Mini-Dissertation Write-up Guide

Part 07 - Detailed ANOVA Step by Step

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Step-by-Step Guide: Between-Subjects 2x2 ANOVA in SPSS

1. **Prepare Your Data**

   - Ensure your data is in the proper format. You should have one column for each of the two independent variables (IVs) and one column for the dependent variable (DV). Each row represents a participant's scores.

   Between-Subjects 2x2 ANOVA Dataset:

Participant	Group	Condition	Score
1	Group1	Condition2	38.35
2	Group2	Condition1	59.01
3	Group2	Condition1	54.66
4	Group1	Condition2	34.64
5	Group2	Condition1	64.88
...	...	...	...

2. **Open SPSS and Load Data**

   - Open SPSS.
   - Enter your data into the Data View or import your dataset.

3. **Define Your Variables**

   - In Variable View, label your variables and define their properties (e.g., scale, nominal, ordinal).

4. **Accessing the ANOVA Function**

- Go to `Analyze` > `General Linear Model` > `Univariate`.

5. **Setting Up the ANOVA**
    - In the Univariate dialog box, move your dependent variable to the `Dependent Variable` box.
    - Move your two independent variables to the `Fixed Factor(s)` box.
6. **Post Hoc Tests (If Needed)**
    - If you want to conduct post hoc tests for significant effects, click on `Post Hoc`. Select the factor(s) and the post hoc test you want to use (e.g., Tukey).
7. **Options for Analysis**
    - Click `Options`. Here, you can select additional statistics like `Descriptive Statistics` and `Estimates of effect size`.
    - Ensure `Display Main Effects and Interactions` is checked to view the interaction between the IVs.
8. **Running the Analysis**
    - Click `OK` to run the analysis.

Explore Interaction Effects

For significant interactions, post-hoc comparisons are a bit more complex and often involve conducting simple effects analysis:

- You need to examine the effect of one factor at each level of the other factor separately.
- This can be done through planned contrasts or by splitting the file and conducting separate ANOVAs for each level of one of the factors, but SPSS doesn't directly provide a "Post Hoc" option for interactions in the same way it does for main effects.

Conducting Simple Effects Analysis:

1. To analyze simple effects, you may need to use the `Split File` feature or run separate ANOVAs manually for each subgroup defined by one factor, comparing levels of the other factor within these subgroups.
2. **Interpreting the Output**
    - The SPSS output window will display the results.
    - Look at the `Tests of Between-Subjects Effects` table for your main effects and interaction effect.

- The `Sig.` column indicates the p-value. Typically, a p-value less than .05 indicates a significant effect.

3. **Report the results**

- In your report, include F-statistic, degrees of freedom, p-value, and effect sizes.

Results

A 2x2 between-subjects ANOVA was conducted to examine the effects of [Factor 1 Name] and [Factor 2 Name] on [Dependent Variable Name]. The independent variables were [Factor 1 Description, e.g., gender with two levels: male and female] and [Factor 2 Description, e.g., treatment with two levels: control and experimental]. The dependent variable was [Dependent Variable Description, e.g., test scores].

The main effect of [Factor 1 Name] was significant, F(1, N - 1) = [F-Value], p < .05, η^2 = [Effect Size], indicating that [brief interpretation of the result, e.g., males and females differed significantly in their test scores]. Similarly, the main effect of [Factor 2 Name] was also significant, F(1, N - 1) = [F-Value], p < .05, η^2 = [Effect Size], showing that [brief interpretation, e.g., participants in the experimental group scored significantly higher than those in the control group].

Furthermore, the interaction between [Factor 1 Name] and [Factor 2 Name] was found to be significant, F(1, N - 1) = [F-Value], p < .05, η^2 = [Effect Size]. This suggests that the effect of [Factor 1 Name] on [Dependent Variable Name] depends on the level of [Factor 2 Name].

To further explore this interaction, post hoc tests were conducted using [Name of Post Hoc Test, e.g., Tukey's HSD]. The results indicated that [describe specific findings from the post hoc tests, e.g., the difference between males and females was more pronounced in the experimental group than in the control group].

Overall, these results suggest that both [Factor 1 Name] and [Factor 2 Name] significantly influence [Dependent Variable Name], and their interaction is also important in understanding the relationship between these variables.

11. **Assumption Checks**

- Check for assumptions like normality and homogeneity of variances.
- Use `Explore` under `Descriptive Statistics` for normality checks and `Levene's Test for Equality of Error Variances` for homogeneity.

12. **Graphical Representation**

- For visual representation, you can create interaction plots using `Graphs` > `Legacy Dialogs` > `Interaction`.

