Within subjects Design

Characteristics of Within-Subjects Designs

- **within-subjects design** uses a single group of participants and tests or observed each participant in all of the different treatments being compared
- two possible structures of a within-subjects design
  - sample gets treatment 1 –> treatment 2 –> treatment 3
  - sample gets all treatments administered together
- also referred to as a **repeated-measures design** because you test the same participants under different conditions while repeating measurements
- **within-subjects experimental design** or **repeated-measures experimental design** is an experimental design where you compare treatments instead of comparing groups

Threats to Internal Validity - Within-Subjects Experiments

- two main confounding sources are confounding from environmental variables and confounding from time-related variables
- confounding from environmental variables
  - environmental characteristics that can change from one condition to the next
  - Ex: loud environment vs quiet environment

Threats to Internal Validity - Within-Subjects Experiments

- confounding from time-related variables
  - because measurements happen over time, confounding factors may influence participants
    - **history** refers to confounding factors that change over time and can result in different scores from participants in different treatment conditions
    - **maturation** is any systematic change in participants' physiology or psychology
    - **instrumentation** is sometimes called **instrumental bias** or **instrumental decay**
    - mainly for behavioral observation where measurement changes over time
    - **regression toward the mean** or **statistical regression** is the tendency for extreme scores on a measurement to move toward the mean when tested repeatedly
    - taking exams and having some luck in addition to students' knowledge

Threats to Internal Validity - Within-Subjects Experiments

- **order effects** are changes in performance from participating in other conditions
  - **practice effects** are when participants improve from gaining experience in conditions
  - **fatigue effects** are progressive decline from going through conditions
  - **carry-over effects** are when one condition's treatment leads to change in participant scores in the following conditions
    - **contrast effects** are when the previous treatment leads to change because of how different the previous treatment was to the current treatment
    - Ex: Being in a dark room and then going to a moderately lit room compared to starting from a bright room and going to a moderately lit room
  - **progressive error** is when participants' behaviors are influenced by the study itself and not the treatment
    - practice effects and fatigue

Separating Time-Related Factors & Order Effects

- history, maturation, instrumentation, and regression are specifically related to issues with time
  - often referred to as time-related threats to internal validity
- order effects are related to experiences by participants in treatment conditions
- both only occur in within-subjects experimental designs

Order Effects as a Confounding Variable

- the order of treatment conditions a participant takes can directly influence their scores
  - good reason to test the order of treatment conditions to see whether they act as a moderator
- if all participants are exposed to the treatments in the same order, increase/decrease in scores from condition 1 to condition 2 for participants would indicate an order effect
  - while the difference in conditions could show a significant difference, it could also be indicating that there is an order effect
- if the order effect varies systematically between treatments, it is a confounding variable
  - influences second treatment, but never influences the first treatment
- can distort findings because the confound of an order effect can distort findings
  - either show an exaggerated real difference or show a diminished difference

Within-Subjects Design & Environmental Threats

- similar to between-subjects design, you can control for environmental threats to internal validity
  - randomization
  - holding environmental factors constant
  - matching across treatment conditions
- Ex: depression treatments (medication, cognitive-behavioral therapy, and CBT + medication)

Controlling Time

- things like history or maturation are related to the length of time to complete your study as threats to internal validity
- if the time difference between treatments is large (weeks, months, years), then there is a higher likelihood of having issues like history or maturation arise
- shortening the time between treatments can also be problematic because it can lead to order effects
  - trade off of time-related threats or order effects
- What are your options as a within-subjects experimental researcher?

Switch to a Between-Subjects Design

- while some studies can assume that exposure to several treatments can lead to order effects (e.g., fatigue, boredom), there are some situations where these order effects may be too larger
- a between-subjects design can be a great alternative to a within-subjects design, especially if the conditions will provide some information to students
  - Many of your projects would be horrible within-subjects designs? (Not to say that a mixed-design would be bad. Those are fine.)
  - How does a researcher know when to switch to a between-subjects design?

Counterbalancing: Matching Treatments with Respect to Time

- in an attempt to remove time-related threats to internal validity, we can use **counterbalancing**
  - counterbalancing is the process of matching treatments with respect to time
- the main concept behind counterbalancing is that you remove the time-related threats by switching the order of some participants when receiving treatment conditions
  - Some may get treatment 1 first, others may get treatment 2 first

Counterbalancing & Order Effects

- counterbalancing has exactly the same effect on order effects as it does for time-related threats
- counterbalancing distributes order effects evenly between two treatments, where order effects are balanced across treatment conditions
  - there are still order effects (no way around that), but the order effects, like fatigue, affect both groups (treatment 1 first, treatment 2 first) equally
    - cancels out the order effect on participants
- Note: counterbalancing does not eliminate order effects
  - it just distributes them evenly