Chapter 9 —— Experiments

Def: An "Observational Study" observes individuals and measures variables of interest but does NOT attemp to influence the response.

Ex: A sample Survey like an election poll

Def: An "experiment" deliberately imposes treatments on individuals in order to observe their responses.

The purpose of an experiment is to determine if a treatment causes a change in response.

Ex: Many observational studies show that people who drink a moderate amount of alcohol are less likely to get heart disease than heavy drinkers and less likely than people who don't drink.

Does this association imply that moderate drinking causes less heart disease?

Moderate drinkers are also more likely to maintain a healthy weight, get enough sleep, and exercise regularly.

We could design an experiment to determine if moderate drinking causes less heart disease.

Randomly select half of a large group to be drinkers. Force them to drink 1-2 glasses per day. This is the treatment group.

Force the other half not to drink. This is the control group.

Follow this group for several decades to see if they get heart disease.

The problem with the observational studies is that the effect of alcohol is "confounded" with (mixed up with) the effect of lurking variables such as weight, exercise, and other lifestyle choices that moderate drinkers tend to make.

Experimental Studies don't have the problem of confounding.

What problems are there with THIS experiment?

Ans: - Can you really force people to drink or not to drink?

- It takes several decades.

Terminology for experiments:

- Individuals are called "subjects."
- Explanatory variables are called "factors."
- A "treatment" is any specific experimental condition applied to the subjects.

Ex: A group of 136 children who had been abandoned at birth were studied. Half were randomly chosen to be placed in foster care. The other half were placed in an institution. They were followed for several years during which their mental and physical health was measured.

What are the subjects?
What is the factor?
What are the two treatments?

Ex: (Confounding in an experiment?)
A certain college switched from offing a classroom-based GMAT prep course to an online prep couse.

Those who took the online course did 10% better on average than those from previous years who took the classroom-based course.

What are the subjects?
What is the factor?

Is the online course better?

Ans: It may actually be worse. Those who took the online course were typically older and with full-time jobs. They were a very different group than those who took the classroom-based course.

What is the experiment missing?

Ans: The problem here is similar to a survey that uses a "voluntary response sample." It is essential that we randomly choose which subjects receive which treatment. Otherwise, the treatment may be confounded with other variables.

What are the lurking variables?

Some Terms to know: (see pg 229-230)

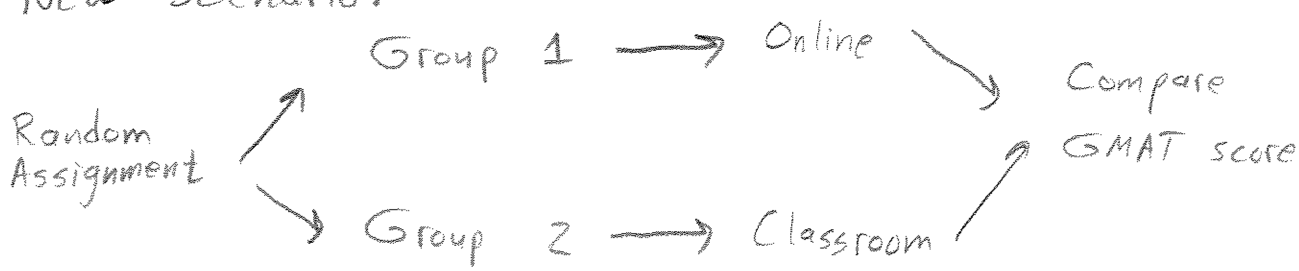
Randomized Comparative Experime[nt]
Completely Randomized Experiment.

A Closer Look at Randomization:

Randomly assigning subjects to different groups means that the groups "should" be equal in all regards.

This isn't completely true. Two groups are Never exactly the same. However, any and all differences between the groups is due to chance. Thus there is no systematic difference (ie no bias).

Ex: Online GMAT Prep Course:
New Scenario:



Can We say that any difference in scores is due to the difference in treatment?

Ans: No, Even if both groups had the classroom course, there would still probably be some difference in their GMAT scores. Why? Because there are random differences between the two groups.

Ex: Suppose in the previous example that each group contains only 1 person. Then, the two groups are assigned a random treatment. The two groups may be very different if one person is smarter. Too much depends on chance. Whichever treatment the smart guy ends up receiving will appear better.

How do we solve this problem?

Ans: Use enough subjects in each group to reduce chance variation between the two groups.

If each group contains 100 students that are randomly assigned to one of the two treatments, then

- Randomization has eliminated bias

- Large group size has reduced the possibility that chance will lead to unequal groups.

Def: Then, we hope to see a difference in the responses that is so great that it is unlikely to be caused by chance. We then say the effect of the treatment is statistically significant.

Cautions about Experimentation:

A subject may respond favorably to a treatment even though the treatment has no real benefit.

A person who is given a sugar pill but told they are taking a medication for pain will often report favorable results.