Step-by-Step Guide: Mixed 2x2 ANOVA in SPSS

1. **Data Preparation**

   - Organize your data: one column for the between-subjects factor (independent variable), one column for the within-subjects factor (repeated measures), and columns for each level of the within-subjects factor (dependent variable measurements).
   - Each row represents a participant's scores across conditions.

   Mixed 2x2 ANOVA Dataset:

Participant	Between_Subjects_Factor	Within_Subjects_Condition	Score
1	Level1	Condition1	40.39
1	Level1	Condition1	53.77
1	Level1	Condition2	50.33
1	Level1	Condition2	56.81
2	Level2	Condition1	34.37
...	...	...	...

2. **Loading Data into SPSS**

   - Open SPSS.
   - Input or import your data into the SPSS Data View.

3. **Defining Variables**

   - In Variable View, label your variables and specify their properties (e.g., scale for DV, nominal for IVs).

4. **Accessing the ANOVA Function**

   - Navigate to `Analyze` > `General Linear Model` > `Repeated Measures`.

5. **Setting Up the Within-Subjects Factor**

   - In the Repeated Measures dialog box, define the within-subjects factor. Give it a name and specify the number of levels (e.g., 2 for a 2x2 design).
   - Add the names of the within-subjects conditions and click `Add`.
   - Click `Define`.

6. **Specifying Variables**

- Move your dependent variable(s) for each level of the within-subjects factor to the `Within-Subjects Variables` box.
- Move your between-subjects factor to the `Between-Subjects Factor(s)` box.

7. **Running the Analysis**
    - Click `OK` to perform the mixed ANOVA.
8. **Post Hoc Tests and Options**
    - For post hoc analyses of significant effects, use `Post Hoc` (mainly for between-subjects factor).
    - In `Options`, select additional statistics like `Descriptive Statistics` and `Estimates of effect size`. Ensure `Display Main Effects and Interactions` is checked.

Conducting Post-Hoc Pairwise Comparisons

After running the mixed ANOVA, if you find significant main effects or interactions, you'll want to conduct post-hoc tests to explore these differences further.

For the Between-Subjects Factor:

1. **Access the One-Way ANOVA Dialog**: For post-hoc tests on the between-subjects factor, navigate to `Analyze` > `Compare Means` > `One-Way ANOVA`.
2. **Set Up Your Analysis**: Place the dependent variable in the `Dependent List` box and the between-subjects factor in the `Factor` box.
3. **Specify Post-Hoc Tests**: Click `Post Hoc ...` and select an appropriate test for your analysis (e.g., Bonferroni, Tukey) to adjust for multiple comparisons.
4. **Run the Test**: Click `OK` to run the post-hoc test. Review the output for pairwise comparisons among levels of the between-subjects factor.

For the Within-Subjects Factor and Interaction Effects:

SPSS's main interface does not directly provide post-hoc tests for within-subjects factors or their interactions with between-subjects factors in a mixed design. Instead, you can use:

- **Simple Effects Analysis**: For interactions, you may need to conduct simple effects analyses to explore the effect of one factor at each level of another. This involves running separate ANOVAs for subsets of your data.

Simple Effects Analysis

The goal here is to break down the interaction by looking at the effect of one factor at each level of the other factor separately.

For Factor B (Within-Subjects) at Each Level of Factor A (Between-Subjects):

1. **Split Your File by Factor A**: This allows you to analyze the effect of Factor B within each level of Factor A separately.
    - Go to `Data` > `Split File`.
    - Select `Organize output by groups`.
    - Move your between-subjects factor (Factor A) into the `Groups Based on` box (e.g., Gender).
    - Click `OK`.
2. **Conduct Separate Repeated Measures ANOVAs**:
    - Go to `Analyze` > `General Linear Model` > `Repeated Measures`.
    - Define your within-subjects factor (Factor B) by specifying the number of levels (e.g., 2 for Pretest and Posttest) and measure name.
    - Click `Define`. For your dependent variables, select the scores corresponding to the within-subjects factor levels (e.g., Pretest and Posttest scores).
    - In the `Subject Variables` field, make sure to include your participant ID or a variable that uniquely identifies each case.
    - Run the analysis. SPSS will perform the analysis separately for each level of Factor A due to the file splitting.
3. **Interpret the Output**: You'll receive separate outputs for each level of Factor A, showing the main effect of Factor B (the within-subjects factor) within each group defined by Factor A. This tells you how the dependent variable changes from Pretest to Posttest within each gender, for example.

