Experimental Design

PSY 4433

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Agenda

- What is a Cause & Effect Relationship?
- Elements of the Experiment
- Extraneous Variables & Confounding Variables
- Controlling Extraneous Variables
- Control by Randomization
- Comparing Methods of Control
- Pros and Cons of Control Methods
- Manipulation Checks
- Increasing External Validity

Cause & Effect

- Won't cover correlational designs much in this class
- Focus on **experimental research strategy**
    - to have a cause and effect, rather than predictor(s) and relationship, we rely on **experiments**, specifically **true experiments**
    - demonstrates that change in one variable (IV) leads to chanes in second variable (DV/outcome)
- must contain 4 crucial components
    - **manipulation**: alters IV by changing its value to create 2 or more treatment conditions
    - **measurement**: second variable (DV) measured for a group to obtain set of scores in each treatment condition
    - **comparison**: scores (DV) compared between the two or more treatment groups (IV)
    - **control**: all other variables that could influence the IV and DV controlled for (included in analyses)

Terminology

- **independent variable (IV)** the variable that will be manipulated to see a change in your outcome (experiments = categorical)
    - **treatment conditions** groups that are created to see if your manipulation is the reason for the change in your outcome
    - **levels** are often used in experiments, synonymous with conditions
- **dependent variable (DV)** is your outcome of interest; could be behavior, self-report, physiological, etc.
- **extraneous variables** refers to variables other than your IV and/or DV
    - JP Note: we'll go into more detail about these and why they are important for your surveys

Causation & Third Variable Problem

- relationship between IV and DV can be true or it could also be due to outside factors
  - **third-variable problem** is when there is a third (or possibly fourth) variable that is actually influencing a relationship
  - indicates that there may not be a causal relationship between the two variables, due to the lack of presence of a third variable in your analyses


YOU CHOO-CHOO-CHOOSE ME?


I AM SO GLAD
YOU CHO-CHO-CHOSE
TO COME.

Causation & Directionality Problem

- a relationship between your IV and DV does not automatically mean IV causes your DV due to **directionality problem**
- IV: BMI
    - Conditions/levels: Underweight, normal, overweight, obese
- DV: physical activity
- IV: physical activity
    - Conditions/levels: low, medium, high
- DV: BMI

Controlling Nature

- can't control for everything
  - with experiments on zoom, people can take your study anywhere

Experiments

- Steps of Experiment

1. cause before effect
2. *know* that your IV is responsible for change in your DV

Manipulation

- deciding what part of your IV will need to be changed and creating conditions for those values
- intervention 1 vs intervention 2 vs control

Manipulation

You're interested in examining college students math exam scores. You give 2 lectures, one with a chalkboard and the other with powerpoint slides, additionally another group is given a handout with all the information covered. You are also interested in how well students understand the materials by changing the temperature in the room. One lecture you have the AC on full blast, the second you have the AC on to a reasonable setting, and the other you have no AC. You randomly assigned students to each condition.

What is/are your IV(s)?

What is your DV?

What are the conditions for your IV(s)?

Who are your participants?

Manipulation

- Directionality
  - know what variable should be manipulated
  - look at your literature
- Third-variable problem
  - correlational studies will help with what to consider regarding third variables
  - while most of your studies will randomize participants, adding potential confounding variables will give you the most accurate findings

Control

- to make sure that you are actually seeing a true cause and effect
    - you need to have control over other potential influential variables/constructs
- third-variable problem
    - **confounding variables** are third variables that allowed to change systematically along with your IV(s) and DV
    - a confounding variable can deem your significant findings irrelevant because your finding could be due to another variable
- Book: IV - cereal color --> DV - cereal preference
    - confounding variable: cereal sweetness
- think about what variables may cause a change in your effect between IV and DV

Control

- there are extraneous variables that can be confounding variables based on design, time constraints, time of day, temperature, etc.
    - only confounding variable if it influences the DV and varies systematically with IV (not randomly)
    - if relationships look similar between confounding variable and DV to that of IV and DV
- in a lab setting, you must control for all of these by having them be constant for each participant
    - can be a problem in within-subjects design
- smallest things could have an impact
    - having to change rooms because you couldn't reserve the same room, now the second room has a glare from outside
    - time of day because you all have busy schedules (first group - 8am, second group - 6pm)

Control

You're interested in examining college students math exam scores. You give 2 lectures, one with a chalkboard and the other with powerpoint slides, additionally another group is given a handout with all the information covered. You are also interested in how well students understand the materials by changing the temperature in the room. One lecture you have the AC on full blast, the second you have the AC on to a reasonable setting, and the other you have no AC. You randomly assigned students to each condition.

What is/are your IV(s)?

What is your DV?

What are the conditions for your IV(s)?

Who are your participants?

What other variables could be impacting score?

