2.4: Type of Research Designs

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Research studies come in many forms, and, just like with the different types of data we have, different types of studies tell us different things. The choice of research design is determined by the research question and the logistics involved. Though a complete understanding of different research designs is the subject for at least one full class, if not more, a basic understanding of the principles is useful here. There are three types of research designs we will discuss: non-experimental, quasi-experimental, and random experimental.

Non-Experimental Designs

Non-experimental research (sometimes called correlational research) involves observing things as they occur naturally and recording our observations as data. In **observational studies**, information is gathered from observing. This could include self-report as well as interviews.

> Consider this example: A data scientist wants to know if there is a relation between how conscientious a person is and whether that person is a good employee. She hopes to use this information to predict the job performance of future employees by measuring their personality when they are still job applicants. She randomly samples volunteer employees from several different companies, measuring their conscientiousness and having their bosses rate their performance on the job. She analyzes this data to find a relation. Conscientiousness is a person-based variable that researcher must gather data from employees as they are in order to find a relation between her variables.

This type of research design cannot establish causality, it can still be quite useful. If the relation between conscientiousness and job performance is consistent, then it doesn't necessarily matter is conscientiousness causes good performance or if they are both caused by something else – she can still measure conscientiousness to predict future performance. Additionally, these studies have the benefit of reflecting reality as it actually exists since we as researchers do not change anything.

Experimental Designs

If we want to know if a change in one variable causes a change in another variable, we must use a true experiment. *A true experiment is an experimental design with random assignment.* In an **experimental design** a researcher assigns or manipulates, the group's participants will be in. Further, each participant is **randomly assigned** to a group. If there is no random assignment, the experiment can not have cause-effect conclusions.

Types of Variables in an Experiment

When conducting research, experimenters often manipulate variables. For example, an experimenter might compare the effectiveness of four types of antidepressants. In this case, the variable is "type of antidepressant." When a variable is manipulated by an experimenter, it is called an **independent variable**. The experiment seeks to determine the effect of the independent variable on relief from depression. In this example, relief from depression is called a **dependent variable**. In general, the independent variable is manipulated by the experimenter and its effects on the dependent variable are measured.

> To understand what this means, let's look at an example: A clinical researcher wants to know if a newly developed drug is effective in treating the flu. Working with collaborators at several local hospitals, she randomly samples 40 flu patients and randomly assigns each one to one of two conditions: Group A receives the new drug and Group B received a placebo. She measures the symptoms of all participants after 1 week to see if there is a difference in symptoms between the groups.

In the example, the *independent variable* is the drug treatment; we manipulate it into 2 levels: new drug or placebo. Without the researcher administering the drug (i.e. manipulating the independent variable), there would be no difference between the groups. Each person, after being randomly sampled to be in the research, was then randomly assigned to one of the 2 groups. That is, random sampling and random assignment are *not* the same thing and cannot be used interchangeably. *For research to be a true experiment, random assignment must be used.* For research to be representative of the population, random sampling must be used. The use of both techniques helps ensure that there are no systematic differences between the groups, thus eliminating the potential for sampling bias. The *dependent variable* in the example is flu symptoms. Barring any other intervention, we would assume that people in both groups, on average, get better at roughly the same rate. Because there are no systematic differences between the 2 groups, if the researcher does find a difference in symptoms, she can confidently attribute it to the effectiveness of the new drug.

Can you identify the independent and dependent variables?

Example #1: Can blueberries slow down aging? A study indicates that antioxidants found in blueberries may slow down the process of aging. In this study, 19-month- old rats (equivalent to 60-year-old humans) were fed either their standard diet or a diet supplemented by either blueberry, strawberry, or spinach powder (randomly assigned). After eight weeks, the rats were given memory and motor skills tests. Although all supplemented rats showed improvement, those supplemented with blueberry powder showed the most notable improvement.

- What is the independent variable? (dietary supplement: none, blueberry, strawberry, and spinach)
- What are the dependent variables? (memory test and motor skills test)

Example #2: Does beta-carotene protect against cancer? Beta-carotene supplements have been thought to protect against cancer. However, a study published in the Journal of the National Cancer Institute suggests this is false. The study was conducted with 39,000 women aged 45 and up. These women were randomly assigned to receive a beta-carotene supplement or a placebo, and their health was studied over their lifetime. Cancer rates for women taking the beta-carotene supplement did not differ systematically from the cancer rates of those women taking the placebo.

