Factorial Designs
Chapter 11

PSY 250

Factorial Designs
Chapter 11

Experimental Factorial Designs
- More than one IV (factors)
- Imp. of interactions
- A 2 X 3 design involves 2 levels of factor A and 3 levels of factor B
- E.g. Factor A (Gender)
  - Males (level 1)
  - Females (level 2)
- Factor B (Dress)
  - Sloppy (level 1)
  - Casual (level 2)
  - Dressy (level 3)

Analyzing Factorial Designs
- We analyze factorial designs with the same type of statistical test that we used for analyzing the multiple-group designs (ANOVA).
- Labels you may hear that refer to the size of the design include:
  - Factorial ANOVA as a general term
  - Two-way ANOVA for two IVs
  - Three-way ANOVA for three IVs
- Also, researchers indicate the size of the design as X by Y, where X and Y represent the number of levels of the two factors.

One-Way Vs. Two-Way ANOVAs
- One-Way ANOVA – 1 Factor (IV) with as many levels as you want
- Two-Way ANOVA – 2 Factors with at least 2 levels each
- Dealing with cells of a matrix instead of columns

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sloppy</td>
<td>82</td>
<td>62</td>
</tr>
<tr>
<td>Casual</td>
<td>79</td>
<td>59</td>
</tr>
<tr>
<td>Dressy</td>
<td>69</td>
<td>49</td>
</tr>
</tbody>
</table>
Rationale of Factorial ANOVA

- The equations used to separately evaluate the effects of each of the two IVs as well as their interaction are as follows:

\[ \text{Main Effect A} = \frac{MS_A}{MS_{error}} \]

\[ \text{Main Effect B} = \frac{MS_B}{MS_{error}} \]

\[ \text{Interaction} = \frac{MS_{AB}}{MS_{error}} \]

If you use a larger factorial design, you would end up with an F ratio for each of the IVs and each interaction.

Main Effects

- The effect of one IV on the DV, while ignoring the other IV.
- "Collapsing across" the levels of the other IV.
- So look at whether clerks respond more quickly to male or female shoppers, ignoring how they're dressed.
- OR
- Look at whether clerks respond more quickly to dressy vs. sloppy shoppers regardless of whether they are male or female.

Main Effects cont.

- Can be significant effect with one IV but not with the other.
- OR
- Both main effects can be significant.

Understanding Interactions

- A significant interaction means that the effects of the various IVs are not straightforward and simple.
- Interdependent.
- Effects of factor A depend on levels of factor B or vice versa.
- Thus, we basically ignore the main effects of our independent IVs when there is a significant interaction.
Extra Mean Differences Between Cells

<table>
<thead>
<tr>
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Understanding Interactions

- A good way to understand interactions is to graph them.
- By graphing your DV on the y axis and one IV on the x axis, you can depict your other IV lines on the graph.
- When you have a significant interaction, you will notice that the lines of the graph cross or converge.
  - This pattern is a visual indication that the effects of one IV change as the second IV is varied.
- Non-significant interactions typically show lines that are close to parallel.

Significant Interactions

![Graph showing significant interactions between dress styles and gender for males and females.](https://example.com/graph1.png)
BUT need statistics to verify that interactions, as well as main effects are significant.
- Typically don’t report main effects if interaction is significant.
- Presence of interaction can distort main effects of either factor.

Mixed Design
- Factorial designs can involve different subjects participating in each cell of the matrix (Between Subjects), the same subjects participating in each cell of the matrix (Within Subjects) or a combination where one (or more) factor(s) is manipulated between subjects and another factor(s) is manipulated within subjects (Mixed Design).
- Factors can be experimental or nonexperimental (Combined Design).
Mixed/Combined Design Example

<table>
<thead>
<tr>
<th></th>
<th>Explicit Memory Test</th>
<th>Implicit Memory Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depressed</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>Non-Depressed</td>
<td>82</td>
<td>85</td>
</tr>
</tbody>
</table>

Mixed Design Example cont.

Three Factor Designs

- Fairly easy to interpret 3-way interactions
- E.g. A X B Pattern differs for C1 and C2
- But very difficult to interpret 4-way interactions and beyond

Two-way interaction between Factors A and B for one level of Factor C but not for another level of Factor C
- E.g. Larger effects of Condition by Treatment Interaction for 4 Year olds than for 3 Year olds
Reducing Variance Between Groups

- Include factor contributing to increased variance within groups (e.g. age) such that groups are now divided into the levels of this factor (young vs. older)
- Doesn't limit external validity like restricting range or holding constant does
- One reason to do factorial studies

Order Effects as a Factor

- E.g. treatment within subjects, order between subjects
- Examine nature and magnitude of order effects

No Order Effects

- No difference if treatment is presented first or second
- Where for Group A, Treatment 1 occurred 1st and for Group B Treatment 2 occurred 1st
- Difference of 5 points between Treatments regardless of when presented

<table>
<thead>
<tr>
<th>Group</th>
<th>Treatment 1</th>
<th>Treatment 2</th>
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<tbody>
<tr>
<td>A (1-2)</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>B (2-1)</td>
<td>20</td>
<td>15</td>
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<td>20 Treatment 1</td>
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Symmetrical Order Effects

- Order Matters and is the same regardless of what the treatment is
- E.g. second treatment score always raised by 10 points regardless of which treatment it is

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</tr>
<tr>
<td>Group B (2-1)</td>
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<td>34 Treatment 1</td>
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Nonsymmetrical Order Effects

- Specific treatments determine the type of order effects, e.g. fatigue vs. practice
- Group A does better on Treatment 2 when receiving it second, but Group B does the same on both treatments when receiving treatment 2 first

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