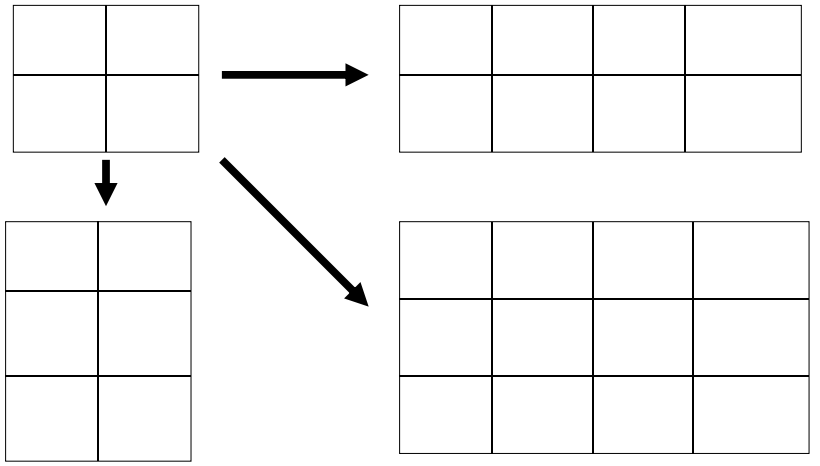
3-way Factorial Designs

- Expanding factorial designs
- Effects in a 3-way design
- Causal Interpretations of 3-way factorial effects
- Defining a 3-way interaction
- Describing and "checking" a 2-way interaction
- Describing and "checking" a main effect
- Summary of "Descriptive" & "Misleading" effects
- Causal Interpretations of 3-way factorial effects

3-way Factorial Designs

The simplest factorial design is a 2x2, which can be expanded in two ways:

1) Adding conditions to one, the other, or both IVs



2) Add a 3rd IV (making a 3-way factorial design)

	Learning Psyc Methods		Learning Psyc Content	
	Ugrads	Grads	Ugrads	Grads
Computer Instruction				
Lecture Instruction				

Identify the three IVs in this design . . .

Specify the properties of each condition/cell of this design . . .

3-Way Factorial Effects

There are 7 effects involved in a 3-way factorial

- 3 main effects (one for each IV)
- 3 2-way interactions (one for each pair of IVs)
- 1 3-way interaction

For the example name the ...

- main effects 1. Topic 2. Instruction Method 3. Ed. level

- 2-way interactions
  1. Topic X Inst. Method 2 .Topic X Ed. Level
  3. Inst. Method X Ed. Level

- 3-way interaction Topic X Instruction Method X Ed. level

What does a 3-way interaction look like?

- Remember that a 2-way interaction is, "when the effect of one IV is different for different levels of a 2nd IV"
- Extending this to a design with 3 IVs, a 3-way interaction is, "when the interaction of two IVs is different for different levels of a 3rd IV"

	Practice	
Difficulty	1	10
Easy	90	90
Hard	50	70

SE of Practice is different for Easy and Hard Tasks (all Familiar tasks)

Familiar Task

	Practice	
Difficulty	1	10
Easy	90	90
Hard	50	70

Unfamiliar Task

	Practice	
Difficulty	1	10
Easy	70	80
Hard	10	60

The 2-way interaction of Practice and Difficulty is different for Familiar and Unfamiliar Tasks

3-Way Factorial Effects

Familiar Task

	Practice	
Difficulty	1	10
Easy	90	90
Hard	50	70

Unfamiliar Task

	Practice	
Difficulty	1	10
Easy	60	80
Hard	10	60

3-way Interaction

The three-way interaction is described based on cell means

In order to describe the 3-way interaction you must pick:

1. The "primary simple effect" → which IV you care about most
2. The "primary moderating variable" → which IV you want to know if it "conditionalizes" the primary SE
3. The "secondary moderating variable" → which IV you want to know if it "further conditionalizes" the primary SE

3-Way Factorial Effects

Familiar Task

Difficulty	Practice 1	Practice 10
Easy	90	90
Hard	50	70

Unfamiliar Task

Difficulty	Practice 1	Practice 10
Easy	70	80
Hard	10	60

3-way Interaction

The three-way interaction is described based on cell means

Using Practice, Difficulty and Familiarity, respectively…

We want to describe how the Practice SE is different for Easy & Hard tasks, and how that pattern is different for Familiar v Unfamiliar tasks

