

1.6: Types of Statistical Studies (4 of 4)

Learning Objectives

- Based on the study design, determine what types of conclusions are appropriate.

Example

Multitasking



Do you constantly text-message while in class? Do you jump from one website to another while doing homework? If so, then you are a high-tech multitasker. In a study of high-tech multitasking at Stanford University, researchers put 100 students into two groups: those who regularly do a lot of media multitasking and those who don't. The two groups performed a series of three tasks:

(1) A task to measure the ability to pay attention:

Students view two images of red and blue rectangles flashed one after the other on a computer screen. They try to tell if the red rectangles are in a different position in the second frame.

(2) A task to measure control of memory:

Students view a sequence of letters flashed onto a computer screen, then recall which letters occurred more than once.

(3) A task to measure the ability to switch from one job to another:

Students view numbers and letters together with the instructions to pay attention to the numbers, then recall if the numbers were even or odd. Then the instructions switch. Students are to pay attention to the letters and recall if the letters were vowels or consonants.

On every task, the multitaskers did worse than the non-multitaskers.

The researchers concluded that “people who are regularly bombarded with several streams of electronic information do not pay attention, control their memory, or switch from one job to another as well as those who prefer to complete one task at a time” (as reported in *Stanford News* in 2009).

“When they're [high-tech multitaskers] in situations where there are multiple sources of information coming from the external world or emerging out of memory, they're not able to filter out what's not relevant to their current goal,” said Wagner, an associate professor of psychology at Stanford. “That failure to filter means they're slowed down by that irrelevant information.”

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In general, we should not make cause-and-effect statements from observational studies, but in reality, researchers do it all the time. This does not mean that researchers are drawing incorrect conclusions from observational studies. Instead, they have developed techniques that go a long way toward decreasing the impact of confounding variables. These techniques are beyond the scope of this course, but we briefly discuss a simplified example to illustrate the idea.

Example

Smoking and Cancer



Consider this excerpt from the National Cancer Institute website:

Smoking is a leading cause of cancer and of death from cancer. Millions of Americans have health problems caused by smoking. Cigarette smoking and exposure to tobacco smoke cause an estimated average of 438,000 premature deaths each year in the United States.

Notice that the National Cancer Institute clearly states a cause-and-effect relationship between smoking and cancer. Now let's think about the evidence that is required to establish this causal link. Researchers would need to conduct experiments similar to the hormone replacement therapy experiments done by the Women's Health Initiative. Such experiments would be very difficult to do. The researchers cannot manipulate the smoking variable. Doing so would require them to randomly assign people to smoke or to abstain from smoking their whole life. Obviously, this is impossible. So how can we say that smoking *causes* cancer?

In practice, researchers approach this challenge in a variety of ways. They may use advanced techniques for making *statistical adjustments* within an observational study to control the effects of confounding variables that could influence the results. A simple example is the cell phone and brain cancer study.

In this observational study, researchers identified a group of 469 people with brain cancer. They paired each person who had brain cancer with a person of the same sex, of similar age, and of the same race who did not have brain cancer. Then they compared the cell phone use for each pair of people. This matching attempts to control the confounding effects of sex, age, and race on the response variable, cancer. With these adjustments, the study will provide stronger evidence for (or against) a causal link.

However, even with such adjustments, we should be cautious about using evidence from an observational study to establish a cause-and-effect relationship. Researchers used these types of adjustments in the observational studies with hormone replacement therapy. We saw in that research that the results were still misleading when compared to those of an experiment.

So how can the National Cancer Institute state as a fact that smoking causes cancer?

They used other nonstatistical guidelines to build evidence for a cause-and-effect relationship from observational studies. In this approach, researchers review a large number of observational studies with criteria that, if met, provide stronger evidence of a possible cause-and-effect relationship. Here are some simplified examples of the criteria they use:

- (1) There is a reasonable explanation for how one variable might cause the other.
 - For example, experiments with rats show that chemicals found in cigarettes cause cancer in rats. It is therefore reasonable to infer that these same chemicals may cause cancer in humans.
 - Consider these experiments together with the observational studies showing the association between smoking and cancer in humans. We now have more convincing evidence of a possible cause-and-effect relationship between smoking and cancer in humans.
- (2) The observational studies vary in design so that factors that confound one study are not present in another.
 - For example, one observational study shows an association between smoking and lung cancer, but the people in the study all live in a large city. Air pollution in a large city may contribute to the lung cancer, so we cannot be sure that smoking is the cause of cancer in this study.
 - Another observational study looks only at nonsmokers. This study shows no difference in lung cancer rates for nonsmokers living in rural areas compared to nonsmokers living in cities.

- Consider these two studies together. The second study suggests that air pollution does not contribute to lung cancer, so we now have more convincing evidence that smoking (not air pollution) is the cause of higher cancer rates in the first study.

Let's Summarize

- There are four steps in a statistical investigation:
 - Ask a question that can be answered by collecting data.
 - Decide what to measure, and then collect data.
 - Summarize and analyze.
 - Draw a conclusion, and communicate the results.
- There are two types of statistical research questions:
 - Questions about a population
 - Questions about cause-and-effect
- To answer a question about a population, we select a sample and conduct an observational study. To answer a question about cause-and-effect we conduct an experiment.
- There are two types of statistical studies:
 - Observational studies: An *observational study* observes individuals and measures variables of interest. We conduct observational studies to investigate questions about a population or about an association between two variables. An observational study alone does not provide convincing evidence of a cause-and-effect relationship.
 - Experiments: An *experiment* intentionally manipulates one variable in an attempt to cause an effect on another variable. The primary goal of an experiment is to provide evidence for a cause-and-effect relationship between two variables.
- In statistics, a *variable* is information we gather about individuals or objects.
- When we investigate a relationship between two variables, we identify an *explanatory* variable and a *response* variable. To establish a cause-and-effect relationship, we want to make sure the explanatory variable is the only thing that impacts the response variable. Other factors, however, may also influence the response. These other factors are called *confounding* variables.
- The influence of confounding variables on the response variable is one of the reasons that an observational study gives weak, and potentially misleading, evidence of a cause-and-effect relationship. A well-designed experiment takes steps to eliminate the effects of confounding variables, such as random assignment of people to treatment groups, use of a placebo, and blind conditions. For this reason, a well-designed experiment provides convincing evidence of cause-and-effect.

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