Statistics is filled with associations between variables, some positive, some negative.
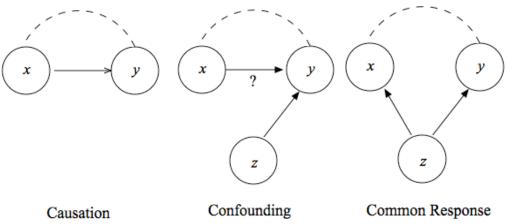
x = how much hair a man has at age 40	y = how much hair his father had at age 40
x = how much soda you drink	y = how many cavities you have
x = your high school GPA	y = your college GPA
x = how many times you go to church	y = how long you live
x = how much your car costs	y = how low a golfing average do you have

What statisticians hope to prove is that changes in the explanatory variable will *cause* changes in the response variables. How many times have you heard lines like this?

- If you smoke, you will get cancer.
- If you don't study, you won't pass.
- If you eat chocolate, you will break out.
- If you practice your piano, you will get better.

All of these are cause and effect statements and very powerful ones, if true. The fact is that none of them can be proven true. People smoke and don't get cancer. People never study and pass courses. People eat chocolate and their faces are clear. People can practice the piano until the cows come home and still be awful.

There are three types of associations in which we are interested. In each diagram below, the dashed line represents an observed association between variables.

Causation   Confounding   Common Response

Causation is very difficult to prove and there are not that many examples that I can give you and the ones I mention are kind of obvious.

- Driving faster causes you to use more gasoline.
- Talking more on your telephone causes you to pay more money.

It is very difficult to prove causation although you hear about studies all the time ... drinking more wine causes people to live longer or eating more broccoli leads to lower blood pressure.

Common response refers to a "hidden variable" z. When z changes, x changes AND y changes. That creates an association between x and y although there may not even be a causal link between x and y.

> • There is a positive association between one's high school GPA and one's college GPA. Students who are low in high school are usually low in college and students high in high school are usually high in college. But there is no causation. There are hidden variables that effect each causing a common response. What are some of them?

> • Suppose a study was done and the results showed that people who drove more expensive cars were better golfers. Could we then say that driving expensive cars cause you to score lower on a golf course? Of course not. There are confounding variables affecting both the cost of your car and the score on a golf course making it a common response situation. Can you give a couple?

Confounding is a little more complex. We think x causes y but there are other hidden variables which also can have an influence on y. We have no idea how much x has to do with y.

In common response, the hidden variables affect both x and y, but in confounding, the hidden variables affect just y.

> • People who go to church (synagogue, mosque) tend to live longer. Suppose a study was done and there was evidence to this fact. But how long one lives has many hidden variables. Name some of them.

So while this study might have merit, there is certainly no causation and it is difficult to know how much influence going to church might actually have on the duration of one's life.

> • People who own pets tend to have lower blood pressure. Suppose a study was done and there was evidence to this fact. But blood pressure has many hidden variables. Name some of them.

So again, while this study might have merit, there is certainly no causation and it is difficult to know how much influence having pets might have on one's blood pressure.

Most of the studies I have mentioned would need some experiment to test them. We will talk about how this is done in Unit 03. But many of life's big questions cannot easily be settled by an experiment.

> • Gun control will reduce crime. A simple causation statement. But how do we ethically test it?

> • Smoking causes lung cancer. There certainly is a strong association. Also a consistent one – not just Americans or Asians or Christians or women. The association is strong among all groups. People who smoke more often and more cigarettes a day get long cancer more often. People who stop don't get it as often. Experiments with animals shows that tars from cigarette smoke cause cancer. And still, there is no agreement that smoking causes cancer. Why?