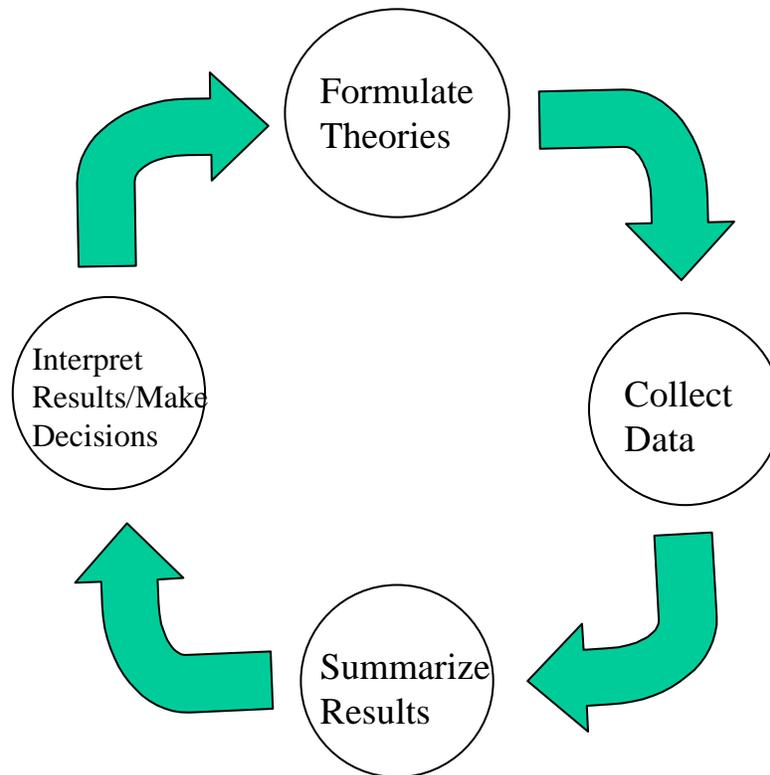


Chapter Goals

To understand the importance of looking at studies critically.



The Language of Studies

Observation versus Experimentation

Definition *In an **experiment**, the researcher actively imposes some treatment on the **units** or **subjects** in order to observe the response.*

Definition *In an **observational study**, the researcher simply observes the subjects or units and records the variables of interest.*

Note: Are there circumstances when an experiment is not feasible?

Relating Variables

Definition *A **response variable** measures an outcome of the study. It is sometimes referred to as the **dependent variable**.*

Definition *An **explanatory variable** or **factor** is a variable that is thought to explain or cause the observed outcome in the **response variable**. The explanatory variables are sometime referred to as **independent variables**.*

Definition *The possible values of the explanatory variables are called **levels**, and a specific combination of the levels of an explanatory variable is called a **treatment**.*

Example

Let's do it! 3.2

Research done at Harvard showed that regular soda drinkers may have a tendency toward the weak and brittle bones associated with osteoporosis. The researchers surveyed 2622 women who were active athletes in college and classified them as to whether or not they regularly drank soda. The proportion of women in each group who suffered from bone fractures was determined. It was found that those who drank soda regularly were twice as likely to suffer from bone fractures than those who did not drink regularly.

- 1.** Is this an observational study or an experiment?
- 2.** What is the population under study?
- 3.** What was the explanatory variable?
- 4.** What was the response variable?
- 5.** Suppose the 2622 women were selected as follows: From a list of all women sports events available at Harvard, three events were selected at random. Then all women athletes who participated in these three events were contacted for the study. What type of sampling technique is illustrated here?

Confounding

Definition *A confounding variable is a variable whose effect on the response variable cannot be separated from the effect of the explanatory variable on the response variable.*

Let's do it! 3.3

Researchers examined the records of a large number of cancer patients. Some patients received an invasive treatment, and the other did not. Patients who received the invasive treatment survived longer than patients who did not receive the invasive treatment.

What can you conclude?

- Is this an observational study or an experiment?

Observational Studies

Observational studies are normally categorized into retrospective and prospective studies.

