Mr. Murphy **HW Pg 32 #2.4, 2.8, 2.12 Pg**
AP Statistics **57 #2.36, 2.43, 2.49, 2.51 Pg**
3.2 Statistical Studies: Observations and Experiments **63 #2.56, 2.63**

Goals:
1. Distinguish between an observational study and experiment.
2. Identify possible confounding variables.
3. Distinguish double-blind from single-blind experiments.
4. Recognize the placebo effect.
5. Use a control group in an experiment when appropriate.
6. Remember the M & Ms days.

- A study is an **observational study** if the investigator observes characteristics of a sample (ideally a random sample) from a population, but does not impose a treatment.

- An **experiment** differs from an observational study in that the investigator deliberately imposes a treatment (ideally treatments are randomly assigned to test subjects).

An investigator must identify at least one or more **explanatory variables, x,** also called **factors**, to manipulate and at least one **response variable, y.** A group is treated with some **level** of the explanatory variable, and the outcome on the response is measured.

A **cause-and-effect relationship** is only possible to determine in an *experiment*.

Ex1 The Associated Press reported on an investigation that concluded that women who suffer severe morning sickness early in pregnancy are more likely to have a girl. This conclusion was reached by researchers in Sweden based on a "scientific study". Do you think that the "scientific study" referred to in the article was an experiment or an observational study?

Ex2 A study is to be designed to examine the life expectancy of tall people versus short people. Which is more appropriate, an observational study or an experiment?

Ex3 A study is to be designed to examine the GPAs of students who take marijuana regularly and those who don't. Which is more appropriate, an observational study or an experiment?

Ex4 To test the value of help sessions outside the classroom, students could be divided into three groups, with one group receiving 4 hours of help sessions per week, a second group receiving 2 hours per week, and a third group receiving no help. What are the explanatory and response variables and what are the levels?

★ When there is uncertainty with regard to which variable is causing an effect, we say the variables are **confounded**. It is easier to control **confounding variables** in an experiment rather than an observational study.

Ex5 A study of human development showed two types of movies to groups of children. Crackers were available in a bowl, and the investigators compared the number of crackers eaten by children watching the different kinds of movies. One kind of movie was shown at 8 AM (right after the children had breakfast) and another at 11 AM (right before the children had lunch). It was found that during the movie shown at 11 AM, more crackers were eaten than during the movie shown at 8 AM. The investigators concluded that the different types of movies had an effect on appetite.

The results cannot be trusted because
(a) boys and girls have different eating patterns.
(b) the investigators were biased. They knew beforehand what they hoped the study would show.
(c) the investigators should have used several bowls, with crackers randomly placed in each.
(d) the time the movie was shown and the type of movie are confounded.
(e) Children do not like movies.

Ex6 A study is made to determine whether studying Latin helps students achieve higher scores on the verbal section of the SAT exam. In comparing records of 200 students, half of whom have taken at least 1 year of Latin, it is noted that the average SAT verbal score is higher for those 100 students who have taken Latin than for those who have not. Based on this study, guidance counselors begin to recommend Latin for students who want to do well on the SAT exam. Which of the following statements are true?

I. While this study indicates a relation, it does not prove causation.
II. There could well be confounding variables responsible for the seeming relationship.
III. Self-selection here makes drawing the counselors' conclusion difficult.

(a) I and II (b) I and III (c) II and III (d) I, II, and III (e) None of the above

Ex7 Based on a survey conducted on the Dietsmart.com web site, investigators concluded that women who regularly watched Oprah were only one-seventh as likely to crave fattening foods as those who watched other daytime talk shows.

(a) Is it reasonable to conclude that watching Oprah causes a decrease in fattening foods?

(b) Is it reasonable to generalize the results this survey to all women in the United States? To all women who watch daytime talk shows? Why or why not?

- If the purpose of an experiment is to determine whether some treatment has an effect, it is important to include an experimental group that does not receive the treatment, called the **control group**.

Ex8 (2003B Q4) There have been many studies recently concerning coffee drinking and cholesterol level. While it is known that several coffee-bean components can elevate blood cholesterol level, it is thought that a new type of paper coffee filter may reduce the presence of some of these components in coffee.

