Stat 218 - Day 19
Statistical Principles of Design

Recall what we studied earlier concerning the design of studies:

- **Observational Study**- observes individuals and measures variables of interest but does not attempt to influence responses; goal is to *describe* situation.
- **Experiment**- deliberately imposes some treatment on individuals to observe their responses; goal is to study whether treatment *causes* a change in the response.
- **Response variable**- a variable that measures an outcome or result of a study
- **Explanatory variable**- a variable that researchers think explains or causes changes in the response variable
- **Lurking variable**- one that has an important effect on the relationship among the variables in a study, but which is not among the explanatory variables studied
- **Confounding**- two variables whose effects on a response variable cannot be distinguished from each other
- **Randomization**- seeks to eliminate confounding variables by producing groups that are similar in all respects before the treatments are applied
- **Causation**- cause/effect conclusions can be drawn from randomized comparative experiments but not from observational studies

Some closely related ideas, important for designing experiments well, include:

- **Placebo effect**- Many people respond favorably to any treatment, due to the psychological effect of receiving care. For this reason, it is much better to compare a new treatment to a placebo rather than to "no treatment."
- **Blindness**- Particularly with experiments involving placebos, it is advantageous to keep subjects know knowing which treatment they are receiving.
- **Double blindness**- Ideally, the person evaluating the responses of the subjects should also be kept blind as to which treatment group the subjects were in, to eliminate the possibility of any (possibly sub-conscious) bias affecting his/her judgment

Example 1: Cold Durations
To study the effectiveness of a zinc nasal spray for reducing the duration of a common cold, researchers recruited 104 subjects who agreed to report to their lab within 24 hours of getting cold symptoms. Each subject was randomly assigned to one of three groups: one received full dosage of the zinc spray, another received a low dosage, and a third received a placebo spray. The cold symptoms lasted an average of 1.5 days for the full dosage group, 3.5 days for the low dosage group, and 10 days for the placebo group.

(a) Is this an observational study or an experiment? Explain.

(b) Identify the explanatory variable.

(c) Identify the response variable.

(d) Why do you think the researchers use a placebo spray, as opposed to just providing no treatment for that group of subjects?

Example 2: Back Pain
In a recent study 15 patients suffering from severe back pain were assigned to receive the drug botulinum, and 9 of the patients reported a substantial decrease in pain.
(a) Would you conclude that botulinum is an effective treatment for back pain? Explain.

(b) How would you design an experiment to provide a better test of the drug?

Example 3: Maternal Feelings
Many studies have shown that mothers who nurse their new-born babies tend to have stronger feelings of attachment to their children than mothers who bottle-feed their new-born children.
(a) Are these observational studies or experiments? Explain.

(b) Identify the explanatory variable.

(c) Identify the response variable.

(d) Is it reasonable to conclude that nursing *causes* stronger feelings of attachment? Explain.

(e) Identify a potential confounding variable in this study.

Example 4: Winter Heart Attacks
Studies conducted in New York City and Boston have noticed that more heart attacks occur in December and January than in all other months. Some people have tried to conclude that holiday stress and overindulgence causes the increased risk of heart attack.
(a) Identify a lurking variable that might be confounded with those of the month variable, providing an alternative explanation for the increased risk of heart attack in these months.

A more recent study in Los Angeles that revealed a similar finding eliminated one potential confounding variable from consideration.
(b) Identify another lurking variable that still pertains to the Los Angeles study.

Example 5: Meditation and Blood Pressure
To study whether meditation can reduce blood pressure, researchers randomly assigned subjects either to a group that practiced meditation for an hour every day or to a control group that was simply told to relax more. The subjects' blood pressure measurements were taken prior to the beginning of the study and at the end of one month.
(a) Is it possible for the subjects in this study to be blind as to which treatment they receive?

(b) Why should those taking the blood pressure measurements be blind as to which treatment group the subject is in?

Example 6: Maze Runners
Researchers gave five rats to each of twelve experimenters and asked them to train the rats to run a maze. Six of the researchers were (falsely) told that their rats had been especially bred to do well, and the other six were (falsely) told that their rats had exhibited dullness. It turned out that the rats in the former group did significantly better than those in the latter group?
(a) Is this an observational study or an experiment?

(b) Identify the explanatory and response variables.

(c) Who are the subjects in this study?

(d) What difficulty of conducting experiments does this study reveal?

Example 7: Cold Attitudes
In a study published in the July 2003 issue of the journal *Psychosomatic Medicine*, researchers reported that people who tend to think positive thoughts catch a cold less often than those who tend to think negative thoughts. The scientists recruited over 300 initially healthy volunteers, and they first interviewed them over two weeks to gauge their emotional state, eventually assigning them a numerical score for positive emotions and a numerical score for negative emotions. Then the researchers injected rhinovirus, the germ that causes colds, into each subject's nose. The subjects were then monitored for the development of cold-like symptoms. Subjects scoring in the bottom third for positive emotions were three times more likely to catch a cold than those scoring in the top third.
(a) Identify the explanatory and response variables in this study. Classify each as categorical or quantitative.

(b) Is this an observational study or an experiment? Explain. [*Hint*: Ask yourself whether the explanatory variable was assigned by the researchers or not.]

(c) Can we draw a cause/effect conclusion between emotional outlook and likelihood of catching a cold, based on this study? Explain.

Example 8: Water-Proofing Boots
Suppose that you want to compare two methods of water-proofing boots and that you have recruited 100 subjects to participate in an experiment.
(a) Suggest a better experimental design than randomly assigning 50 subjects to wear boots with each type of water-proofing.

(b) What is the primary advantage of the *matched-pairs* design in this study?

(c) Explain why double-blindness would be important in this study.

Example 9: Melting Morsels
We will conduct a study to see if there is a difference in the melting times of semi-sweet milk chocolate chips and peanut butter chips. You will be asked to put a chip on your tongue, touch it to the rough of your mouth, and then time how long it takes before the chip is completely melted, without any "encouragement" on your part. You will repeat this with both types of chips, randomly determining which chip you use first.