PS 211: Introduction to Experimental Design

Fall 2025 · Section C1

Discussion 11: Repeated-measures and two-way ANOVA; poster analysis, limitations, and design

Outline for Today

- **Attendance:** please sign your name at the front within the first 2 minutes.
- **Quick intro to repeated-measures and two-way ANOVA for your posters**
- **Poster Work:** Finish your **analysis plan** and **limitations** section
  - Update your Google Doc from last week in **Slack** so I can comment on it.
  - Include both your Introduction and Methods sections.
  - **Turn in an image or PDF of your actual poster design by the end of class**

Why we're learning about more ANOVAs today

- Some of your posters use designs that go **beyond**:
  - One IV with 2 levels (t-test)
  - One IV with 3+ levels (one-way ANOVA)
- You **do not need to calculate** any new statistics, only **degrees of freedom**.
- You **only** need to:
  1. Identify the correct test for your design
  2. Know *what result pattern* would support your hypothesis
  3. Write your analysis plan clearly in your poster

When to use *Repeated-Measures* ANOVA

- Use when the **same participants** experience **multiple conditions**
  - Example: Each person does Task A, Task B, and Task C
- This controls for individual differences (each person is compared to themselves)
- **How to report it:**
  - Format is the **same** as one-way ANOVA:
    $F(df\_B, df\_W) = value, p, \eta^2$
  - Degrees of freedom for one factor with k levels and n participants:
    - df_B = k - 1
    - df_W = (n - 1) * (k - 1)
- You **do not need to calculate the numbers** — just **degrees of freedom** and state the plan.

When to use a *Two-Way* ANOVA

- Use when your study has **two independent variables**
  - Example: Study method (flashcards vs practice test) × Study time (20 min vs 40 min)
- A two-way ANOVA tests **three effects**:
  1. **Main effect of IV1**
  2. **Main effect of IV2**
  3. **Interaction** (whether the effect of one variable depends on the other)
- **How to report:** still F(df_B, df_W), p, η^2 for **each effect**
- For a **between-subjects** two-way design with a levels of IV1, b levels of IV2, and N total participants:
  - df_IV1 = a - 1
  - df_IV2 = b - 1
  - df_IV1xIV2 = (a - 1) * (b - 1)

Writing your hypothetical analysis plan (all poster types)

- I have changed this slightly, so please pay attention! **Check Step 1 and Step 2**

1. If you use **t-tests**:
    - Calculate the correct degrees of freedom based on your t-test
    - Figure out the t_critical value from the t-table (Lecture 9, Page 37)
    - Find a Cohen's d for a large effect for significant results and a small effect for not significant results (Lecture 10, Page 34)

- If you use **ANOVAs**, you **do not need to calculate the F_critical value**
    - Make sure all of your degrees of freedom calculations are correct (you have multiple!).
    - Find an eta-squared that would suggest a large effect for sig results and a small effect for n.s. results (Lecture 14).

2. If you have **only one independent variable**: describe as if (1) if the results are significant and (2) if the results are not

- If you have **multiple independent variables**: describe as if each of your independent variables are significant

Example Analysis Plans (find the one you need)

- Find example(s) that match your expt. and **fill in everything that is bolded (see previous slide)**

Example 1: Independent-Samples t-test (1 IV, 2 levels)

"An independent-samples *t*-test will be conducted to compare reaction times on an object recognition task between participants who slept 8 hours and those who slept fewer than 5 hours.

If the results are significant, then reaction times are faster for the 8-hour group, t(**df**) > t_crit, $p < 0.05$, $d \approx$ (**a large effect**). These results would suggest that adequate sleep improves object recognition performance.

If the results are not significant, then we fail to reject the null hypothesis that reaction times do not differ based on sleep, t(**df**) < t_crit, $p > 0.05$, $d \approx$ (**a small effect**). This would suggest that sleep may not influence reaction time in this task."

Example 2: One-Way ANOVA (1 IV, 3+ levels)

"A one-way ANOVA will be conducted to compare reaction times among three sleep groups: (1) 8+ hours, (2) 5–8 hours, and (3) fewer than 5 hours. We will report F, p, and η^2.

If the overall ANOVA is significant, F(**df_B, df_W**), $p < 0.05$, $\eta^2 \approx$ (**a large effect**), this suggests that sleep amount influences reaction time. We would then conduct a Tukey HSD post-hoc test to determine *which* sleep groups differ from each other.

If the ANOVA is not significant, F(**df_B, df_W**), $p > 0.05$, $\eta^2 \approx$ (**a small effect**), then we fail to reject the null hypothesis that sleep amount does not meaningfully change reaction time."

Example Analysis Plans (find the one you need)

Example 3: Two-Way ANOVA (2 IVs, Testing Main Effects + Interaction)

"A two-way ANOVA will be conducted to examine the effects of sleep amount (8 hours vs. <5 hours) and caffeine (caffeine vs. no caffeine) on reaction time. We will report *F*, *p*, and η^2 for each main effect and for the interaction.

If the sleep main effect is significant, this suggests that sleep quantity influences reaction time, regardless of caffeine, *F*(**df_sleep, df_W**), $p < 0.05$, $\eta^2 \approx$ (**a large effect**).

If the caffeine main effect is significant, this suggests that caffeine influences reaction time, regardless of sleep, *F*(**df_caffeine, df_W**), $p < 0.05$, $\eta^2 \approx$ (**a large effect**).

If the interaction is significant, this means the effect of caffeine *depends on* sleep amount (or vice versa). We would describe the pattern in plain language (e.g., "caffeine speeds performance only when participants were well-rested").

Limitations section

List 2-3 limitations to your study in a concise format.

Example for effect of coffee on anxiety

1. Whether the participant likes or dislikes coffee
2. Results may not generalize beyond college student population
3. Self-report measures may introduce bias

Poster checklist

- Title
- Group members' names
- Introduction – broad to focused: background literature with citations, research question, hypothesis
- Methods – participants, IVs, DVs, procedure, design (within/between)
- Analysis plan – correct statistical test, calculate degrees of freedom, correct effect size, result statements
- Limitations – 1-3 that cannot be resolved by your experiment
- References – cited in APA or another style

What’s Coming Next

- **Next Week (Discussion 12):**
  - Final poster draft workshop
  - Finish making the posters themselves so you can present them to the class on the TV
  - Practice explaining your introduction, methods, analysis, and limitations sections clearly
  - Each group member should contribute to the presentation
- **Following Week (Discussion 13):**
  - **Poster Presentations in class**
  - You will talk through your poster in ~5 minutes
  - Focus on clarity and reasoning

Goals for Today

- Finalize your **Analysis Plan** and **Limitations** sections
- Divide the work: While your groupmates are working on the **Analysis Plan**, you can help finish the **Limitations** section or vice versa
- Refine your **poster layout**
- Submit your **poster draft (PDF or image)** before leaving class