EXPERIMENTAL DESIGN
Experimental Design and the struggle to control threats to validity

Researchers at MIT prove that rolling shopping carts will almost invariably hit the most expensive car in their vicinity.
INCORPORATING INCREASINGLY CONstrained

LOW

NATURALISTIC

CASE-STUDY

CORRELATIONAL

DIFFERENTIAL

EXPERIMENTAL

HIGH
Experimental design is a planned interference in the natural order of events by the researcher.
What is Experimental Design?

Experimental research allows us to test hypotheses and infer causality under controlled conditions designed to maximize internal validity.

The high control and internal validity often mean a reduction of external validity.

That is, the more precise, constrained, and artificial we become in the experiment, the less natural are the procedures and findings.

The result is that we sometimes have difficulty generalizing experimentation to the natural environment, or a larger population.
Experimental Design

- Comparisons are made under different and **controlled** conditions.
- Subjects are **assigned** to each type of condition in an unbiased manner, usually matched or random.
- Although **causality** can often be inferred, results may not be applicable outside of the experimental setting.
- Causality: If $X$, then $Y$
  
  AND
  
  If not $X$, then not $Y$
TIME 0: PRE-TEST. Collect baseline data.
TIME 1: TREATMENT GIVEN

CONTROL

COKE

JOLT

COFFEE

Experimental
TIME 3: POST-TEST. Collect data on the effects of the treatment and compare to pretest, and to each treatment.

**Experimental**
Hypotheses

- **NULL (Statistical)**
  \[ \text{mean JOLT} = \text{mean COKE} = \text{mean COFFEE} = \text{mean CONTROL} \]

- **RESEARCH (Causal)**
  Caffeine causes people to grow tall and nervous.

- **CONFOUNDING (Rival)**
  The differences are due to the amount of citric acid in the drinks.
A simple 2-group, posttest-only design

- Outfitters given low-impact training
- Outfitters given **NO** low-impact training

- Measure impacts caused by their clients

Compare Scores

- Measure impacts caused by their clients
Hypotheses

- **NULL (Statistical)**
  \[ \text{mean Trained} = \text{mean Un-trained} \]

- **RESEARCH (Causal)**
  The clients of outfitters trained in low impact methods will cause fewer impacts than clients of outfitters who did not receive such training.

- **CONFOUNDING (Rival)**
  Prior knowledge may have caused the observed differences in response.
Road map for experimental success

- Anticipate all threats to validity.
- Take plans to eliminate them.

1. Maturation
2. History
3. Testing
4. Instrumentation
5. Regression to the mean
6. Selection
7. Attrition
8. Diffusion
9. Sequencing effects
Maturation

- If the time between pre- and posttest is great enough to allow the subjects to mature, they will!

- Subjects may change over the course of the study or between repeated measures of the dependent variable due to the passage of time per se.

- Some of these changes are permanent (e.g., biological growth), while others are temporary (e.g., fatigue).
Outside events may influence subjects in the course of the experiment or between repeated measures of the dependent variable. Eg., a dependent variable is measured twice for a group of subjects, once at Time A and again at Time B, and that the independent variable (treatment) is introduced between the two measurements. Suppose also that Event X occurs between Time A and Time B. If scores on the dependent measure differ at these two times, the discrepancy may be due to the independent variable or to Event X.
Subjects gain proficiency through repeated exposure to one kind of testing. Scores will naturally increase with repeated testing.

If you take the same test (identical or not) 2 times in a row, over a short period of time, you increase your chances of improving your score.

http://www.addictinggames.com/th eidiottest.html
Instrumentation

- Changes in the dependent variable are not due to changes in the independent variable, but to changes in the instrument (human or otherwise).
- Measurement instruments and protocols must remain constant and be calibrated.
- Human observers become better, mechanical instruments become worse!
If you select people based on extreme scores (High or low), in subsequent testing they will have scores closer to the mean (they would have regressed to the center).
When random assignment or selection is not possible the two groups are not equivalent in terms of the independent variable/s.

For example, males=treatment; females=control.

Highest threats in naturalistic, case study and differential approaches.
Attrition

- When subjects are lost from the study.
- If random it may be OK.
- Confounding attrition is when the loss is in one group or because of the effects of the independent variable. (Jolt killed off 2 people!)
Diffusion of treatment

- When subjects communicate with each other (within and between groups) about the treatment they diffuse the effects of the independent variable.
Sequencing effects

- The effects caused by the order in which you apply the treatment.
  - A B C
  - A C B
  - B A C, etc.
Subject effects

- Subjects “know” what is expected of them, and behave accordingly (second guessing).
- Social desirability effect.
- Placebo effect. A placebo is a dummy independent effect. Some people react to it.
Experimenter effects

- Forcing the study to produce the desired outcome.
- Expectations of an outcome by persons running an experiment may significantly influence that outcome.
Single- and double-blind procedures

- Single blind — subjects don’t know which is treatment, which is not.
- Double blind — experimenter is also blind.

“Do a double-blind test. Give the new drug to rich patients and a placebo to the poor. No sense getting their hopes up. They couldn’t afford it even if it works.”
Designs

- **One shot:**
  - \( G1 \) \( T \rightarrow O2 \)

- **One Group Pre-Post:**
  - \( G1 \) \( O1 \rightarrow T \rightarrow O2 \)

- **Static Group:**
  - \( G1 \) \( T \rightarrow O2 \)
  - \( G2 \) (C) \( \rightarrow O2 \)

\( T = \text{Treatment} \)
\( O = \text{Observation} \)
\( (\text{measurement}) \)
\( C = \text{Control} \)
More designs

- **Random Group:**
  - RG1
  - RG2 (C)

- **Pretest-Posttest, Randomized Group:**
  - RG1
  - RG2 (C)

R = Random
Yet another design:

- **Solomon four-group:**
  - RG1  O1------T------O2
  - RG2  O1----------O2
  - RG3  T------O2
  - RG4  O2
One last one!

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