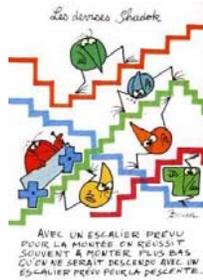


## 9.63 Laboratory in Visual Cognition

Fall 2009

Variables & Controls

(Chapters 5 & 8)



Why do you need to know about methods if you work in an advertising firm ?

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## Confounded Experiment in Advertising

In the ad., people were asked to choose between two cola drinks. In one series Pepsi was in a cup labeled **S** and Coke in a cup labeled **L**.

Most people choose the drinks in the **S** cup (Pepsi)  
Conclusion was Cola drinkers prefer Pepsi.

Is this a legitimate conclusion?

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## Confounded Factor

- **The labels on the cup may have had influence on the choices made by the people.**
- This supposition is based on the knowledge that labeling of various kind can have a strong effect on consumer behavior.
- In another experiment, Woolfolk et al. thought that college students like the letter **S** better than the letter **L** (the type of cola in the cups were held constant)
- For half of the subjects, both cups contained coke.
- Regardless of the type of cola, in the cups, the students preferred **cola S** to cola **L** in 85 % of the cases.

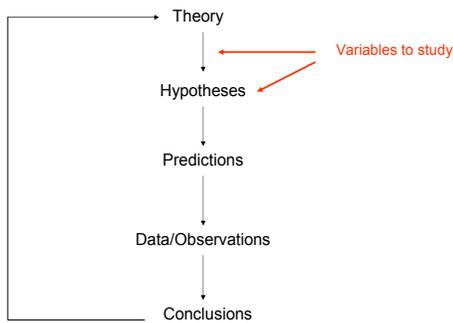
## Scientific Thinking

- 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 the results
  - Prepare an article
  - Go the conferences

## Research Path

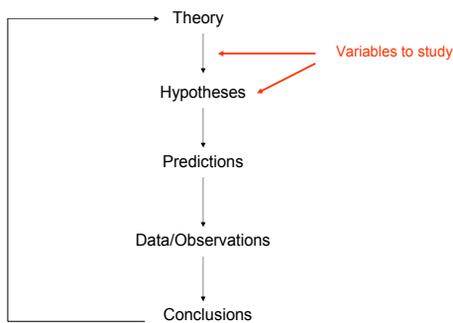


## (The other) Research Path

Playing ...

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## 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 variables 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

## An experiment on change blindness

- Independent variable: A change in the image
- Level 1: object change
- Level 2: color change
- Dependent variable: the reaction time to detect the change

Figures removed due to copyright restrictions.

## Detecting change

Figure removed due to copyright restrictions.

Here is an image

## Detecting change

Figure removed due to copyright restrictions.

What has changed?

## Detecting change Side by side

Figure removed due to copyright restrictions.

What has changed?

## Detecting change This is much easier

Figure removed due to copyright restrictions.

What has changed?

## Detecting change This is easier

Figure removed due to copyright restrictions.

What has changed?

## Independent / Dependant Variable ?

Duration of an image?	skin conductance ?
Number of errors?	anxiety level ?
Reaction time?	attractiveness?
Number of images recognized?	brightness/contrast?
Number of items in an image? (set size)	object domain
Orientation of a face? (e.g. 0, 45, 90, 135)	(animal/artifact)?
D-prime?	distance to an image?
Types of movies?	field of study?
Age?	income level?
	political party?

- 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

## Continuous and Discrete Variables

- Some Quantitative variables can take any value on a continuum: continuous variables (e.g. latency, duration)
- Discrete variable falls into bins, with no intermediate values possible (e.g. number of books written)
- A variable may be continuous, but its measurement is often discontinuous.
- Examples ?

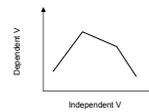
## Emotion: Continuous or Discrete factor?



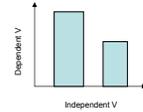
Figure by MIT OpenCourseWare.

## Quantitative and Categorical Variables

- Quantitative variable varies in amount
- Qualitative variable varies in kind



When do we use line graph?

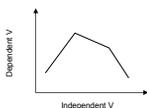


When do we use bar graph?

