BOSTON UNIVERSITY

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PS 211: Introduction to Experimental Design

Fall 2025 · Section C1

Discussion 9: Independent t Tests & Finalizing Methods

Outline for Today

- **Attendance:** please sign your name at the front within the first 2 minutes.
- **Lecture 11–12 Review:** Independent-samples *t*-tests
  - Compare *two different groups* rather than repeated measures.
- **Worksheet Practice:** follow the step-by-step guide for analyzing a between-subjects scenario.
- **Poster Work:** finalize your *Methods* section and check for clarity and completeness.
  - Update your Google Doc from last week in **Slack** so I can comment on it.
  - Include both your Introduction and Methods sections.

Review – Paired vs. Independent t Tests

- **Paired-samples t test:**
  - One group measured twice (e.g., before vs after).
  - Each participant provides *two* related scores → difference score D.
- **Independent-samples t test:**
  - Two separate groups (e.g., Control vs Experimental).
  - Each participant contributes *one* score → compare two group means.
- Between-subjects designs use **independent t tests**; within-subjects designs use **paired t tests**.

The Logic of the Independent t Test

- We compare two group means:
  - *Group 1 mean* (M_1)
  - *Group 2 mean* (M_2)
- The question: *Is the observed difference ($M_1 - M_2$) larger than what random sampling would likely produce?*
- **Formula:** $t = (M_1 - M_2) / SE_{(M_1 - M_2)}$
- The **standard error of the difference** reflects how much random variation we expect between two independent sample means.
- Large t → unlikely under H_0 → reject H_0
- Small t → plausible under H_0 → fail to reject

Standard Error and Pooled Variance

- When two groups are assumed to have **equal variance**, we combine them into a single **pooled variance (s^2_p)** estimate.
- Formula (you do *not* need to memorize):
  - $s^2_p = (n_1 - 1)s_1^2 + (n_2 - 1)s_2^2 / (n_1 + n_2 - 2)$
- Then compute:
  - $SE_{(M_1 - M_2)} = \sqrt{s^2_p} \times (1/n_1 + 1/n_2)$
- Intuition:
  - Larger sample size → smaller SE.
  - Greater within-group variability → larger SE (harder to detect differences).

Interpreting t and Confidence Intervals

- The t value shows *how many SE units* separate the two sample means.
- Confidence interval (95 %):
  - $(M_1 - M_2) \pm (t\_crit \times SE_{(M_1 - M_{2)}})$
- If the CI **includes 0**, we cannot rule out no difference.
- If the CI **does not include 0**, we conclude a statistically significant difference.
- Always report:
  - *t*(df) = __, *p* = __, Cohen's *d* = __.

Worksheet: Independent-Samples t Test

Scenario: Two groups of students take the same memory quiz.

- **Group A ($n_1 = 5$)** – chewed gum while studying: 85, 88, 90, 84, 87
- **Group B ($n_2 = 5$)** – did *not* chew gum: 78, 82, 79, 81, 80

Step-by-step (show all work):

1. Write a **null (H_0)** and **alternative (H_a)** hypotheses. Decide whether this is a **one-tailed** or **two-tailed** test.
2. Compute the **mean** and **variance** for each group. Then, compute the **pooled variance**.
3. Compute the **standard error** of the difference.
4. Compute the **t statistic**; the **df**; and find the critical *t* (based on your chosen tail).
5. Decide whether to **reject H_0** at $\alpha = .05$.
6. Construct the **95 % confidence interval** for $(M_1 - M_2)$.
7. Interpret your results in plain English — what is the relationship between chewing gum and memory?

Finalizing the Poster Methods Section

- The **Methods** section explains *how you will test* your hypothesis.
- Include:
  1. **Participants** – who and how many?
  2. **Design** – within- or between-subjects?
  3. **Procedure** – what participants do, what you measure.
  4. **Dependent variable** – how is it quantified and analyzed?
  5. **Independent variable** – how is it manipulated?
  6. **Planned analysis** – describe which statistical test you will run (*t* test, correlation, etc.) and why it fits your design.
- If you have any questions or are ready for feedback, please raise your hand!

Goals for Today

- Turn in your updated Introduction + Methods section
- Understand independent-samples *t* logic and pooled variance
- Complete the worksheet by showing all calculations
- Finalize your **Methods** section including your planned analysis