For Factor A (Between-Subjects) at Each Level of Factor B (Within-Subjects):

Performing this in SPSS directly can be complex because it involves analyzing between-subjects effects at each level of a within-subjects factor, which is not straightforward with the standard menu options. Instead, consider:

- **Exporting Data**: For each level of your within-subjects factor, create a new dataset or use syntax to treat each level as a separate group, then perform a standard independent samples t-test or one-way ANOVA on these groups.

- **Use Syntax**: Advanced users can write SPSS syntax to more precisely control the analysis, specifying the model and contrasts for simple effects within the mixed model framework.

Step 4: Adjust for Multiple Comparisons

When interpreting the results from these separate analyses, remember that conducting multiple tests increases the risk of Type I error. Apply a correction for multiple comparisons (e.g., Bonferroni) to the p-values obtained from your simple effects analyses.

10. **Interpreting the Output**

- Examine the output for main effects and interactions in the `Tests of Between-Subjects Effects` and `Tests of Within-Subjects Effects` tables.
- Check the `Sig.` column for p-values to determine significance.

11. **Reporting the results**

Results

A mixed 2x2 ANOVA was conducted to investigate the effects of [Between-Subject Factor Name] (with levels [Level 1 Name] and [Level 2 Name]), [Within-Subject Factor Name] (with levels [Level 1 Name] and [Level 2 Name]), and their interaction on [Dependent Variable Name].

The main effect for the between-subjects factor, [Between-Subject Factor Name], was significant, F(1, N - 1) = [F-Value], p < .05, η^2 = [Effect Size], indicating that [interpret the result, e.g., participants in Level 1 of the between-subjects factor showed different scores in the dependent variable compared to participants in Level 2].

Similarly, the main effect for the within-subjects factor, [Within-Subject Factor Name], was significant, F(1, N - 1) = [F-Value], p < .05, η^2 = [Effect Size]. This suggests that [interpretation, e.g., there was a significant difference in the dependent variable across the two levels of the within-subjects factor].

Moreover, the interaction between [Between-Subject Factor Name] and [Within-Subject Factor Name] was significant, F(1, N - 1) = [F-Value], p < .05, η^2 = [Effect Size]. This indicates that the effect of [Within-Subject Factor Name] on [Dependent Variable Name] varies depending on the level of [Between-Subject Factor Name].

To further investigate the nature of this interaction, post hoc tests were performed using [Name of Post Hoc Test, e.g., simple effects analysis or pairwise comparisons with Bonferroni adjustment]. The post hoc analysis revealed that [describe the specific findings from the

post hoc tests, including any significant pairwise comparisons or specific patterns observed in the interaction].

Overall, these findings suggest that both [Between-Subject Factor Name] and [Within-Subject Factor Name] significantly affect [Dependent Variable Name], and their interaction provides additional insights into how these factors jointly influence the outcome.

12. **Assumption Checks**

- Verify assumptions such as sphericity (Mauchly's Test) for within-subjects factors.
- Address violations with corrections like Greenhouse-Geisser if needed.

13. **Graphical Representation**

- Use the `Graphs` option to create interaction plots or profile plots for a visual representation of interactions and main effects.

Step-by-Step Guide: Repeated Measures 2x2 ANOVA in SPSS

1. **Data Organization**

    - Arrange your data so that each column represents a different condition combination of your two within-subjects factors, and each row represents a different participant.
    - Ensure each participant has measurements under all condition combinations.

Repeated Measures 2x2 ANOVA Dataset:

Participant	Condition	Score
1	Condition_A1	67.64
1	Condition_A1	54.00
1	Condition_A2	59.79
1	Condition_A2	72.41
2	Condition_A1	68.68
...	...	...

2. **Opening SPSS and Data Entry**

    - Start SPSS and input your data in the Data View, or import your dataset.

3. **Variable Definition**

    - In Variable View, label your variables and set their properties appropriately.

4. **Accessing Repeated Measures ANOVA**
    - Go to `Analyze` > `General Linear Model` > `Repeated Measures`.
5. **Defining Within-Subjects Factors**
    - In the Repeated Measures Define Factor(s) dialog box, name your first factor (Factor A) and specify the number of levels (e.g., 2 for a 2x2 design).
    - Repeat the process for the second factor (Factor B).
    - Click `Define` after adding both factors.
6. **Specifying Dependent Variables**
    - Move the dependent variables corresponding to each level of your factors into the `Within-Subjects Variables` box.
7. **Model Specifications**
    - Choose the type of model (typically Full Factorial) under `Model`.
    - In `Contrasts`, set contrasts for your factors if specific comparisons are needed.
8. **Options and Post Hoc Tests**
    - Select `Options` to choose additional statistics, like `Descriptive Statistics` and `Estimates of effect size`.
    - Post hoc tests are usually not applicable in a fully within-subjects design.

