2.5 – Experiment Design

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https://www.youtube.com/watch?v=c6FS3D4a_kA

Part 1: Experiment Design Video

http://www.learner.org/courses/againstallodds/unitpages/unit15.html

While watching the video, answer the following questions

1. Why is the study of the effect of humans on the coral reefs not an experiment?

The study did not impose human populations on the various coral reefs. Instead, scientists simply observed the health of the coral reefs in four areas where human interaction with the areas was varied from no humans living in the area to a sizable population of humans currently living in the area.

2. Who were the subjects in the Glucosamine/Chondroitin study? What did researchers want to find out?

The subjects were patients suffering with osteoarthritis of the knee. Researchers wanted to compare the effects on joint pain of the dietary supplements of Glucosamine or Chondroitin compared to a prescription medication or a placebo.

3. Why were subjects randomly assigned to the treatments?

Randomization produces groups of subjects that should be similar in all respects before the treatments are applied. It allows us to equalize the effect from unknown or uncontrollable sources of variation.

4. Dr. Confound conducted a very badly designed experiment on mood-altering medication. List some of the problems with his experiment.

Sample answer: His sample size was extremely small (the last two he called 7 and 8, so there were 8 subjects total). He treated the two subjects differently – one was allowed to sit and the other had to stand for over an hour. The treatment and having stand are now confounding variables. This difference in treatment would certainly affect subjects' moods. He didn't randomly assign the medications. He interacted with the patients sympathizing with their responses. He didn't record exactly what one of his patients said and instead recorded only the higher ranking of mood.

Part 2: Observational Studies vs. Experiments

A sample survey aims to gather information about a population without disturbing the population in the process. Sample surveys are one kind of observational study. Other observational studies watch the behavior of animals in the wild or the interactions between teacher and students in the classroom. This section is about statistical designs for experiments, a very different way to produce data.

In contrast to observational studies, experiments don't just observe individuals or ask them questions. They actively impose some treatment to measure the response. The purpose of an experiment is to determine whether the treatment causes a change in the response.

When our goal is to understand cause and effect, randomized experiments are the only source of fully convincing data.

An experimenter must identify at least one independent variable to manipulate (this is the treatment) and at least one dependent variable (response) to measure. The experimenter deliberately manipulates the treatments and must assign subjects to treatments at random.

Experimental units (subjects) are the collection of individuals to which treatments are applied.

Example 1: Observation vs. Experiment

Should women take hormones such as estrogen after menopause, when natural production of these hormones ends? Several major medical organizations thought yes because women who took hormones seemed to reduce their risk of a heart attack 35 to 50%. The evidence in favour of hormone replacement came from a number of observational studies that compared women who were taking hormones with other who were not. But the women who chose to take hormones were richer and better educated and saw doctors more often than women who didn't take hormones. It isn't surprising that they had fewer heart attacks. In this scenario, wealth, education level, and number of doctor visits are confounding (we don't know if it was the hormone or any of these variables that caused a reduce in heart attacks)

To get convincing data on the link between hormone replacement and heart attacks, we should do an experiment. Experiments don't let women decide what to do. They assign women to either hormone replacement pills or to placebo pills that look and taste the same as hormone pills. The assignment is done by a coin toss, so that all kinds of women are equally likely to get either treatment.

By 2002, several experiments with women of different ages agreed that hormone replacement does not reduce the risk of heart attacks. In fact, some studies concluded that hormone replacement with estrogen carried increase risk of stroke.

Example 2: In 2007, deaths of a large number of pet dogs and cats were ultimately traced to contamination of some brands of pet food. The manufacturer now claims that the food is safe, but before it can be released, it must be tested. In an experiment to test whether the food is now safe for dogs to eat, what would be the treatments and what would be the response variable measured?

Treatments: ordinary sized portions of two dog food: the new one from the company, and one other type that is known to be safe

Response: a veterinarian's assessment of the health of the test subjects

Note: the test subjects (dogs) must be randomly assigned to either treatment

Part 3: Experimental Design

4 Principles of Experimental Design

1. Comparison – use a design that compares two or more treatments

2. Random Assignment – Use chance to assign experimental units to different treatments.

3. Control – Keep other variables (besides the ones you are testing) that might affect the response of the subject the same for all groups.

