Notes on Experimental Design

In stats, we often want to find and explore relationships (association, correlation).

"Is there a correlation between blood pressure and heart rate?"

"Is living in tropical climates related to having nut allergies?"

We can determine if there is a relationship or correlation by looking at data (observational study).

However, sometimes it is necessary to prove cause and effect. To prove cause and effect you need an experiment!

Example 1

Explanatory (Treatment) Variable: Smoking cigarettes or not

Response Variable (what we will measure): Did the person get lung cancer later in life?

We need to prove that smoking cigarettes causes lung cancer.

There is plenty of data that shows a relationship (correlation) between smoking cigarettes and getting lung cancer. However that does not prove cause.

Correlation ≠ Causation!!!!!

Correlation (relationships) does not imply that one causes the other.

What is the problem? Why doesn't it show causation? Cannot show cause because of confounding variables (lurking variables)

We need to prove that it was the cigarettes that caused the lung cancer and not something else.

Confounding variables for lung cancer?

Genetics, chemicals, job, asbestos exposure, age, gender, smoking other things, poor air quality

Experimental Design is not Frankenstein!!! We do not experiment on people. We collect the data in a special way to control confounding variables.

Experimental Design is controlling the confounding variables so that we can prove cause and effect.

Experimental Design

Randomly assign people into two groups. (Random Assignment)

Two groups will be as alike as possible. (Similar ages, similar genders, similar stress levels, similar racial and ethnic groups, similar places that they live, similar number of people that smoke other things, similar jobs, similar air quality, similar asbestos exposure) Can also use Direct Control (blocking) to make the groups more alike if needed. Random Assignment does most of the work though.

Group 1: Treatment group (smoked cigarettes)

Group 2: Control group (not smoke cigarettes)

Remember these two groups of people are very alike. So if group 1 has a significantly higher rate of lung cancer, then we have controlled all the confounding variables and proved that smoking cigarettes causes lung cancer.

Example 2

Prove that taking a new blood pressure medicine does decrease a person's blood pressure. (Prove cause and effect)

Confounding Variables? Stress, Diet, Genetics, Age, Gender, Racial / ethnic groups, Human Brain (placebo effect)

Experiment:

Randomly assign people to two groups. Also use direct control (blocking) to make the two groups alike.

Group 1: Treatment (get the medicine)

Group 2: Control group (not get the medicine)-Get a placebo (fake medicine) (Double Blind is best)

Single Blind: means that the people in the groups do not know if they are getting medicine or placebo

Double Blind: means that the people in the groups and the people giving the medicine do not know if it is a placebo or not. *(Obviously someone knows, just not the person giving the medicine or treatment.)*

If Group 1 has significantly lower blood pressure, then we have succeeded in proving that the medicine lowers blood pressure.

Overall Take-Away:

Don't do an experiment unless you have to prove cause and effect. Experiments are expensive and time consuming.

Observational Study: Look at data and see if there is a relationship (correlation) between two things. Remember observational studies do not control confounding variables.

Experiment: Randomly assign two groups, double blind placebo, and control all confounding variables so that you can prove cause and effect.

Now do Sampling Experiment Activity 6
Ruler and Reflexes Experiment!!

Ruler Experiment Data (Previous Class)

With Phone

Mean average catch : 10.3 inches

Number of Drops: 37

Without Phone

Mean average catch: 8.2 inches

Number of Drops: 9