

Types of Studies

- Experiment: researcher manipulates 1 or more independent variables (treatments)
Experimental Unit (EU) – One replication of the experiment
- Quasi-Experiment: treatments not randomly assigned to EUs
- Observational: no variables manipulated by researcher
experiment may not be ethical or feasible
- Survey: voluntary response

Causal inference can be made from an experiment

Association relationships can be inferred from an observational study

Experimental Error - Variation among identically treated EUs

- Natural variation among EUs
- Measurement variability
- Variation in treatment conditions
- Extraneous factors (nuisance/lurking variables)
- Interaction of treatments and EUs

Control Treatments – A benchmark for comparing experimental treatments

- No treatment
- Placebo
- Standard practice

3 Principles of Experimental Design

- 1) Blocking (local control) to reduce experimental error
- 2) Randomization to reduce hidden bias
- 3) Replication on a large number of subjects

Key Ingredients to identify:

A hypothesis
Dependent variables
Experimental conditions
Nuisance variables
of EUs
Assignment mechanism

Blocking - Grouping of EUs into similar classes

- Common Criteria for blocking
 - Location
 - Characteristics (age, weight, sex, ...)
 - Time

Randomization - Random assignment of treatments to EUs

- Independent observations needed for valid estimates of experimental error (and thus tests of hypotheses)
- Randomization simulates the effect of independence
 - Allows the assumption of independence & normal distribution

Replication

- Demonstrates reproducibility
- Allows estimation of experimental error variance
- Allows for increased precision of treatment effects

Effect of watching Children's Television Workshop programs on test scores.

Ho: Watching has no effect on post-program test scores

H1: Watching increases post-program test scores

With three individuals assigned to each of two treatments, there are 20 possible treatment assignments.

Below is data for the **observed** treatment assignment vector: (0, 0, 0, 1, 1, 1)

Unit	Treatment	Response	Trt Mean
1	0	55.0	
2	0	72.0	66.6
3	0	72.7	
4	1	70.0	
5	1	66.0	71.6
6	1	78.9	

$$\begin{aligned}t &= (71.6 - 66.6) / 6.935 \\ &= 5.07 / 6.935 \\ &= 0.731\end{aligned}$$

$$\text{p-value} = 0.25$$