4. Replication – use enough experimental units in each group so that any differences in the effects of the treatments can be distinguished from chance differences between groups

Example 3: We're planning an experiment to see if the new dog food is safe to eat. We have established that we will feed some dogs the new food and some dogs food that is known to be safe (principle of comparison). In this experiment, how could you implement the principles of control, random assignment, and replication?

Control:

- control portion sizes
- control environment (pen, amount of water drank, amount exercise and sleep)
- restrict experiment to single breed of dog

Random Assignment:

- assign dogs to the two different treatments randomly by flipping a coin

Replication:

- Assign more than one dog to each treatment to allow for variability among dogs.

Strategies to Improve Experiments

1. Use a control group – researchers vary the independent variable (treatment) for the experimental group but not for the control group. Any differences in the dependent variable (response) for the two groups can be attributed to the changes in the independent variable.

Example: A medial researcher wants to test a new drug believed to help smokers quit. 50 people volunteer for the study. The researcher randomly divides the smokers in to two groups. One group is given nicotine patches with the new drug, while the second group uses ordinary nicotine patches. The researcher then measures how many in each group quit smoking.

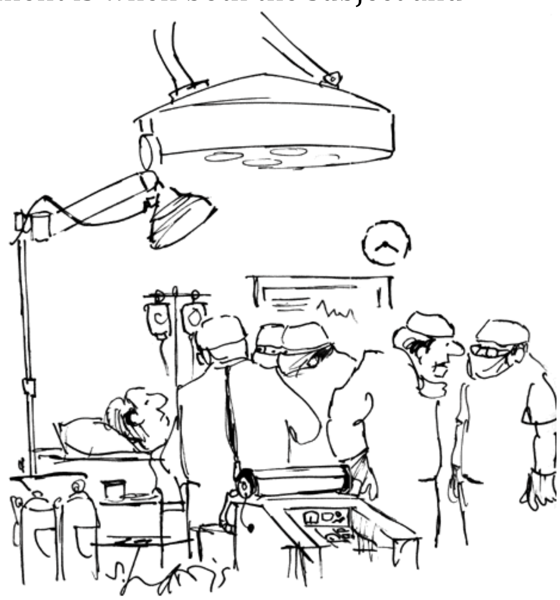
2. Blinding – keep anyone who could affect the outcome of the response from knowing which subjects have been assigned to which treatments. A double-blind experiment is when both the subject and experimenter don't know which treatment the subject has been given.

Example: in the earlier pet food example, the vet should not be told which dogs ate which food.

3. Use a placebo – often, simply applying any treatment can induce an improvement. A fake treatment that looks just like the treatments being tested is called a placebo. Placebos are the best way to blind subjects from knowing whether they are receiving the treatment or not.

4. Blocking – group similar experimental units together. Then random assignment of subjects to treatments is carried out separately within each block.

Example: in the previous dog food example, different breeds of dogs may respond differently to the foods. Blocking by breeds can remove that variation.



"We'll just mill around till he's asleep, and and then send him back up. This operation is actually for a placebo effect."

Example 4: Tire Blocking

A firm wishes to test the durability of four tire types that we'll call A, B, C, and D for convenience. Here are four possible studies they might perform. In all cases, the cars are to be driven on a track under controlled conditions until its tires are deemed "worn out". The response variable for each experimental unit (a car) is the number of miles the car drove with the tires. Each of the first three designs contains at least one serious weakness. Comment briefly on them. The fourth design is called a blocked design. State what the blocks are and explain what the advantage is of this design over design number 3.

1. Four Cadillacs of the same type are purchased new from four dealers. One gets tire A (i.e., gets outiftted with four type A tires), one gets B, one gets C, and one gets D.

This design involves no replication. Without replication, you can't tell whether any difference in wear is due to tire type or to car differences.

2. Twelve Cadillacs of the same type are purchased new from four dealers. Three get tire A, three get B, three get C, and three get D.

You can't infer to all cars what you observe only on Cadillacs. This was true in design 1 as well.

3. Twelve vehicles of different types are randomly selected from a list of many vehicle types and then are randomly allocated into four groups of three. One group gets tire A, one group gets tire B, one group gets tire C, and one group gets tire D.

The differences in wear on the tires may be due to the types of car in the group and not the tire type.

4. Four Cadillacs, four Fords, and four Volkswagens are purchased. One of each type of car gets tire A, one gets tire B, one gets tire C, and one gets tire D.

The blocks in this design are the car types. If there is a difference in tire types, it would be most easily detected with this design.