This is called the "Placebo Effect."

Thus the "Placebo Effect" is confounded with the effect of the treatment.

How do we eliminate this confounding?

Ans: If you are testing a drug, you give the first group the drug and the second group gets the sugar pill (placebo). Then you can compare the two groups

Another problem arises when the doctor administering the drug and placebo firmly believes in the efficacy of the drug. He will unknowingly act differently around the two groups. He will treat them somewhat different. Thus the doctor's actions are confounded with the effects of the treatments.

How do we eliminate this confounding?

Ans: We don't allow the doctor or the subjects to know who is recieving the drug treatment and who is recieving the placebo treatment. This type of study is called "Double Blind."

The completely randomized design has given us the opportunity to learn about the important concepts of
- control
- randomization
- adequate # of subjects

However, more elaborate statistical designs are often superior to the completely randomized design.

Ex: The "Matched Pair Design."
In this design subjects are paired with a similar subject. They might be matched based on age, health, etc.

Then one subject from each pair is randomly selected to be in group 1. The other subject will be in group 2.

So, What is the advantage of the "matched pair design?"

Ans: Remember that the goal is to create two group that are as similar as possible. Pairing ensures that the two groups are more equal. Then, randomly choosing which subject from each pair will joint group 1 eliminates bias.

Note: It is possible in a "matched pair" design that a single subject is a "pair." That is, the subject receives both treatments — one after the other. The advantage is that the pair is <u>very</u> equally matched. There may be bias based on which treatment is administered first, so we randomly select which treatment to give first.

Ex: Driving and Cell Phones
We would like to determine if drivers are distracted by talking on a hands-free headset for their phone. Breaking reactions will be measured in a car simulator. In a completely randomized design our 40 subjects would be randomly placed into two groups. One group to drive with and one without talking.

In a matched pair design we might pair subjects by age and then randomly assign one subject from each pair to be in the group that drives while talking.

Another way to do a matched pair design is for each subject to be a "pair." That is, each subject will drive the simulator once while talking and once without talking. Since a person may tend to get better at the simulator, there may be bias depending on which treatment they receive first. This bias is eliminated by randomly choosing whether each subject drives first with or first without talking.

The reason the matched pair design is better is that the completely randomized design relys on chance to equally distribute those subjects with faster reactions among two groups.

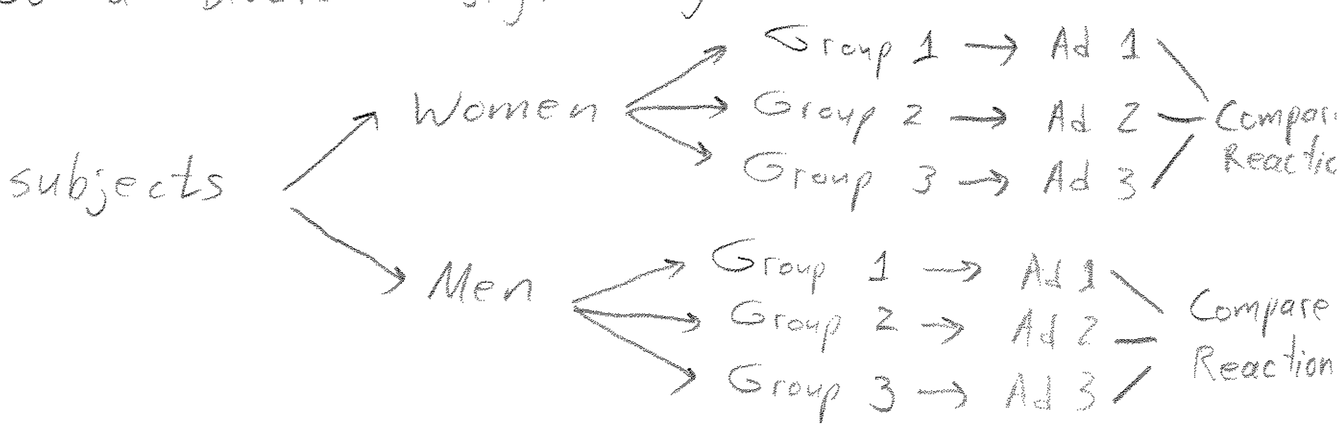
- A "matched pair design" is one example of a "block design."

Def: A "block" is a group of individuals that are known to be similar.

Def: In a "block design" the random assignment of individuals to treatments is carried out separately within each block.

Thus in a matched pair design the block is a pair of individuals.

- Ex: Men, Women, & Advertising:
  Men and women respond differently to ads.
  So a Block design might look like this:



Assignment to blocks is NOT random
Assignment with each block to a treatment group is random

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What are the advantages of a block design?

Ans: Remember that the goal is to create equal groups.

Separating into blocks ensures that each group (not block) will have the same number of individuals from each block.

In our case this means that each group will have the same number of men and the same number of women.

Then, random assignment within each block ensures that we don't have bias.