## Quantitative and Categorical Variables

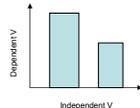
- Quantitative variable varies in amount
- Qualitative variable varies in kind

To show relationships between Quantitative variables



When do we use line graph?

To show relationships between Categorical (qualitative) variables



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 (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

## 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 (factors) are often measured on nominal 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

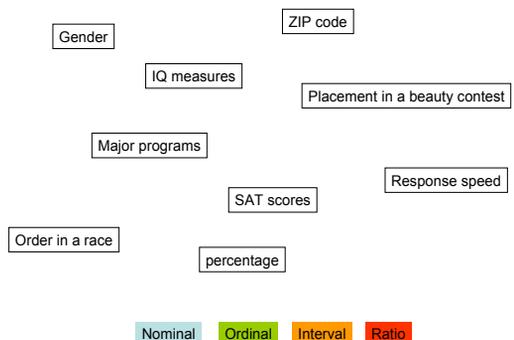
## Interval Scale

- A measure in which the differences between numbers are meaningful; include both nominal and ordinal information: the distance between adjacent points on the scale are equal.
- 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.
- For instance, the Fahrenheit scale is an interval scale, since each degree is equal but there is no absolute zero point. This means that although we can add and subtract degrees (100° is 10° warmer than 90°), we cannot multiply values or create ratios (100° is not twice as warm as 50°).
- When you are asked to rate your satisfaction with a piece of software on a 7 point scale, from Dissatisfied to Satisfied, you are using an interval scale.

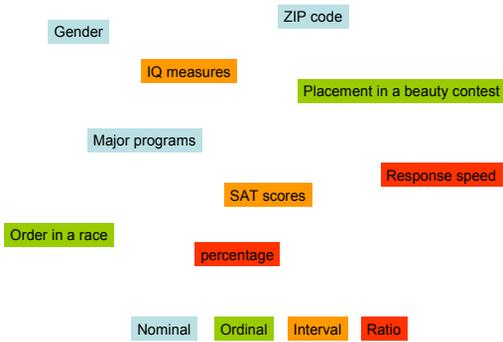
## Ratio Scale

- 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.

## Variables and Scales



## Variables and Scales



## IQ as an interval factor

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

- The IQs tests are designed so that the amount of the difference between people can be meaningfully represented by the IQ score.

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- IQ is *not* a ratio scale: it would be meaningless to say that a person with an IQ of 120 is twice as smart as someone with an IQ of 60

## Which 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 (high to low complexity)?
- Distance of viewing a scene?
- Levels of depression?
- List of your 10 preferred CDs from most to the less?
- Length of a line?
- weight?

Nominal   Ordinal   Interval   Ratio

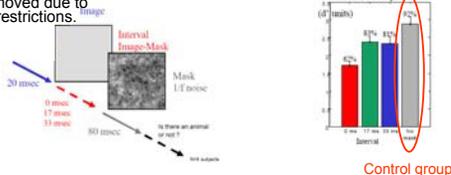
## Why is that so important?

- 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). Parametric statistics make assumptions about the population from which the data are drawn – namely that the data are normally distributed and each group has the same (similar) variance

## 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 has 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.

## Between-subject design

- When different groups of subjects are used (within-design are not possible because of the possibility of carry-over effects: practice, expertise, learning, memory).

Leading question:  
"About how fast were the cars going  
When they *smashed* into each other?"

Figures removed due to copyright restrictions.

## What is a leading Question?

- A "leading question" is a question intended to guide the person answering it toward a particular response. Example: "Would you vote for John Smith, a man who has been known to break campaign promises?"
- The way a hypothetical question was worded could influence a person's answer to it.
- A classic experiment (Loftus & Palmer, 1974) showed that leading questions could affect subjects' estimates of car speed after they viewed simulated car accidents.
- This experiment suggested that the leading questions had planted lasting 'misinformation' that affected the subjects' later memory of the event.

## The experiment

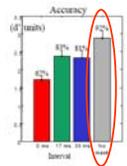
- Participants shown video (slides) of an accident between two cars
- Two groups will be asked different questions
- Group 1 : How fast were the cars going when they *smashed* into each other?
- Group 2 : How fast were the cars going when they *hit* each other?

Leading question:  
"About how fast were the cars going  
When they *smashed* into each other?"

Figures removed due to copyright restrictions.

## 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

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