Lecture 2: Chapter 3, Section 3
Designing Studies
(Focus on Observational Studies)

- Issues for any Study Design
- Design; Experiment or Observational Study
- Establishing Causation
- Paired vs. Two-sample Design
- Pitfalls of Observational Studies

Issues to Consider for Any Study Design

- Sample size
- Errors in Study's Conclusions

Example: *Sample Size and Study Design*

- **Background:** Researchers want to know if stronger sunscreens cause more time in sun. They could test this with an observational study or an experiment.
- **Question:** Which is better, using 10 students or 100 students?
- **Response:** It depends…
  - If study is flawed (poorly designed experiment or observational study)

    → _____
  - If study is well-designed

    → _____

Issues to Consider for Any Study Design

- Sample size
- Errors in Study's Conclusions

Example: *Two Types of Error*

- **Background:** A study tested effectiveness of radar guns to identify speeders, concluding the guns do work properly or they don't.
- **Question:** What are the two possible errors in the study's conclusions, and the potential harmful consequences of each?
- **Response:**
  1. conclude guns _____ (consequence: _____)
  2. conclude guns _____ (consequence: _____ or _____)

Example: *Sample Size and Error*

- **Background:** A study tested effectiveness of radar guns to identify speeders.
- **Question:** Which error is more likely to be made if only a small sample of guns is tested?
- **Response:**

Example: *Errors in Home Drug Testing*

- **Background:** A study discussed limitations and risks in the use of home drug testing kits.
- **Question:** What are the two possible errors in a drug test's conclusions, and the potential harmful consequences of each?
- **Response:**
  - False positive due to _____
    → _____
  - False negative due to _____
    or _____
    → _____

Looking Back: *Review*

- **4 Stages of Statistics**
  - Data Production
    - Obtain unbiased sample *(discussed in Lecture 1)*
    - Design a study that assesses sampled values of single variable or relationship without bias
  - Displaying and Summarizing
  - Probability
  - Statistical Inference

Definitions

- **Observational study**: researchers record variables' values as they naturally occur (can be retrospective or prospective).
- **Sample survey:** observational study with self-reported values, often opinions
- **Experiment:** researchers manipulate explanatory variable, observe response
- **Anecdotal evidence:** personal accounts by one or a few individuals selected haphazardly or by convenience. *(To be avoided.)*

Definitions

- **Retrospective** observational study: researchers record variables' values backward in time, about the past.
- **Prospective** observational study: researchers record variables' values forward in time from the present.

Example: *Scientific Evidence?*

- **Background**: In response to a newspaper report, a mother wrote to the editor:

"I have a problem with the study that stated that breast-fed babies are smarter than bottle fed…My 10-month old son has always been bottle fed and he is very smart. I have been told by his pediatrician that in some aspects he is ahead for his age. I feel that this study contains some inaccuracies. Obviously, the people who conducted this study have never met my son."

- **Question:** What kind of evidence does she provide?
- **Response:**

Practice: 3.1b p.36

Example: *Studies Claiming Causation*

- **Background**: Consider these headlines…
  - *When your hair's a real mess, your self-esteem is much less*
  - *Dental X-rays might result in small babies*
  - *Family dinners benefit teens*
  - *When Parents Pay for College, Kids' Grades Could Suffer*
- **Question:** How convinced should we be that changes in the first variable actually *cause* changes in the second variable?
- **Response:** It depends on _____

Since various designs are subject to various pitfalls, the first step is identify type of design.

Example: *Identifying Study Design*

- **Background**: Suppose researchers want to determine if TV makes people snack more.
  - *While study participants are presumably waiting to be interviewed, half are assigned to a room with a TV on (and snacks), the other half to a room with no TV (and snacks). See if those in the room with TV consume more snacks.*
- **Question:** What type of study design is this?
- **Response:**

Practice: 3.50a p.62

Example: *Identifying Study Design*

- **Background**: Suppose researchers want to determine if TV makes people snack more.
  - *Poll the class: "How many of you tend to snack more than usual while watching TV?"*
- **Question:** What type of study design is this?
- **Response:**

Example: *Identifying Study Design*

- **Background**: Suppose researchers want to determine if TV makes people snack more.
  - *Give participants journals to record hour by hour their activities the following day, including TV watched and food consumed. Afterwards, assess if food consumption was higher during TV times.*
- **Question:** What type of study design is this?
- **Response:**

Example: *Identifying Study Design*

- **Background**: Suppose researchers want to determine if TV makes people snack more.
  - *Ask participants to recall for each hour of the previous day, whether they were watching TV and what food they consumed. Assess if food consumption was higher during TV times.*
- **Question:** What type of study design is this?
- **Response:**

Example: *Designing Particular Type of Study*

- **Background**: Suppose researchers want to determine if sugar makes children hyperactive.
- **Question:** How can they test this, using each of the following types of design?
  - observational study
  - experiment
- **Response:** Obtain a sample of children, compare proportions hyperactive for low vs. high sugar intake
  - (for an observational study) with sugar intake determined by _____
  - (for an experiment) with sugar intake determined by _____

Practice: 3.8 p.37

Example: *Main Pitfall in Observational Studies*

- **Background**: Suppose the observational study shows that a greater proportion of children with high sugar intake were found to be hyperactive.
- **Question:** Can we conclude sugar *causes* hyperactivity?
- **Response:** _____

  Individuals who opt for certain explanatory values may differ in ways that also affect the response.