Definition *A **retrospective study** is a study of past events. Researchers identify subjects that have experienced certain responses and look back to see if the subjects also had various factors or explanatory variables. A retrospective study works from the responses to the potential explanatory variables.*

Definition *A **prospective study** is a study of ongoing or future events. Researchers identify subjects who have various explanatory variables or factors and follow them into the future and record the responses. A prospective study works from the potential explanatory variables to the responses.*

Example *Suicide researchers are faced with a major problem because their subjects are no longer alive. How can investigators draw conclusions about the intentions, feelings, and circumstances of people who are no longer available to answer such questions?*

Example *In a study of 43,000 health professionals, it was found that a diet high in fiber from cereal, fruit and vegetables could significantly lower the risk of heart attacks in men. In this study, healthy dentists, veterinarians, pharmacists, optometrists, osteopaths, and podiatrists, ages 40 to 75, were divided into five groups from highest to lowest fiber consumption. The men were observed for six years. The number of heart attacks that occurred for the men in each group was recorded. The men in the highest-fiber group had a 36% lower risk of a heart attack during the study period than men in the lowest-fiber group.*

Experiments

Experiments are designed to study the links between explanatory variables and the response variable by holding everything constant except the explanatory variable.

Definition *The objects on which an experiment is performed are called the **experimental units**, or **subjects**.*

Definition *The possible values of an explanatory variable are called the **levels** of that **factor**. A **treatment** is a particular combination of the levels of each of the explanatory variables.*

Definition *A **design layout table** displays the various combinations of the levels of each of the explanatory variables in an experiment.*

Let's do it! 3.5

An experiment has been conducted to study the effect of temperature and type of oven on the lifetime of a metal clutch component. Four types of ovens and three temperature levels were used in the experiment. Two clutch components were assigned randomly to each combination of type of oven and temperature level.

- 1.** For this experiment:
 - a.** what are the experimental units?
 - b.** what is the response variable?
 - c.** what are the factors and the levels of the factors?
 - d.** list the treatments.

- 2.** Draw the design layout table for this situation.

Planning Experiments

Exercise *A researcher believes that taking a daily dose of vitamin C will help reduce the incidence of colds in elementary school children. To assess this claim, 100 elementary school children, who volunteered and for whom parental consent was received, were given a daily dose of vitamin C for a three-month winter period. The number of colds during this season was recorded for each subject. For this experiment we have 100 subjects, one response variable, the number of colds, and one explanatory variable, vitamin C, at one level, a daily dose.*

Results

# of Colds	0	1	2	3	≥ 4
Frequency	45	28	12	7	8

Based on this data, does taking a daily dose of Vitamin C help?

Definition *A **treatment group** is a group of subjects or experimental units that receive an actual treatment.*

Definition *A **control group** is a group of subjects or experimental units that are treated identically in every way, except that they do not receive an actual treatment.*

Exercise *Can you now think of a better way of assigning the 100 subjects? How would you decide which subject gets what treatment?*

Definition *In a completely randomized experiment, experimental units are randomly assigned to the treatments.*

Exercise *A researcher has a treatment group and a control group. The control group will receive a placebo. The subjects will be randomly assigned to one of the two groups. Those in the treatment groups receive a bottle of medication marked DRUG, while those in the control group receive a bottle of medication marked PLACEBOS. Comment on this experimental design?*

Definition *The **placebo effect** is a phenomenon in which even administration of an inert drug improves the condition of the subjects.*

Definition ***Experimenter bias** is the distortion that can arise on the part of the experimenter due to how the subjects are assigned to the groups, which variables are measured and how they are measured, and how the results are interpreted.*

Definition *A **single-blind** experiment is one in which the subjects are ignorant of which treatment they receive.*

Definition *A **double-blind** experiment is one in which neither the subjects nor those working with the subjects knows who is receiving which treatment.*

Definition *If at least two units are assigned to each treatment combination, we have **replication** in an experiment.*

Definition *An experimental design is **balanced** when each treatment combination has the same number of experimental units.*

Chapter Summary

Basic Principles for Design of Experiments:

Randomization Use randomization to assign units to the groups. Randomization tends to produce groups of experimental units that are similar with respect to potential confounding factors. Randomization ensures that the experiment does not intentionally favor one treatment over another.

Control Control the effects of confounding variables by using a comparative design. If all subjects are treated exactly the same across the groups, except for the actual treatment they received, potential confounding variables should affect both groups equally and tend to cancel each other out when comparing the results from two groups.

Blinding If possible, give a placebo to the control group. Neither the subjects nor anyone working with the subjects should know who is receiving the treatment and who is getting the placebo.

Replication If possible, assign at least two units to each treatment combination to help assess the natural variation in the responses between