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# **Week 12 Lecture - Complex Experiments**

Undergraduate Research Methods in Psychology

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# 1 Learning Objectives

## 1.1 Textbook Objectives

- Explain why researchers combine independent variables in a factorial design.
- Describe an interaction effect in both everyday terms and arithmetic terms.
- Identify and interpret the main effects and interactions from a factorial design.

## 1.2 Professor's Objectives

- Understand and produce examples of when factorial design would be useful and/or appropriate
- Discuss some basic statistics procedures that can be used with these designs

# 2 Chapter Overview

## 2.1 Chapter Overview

- Up until now, we have only talked about experimental designs that deal with \_\_\_\_\_ manipulated/independent variable and one measured/dependent variable.
- However, we have designs that can look at two (or more) IVs at once and see their individual and \_\_\_\_\_ impact on the DV!
- We refer to these as \_\_\_\_\_ designs.

# 3 Experiments with Two IVs

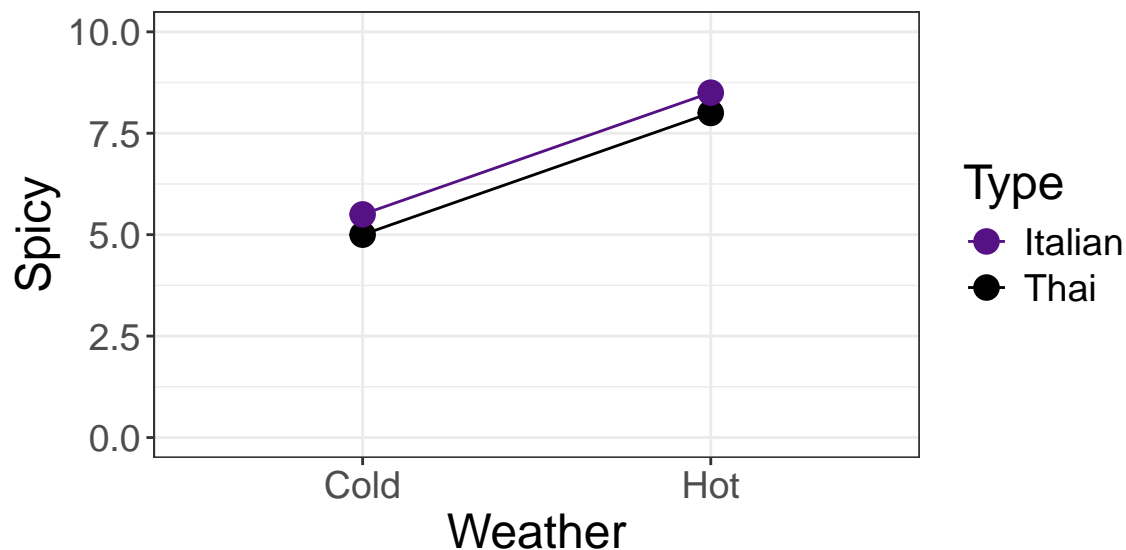
## 3.1 Overview

- We can add a second (and third) \_\_\_\_\_ variable if we are curious about more than one.
  - In addition to the individual effects of both of the IVs, we also get an \_\_\_\_\_ effect that describes how they change each other's relationship with the outcome.
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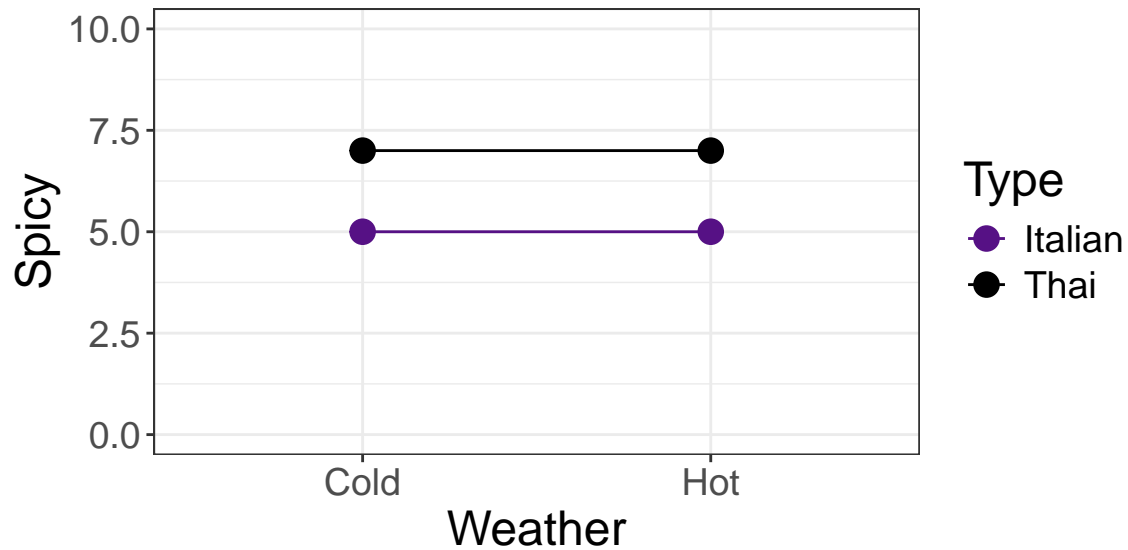
- Statistically, we might say this interaction is a “\_\_\_\_\_ in differences”
  - Practically, this means that the differences between our groups may be different based on some other trait.
  - More on this later