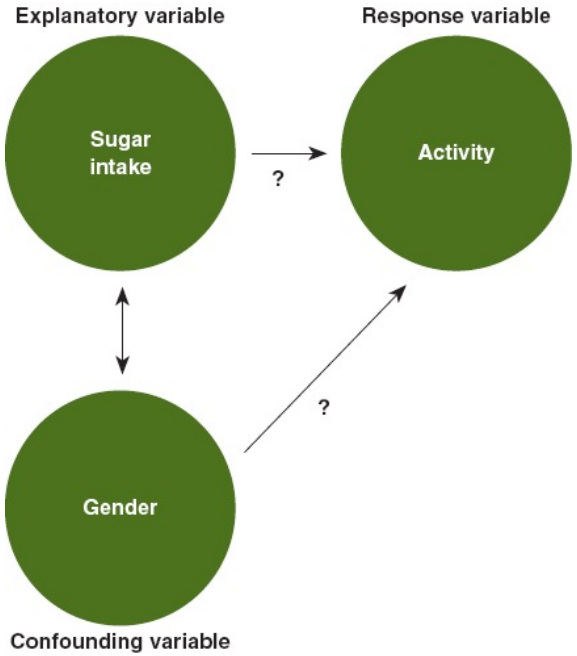
Definition

- **Confounding variable**: one that confuses the issue of causation because its values are tied in with those of "explanatory" variable, and also play a role in "response" variable's values.

Looking Ahead: *Confounding variables are by far the most common weakness of observational studies.*

Example: *Controlling for Confounding Variables*

- **Background:** Gender may be a confounding variable in the relationship between sugar and hyperactivity.
- **Question:** How can researchers take this possible confounding variable into account?
- **Response:**



Practice: 3.30c p.50

Example: *Multiple confounding variables*

- **Background**: Suppose researchers want to determine if sugar makes kids hyperactive.
- **Question:** What are other possible confounding variables besides gender?
- **Response:** There are many other possible confounding variables:

Definitions

- **Two-sample design:** compares responses for two independent groups.
- **Paired design:** a pair of response values is recorded for each unit.

A Closer Look: *Typical paired designs include before-and-after studies and comparisons of responses for pairs of individuals like twins, siblings, or married couples. "Matched pairs" is a specific type of paired design.*

Example: *Two-sample vs. paired study*

- **Background**: Researchers seek evidence that sugar causes hyperactivity in children. A two-sample design would compare proportions hyperactive for 2 groups (low or high sugar).
- **Question:** How could evidence be gathered via a paired design?
- **Response:**

A Closer Look: *Either design could be an observational study or an experiment.*

Other pitfalls in observational studies

Recall: two types of observational study—

- Retrospective (carried backward in time)
- Prospective (carried forward in time)

Example: *Drawback of prospective study*

- **Background**: Suppose researchers use a prospective study to determine if TVmakes people snack more.
  - *Give participants journals to record hour by hour their activities the following day, including TV watched and food consumed. Afterwards, assess if food consumption was higher during TV times.*
- **Question:** What is the study design's disadvantage?
- **Response:**

Example: *Drawback of retrospective study*

- **Background**: Suppose researchers use a retrospective study to determine if TV makes people snack more.
  - *Ask participants to recall for each hour of the previous day, whether they were watching TV and what food they consumed. Assess if food consumption was higher during TV times.*
- **Question:** What is the disadvantage of this study design?
- **Response:**

Example: *Vulnerability to Confounding Variables*

- **Background**: Consider these headlines…
  - *When your hair's a real mess, your self-esteem is much less*
  - *Dental X-rays might result in small babies*
  - *Family dinners benefit teens*
  - *When Parents Pay for College, Kids' Grades Could Suffer*
- **Question:** To decide if each study is vulnerable to confounding variables, what should be the first step?
- **Response:** Determine if it was _____

_____

Example: *Considering Confounding Variables*

- **Background**: Consider this headline…
  - *When your hair's a real mess, your self-esteem is much less*
- **Questions:** Was the study observational? Are there possible confounding variables?
- **Responses:** We'd suspect it to be

_____

Practice: 3.1a p.36

Example: *More on Confounding Variables*

- **Background**: Consider this headline…
  - *Dental X-rays might result in small babies*
- **Questions:** Was the study observational? Are there possible confounding variables?
- **Responses:** It had to be _____

No obvious confounding variables would link dental X-rays and small babies. (_____ if anything, would cause the opposite result.)

Example: *More Examples of Confounding*

- **Background**: Consider these headlines…
  - *Family dinners benefit teens*
  - *When Parents Pay for College, Kids' Grades Could Suffer*
- **Questions:** Were the studies observational? Are there possible confounding variables?
- **Responses:** The first _____

Confounding? _____

_____

The second was _____

Confounding? _____

_____

Lecture Summary *(Designing Studies)*

- Issues for any study design: Sample Size, Errors
- Types of Study
  - Experiment
  - Observational study (includes sample survey)
  - Anecdotal evidence
- Causation and confounding variables in observational studies
- Paired or two-sample design
- Other pitfalls of observational studies
  - Faulty memory (retrospective design)
  - Less natural behavior (prospective design)