

# 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* ( **$\mu$** , "mu")
  - Population standard deviation ( **$\sigma$** , "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  **$H_0$**  (null: no effect) and  **$H_1$**  (research: expected effect)
  3. Determine comparison distribution (find  $\mu$ ,  $\sigma$ , SE)
    - Establish the "reference" distribution if  $H_0$  were true
    - Find its **mean ( $\mu$ )**, **standard deviation ( $\sigma$ )**, and **standard error ( $SE = \sigma / \sqrt{n}$ )**
    - This lets us see how far M is from  $\mu$  in standardized units (z)

# Lecture 8: Z Tests & Confidence Intervals

4. Choose  **$\alpha$  (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
    - $p < \alpha \rightarrow$  statistically significant result
  - **Confidence Intervals (CIs)**:
    - Range of values that likely include the true  $\mu$
    - $95\% \text{ CI} = M \pm (1.96 \times \text{SE})$
    - Larger **n** or smaller  **$\sigma$**   $\rightarrow$  **smaller SE**, so CI becomes *tighter around the mean*, meaning a *more precise* estimate of  $\mu$

# 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  $\approx 0.2$  · Medium  $\approx 0.5$  · Large  $\approx 0.8$
- **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 ( $\sigma$ )** is smaller

# Lecture 9: Effect Size, Power, and t Tests

- **t tests:** used when  $\sigma$  (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  $\mu$ )
    - 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  $\mu$ ?
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 ( $\sigma$ ) 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/>

# The Effect of Positive Affirmations on Self-Esteem and Well-Being in College Students

Lynnelle Arquiza  
Dominican University of California



## Introduction

- Spontaneous other- and self-affirmation have been associated with **greater levels of resilience, hopefulness, and more health benefits** (Emanuel et al., 2018).
- Past research has shown that self-esteem can be **fortified through positive regard from others** (Rogers, 1951 as cited by Maxwell & Backrow, 2010).
- Well-being theorists believe that it is important to examine if people can **intentionally enhance their resiliency** by using happiness-enhancing strategies such as **affirmations** (Lynnelle & Della Porta, 2010 as cited by Howell, 2017).
- Delivering virtual messages through a mobile phone is a **widely accessible method in facilitating behavior changes** through the support and immediate feedback (Shariff et al., 2015).

## Method

This study had a sample of 38 students from a small liberal arts university in the Bay Area. 23 of which completed the study (21 females and 2 males aged 18-22 years old; mostly of Asian descent).

Participants were asked to complete an online survey consisting of the three measures listed below.

- Rosenberg Self-Esteem Scale** (Rosenberg, 1965) measuring positive and negative feelings about the self using a 4-point Likert scale.
- Flourishing Scale** (Diener & Biswas-Diener, 2000) measuring self-perceived success in key areas of life using a 7-point Likert scale.
- Satisfaction with Life Scale** (Diener, Emmons, Larsen, & Griffin, 1981) measuring cognitive judgments of the self-perceived life satisfaction aspect of subjective well-being using a 7-point Likert scale.

For two weeks, participants in both conditions received affirmations twice daily between the hours of 10am and 10pm. Then asked to take a post-test survey.

```

graph TD
    A[Pre-test Survey] --> B{Daily Affirmations}
    B --> C[Post-test Survey]
    B --> D["Ex. 'Believe in yourself, push the limits, and do whatever it takes to conquer your goals!'"]
  
```

## Hypotheses

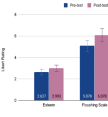
Virtual affirmations will have a beneficial impact on college students' self-esteem and well-being. Affirmations given via text message will have a greater positive impact on self-esteem and well-being than affirmations given via mobile application.

## Results

When comparing pre- and post-test scores, there were significant increases in: **Esteem** ( $t(23) = -4.447, p < 0.001$ ), **Flourishing** ( $t(23) = -3.274, p < 0.005$ ), and **SWLCS** ( $t(23) = -3.760, p < 0.005$ ).

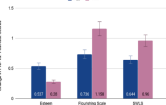
When comparing score changes for each condition, there were no significant changes in: **Esteem** ( $t(22) = 1.511, p > 0.05$ ), **Flourishing** ( $t(22) = 0.723, p > 0.05$ ), and **SWLCS** ( $t(22) = 0.674, p > 0.05$ ).

### Average Pre-Test and Post-Test Scores



Measure	Pre-test	Post-test
Esteem	~4.5	~5.5
Flourishing	~5.5	~6.5
SWLCS	~5.5	~6.5

### Differences in App vs. Text



Measure	App	Text
Esteem	~0.5	~0.5
Flourishing	~0.5	~0.5
SWLCS	~0.5	~0.5

## Conclusions

### Key findings


- Significant differences were found between pre-test and post-test scores for self-esteem, flourishing, and satisfaction with life.
- No significant differences were found between changes in scores of the text and mobile app conditions.
- One variable had greater change in one condition, while the other two had greater change in the other condition

### Future directions

- Replicate this study with a different population
- Follow up after 4-6 weeks to see if these benefits last beyond the intervention

### Implications

- Virtual positive affirmations have a statistically significant beneficial impact on reported self-esteem and well-being
- There are simple things people can do to better the lives of others

[illegible]

# 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!