

## SAMPLING METHODS AND RESEARCH DESIGNS

Chapter 4

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Scientific research can be divided into two categories:

- Observational studies
  - EXAMPLES:
    - Collecting the sale price for existing homes
    - Sampling gas prices from 50 local gas stations
    - Counting the number of drivers not wearing seatbelts at a busy intersection
- **2** True experiments
  - EXAMPLES:
    - Testing the effect of a new sleep-aid medication
    - Comparing HEAD start to traditional education methods



Scientific research can be divided into two categories:

# Observational studies

- The researcher is only observing and collecting data
- No variables (i.e., IV) are manipulated by the researcher
- Data is collected to describe:
  - Characteristics of a variable for a sample or population
    - EXAMPLE: Mode, median, mean, and standard deviation
  - How much two or more variables have in common
    - EXAMPLE: Correlation



Scientific research can be divided into two categories:

- A true experiment
  - Requires comparing two or more conditions
    - A typical comparison is treatment versus placebo
      - A placebo simulates the treatment in every way except it has no effect on the dependent variable
  - Often involves more than one independent variable
    - EXAMPLE:
      - Giving participants a sleep aid (IV #1) and training them how to meditate for relaxation (IV #2)



#### True experiments:

## In a true experiment

- The researcher manipulates the IV and determines if different types or amounts of the IV affect the DV differently
  - Provides a method for discovering a cause-andeffect relationship between the IV and DV
- The researcher attempts to control all variables, except the IV, and tries to answer the question "does the IV cause the DV to change?"



#### True experiments:

- **1** True experiments
  - EXAMPLES:
    - Does toothpaste with baking soda brighten teeth more than regular toothpaste without baking soda?
      - $IV \rightarrow$  Amount of baking soda (some or none)
      - $DV \rightarrow$  Amount of change in brightness of teeth
    - How does wearing jeans versus dress pants affect an employee's sales?
      - $IV \rightarrow Type$  of pants (blue jeans or dress pants)
      - DV → Number of sales made



#### Observational Studies versus True Experiments:

- Observational studies involve describing what was observed, whereas experiments often attempt to identify a cause-and-effect relationship
- Observational studies collect information without manipulating any variables or changing the environment
- True experiments involve holding all variables constant while changing the type or amount of the IV from one group/condition to the next
- Results from observational studies may be easier to generalize to the population, but the results from true experiments are less likely to contain lurking and confounding variables



#### Lurking and confounding variables:

- Well designed experiments attempt to remove the effects of any lurking and possibly confounding variables
  - A lurking variable is a variable not accounted for by the researcher
    - These variables may or may not contaminate the results of the study
  - A lurking variable that interacts with the IV and DV is known as a confounding variable
    - Confounding variables are those unaccounted variables that the researcher mistakenly associates an effect with the IV when in fact the effect is due to the confounding variable



#### Lurking and confounding variables:

# **0** EXAMPLES:

- Examining the effects of a new skincare product by comparing *before* and *after* pictures
  - The *after picture* is brighter than the *before picture* and the person is smiling in the *after picture* but not in the *before picture*
- Comparing the average final exam score of a lecture only class to the average final exam score of a lecture plus group activities class
  - During the final exam for the lecture plus group activities class, the gardeners were outside making noise



#### Subjects can be:

- People, animals, plants and trees, equipment, manufactured items, stores, cars, times of the year
  - EXAMPLES:
    - Patients, students, elderly, shoppers
    - Honeybees, stalks of corn, field grass
    - DVD players, copy machines, tools
    - Spring, summer, fall, winter



#### Example 1:

- A university wants to know if the cost of using the internet for long-distance phone calls affects students' willingness to use this service. An internet phone service is offered to all 350 students in one of the dormitories. Some students pay a low flat rate per month, while others pay higher rates during peak usage periods. Researchers will measure the amount and time students use this service, and how these two plans affect congestion on the network.
  - Who are the subjects?
  - What is the IV and its levels? What's the DV?

Example 2:

- A chemical engineer is designing the production process for a new product. The chemical reaction that produces the product may have higher or lower yield, depending on the temperature and the stirring rate in the vessel in which the reaction takes place. The engineer decides to investigate the effects of combinations of two temperatures (50°C and 60°C) and three stirring rates (60 RPM, 90 RPM, and 120 RPM) on the yield of the process. She will process two bathes of the product at each combination of temperature and stirring rate.
  - Who are the subjects?
  - What is the IV and its levels? What's the DV?

