Chapter 13

Experiments

At the end of this chapter, you should be able to

- Apply the concepts of control, replication, randomization and blocking to an experiment.
- Draw the design of an experiment.
- Identify problems with experiments.
- Define the placebo effect and blinding in experiments.

Observational Studies

- Observing data "in the wild".
- Researcher makes no attempt to assign values of the variable to certain people.
  - Retrospective study
  - Prospective study
- Result shows association between variables, but does not show causation.

What is an experiment?

- A way to prove a cause-and-effect relationship between two or more variables.
  - Manipulate an explanatory variable to observe a change in a response variable.

Experiments

- _____
  - who or what the experiment is performed on.

Experiments

- _____
  - Need at least one for every experiment.
  - _____
    - Need at least two for each factor

Experiments

- _____
  – The combination of factors and levels given to experimental units.

Experiments

- _____
  – experimental units' response to the treatment.
  – Could measure more than one.

Three Principles of Design

- _____
  – Only aspect that affects response is treatment.
  – Make everything as equal as possible for experimental units.
  – Only difference in treatment of units is the _____.

Three Principles of Design

- _____
  – Experimental units assigned randomly to treatments.
  – Controls for unseen factors.

Three Principles of Design

- _____
  – Each treatment is given to more than one experimental unit.
  – Helps negate individual differences in experimental units.

Three Principles of Design

- Blocking (*and sometimes y*)
  – Variable of interest in experimental units.
    - _____
    - _____
    - _____

Three Principles of Design

- Divide experimental units into these blocks.

Picture of an Experiment

UNITS → TREATMENT → RESPONSE

Example 1

- Assess Nutritional Value of instant breakfast meal for lab mice.
  - Units = 30 mice.
  - Factor = type of breakfast
    - Levels (new instant meal, standard diet)
  - Treatments
    - New Instant Meal
    - Standard Diet
  - Response = weight gain.

Example 1 (cont)

- Control
  - _____
  - _____
  - _____
- Randomization
  - _____
- Replication
  - _____

Design of Lab Mice Experiment

Placebo Effect

Blinding

- _____
  - Could influence response
- _____
  - Could influence way subjects are treated.
- Experiment should be _____

Example 2

- Determine the effectiveness of AZT in treating AIDS.
  - Subjects = 100 people with advanced AIDS.
  - Factor – Drug
    - Levels = AZT, placebo
  - Treatments
    - AZT
    - placebo
  - Response = survival after one year

Example 2 (cont)

- Control
  - _____
  - _____
  - _____
  - _____
- Randomization
  - _____
- Replication
  - _____

Design of AZT Experiment

Confounding Variables

- Instructor wants to determine effect of teaching style on student's attitude about class.
- Factor – Teaching style
  - _____
  - _____
- Response – student attitudes about course.

Confounding Variables

- _____
- Levels of one factor are associated with levels of another variable.
- No way to _____
- Use randomization and control to limit confounding variables.

Example 3

- A chemical engineer is designing a production process for a new product. The chemical reaction that produces the product depends on the temperature and the stirring rate in the vessel in which the action takes place. The purity of the product is then measured.

Example 3 (cont)

- Factors
  - _____
    - 50°C
    - 60°C
  - _____
    - 60 rpm
    - 90 rpm
    - 120 rpm
- Treatments
  - 50°C and 60 rpm
  - 50°C and 90 rpm
  - 50°C and 120 rpm
  - 60°C and 60 rpm
  - 60°C and 90 rpm
  - 60°C and 120 rpm
- Response = purity of product

Example 4 (cont)

- Control
  - _____
- Randomization
  - _____
  - _____
- Replication
  - _____

Design of Experiment

Example 4

- Look at differences in watering on the juiciness and taste of tomatoes.
- Have 12 plants from one store and 6 plants for another store.
- Experimental Units = 18 tomato plants.
- Block – _____
  - _____
  - _____

Example 4 (cont.)

- Factor – _____
  - _____
  - _____
  - _____
- Treatments
  - _____
  - _____
  - _____
- Response – juiciness and taste of tomato

Design of Tomato Plant Experiment

Outcome of Experiment

- Response is different between treatment groups.
- No Real Difference
  - Observed differences are due to random assignments of experimental units to treatments.
  - Treatments produce same response.

Outcome of Experiment

- Statistically Significant Difference
  - Differences expected from random assignment are much smaller than observed differences between treatment groups.
  - Differences in response between treatment groups are real.

Cautions about Experiments

- _____
  - Not able to duplicate conditions of interest.
  - Subjects know it's an experiment.

Cautions about Experiments

- _____
- Experimental units not necessarily a random sample from a population.
- Do the results apply to units outside of the experiment?

Cautions about Experiments

- Do a small trial experiment first.
  - Fix any problems without running out of money and time.