
- However, a score of 0 on an IQ test does not indicate the complete absence of intelligence – there is no absolute zero point

Measurement Scales: Ratio Scale

- A ratio scale is one that has a meaningful zero point as well as meaningful differences between the numbers on the scale. As well as all of the nominal, ordinal and interval properties.
- It is meaningful to consider multiplicative differences among attributes.
- Measures such as responses speed and percentage correct are ratio measures because you can exhibit zero speed or no correct response.

Experimental controls: The most important aspect of the validation of an hypothesis

- Control: any means used to rule out threats to the validity of a research.
- Research often involves the use of a group of subjects who do not experience the manipulation (of your hypothesis)
- Controls as two meanings:
 - (1) a standard against which to compare the effects of a particular independent variables
 - (2) One or more additional conditions allowing to rule out the effect of variables others than the independent variable.

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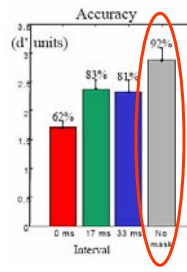


Experimental vocabulary

- An experiment can have a control group or a control condition
- A within-subject experiment: each subject experiences every condition
- A between-subject experiment: different groups of subjects experience different conditions.
- A mixed design: some independent variables are between, others are within.

Experimental vocabulary

- Control: the technique of producing comparisons and holding other variables constant
- Control condition: the comparison condition in a within-subjects design; compare to control group.
- Control group: the group in a between subjects experiment that receives a comparison level of the independent variable
- Control variable: a potential independent variable that is held constant in an experiment.



Control group

We will speak again about controls in the single design (one independent variable) and factorial design lectures