The effect of the new filter on cholesterol will be studied over a 10-week period using 300 nonsmokers who each drink 4 cups of caffeinated coffee per day. Each of these 300 participants will be assigned to one of two groups: the experimental group, who will only drink coffee that has been made with the new filter, or the control group, who will only drink coffee that has been made with the standard filter. Each participant's cholesterol level will be measured at the beginning and at the end of the study.

(a) Describe an appropriate method for assigning the subjects to the two groups so that each group will have an equal number of subjects.

(b) In this study, the researchers chose to include a group who only drank coffee that was made with the standard filter. Why is it important to include a control group in this study even though cholesterol levels will be measured at the beginning and at the end of the study?

(c) Why would the researchers choose to only use nonsmokers in the study?

- A **placebo** is something that is identical (in appearance, taste, feel, etc.) to the treatment received by the treatment group, except that it contains no active ingredients.
- Subjects are subject to the **placebo effect**. Many patients respond favorable to *any* treatment, even a placebo, presumably because of trust in the doctor and expectations of a cure.
- A **single-blind experiment** is one in which the subjects do not know which treatment was received but the individuals measuring the response do know which treatment was received, or one in which the subjects do know which treatment was received but the individuals measuring the response do not know which treatment was received.
- A **double-blind experiment** is one in which neither the subjects nor the individuals who measure the response know which treatment was received.

Ex9 Pismo Beach, California, has an annual clam festival that includes a clam chowder contest. Judges rate clam chowder from local restaurants, and the judging is done in such a way that the judges are not aware of which chowder is from which restaurant. One year, much to the dismay of the seafood restaurants on the waterfront, Denny's chowder was declared the winner (when asked what the ingredients were, the Denny's cook said he wasn't sure - he just had to add the right amount of nondairy creamer to the soup stock he got from the Denny's distribution center).

(a) Do you think that Denny's chowder would have won the contest if the judging had not been "blind"? Explain.

(b) Although this was not an experiment, use your answer in Part (a) to explain why experiments are often blinded this way.

Checkpoint:
Multiple Choice Questions

1. A consumer product agency tests miles per gallon for a sample of automobiles using each of 4 different octanes of gasoline. Which of the following is true?

(a) There are four explanatory variables and one response variable.
(b) There is one explanatory variables with four levels of response.
(c) Miles per gallon is the only explanatory variable, but there are four response variables corresponding to the different octanes.
(d) There are four levels of a single explanatory variable.
(e) Each explanatory level has an associated level of response.

2. In order to assess the effects of exercise on reducing cholesterol, a researcher sampled 100 people. He assigned 50 people to exercise regularly and 50 people to not exercise regularly. They each reported to a clinic to have their cholesterol measured. The subjects were unaware of the purpose of the study, and the technician measuring the cholesterol was not aware of whether subjects exercised regularly or not. This is

(a) an observational study
(b) an experiment, but not a double-blind experiment
(c) a double-blind experiment
(d) a single blind experiment
(e) the placebo effect

This scenario applies to Questions 3 and 4:
A study was done to compare the lung capacity of coal miners to the lung capacity of farm workers. The researcher studied 200 workers of each type. Other factors that might affect lung capacity are smoking habits and exercise habits. Then smoking habits of the two worker types are similar, but the coal miners generally exercise less than the farm workers.

3. Which of the following is the explanatory variable in this study?
(a) Exercise
(b) Lung capacity
(c) Smoking or not
(d) Occupation
(e) Gender

4. Which of the following is a confounding variable in this study?
(a) Exercise
(b) Lung capacity
(c) Smoking or not
(d) Occupation
(e) Gender

Free Response Question

1. (1999 Q3) The dentists in a dental clinic would like to determine if there is a difference between the number of new cavities in people who eat an apple a day and in people who eat less than one apple a week. They are going to conduct a study with 50 people in each group.

Fifty clinic patients who report they routinely eat and apple a day and 50 patients who report they eat less than one apple a week will be identified. The dentists will examine the patients and their records to determine the number of new cavities the patients have had over the past two years. They will then compare the number of new cavities in the two groups.

(a) Why is this an observational study and not an experiment?
(b) Explain the concept of confounding in the context of this study. Include an example of a possible lurking (confounding) variable.
(c) If the mean number of cavities for those who ate an apple a day was statistically smaller then the mean number of new cavities for those who ate less that one apple a week, could one conclude that the lower number of new cavities can be attributed to eating an apple a day? Explain.