- What is the independent variable? (supplements: beta-carotene or placebo)
- What is the dependent variable? (occurrence of cancer)

Example #3: How bright is right? An automobile manufacturer wants to know how bright brake lights should be in order to minimize the time required for the driver of the following car to realize that the car in front is stopping and to hit the brakes.

- What is the independent variable? (brightness of brake lights)
- What is the dependent variable? (time to hit brakes)

Levels of an Independent Variable

In order to establish that one variable must cause a change in another variable and so a researcher will likely use two groups or levels in order to observe the changes and make comparisons.

- **Experimental (treatment) group** is the group who are exposed to the independent variable (or the manipulation) by the researcher; the experimental group represents the treatment group.

- **Control group** is the group who are not exposed to the treatment variable; the control group serves as the comparison group.

If an experiment compares an experimental treatment group with a control group, then the independent variable (type of treatment) has two levels: experimental and control. Further, if an experiment were comparing five types of diets, then the independent variable (type of diet) would have 5 levels. In general, the number of levels of an independent variable is the number of experimental conditions. *Another term for levels for the independent variable is groups, treatments, or conditions.*

Scores from the experimental group are compared to scores in the control group and if there is a systematic difference between groups then there is evidence of a relationship between variables. Let's use our earlier example of stress as a way to illustrate the experimental method. Let's assume that a researcher examining stress wants to test the impact of a stress reduction program on the stress levels of students and recruits 100 students to participate. Students are randomly assigned to either the experimental group or the control group. The experimental group participates in the stress reduction program but the control group does not. The stress-reduction program is the independent variable and stress level is the dependent variable. At the end of the training program each group, the experimental group, and the control group complete a stress test, and the scores are compared. If the stress reduction program worked, then the stress levels for the experimental group should be lower than the stress levels for the control group.

Quasi-Experimental Designs

Quasi-experimental research involves getting as close as possible to the conditions of a true experiment when we cannot meet all requirements. Specifically, a **quasi- experiment** involves manipulating the independent variable but *not* randomly assigning people to groups. There are several reasons this might be used. First, it may be unethical to deny potential treatment to someone if there is good reason to believe it will be effective and that the person would unduly suffer if they did not receive it. Alternatively, it may be impossible to randomly assign people to groups.

> Consider the following example: A professor wants to test out a new teaching method to see if it improves student learning. Because he is teaching two sections of the same course, he decides to teach one section the traditional way and the other section using the new method. At the end of the semester, he compares the grades on the final for each class to see if there is a difference.

In this example, the professor has manipulated his teaching method, which is the independent variable, hoping to find a difference in student performance, the dependent variable. *However, because students enroll in courses, he cannot randomly assign the students to a particular group, thus precluding using a true experiment to answer his research question.* Because of this, we cannot know for sure that there are no systematic differences between the classes other than teaching style and therefore cannot determine causality.

Extraneous and Confounding Variables

Sometimes in a research study things happen that make it difficult for a researcher to determine whether the independent variable caused the change in the dependent variable. These have special names.

- An **extraneous variable** is something that occurs in the environment or happens to the participants that unintentionally (accidentally) influences the outcome of the study. An extraneous variable affects everyone in a study.In an experiment on the effect of expressive writing on health, for example, extraneous variables would include participant variables (individual differences) such as their writing ability, their diet, and their shoe size. They would also include situation or task variables such as the time of day when participants write, whether they write by hand or on a computer, and the weather. Extraneous variables pose a problem because many of them are likely to have some effect on the dependent variable. For example, participants' health will be affected by many things other than whether or not they engage in expressive writing. This can make it difficult to separate the effect of the independent variable from the effects of the extraneous variables, which is why it is important to control extraneous variables by holding them constant.
- A **confounding variable** is a type of extraneous variable that changes at the same time as the independent variable, making it difficult to discern which one is causing changes in the dependent variable.