Major, math competency, sex

Controlling Extraneous Variables

- Controlling by Holding Constant or Matching
    - if you are including information in a vignette to participants, make sure to only change one component
- Ex: if providing materials for an exam through different formats
    - all conditions receive the same materials/information
    - information should take roughly the same time to read/comprehend
    - if you provide additional resources to one group, its no longer constant

Controlling Extraneous Variables

- matching values across conditions
    - if using a quasi-experiment, you could separate groups by some parameter
- Ex: if separating groups by age (18-15 & 26+)
    - there is still variation in the groups that is reasonable between the groups
    - there are older non-traditional students but it is unlikely that your sample will vary that much
- might result in collecting data in multiple periods

Controlling Extraneous Variables

- JP Note: when separating groups into high and low technology groups, we collected survey data before to use for correlational research purposes
- then used a measure to get quartiles (top 25% and lowest 25%)
    - additional controlled variables were needed --> age

Controlling Extraneous Variables

- **Randomization** is used to disrupt any systematic relationship between extraneous variables and IV(s)
    - stop confounding variables
- **random process** is that both random selection (choosing participants) and random assignment (choosing which group/condition participants are assigned) is equally likely
- **random assignment** will be done for you by Qualtrics, but other options include:
    - choosing names from a hat
    - randomizer websites
    - coin flips

Random Assignment

Randomization

- can be used to control for environmental variables
- probably the best way for controlling extraneous variables
- gets rid of the influence from several variables

Comparing Methods of Control

- some are easier to implement than others
- at the same time, your research question may rely on a certain design
    - if you are interested in comparing extremely stressed students to super chill students, you'll need to get survey data beforehand to separate those groups

Methods of Control Comparison

TABLE 7.1

A Confounding Variable and Three Methods to Prevent Confounding

(A) IQ Confounded		(B) IQ Held Constant		(C) IQ Matched		(D) IQ Randomized	
Treatment		Treatment		Treatment		Treatment	
I	II	I	II	I	II	I	II
High	High	Low	Low	High	High	High	Low
High	High	Low	Low	High	High	Low	High
Low	High	Low	Low	High	High	Low	Low
Low	High	Low	Low	High	High	High	Low
Low	High	Low	Low	Low	Low	Low	High
Low	High	Low	Low	Low	Low	High	High
Low	High	Low	Low	Low	Low	High	Low
Low	High	Low	Low	Low	Low	Low	Low
Low	Low	Low	Low	Low	Low	High	High
Low	Low	Low	Low	Low	Low	Low	High

Column A shows two treatment conditions with 10 participants in each treatment. In this column, IQ (high and low) is confounded with the treatments; 80% of the participants in treatment I are low IQ but in treatment II, only 20% are low IQ. If this study found differences between the scores in treatment I and treatment II, the differences in scores could have been caused by the differences in IQ.

Methods of Control Comparison

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A Confounding Variable and Three Methods to Prevent Confounding

(A) IQ Confounded		(B) IQ Held Constant		(C) IQ Matched		(D) IQ Randomized	
Treatment		Treatment		Treatment		Treatment	
I	II	I	II	I	II	I	II
High	High	Low	Low	High	High	High	Low
High	High	Low	Low	High	High	Low	High
Low	High	Low	Low	High	High	Low	Low
Low	High	Low	Low	High	High	High	Low
Low	High	Low	Low	Low	Low	Low	High
Low	High	Low	Low	Low	Low	High	High
Low	High	Low	Low	Low	Low	High	Low
Low	High	Low	Low	Low	Low	Low	Low
Low	Low	Low	Low	Low	Low	High	High
Low	Low	Low	Low	Low	Low	Low	High

In column B, IQ is held constant. All the participants in treatment I are low IQ, and all the participants in treatment II are low IQ. In this case, there is absolutely no IQ difference between the two treatments, so IQ cannot be responsible for causing differences in the scores.

Methods of Control Comparison

TABLE 7.1

A Confounding Variable and Three Methods to Prevent Confounding

(A) IQ Confounded		(B) IQ Held Constant		(C) IQ Matched		(D) IQ Randomized	
Treatment		Treatment		Treatment		Treatment	
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High	High	Low	Low	High	High	Low	High
Low	High	Low	Low	High	High	Low	Low
Low	High	Low	Low	High	High	High	Low
Low	High	Low	Low	Low	Low	Low	High
Low	High	Low	Low	Low	Low	High	High
Low	High	Low	Low	Low	Low	High	Low
Low	High	Low	Low	Low	Low	Low	Low
Low	Low	Low	Low	Low	Low	High	High
Low	Low	Low	Low	Low	Low	Low	High

In column C, IQ is matched across the treatments. In treatment I, 40% are classified as high IQ, and in treatment II, 40% are high IQ. Again, the two groups are balanced with respect to IQ, so any differences in scores for the two treatments cannot be caused by IQ.

Methods of Control Comparison

TABLE 7.1

A Confounding Variable and Three Methods to Prevent Confounding

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Treatment		Treatment		Treatment		Treatment	
I	II	I	II	I	II	I	II
High	High	Low	Low	High	High	High	Low
High	High	Low	Low	High	High	Low	High
Low	High	Low	Low	High	High	Low	Low
Low	High	Low	Low	High	High	High	Low
Low	High	Low	Low	Low	Low	Low	High
Low	High	Low	Low	Low	Low	High	High
Low	High	Low	Low	Low	Low	High	Low
Low	High	Low	Low	Low	Low	Low	Low
Low	Low	Low	Low	Low	Low	High	High
Low	Low	Low	Low	Low	Low	Low	High

Finally, in column D, IQ is randomized across treatments. By using a random process to assign high and low IQ participants to the treatment conditions, it is reasonable to expect that IQ will be balanced across treatments. If there are no substantial IQ differences between treatments, then IQ cannot cause the scores in one treatment to be different from the scores in the other treatment.