PS 211: Introduction to Experimental Design

Fall 2025 · Section C1

Discussion 6: Lectures 8–9 Review & Poster Introduction (Part 1)

Outline for Today

- Attendance – please sign the sheet at the front
- Lectures 8 and 9 review
- Worksheet practice
- Poster Project: Introduction (Part 1)

Lecture 8: Z Tests & Confidence Intervals

- **Z tests** compare a *sample mean* (**M**) to a *population mean* (**μ**, "mu")
    - Population standard deviation (**σ**, "sigma") must be known
- **Six steps of hypothesis testing**

1. Define the population your sample represents and what it's compared to, and confirm your test is appropriate.
    - Check these assumptions: data approx. normal, scores independent, population standard deviation (sigma) is known
2. State $\mathbf{H_0}$ (null: no effect) and $\mathbf{H_1}$ (research: expected effect)
3. Determine comparison distribution (find μ, σ, SE)
    - Establish the "reference" distribution if H_0 were true
    - Find its **mean (μ)**, **standard deviation (σ)**, and **standard error (SE = σ / √n)**
    - This lets us see how far M is from μ in standardized units (z)

Lecture 8: Z Tests & Confidence Intervals

4. Choose **α (alpha)**, the cutoff for significance — usually **.05** (5%)
5. Compute the **z statistic**
6. Decide: *reject* or *fail to reject* H_0

- **p-value**: probability of your data (or more extreme) if H_0 is true
  - $p < \alpha$ → statistically significant result
- **Confidence Intervals (CIs):**
  - Range of values that likely include the true μ
  - 95% CI = M ± (1.96 × SE)
  - Larger **n** or smaller **σ** → **smaller SE**, so CI becomes *tighter around the mean*, meaning a *more precise* estimate of μ

Lecture 9: Effect Size, Power, and t Tests

- **Effect size (Cohen's d):** Formula: $d = (M_1 - M_2) / SD$
  - M_1 and M_2 are group means (e.g., control vs. experimental)
  - Describes the *magnitude* of a difference, regardless of sample size
  - Small ≈ 0.2 · Medium ≈ 0.5 · Large ≈ 0.8
- **Power:** probability of correctly rejecting H_0 *when it's actually false*
  - Greater power means the study is *more likely to detect a real effect*
  - Power increases when:
    - **Sample size (n)** is larger
    - **Effect size (d)** is larger
    - **Population variability (σ)** is smaller

Lecture 9: Effect Size, Power, and t Tests

- **t tests:** used when **σ** (population SD) is *unknown*
  - Estimate variability using *sample SD (s)*
  - Uses **t distribution** (wider tails, especially for small n)
  - **Degrees of freedom (df)** = number of values that can vary = n – 1
    - As df increases, t distribution approaches normal
  - Used for:
    - Single-sample t (sample vs. known μ)
    - Paired-samples t (before vs. after)
    - Independent-samples t (two separate groups)

Worksheet for Today

1. A researcher wants to compare BU students' average sleep ($M = 7$ hours) to the national mean ($\mu = 8$).
   - When would a **z test** be appropriate?
   - When would a **t test** be more realistic?
2. A sample of 25 students has $M = 70$ and $SD = 10$.
   - Estimate $SE = SD / \sqrt{n}$
   - Estimate the 95% CI $\approx M \pm (1.96 \times SE)$ = ?, ?. What does this interval tell us about μ?
3. **Effect Size:** Two different studies both found a mean difference of 8 points between two groups ($M1 - M2 = 8$). However, the two studies have different SDs: Study A $SD = 4$, Study B $SD = 12$.
   - Which study shows the larger effect size (Cohen's d)?
   - Why would that same 8-point difference appear more distinct in one study than the other?
4. **Power & Design:** Study A has 10 students per condition; Study B has 40 per condition.
   - Which study has **greater statistical power**?
   - If the variability (σ) increases, how would that affect power? Why?
5. **Degrees of Freedom (df):** You have 5 scores and a fixed mean.
   - If the mean is fixed, how many of the 5 scores can vary freely before the last one is determined?
   - What does this number represent in a **t test**?
6. **Wrap-up Discussion:**
   - Why is it better to report both **significance (p)** and **effect size (d)** on a poster?
   - How do these two values tell *different stories* about your results?

Poster Project: Writing Your Introduction (Part 1)

- Your **Introduction** should now connect your **topic, prior research, and hypothesis**
- Write using **concise bullets**, not paragraphs
- Focus on *logical flow*: each point should set up the next
- Start big and then end specific to your experiment

Recommended structure:

Introduction:

1. **Topic importance** – why this question matters
2. **Key findings from past studies** with citations
3. **Gap or motivation** – what is still unclear?

Hypothesis:

4. **Your research question & hypothesis**
   - "If (change in IV), then (change in DV)"
   - Make sure to include all hypotheses, IV levels, and the specific, directional predicted pattern
   - e.g., Group A > Group B in accuracy
   - or Performance decreases as noise increases

Goal for today:

✅ Draft your bullet-style **Introduction**
✅ Confirm that your **3–5 references** are credible (peer-reviewed or review articles)
✅ During downtime, begin planning your **poster layout and design**

Get ahead on your poster design!