Conducting Post-Hoc Pairwise Comparisons

If your ANOVA results indicate significant effects, you'll conduct post-hoc tests to explore these differences further.

For Main Effects:

1. **Access the Compare Means Analysis**: If the main effect is significant and you're interested in pairwise comparisons for a specific factor, navigate to `Analyze` > `Compare Means` > `One-Way ANOVA`.
2. **Set Up Your Analysis**: Place the dependent variable in the `Dependent List` box and the factor variable in the `Factor` box.
3. **Specify Post-Hoc Tests**: Click `Post Hoc ...` and select an appropriate test for your analysis (e.g., Bonferroni, Tukey). These options adjust for multiple comparisons, controlling the Type I error rate.
4. **Run the Test**: Click `OK` to run the post-hoc test. The output will include pairwise comparisons for levels of the factor.

For Interaction Effects:

SPSS does not directly offer a simple post-hoc test for interactions in repeated measures ANOVA. You'll need to explore the interaction by examining simple effects.

1. **Simple Effects Analysis**: Use the `General Linear Model` > `Univariate` analysis. Split your file by one factor to analyze the effect of the other factor at each level separately.
    - To split your file, go to `Data` > `Split File`. Choose `Organize output by groups` and move the factor by which you want to split the file into the `Groups Based on` box. This way, you can analyze the simple effects of one factor at each level of the other.
2. **Specify the Model**: In the Univariate dialog, place your dependent variable in the `Dependent Variable` box and the within-subject factor (for which you're examining simple effects) in the `Fixed Factor(s)` box.
3. **Run the Analysis and Interpret**: You will need to manually interpret the interaction by comparing the main effects of one factor at each level of the other. This is more complex and may require additional steps to adjust for multiple comparisons.

Additional Notes:

- **Adjust for Multiple Comparisons**: When conducting any post-hoc tests, always consider how you're controlling for the increased risk of Type I errors due to multiple comparisons. SPSS provides several options for adjustment in the Post Hoc dialog box.
- **Interpret With Caution**: When interpreting your results, consider the context of your study, the size of the effects, and the confidence intervals around your estimates.
- **Consult SPSS Help**: For specific syntax and options, the SPSS Help function can provide additional insights and examples tailored to your version of SPSS.

9. **Running the ANOVA**
    - Click `OK` to perform the analysis.

10. **Interpreting the Output**

- Examine the SPSS output for main effects and interaction effects in the `Tests of Within-Subjects Effects` table.
- The `Sig.` column will indicate significance levels.

11. **Reporting the results**

Results

A 2x2 repeated measures ANOVA was conducted to assess the impact of [Factor 1 Name] (with levels [Level 1 Name] and [Level 2 Name]) and [Factor 2 Name] (with levels [Level 1 Name] and [Level 2 Name]) on [Dependent Variable Name]. Both factors were within-subjects variables.

The main effect of [Factor 1 Name] was found to be significant, F(1, N - 1) = [F-Value], $p < .05$, η^2 = [Effect Size], indicating that [brief interpretation, e.g., there was a significant difference in the dependent variable across the levels of Factor 1].

Similarly, the main effect of [Factor 2 Name] was also significant, F(1, N - 1) = [F-Value], $p < .05$, η^2 = [Effect Size], suggesting that [brief interpretation, e.g., the levels of Factor 2 had a significant impact on the dependent variable].

More importantly, the interaction between [Factor 1 Name] and [Factor 2 Name] was significant, F(1, N - 1) = [F-Value], $p < .05$, η^2 = [Effect Size]. This indicates that the effect of [Factor 1 Name] on [Dependent Variable Name] depends on the level of [Factor 2 Name].

To explore this interaction further, post hoc analyses were conducted using [Name of Post Hoc Test, e.g., pairwise comparisons with a Bonferroni correction]. The post hoc tests revealed that [describe the specific findings from the post hoc tests, e.g., the difference between levels of Factor 1 was more pronounced at Level 1 of Factor 2 than at Level 2].

In summary, the results suggest significant main effects of both [Factor 1 Name] and [Factor 2 Name] on [Dependent Variable Name], with a notable interaction between these two factors, as evidenced by the post hoc analysis.

12. **Assumption Checks**

    - Check for sphericity using Mauchly's Test. If assumptions are violated, consider using Greenhouse-Geisser or Huynh-Feldt corrections.

13. **Graphical Representation**

    - Use `Graphs` > `Legacy Dialogs` > `Line` to create interaction plots that display the interaction of your factors visually.