Example 3:

● The Physicians' Health Study investigated the effects of aspirin and beta carotene. The subjects were 21,996 male physicians. Each independent variable had two levels → one treatment group and one placebo/control



- Who are the subjects?
- What is the IV and its levels? What's the DV?

Example 3:

- Results of the data analysis: Only 139 of the physicians taking aspirin suffered heart attacks, whereas 239 of the physicians who took the placebo pill had heart attacks
- There was no benefit of taking beta carotene observed
  - Rates of cancer in both treatment and placebo conditions were about the same
- Although these results make a strong argument for the benefits of taking a daily aspirin, the results may not generalize to what segment of the population?



# What is a sample?

- A sample is a subgroup of elements from a population
  - Can be any size
    - EXAMPLE: A single person or 50 people
  - The larger the sample, the more likely the sample will share the same characteristics as the population
    - **EXAMPLE:** Flipping a coin
      - The more times we flip a coin, the more likely we are to observe an equal split (i.e., 50/50) of coin tosses into heads or tails



# How should a sample be selected from the population?

- It is more likely a sample will resemble the population when:
  - The sample size is larger
  - The method used to select the sample utilizes a random process
- Non-random sampling methods often lead to results that are not representative of the population
  - EXAMPLE: Asking evening students if there is sufficient parking available on campus
    - Would these results be representative of all students at UNM-Valencia?



## Simple Random Sampling:

- A method that ensures each member of the population has an equal chance of being selected
  - EXAMPLE: A list of all currently enrolled students at UNM-Valencia is obtained and a table of random numbers is used to select a sample of students
  - EXAMPLE: A researcher obtains a list of all residential addresses in the county and uses a computer to generated a random list of homes to be included in a survey
- Other methods may seem random, but don't allow each member to have an equal chance of being selected into the sample



# Cluster Sampling:

- Divides the population into a large number of clusters
- Output the desired number of clusters are randomly selected
- In the selected clusters are included in the study
  - EXAMPLE: A researcher randomly selects 25 zip codes from list of all postal zip codes in the state
    - All residents in the selected zip codes are included in the study



# Stratified Random Sampling:

- Divides the population into pre-existing strata
- Ø Simple random sampling is applied to each strata
- Only those participants selected are included in the study
- Insures that members of each identified group are included in the sample
  - EXAMPLE: A survey of the President's popularity is conducted across racial groups
    - 15 participants are randomly selected from each racial group



## Cluster Sampling versus Stratified Random Sampling

- How would these two sampling methods differ in selecting students from all high schools in New Mexico?
  - Cluster Sampling: A number of high schools would be randomly selected from a list of all high schools in NM
    - All students from selected high schools would be included in the study
  - Stratified Random Sampling: A specific number of students would be randomly selected from each high school in NM
    - Unlike Cluster Sampling, this method ensures that every high school in NM is represented in the study



#### Biased or non-random sampling methods:

- Sampling methods that do not ensure each member of the population has an equal chance of being selected into the study
  - Voluntary response samples
    - Studies that recruit participants through advertising
    - Newspaper, magazine, and television surveys
  - Haphazard or convenience samples
    - Recruiting participants from locations where lots of people tend to congregate (shopping malls, state fairs, concerts, college campuses)



Other problems that can occur in research:

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- Phone surveys of homes conducted during the day
- Response bias (timing and sensitivity)
  - Conducting a survey on a sensitive issue that involves a current event
- Oultural bias and poorly worded questionnaires
  - Language and other cultural bias can affect how people understand and answer a question
  - How a survey question is asked can influence how people answer

# Chapter 4 SYSTEMATIC BIAS



#### What is systematic bias?

- Intentional or unintentional procedures used by the researcher that bias the results
  - Includes poor methods for deciding how participants are assigned to levels of the IV
  - Using measurement tools that are not calibrated correctly
  - Research designs that hide or exaggerate effects of the IV
  - Not accounting for time of day or time of year effects

# Chapter 4 RANDOM ASSIGNMENT



#### What is random assignment?

- A method that reduces systematic bias by assigning participants to a level of the IV where participants have an equal chance of being assigned to each level of the IV
  - Reduces the chance that a given group is overrepresented or under-represented in one or more levels of the IV
- Output State A state of the state of the
  - Flipping a coin (heads  $\rightarrow$  treatment; tails  $\rightarrow$  control)
  - Rolling a die (each number is a level of the IV)
  - Using a table of random numbers

## Chapter 4 EXPERIMENTER BIAS

#### What is experimenter bias?

- Any influence the person conducting the research has on the participant responds to the study
  - EXAMPLES:
    - Pepsi challenge





VS.





