

One way of gathering data is an **observational study**. In an observational study, researchers don't assign choices, they simply observe them. These studies can be **retrospective**, meaning researchers are gathering data from records based on historical data; or they can be **prospective**, meaning they identify **subjects** and collect data as events unfold.

Another way of gathering data is by doing an **experiment**. An experimenter must identify at least one **explanatory variable** to manipulate, and at least **response variable** to measure. The explanatory variables are called **factors**. There are four principles of experimental design; for this class, we will focus on three:

- **Control**- we control sources of variation other than the factors we are testing by making conditions as similar as possible for all treatment groups (**placebos**- a fake treatment that looks like a real treatment, can play a role in control)
- **Randomize**- subjects of an experiment do not have to be random, but treatments must be randomly assigned
- **Replicate**- two types; First, the treatments should be applied to many subjects, not just one or a few (that is an anecdote, not data). Second, the entire experiment must be replicated to see if the results hold true for many groups, not just one

A controlled experiment is the only way to establish a cause and effect relationship. This is why it was so difficult to establish that smoking can cause lung cancer or that humans have caused climate change; there is not ethical way to do a controlled experiment with those topics.

1. Researchers who examined health records of thousands of males found that men who died of heart attack tended to be shorter than men who did not.

a) Was this an experiment? If not, what kind of study was it (prospective or retrospective)?

b) Is it correct to conclude that shorter men are at higher risk for heart attack? Explain.

2. Coffee stations in offices often ask users to leave money in a tray to pay for their coffee, but many people cheat. Researchers at Newcastle University replaced the picture of flowers on the wall behind the coffee station with a picture of staring eyes. They found that the average contribution increased significantly above the well-established standard when people felt they were being watched, even though the eyes were definitely not real.

a) Was this a survey, an observational study, or an experiment? How do you know?

b) Identify the explanatory variable and the response variable.

3. Athletes who suffered hamstring injuries were randomly assigned to one of two exercise programs. Those who engaged in static stretching returned to sports activity in a mean of 15.2 days faster than those assigned to a program of agility and core stabilization exercises.

- a) Was this a survey, an observational study, or an experiment?

- b) Identify the explanatory variable and the response variable.

- c) What were the treatments?

- d) From this single study, can they determine that static stretching is the best treatment for athletes with a hamstring injury?

4. Some doctors suspect that giving people who have just had surgery large doses of Vitamin E will speed their recovery time by helping their incisions heal more quickly. Design an experiment to test this conjecture. Be sure to identify the explanatory and response variables, the treatments, and where you would randomize.

5. A farmer wants to determine if a new fertilizer is effective in increasing her yield of tomatoes. She also wants to know if it's more effective to water her crops in the early morning or the evening. How could you design an experiment to test both?