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

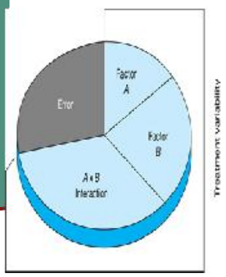
- One-Way ANOVA – 1 Factor (IV) with as many levels as you want
- Two-Way ANOVA – 2 Factors with at least 2 levels each
- Dealing with cells of a matrix instead of columns

Gender

Dress Style

	Males	Females
Sloppy	82	62
Casual	79	59
Dressy	69	49

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:

$$F_A = \frac{\text{IV } A \text{ variability}}{\text{error variability}}$$

$$F_B = \frac{\text{IV } B \text{ variability}}{\text{error variability}}$$

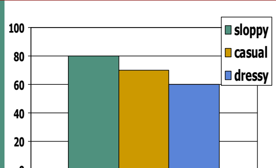
$$F_{A\times B} = \frac{\text{interaction variability}}{\text{error variability}}$$

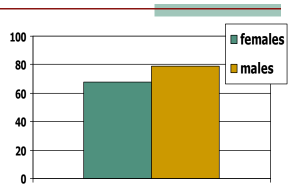
If you use a larger factorial design, you would end up with an *F* ratio for each of the IVs and each interaction

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

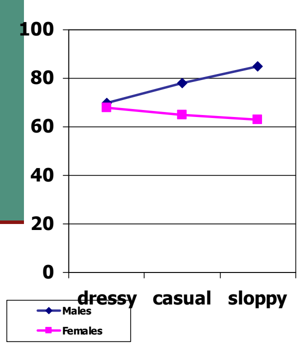
Gender

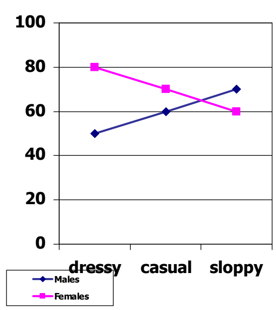
Dress Style		Males	Females		
	Sloppy	82	62	72	
					-3
	Casual	79	59	69	
					-10
	Dressy	69	49	59	
		76.7	56.7		
		-20			

Understanding Interactions

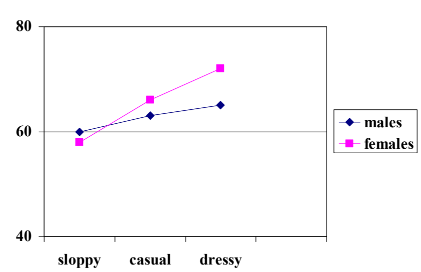
- A good way to understand interactions is to graph them.
  - By graphing your DV on the *y* axis and one IV on the *x* axis, you can depict your other IV lines on the graph.
- When you have a significant interaction, you will notice that the lines of the graph cross or converge.
  - This pattern is 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

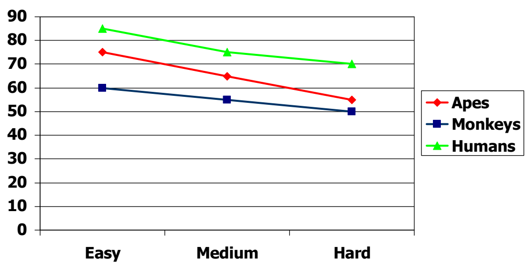




Significant Interactions



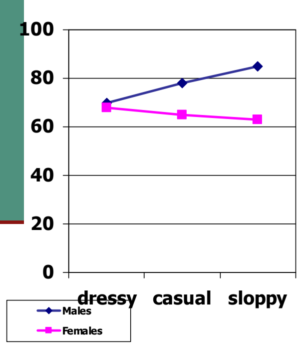
Non-Significant Interactions

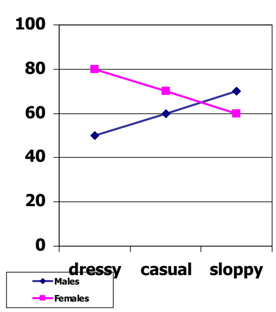


Verify

- 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

Significant Interactions





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)

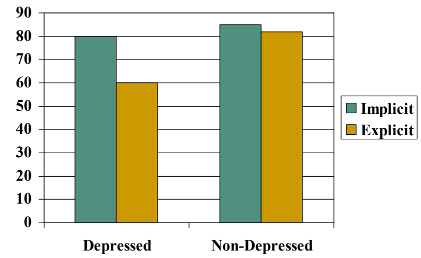
Mixed/Combined Design Example

Within Subjects
Experimental

Between Subjects
Non-Experimental

	Explicit Memory Test	Implicit Memory Test
Depressed	60	80
Non-Depressed	82	85

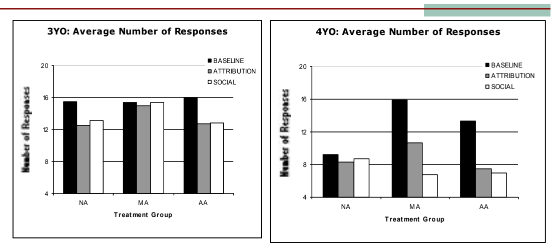
Mixed Design Example cont.



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

Three Factor Designs



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

Group	Treatment 1	Treatment 2
A (1 – 2)	20	15
B (2 - 1)	20	15

Group	Order 1	Order 2
A (1 – 2)	20 Treatment 1	15 Treatment 2
B (2 - 1)	15 Treatment 2	20 Treatment 1

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

Group	Treatment 1	Treatment 2
Group A (1-2)	20	30
Group B (2-1)	34	24

Group	Order 1	Order 2
Group A (1-2)	20 Treatment 1	30 Treatment 2
Group B (2-1)	24 Treatment 2	34 Treatment 1

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

Group	Treatment 1	Treatment 2
Group A (1-2)	20	30
Group B (2-1)	24	24

Group	Order 1	Order 2
Group A (1-2)	20 Treatment 1	30 Treatment 2
Group B (2-1)	24 Treatment 2	24 Treatment 1