Chapter 11 - Experiments and Observational Studies

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In Chapter 10 and 11 we talk about different methods used to collect data. In the last chapter we learned about Sample Surveys. In this chapter we will talk about Observational Studies and Experiments. They all collect data in different ways and lead to different conclusions.

11.1 Observational Studies

Observational Studies (p. 291) - Study where researchers observe individuals but do not attempt to influence the response or impose a treatment.

- **Retrospective Study** (p. 292) - Observational Study that collects data based on information from the subjects' past.

  The music study is a retrospective study since the subjects were first identified and then data was collected on their past grades.

- **Prospective Study** (p. 292) - Observational Study that collects data by following subjects through the future.

11.2 Randomized, Comparative Experiments

Experiment (p. 293) - Study where a treatment is imposed on individuals in order to observe their response.

- Individuals on whom an experiment is performed are commonly called **subjects** or **participants** if human or **experimental units** if not human.

- Experimenter identifies at least one explanatory variable to manipulate called the **factor** and at least one **response variable** to measure.

- The specific values that a experimenter chooses for a factor are called the **levels**. This allows the testing of different amounts of treatment (drug, fertilizer, etc).

- The combination of specific levels from all the factors that a subject receives is called its **treatment**.

11.3 The Four Principles of Experimental Design

1. **Control**: Control sources of variation other than the factors being tested by making conditions as similar as possible for all treatment groups.

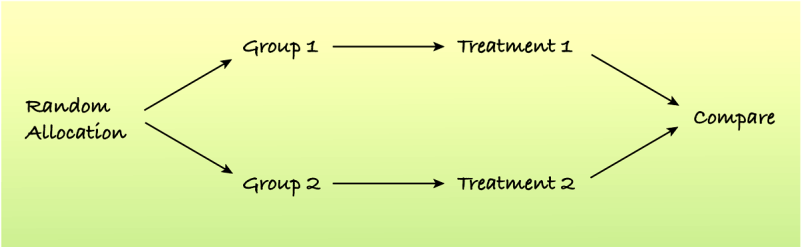
2. **Randomize**: Randomly assign subjects to treatment groups. This allows us to equalize the effects of unknown or uncontrollable sources of variation.
   - It does not eliminate the effects of these sources, but it spreads them out across the treatment levels.
   - Randomization must be used for the experiment to be valid and to be able to use Statistical Methods to draw conclusions.

3. **Replicate**: Repeat experiment, applying the treatment to a number of subjects.
   - The outcome of an experiment with just one subject is an **anecdote**, not data.
   - If a group is not representative of the population of interest, we might repeat the entire study with a different group, from different part of the population.

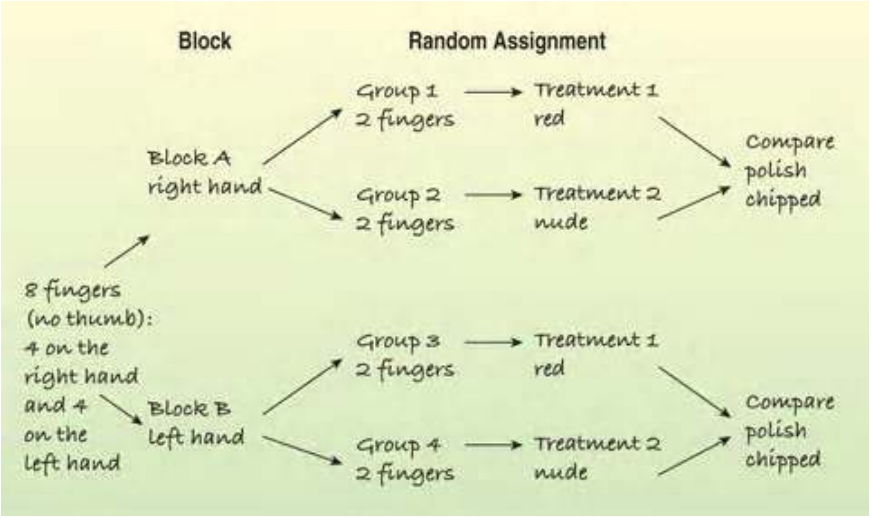
4. **Block**: Group similar individuals together and then randomize within each of these blocks. Reduces the effects of identifiable attributes of the subjects that cannot be controlled. Blocking is ***not*** required in an experimental design.

   Matching (p. 303) - In an Observational Study, subjects might be paired up because they are similar in ways that are not under study.

Diagrams can be used to outline the procedure of the experiment. The diagram emphasizes the random allocation of subjects to treatment groups, the separate treatments applied to these groups, and the comparison of results.



Blocking diagram on p. 302.



How much of a difference is of interest, when looking at the results.

Statistically Significant (p. 298) - When an observed difference is too large to have likely occurred naturally through the randomization process.

Example: Theoretically, you would expect to see a head 50% of the time a coin is tossed. Two coins are tossed one gets 54 heads out of 100 tosses while the other gets 94 heads out of 100 tosses. Which difference is by chance and which would be Statistically Significant?

11.4 Control Treatments

We will talk more about the idea of Statistically Significant in later chapters.
Control Group (p. 299) – Treatment group to which subjects have been assigned to provide a baseline measurement. The subjects receive either no treatment or a treatment which is well understood (older drug).

Blinding (p. 299) - When any individual associated with the experiment is unaware of how subjects have been assigned to different treatment groups. This is to counter any possible bias found when an individual intentionally or unintentionally influences the result.

There are two groups of individuals that can influence the outcome in an experiment.

- Those involved in the treatment phase (subjects, treatment administrators, technicians, etc.)
- Those involved in interpreting the results (judges, treating physicians, etc.)

Double-Blind - When everyone in both groups is blinded.
Single-Blind - When everyone in one of the groups is blinded.

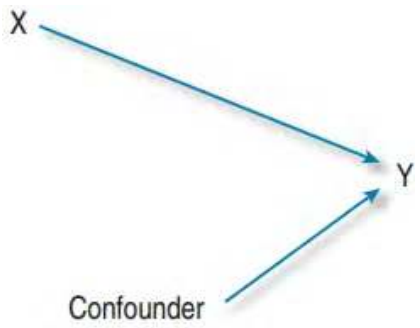
Placebos (p. 301) or fake treatments are the best way to blind subjects from knowing whether they are receiving the treatment or not.

Placebo Effect - When a subjects shows a response even when administered a placebo

11.6 Lurking Variables and Confounding (p. 303)

Confounding

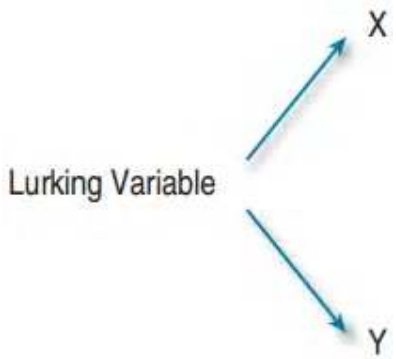
When the levels of one factor are associated with the levels of another factor in such a way that their effects cannot be separated.



The book mentions about a professor from Cornell who did his own experiment by altering teaching style.

Lurking Variables or Common Response

When an observed association between two variables is actually caused by some lurking variable that changes the other two variables.
(Chapter 8 – TVs vs Life expectancy)



Looks like *x* causes *y* when in really lurking variable is associated with both.