

1.4 Experimental Design

Learning Objectives:

In this section, you will:

- Recognize and differentiate between key terms in experimental design.
- Identify proper experimental design.

Experimental Design

The purpose of an experiment is to investigate relationship between two variables.

- **Explanatory variable** is the independent variable in an experiment. This variable causes change in another variable.
- **Response variable** is the dependent variable in an experiment. This variable is measured for change at the end of the experiment.

In a randomized experiment, the researcher manipulates values of the explanatory variable and measures the resulting changes in the response variable.

- **Treatments** are the different values of the explanatory variable.
- **Experimental unit** is a single object or individual to be measured.
- **Lurking variable** is a variable that has an effect on a study even though it is neither an explanatory nor a response variable.
- **Random assignment** is organizing experimental units into treatment groups using random methods.

When participation in a study prompts a physical response from a participant, it is difficult to isolate the effects of the explanatory variable. To counter the power of suggestion, researchers use the following:

- **Control group** is a group that receives an inactive treatment but is otherwise managed exactly as the other group.
- **Placebo** is an inactive treatment that has no effect on the explanatory variable.
- **Blinding** is not telling the participant which treatment a subject is receiving.
- **Double-blinding** is the act of blinding both the subjects and the researchers working with the subjects.

Example 1:

Researchers want to investigate whether taking aspirin regularly reduces the risk of heart attack. Four hundred men between the ages of 50 and 84 are recruited as participants. The men are divided randomly into two groups: one group will take aspirin, and the other group will take a placebo. Each man takes one pill each day for three years, but he does not know whether he is taking aspirin or the placebo. At the end of the study, researchers count the number of men in each group who have had heart attacks.

Identify the following values for this study: population, sample, experimental units, explanatory variable, response variable, treatments.

Example 2:

The Smell & Taste Treatment and Research Foundation conducted a study to investigate whether smell can affect learning. Subjects completed mazes multiple times while wearing masks. They completed the pencil and paper mazes three times wearing floral-scented masks, and three times with unscented masks. Participants were assigned at random to wear the floral mask during the first three trials or during the last three trials. For each trial, researchers recorded the time it took to complete the maze and the subject's impression of the mask's scent: positive, negative, or neutral.

- a. Describe the explanatory and response variables in this study.
- b. What are the treatments?
- c. Identify any lurking variables that could interfere with this study.
- d. Is it possible to use blinding in this study?

Ethics

When a statistical study uses human participants, the researcher should be mindful of the safety of their research subjects. Key protections that are mandated by law include the following:

- Risks to participants must be minimized and reasonable with respect to projected benefits.
- Participants must give informed consent. This means that the risks of participation must be clearly explained to the subjects of the study.
- Data collected from individuals must be guarded carefully to protect their privacy.

Example 3:

Describe the unethical behavior in each example and describe how it could impact the reliability of the resulting data. Explain how the problem should be corrected.

A researcher is collecting data in a community.

- a. She selects a block where she is comfortable walking because she knows many of the people living on the street.
- b. No one seems to be home at four houses on her route. She does not record the addresses and does not return at a later time to try to find residents at home.
- c. She skips four houses on her route because she is running late for an appointment. When she gets home, she fills in the forms by selecting random answers from other residents in the neighborhood.

For more information and examples see online textbook OpenStax Introductory Statistics pages 35-39.

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