- Workshopping your **Introduction** will take a while — use any extra time to think about your **poster layout and design**
- Decide as a **group** what tool and workflow will work best for collaboration
- Look at **real poster examples** online for structure and inspiration

Programs you could use for your poster

- **Google Slides**: easy group editing, PDF export
- Are students familiar with **Canva** or **Figma**? I'm not, but I heard you can use those to collaborate

Design tips

- Use **large, readable fonts**
- **Limit text density** – 1 idea per line
- Use **color sparingly** to highlight structure, not decorate
- Align elements for a clean grid
- Flow should feel natural: Intro → Methods → Results → Conclusion

Broad topics -> testable hypotheses

- Hypothesis = specific, directional prediction that connects your IV & DV
- Must be **measurable**, **clear**, and **feasible**
- Stuck? Think of hypotheses as "If…, then…" statements. *If (change in IV), then (change in DV)*
- Always specify the IV levels you're comparing
    - For >2 levels, describe the expected pattern (e.g., "Performance decreases as noise increases")
- E.g., "If students drink coffee before class, then their reaction times will be faster on a simple task compared to students who don't."
- E.g., "If people listen to upbeat music, then they will complete puzzles more quickly than when listening to calm music."
- E.g., "Students who study in quiet settings will recall more words than those who study with music."
- During class, check in with me so we can workshop your group's hypothesis

Refine topic and compile references

- Use Google Scholar or BU Library databases to search your topic
- Start with **review articles** → they summarize many studies at once
- Look for peer-reviewed journal articles, not blogs or random websites
- Skim the abstract & conclusion first: does it clearly connect to your hypothesis?
- Collect at least **3–5 solid references** this week to support your poster
- Keep track of them in a shared doc (include citation info!) and show me
  - You may use any citation style as long as it is consistent
  - That said, I am most familiar with APA
- Tip: “cited by” on Google Scholar helps you find more recent follow-ups

How to Brainstorm Research Ideas

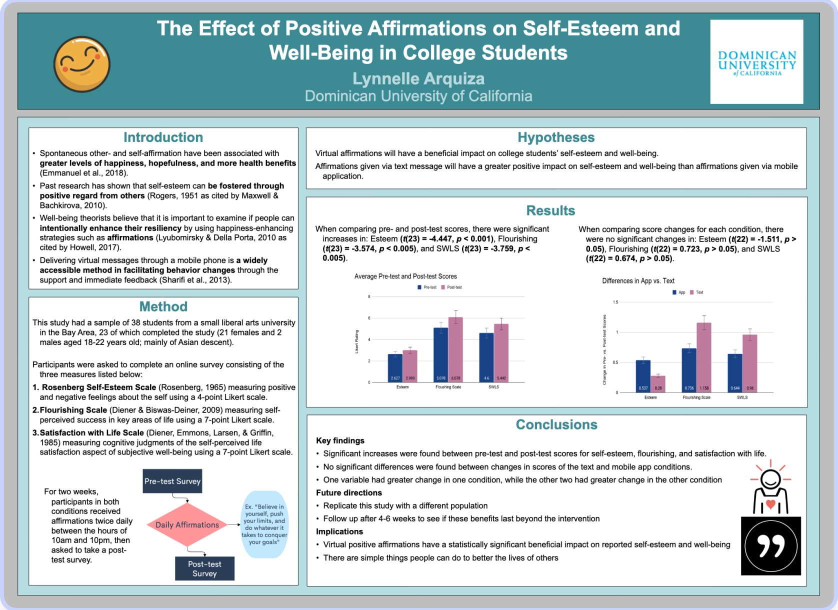
- Start with **broad psych topics** that interest you (e.g., sleep, stress, social media, learning).
- Ask: *What variables could we measure or manipulate?*
  - IV = what we change (e.g., study environment, type of task)
  - DV = what we measure (e.g., accuracy, reaction time, mood)
- Look for **connections to everyday life** or current issues.
- Keep it **simple and testable** within the scope of this class.
  - Although we will not be conducting experiments ourselves, our hypothetical study should still be attainable, understandable, and clearly tied to measurable variables.
- Be creative — but ground your ideas in **experimental design concepts** we've learned so far, so you can connect them directly to your poster.

Checklist – what should my poster have?

- Introduction
  - Current literature
  - Research question
  - Hypothesis
- Methods
  - Participants
  - Independent variable
  - Dependent variable
  - Analysis
- Results
  - Descriptive statistics
  - Inferential statistics
- Figures (1-2)
- Conclusion
- Limitations
- References (choose a citation style)

Design your figures and posters to be easily understood!

Good: https://scholar.dominican.edu/ug-student-posters/101/



Not so good: https://colinpurrington.com/2012/02/example-of-bad-scientific-poster/

Discussion poster project outline

- Discussion 3: Form groups and brainstorm research ideas
- Discussion 4: Research poster topics and form hypotheses
- Discussion 5: Refine topic and compile references
- Discussion 6-7: Introduction section
- Discussion 8-9: Methods section
- Discussion 10-11: Analysis plan and limitations section
- Discussion 12: Finalize poster
- Discussion 13: Group poster presentations!