### 3.2 Intuitive Interactions

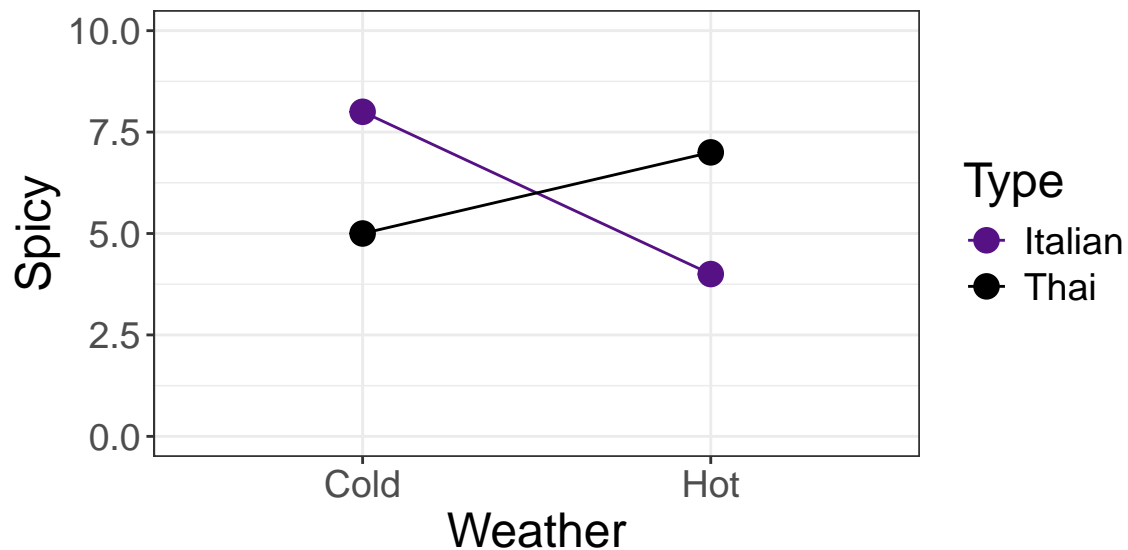
- When confronted with a causal relationship, sometimes we might say, “well it \_\_\_\_\_” - what it depends on is the second (or third) IV
- We can see this even in our personal experiences, and many relationships do depend on \_\_\_\_\_ factors
- *Example:* I am assessing how spicy I like my food (on a scale of 1 to 10; my outcome). First, is it cold or hot outside (IV 1)? Second, am I eating Thai or Italian (IV 2)? It is possible that my answer will be different based upon both of the IVs.
- **4 Possible Outcomes:**
- I like all of my food spicier when it is hot - Weather effect, but *not* food



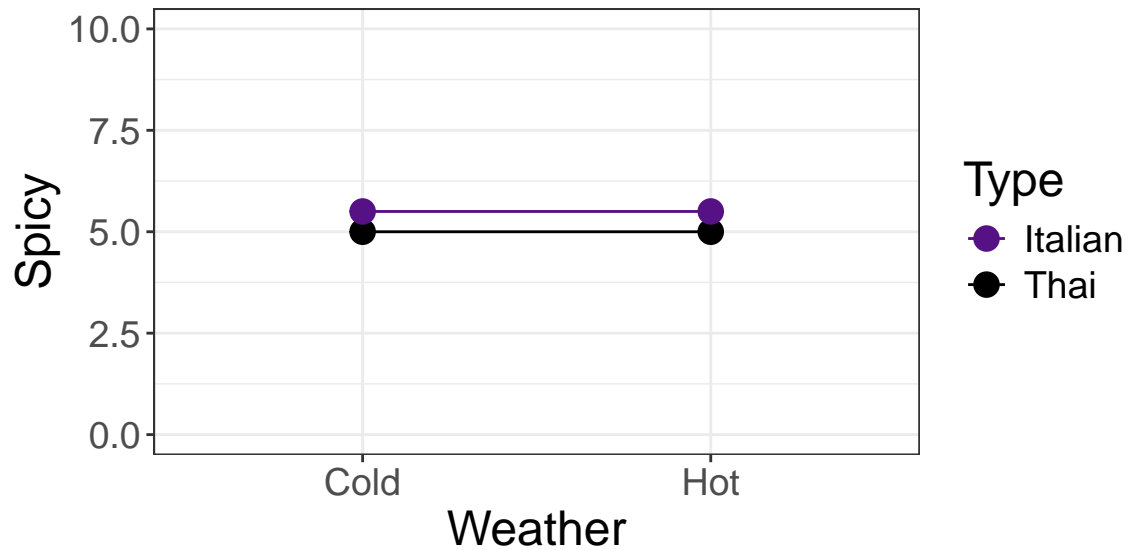
- I like Thai food spicier than Italian, regardless of weather - Food effect, but *not* temperature



