

## Module 4, Unit 9 Lesson 12 – Types of Statistical Studies

### Warm-up

You want to know what proportion of the population likes rock music. You carefully consider three ways to conduct a study.

- You could pick a random sample of people and ask them the question, “Do you like rock music?” and record their answers.
- You could pick a random sample of people and follow them for a period of time, noting their music purchases, both in stores and online.
- You could pick a random sample of people, separate them into groups, and have each group listen to a different genre of music. You would collect data on the people who display an emotional response to the rock music.

What are the similarities and differences between the above three alternatives?

### Finding out about a population

In a statistical study we collect data from a **sample** in order to attempt to understand the **population** of interest. What is the difference between a sample and a population?

A statistical study begins by asking a question that can be answered with data. Often the goal is to identify the relationship between a suspected **explanatory** variable and a suspected **response variable**. The explanatory variable is generally a factor that we believe could be causing the response.

### Three Types of Studies

**Observational Study** -- An observational study is one in which the values of one or more variables are observed with no attempt to affect the outcomes. Often people are followed around and their behavior is noted. Occasionally people are asked to pick from available treatments (such as choosing between running weekly or doing yoga weekly).

**Survey** – In a survey people are asked a series of questions via either an interview or a written questionnaire. An online poll is an example of a survey.

**Experiment** – An experiment differs from an observational study. In an experiment, subjects are **assigned** to treatments for the purpose of seeing what effect the treatment has. An observational study does not assign behaviors or treatments. An experiment is the only legitimate way to establish cause-and-effect relationships.

### Example 1 – Observational Study vs Experiment

In a random sample of students, it was observed that those students who played a musical instrument had better grades than those who did not play a musical instrument. In an experiment, a group of students who do not currently play a musical instrument were assigned at random to having to play a musical instrument or not having to play a musical instrument for six months. Then, at the end of the six months, we compare academic performance between the two groups. Why wasn't the data from the observational study considered proof that playing a musical instrument causes students to get good grades?

**Classify each of the three study methods about rock music from the warm-up as an observational study, a survey, or an experiment.**

***Example 2 – Observational Study***

An observational study records the values of variables for members of a sample.

For example, researchers investigated the link between the use of cell phones and brain cancer. There are two variables in this study: One is the extent of cell phone usage, and the second is whether a person has brain cancer. People were monitored and their cell phone use was recorded. Brain cancer rates among the participants were recorded. How could we alter the study to make it an experiment?

The first study in the US that established the link between cigarette smoking and heart attacks was an observational study. Physicians who did and didn't smoke were monitored and their heart attack rates were compared. Why wasn't this done as an experiment?

Suppose that an observational study establishes a link between asbestos exposure and lung cancer. Based on that finding, can we conclude that asbestos exposure causes lung cancer? Why or why not?

***Example 3 – Experiments***

Suppose that an observational study indicated that a certain type of tree did not have as much termite damage as other trees. Researchers wondered if resin from the tree was toxic to termites. They decided to do an experiment where they exposed some termites to the resin and others to plain water and recorded whether the termites survived. The explanatory variable (treatment variable) is the exposure type (resin, plain water), and the response variable is whether or not the termites survived.

How do we know this is an experiment?

Why were they not able to draw cause and effect conclusions based on the observational study?

A study was done to answer the question, “What is the effect of different durations of light and dark on the growth of radish seedlings?” Three similar growth chambers (plastic bags) were created in which 30 seeds randomly chosen from a package were placed in each chamber. One chamber was randomly selected and placed in 24 hours of light, another for 12 hours of light and 12 hours of darkness, and a third for 24 hours of darkness. After three days, researchers measured and recorded the lengths of radish seedlings for the germinating seeds.

Is this an observational study or an experiment? Why?

### Practice

1. For each of the following study descriptions, identify whether the study is a survey, an observational study, or an experiment, and give a reason for your answer.
  - a. A study investigated whether boys are quicker at learning video games than girls. Twenty randomly selected boys and twenty randomly selected girls played a video game that they had never played before. The time it took them to reach a certain level of expertise was recorded.
  - b. As your statistics project, you collect data by posting five questions on poster board around your classroom and recording how your classmates respond to them.
  - c. A professional sports team traded its best player. The local television station wanted to find out what the fans thought of the trade. At the beginning of the evening news program, they asked viewers to call one number if they favored the trade and a different number if they were opposed to the trade. At the end of the news program, they announced that 53.7% of callers favored the trade.
  - d. The local department of transportation is responsible for maintaining lane and edge lines on its paved roads. There are two new paint products on the market. Twenty comparable stretches of road are identified. Paint A is randomly assigned to ten of the stretches of road and paint B to the other ten. The department finds that paint B lasts longer.
  - e. The National Highway Traffic Safety Administration conducts annual studies on drivers’ seatbelt use at a random selection of roadway sites in each state in the United States. To determine if seatbelt usage has increased, data are analyzed over two successive years.

f. People should brush their teeth at least twice a day for at least two to three minutes with each brushing. For a statistics class project, you ask a random number of students at your school questions concerning their tooth brushing activities.

g. A study determines whether taking aspirin regularly helps to prevent heart attacks. A large group of male physicians of comparable health were randomly assigned equally to taking an aspirin every second day or to taking a placebo. After several years, the proportion of the study participants who had suffered heart attacks in each group was compared.

2. For the following, is the stated conclusion reasonable? Why or why not?

A study found a positive relationship between the happiness of elderly people and the number of pets they have. Therefore, having more pets causes elderly people to be happier.

3. A researcher wanted to find out whether higher levels of a certain drug given to experimental rats would decrease the time it took them to complete a given maze to find food.

a. Why would the researcher have to carry out an experiment rather than an observational study?

b. Describe an experiment that the researcher might carry out based on 30 comparable rats and three dosage levels: 0 mg, 1 mg, and 2 mg.