MATH 201: Lecture 2b Handout

Section 1.4 Experiments

Name:_____ Date:_____

Learning goals for today

By the end of this lecture, you should be able to:

- Distinguish between an **observational study** and an **experiment**
- Identify the **explanatory** and **response** variables in an experiment
- Explain what **random assignment** does and why it matters
- Describe **confounding variables** and how experiments control for them
- Explain the role of **control groups**, **placebos**, and **blinding**

The Sneakers and Speed thought experiment

Consider the following research question: do good running shoes make people run faster? Say we collected a sample and saw that people with better running shoes tended to have lower mile times.

- Response variable:
- Explanatory variable:

Observational study version

Suppose people in the study brought their own shoes. Answer the following:

- Who is more likely to wear good running shoes?

- What variable(s) might affect *both* shoe choice and running speed?

This variable is called a **confounding variable**. Confounding variables can make it appear that there is a relationship between another two variables, when there is not.

- We cannot control for confounding in observational studies, so we **cannot a make causal conclusion from an observational study!**

Experimental version (random assignment)

Now suppose we **randomly assign** people to wear either good shoes or regular shoes. Answer the following:

- Does athletic ability determine who gets good shoes? Yes / No
- What does random assignment do to athletic ability across groups?

Complete the sentence: *Random assignment helps control for confounding because it*:

Key components of an experiment:

Match each term in the **left column** with the correct description in the **right column**. Write the letter of the description next to each term.

Terms		**Descriptions**
1. Treatment	_____	A. A numerical summary that describes a population
2. Control group	_____	B. When neither participants nor researchers know who receives which treatment
3. Placebo	_____	C. A variable related to both the explanatory variable and the response that can distort results
4. Random assignment	_____	D. A fake or inactive treatment designed to look like the real one
5. Blinding	_____	E. A process that assigns individuals to groups by chance to reduce confounding
6. Double-blind experiment	_____	F. A subset of the population that is actually observed
7. Confounding variable	_____	G. The condition applied to individuals in an experiment
8. Statistic	_____	H. When participants do not know which treatment group they are in
9. Parameter	_____	I. A group that does not receive the treatment and is used for comparison

Example: Does chewing caffeine gum improve reaction time compared to regular gum?

Researchers recruit 120 college students to participate in a reaction-time study. Students are randomly assigned to one of two groups:

- One group chews caffeine gum before completing a reaction-time task.
- The other group chews regular gum that looks and tastes the same but contains no caffeine.

Neither the students nor the researchers administering the task know which type of gum each student receives. After chewing the gum, all students complete the same computerized reaction-time test.

Identify the components of the study:

- Response variable:
- Explanatory variable:
  - Treatment group:
  - Control group:
    - Placebo (if used):
- Blinding (if used):
- Study type:

Scope of inference:

Will the findings of this study be generalizable to the population of interest? If so, why?

Is there the potential for a causal conclusion? If so, why?

Applet: Hand-selected mice vs. random assignment

We will examine a simulation that compares **hand-selected groups** to **randomly assigned groups** of mice.

Before running the applet (predict)

When researchers **hand-pick** mice into treatment groups, what is likely to happen?

☐ Groups may differ in important ways
☐ Groups will be balanced automatically
☐ Confounding is unlikely

Explain briefly:

After running the applet (observe)

https://psu-eberly.shinyapps.io/Mouse_Experiment_on_Random_Assignment/
When mice are **randomly assigned** to groups:

- ☐ Groups tend to be more similar overall
- ☐ Groups are guaranteed to be identical
- ☐ Confounding is eliminated completely

Explain what you observed:

We saw an experiment can technically be done without random assignment. Explain why we should do random assignment in an experiment.

Reflection

What is **one new idea** from today's class?

What is **one question** you still have about experiments?