# Chapter 4 DOUBLE BLIND METHOD



#### What is the double blind method?

- A procedure where both the person administering the treatment and the participant don't know which treatment the participant is receiving
  - Helps minimize experimenter bias

• Another member of the research team keeps track of which condition each participant has been assigned to

 The double-blind procedure also helps researchers better understand real side effects from placebo side effects



#### Example 4:

- A research and marketing firm conducts an experiment to investigate the proclaimed benefits of taking the herbal supplement gingko. Two hundred thirty subjects were recruited for the study. Subjects were randomly assigned to either a control group or treatment (gingko) group. Subjects in the gingko group were given a bottle of 42 gingkoba tablets and instructed to take one tablet daily. Subjects in the control group were told to drink one glass of water in the morning immediately after waking up. All subjects took a battery of learning and memory tests before and after six weeks of treatment.
  - What is the IV and its levels? What's the DV?
  - How could the research design for this study been improved?



Example 5:

- O those high center (third) brake lights, now required on all new cars sold in the U.S., really reduce rear-end collisions? Randomized comparative experiments showed that the third brake light reduced rear-end collisions as much as 50%. However, after all manufacturers began installing the third brake light, research showed only a 5% reduction in the number of rear-end collisions.
  - What is the IV and its levels? What's the DV?
  - How could the research design for this study been improved?



How does the researcher decide what kind of research study is conducted?

- The question(s) the researcher is trying to answer
  - Descriptive research
  - Cause-and-effect experiments
- Output the scale of the data collected
  - Nominal, Ordinal, Interval, or Ratio
- Who do the results apply to?
  - The population has been operationally define



#### Three common designs for experiments:

- O Between-groups design
  - Single factor
  - Multi-factor
- 8 Block design
  - Single-level
  - Multi-level
- Within-group designs
  - Repeated measures
  - Matched-pairs



#### Between-groups design

- A design where each level of the IV creates a separate and unique treatment condition or group
- A random sample is taken from the population and randomly assigned to one of the treatment conditions
  - Participants are assigned to only one treatment condition (or level of the IV)
- Each group is assumed to be equal to all others with the exception of individual differences
  - Groups are expected to achieve the same scores on the DV plus the effects from individual differences



#### Between-groups design

- EXAMPLE: A company is planning on purchasing new cell phones for its sales executives. The company wants to know which phone is easier to type text messages and emails from. A random sample of twenty sales executives is recruited for the study. Random assignment is used to decide what type of phone sales executives will use: 1) a touch-screen phone or 2) a Qwerty keyboard phone. Sales executives will use their new phone for two weeks and then complete a survey on the easeof-use to send messages. The phone with the higher rating will be purchased for all sales executives in the company.
  - IV → Type of phone used Two Levels → Touch screen and Qwerty keyboard
  - DV → Ease-of-use survey completed at the end of the two week trial



#### Between-groups design

- EXAMPLE: A potato chip maker is disappointed with sales of its fat-free chips and wants to know if changing the color of the packaging might make a difference. The company creates two new packaging colors to compare to the original packaging color. Fifty food stores are randomly selected in the southwest to participate in the study. Each packaging color is displayed equally at each store. After three months, the chip company compares the sales of each packaging color. The packaging color with the highest sales will be the color the company goes with for the next two years.
  - IV  $\rightarrow$  Packaging color
    - Three Levels  $\rightarrow$  Original, New color #1, New color #2
  - DV  $\rightarrow$  Sales of each packaging color
    - Number of units sold after three months