Familiar Tasks		
Difficulty	1	10
Easy		=
Hard		<<

Unfamiliar Tasks		
Difficulty	1	10
Easy		<
Hard		<<<<<

3-Way Factorial Effects

Familiar Task

Difficulty	Practice 1	Practice 10
Easy	90	90
Hard	50	70

Unfamiliar Task

Difficulty	Practice 1	Practice 10
Easy	60	80
Hard	10	60

2-way Interaction

A two-way interaction is described based on semi-marginal means

For a particular 2-way, the semi-marginal means are the mean for each combination of the IVs for that 2-way, averaging across conditions of the 3rd IV.

If the 3-way is significant, then you have to check whether the pattern of the 2-way is descriptive or misleading, but comparing the simple effect of that 2-way for each value of the 3rd IV.

3-Way Factorial Effects

Familiar Task

Difficulty	Practice 1	Practice 10
Easy	90	90
Hard	50	70

Unfamiliar Task

Difficulty	Practice 1	Practice 10
Easy	60	80
Hard	10	60

Semi-marginal means for the Practice x Difficulty 2-way

Difficulty	Practice 1		Practice 10
Easy	75	<	85
Hard	30	<<<<	65

Checking if that 2-way is descriptive…

Familiar Tasks		
Difficulty	1	10
Easy		=
Hard		<<

Unfamiliar Tasks		
Difficulty	1	10
Easy		<
Hard		<<<<<

Nope !! The simple 2-way patterns are different!

3-Way Factorial Effects

Familiar Task

Difficulty	Practice 1	Practice 10
Easy	90	90
Hard	50	70

Unfamiliar Task

Difficulty	Practice 1	Practice 10
Easy	60	80
Hard	10	60

Main Effect

A main effect is described based on marginal means

For a particular main effect, the marginal means are the mean for each combination of that IV, averaging across conditions of the other two IVs.

If the 3-way is significant, then you have to check whether the pattern of the main effect is descriptive or misleading, but comparing the main effect pattern to the pattern of each simple effect of that IV for each combination of the other two IVs

3-Way Factorial Effects

Familiar Task

Difficulty	Practice 1	Practice 10
Easy	90	90
Hard	50	70

Unfamiliar Task

Difficulty	Practice 1	Practice 10
Easy	60	80
Hard	10	60

Marginal means for the Practice main effect

Practice 1		Practice 10
52.5	<<	75

Checking if that Main effect is descriptive…

Familiar Tasks

Difficulty	1	10
Easy	=	
Hard	<<	

Unfamiliar Tasks

Difficulty	1	10
Easy	<	
Hard	<<<<<	

Nopet!! There is no Practice effect for Easy Familiar tasks!

Descriptive and Misleading Effects in 3-way Designs

What about the 3-way interaction?

The 3-way interaction - significant or not - is always descriptive !

What about the 2-way interactions?

If the 3-way is non-significant, all three 2-ways are descriptive

If the 3-way is significant, all 2-way & main effects are “suspect”

If the 3-way is significant, a 2-way is only descriptive if that 2-way has the same pattern for each condition of the 3rd IV

What about the main effects ?

The main effect of an IV that is not involved in any 2-way or 3-way interaction is always descriptive

If the 3-way is significant, a main effect is only descriptive if that main effect has the same pattern for each combination of the other two IVs

If a 2-way is significant, the main effects of those IVs are “suspect”

If a 2-way is significant, the main effect of an IV involved in that interaction is only descriptive if that main effect has the same pattern for each condition of the other IV

Causal Interpretations of 3-way Designs

- When can a main effect be causally interpreted ?

  When the conditions of the IV is RA, Manip, & there are no confounds..

- When can a 2-way interaction be causally interpreted ?

  When the conditions of both the involved IVs are RA, Manip, & there are no confounds..

- When can a 3-way interaction be causally interpreted ?

  When the conditions of all three of the involved IVs are RA, Manip, & there are no confounds..