#### Block designs

- A design where a pre-existing variable (not the IV) is known to affect the dependent variable and therefore is used to separate the random sample into groups or blocks
  - Provides a method for reducing systematic bias
- Participants are grouped according to the blocking variable and then randomly assigned to a level of the independent variable
  - Participants are randomly assigned into treatment conditions after blocking



#### Block designs

- EXAMPLE: An auto manufacturer wants to test the durability of a new material used to make brake linings. The manufacturer knows that brake linings wear differently for hybrid cars versus gasoline only cars. Twenty-five hybrid and twenty-five gasoline only cars of the same make, model and year were randomly selected off the assembly line and subsequently randomly assigned to be fitted with brakes made with the new lining material or the original lining material. Vehicles were subjected to 1000 stops from a speed of 50 MPH. The amount of brake lining remaining was measured.
  - Blocking variable  $\rightarrow$  Type of engine 1) hybrid or 2) gasoline
  - $IV \rightarrow Type$  of brake lining material
    - Two Levels → Original and New material
  - DV  $\rightarrow$  Amount of brake lining remaining after 1000 stops
    - Measured in millimeters







Block designs

- EXAMPLE: It is previously known that a type of cancer spreads faster in men compared to women. Patients are blocked on gender and then randomly assigned to one of three treatment therapies.
  - Blocking variable  $\rightarrow$  Gender 1) Male or 2) Female
  - $IV \rightarrow Type of cancer treatment$ 
    - Three Levels → Chemotherapy, Radiation, or Chemotherapy + Radiation
  - DV  $\rightarrow$  Longevity measured in days

**Block designs** 





#### Within-group designs

- These research designs reduce the effects of individual differences by either having participants experience all treatment conditions or matching pairs of participants on other variables related to the DV
- On the IV on the DV
  Output: Description:
  - Because this research design is more sensitive, it allows the researcher to use smaller sample sizes
- The two most common within-group designs are:
  - Repeated measures
  - Matched-pairs



#### Within-group designs: Repeated measures

- In a repeated measures design, participants experience every treatment condition
  - This allows the participant to act as his/her own control

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  - Participants' responses are measured before treatment and after treatment
  - The participant's before score is compared to his/her after score (thus, the participant is compared to themselves, also known as acting as their own control)



#### Within-group designs: Repeated measures

- **EXAMPLE:** Researchers are optimistic about a new blood 0 pressure lowering medication. Thirty-five participants with higher than average systolic blood pressure are recruited for the study. For 120 days, participants are given either a placebo pill or the new medication. A rest period of 30 days follows and then the participants medication is switched to placebo or the new medication (depending on which pill they took during the first 120 days). The participants' average blood pressure for both four month periods is compared.
  - IV  $\rightarrow$  Amount of new medication Levels  $\rightarrow$  some or none
  - DV → Average systolic blood pressure (comparing the new medication period to the placebo period for each participant)



#### Within-group designs: Matched-pairs design

- In this design, pairs of participants are matched on variables that are believed to affect participants' scores on the DV
  - EXAMPLE: How well kids do in grade school is related to many factors, including socioeconomic status, highest level of education completed by parents, whether the child lives in a one or two parent home, how many siblings the child has, and how many hours of television the child watches per day



#### Within-group designs: Matched-pairs design

- By matching pairs of kids on these variables, the researcher has reduced the effects of individual differences
- One member of each pair (either 'A' or 'B') is randomly assigned to one of two treatment conditions, while the other member is assigned to the remaining condition

Pair		Current Educational Program
1	В	А
2	В	А
3	А	В
4	В	А
5	А	В



#### Within-group designs: Matched pairs

- **EXAMPLE:** A neuropsychologist wanted to test the 0 effectiveness of a new back-pain treatment. Patients suffering from back pain in the same location were recruited from the local VA hospital. Patients were matched according to current level of pain, current treatment for pain, length of time experiencing pain in months, and gender. One member of each pair was randomly assigned to the new treatment while the other continued his or her current treatment. Participants in both groups recorded their pain level daily on a scale of 1 to 10, where 10 indicated the highest level of pain. The study was conducted over an 18 month period.
  - $IV \rightarrow Type of treatment Levels \rightarrow New or Old$
  - DV → Pain level reported by patients on a scale of 1 to 10 after 18 months

#### Chapter 4 SAMPLING METHODS AND RESEARCH



# **END OF CHAPTER 4**