- Whether I like by food spicy or not depends on both the weather, and type of food - interaction effect
- Specifically, we are looking to see whether we have a \_\_\_\_\_ interaction, like in the graph below:



- My preference for spice doesn't change, regardless of food type or weather - null findings



### 3.3 Study Two IVs

- When we work with \_\_\_\_\_ than one IV, we use a factorial design.
- This creates more \_\_\_\_\_ unique conditions = # of Conditions in IV 1 x # of Conditions in IV 2 = total number of conditions
- Both IVs do *not* have to be \_\_\_\_\_. Often, one will be some categorical, measured trait (e.g., gender, ethnicity, etc.)
- In addition to our statistics, we should show these differences in \_\_\_\_\_ ! Interaction effects become especially clear with visual evidence.

### 3.4 Limit Testing

- Factorial designs can help us find whether outcomes are different for different \_\_\_\_\_ of people.
- A strong intervention may not be as effective in a different group of people.
- This can be a \_\_\_\_\_ to our external validity, as we demonstrate findings in a more heterogeneous group.
- We also can establish whether one variable appears to \_\_\_\_\_ another on the relationship with the outcome variable.

### 3.5 Test Theories

- For some \_\_\_\_\_ reasons, we may have good reason to believe that an effect differs based on some demographic variable.
- *Example:* I have a new intervention meant to encourage flexibility in learning and taking in new content. However, I recognize that the neuroplasticity of older adults is just lesser in general. Therefore, I believe my intervention will likely be more effective for younger adults, than it will for older adults.
- In essence, we may be able to add \_\_\_\_\_ and “it depends” to our hypotheses and investigate with factorial designs.

### 3.6 Main Effects & Interactions

- **Main Effects** are those that come from each IV on the outcome.
    - The main effect is \_\_\_\_\_ as an average over the levels of the other IV. Similar to how we “control” for other variable in multiple regression.
    - You have 1 main effect for each IV
  - **Marginal Means** are the \_\_\_\_\_ that we use to determine whether a main effect is present
    - We can test significance by taking the difference of the two marginal means, and calculating 95% CIs. If CIs \_\_\_\_\_ 0 → non-significant
-

DV: Reaction time (ms)		IV <sub>1</sub> : Photo type		Main effect for IV <sub>2</sub> : Word type
		Alcohol	Plant	
IV <sub>2</sub> : Word type	Aggressive	551	559	555 (average of 551 and 559)
	Neutral	562	552	557 (average of 562 and 552)
Main effect for IV <sub>1</sub> : Photo type		556.5 (average of 551 and 562)	555.5 (average of 559 and 552)	

- An **interaction effect** can be detected by looking at the differences of the main effect differences. If they are \_\_\_\_\_ different from one another, then we would say that there is an interaction effect
  - Interactions are often treated as \_\_\_\_\_ important, theoretically, that main effects - when they are significant.
- Conventional wisdom: If interaction is significant, focus on that mostly. If interaction is non-significant, focus on main effects of IVs.
  - Interpreting the main effects with a significant interaction can be leaving out important information!
- *Stats sidebar*: This type of analysis is usually done via Two-way ANOVA, which does all the work of calculating significance of interactions, and main effects for us.

## 4 Factorial Variations

### 4.1 Overview

- Just like with other experiments, we can lay out a factorial design as being between-groups or \_\_\_\_\_-groups.
- But, we can designate \_\_\_\_\_ variable as between or within, leading to a total of 3 possible designs:



- Independent-Groups Factorial
- Within-Groups Factorial
- Mixed Factorial

## 4.2 Independent-Groups Design

- This is when \_\_\_\_\_ IVs are between-groups (i.e., participants are arranged into entirely separate groups)
- One nuance is that this will likely require the largest sample \_\_\_\_\_, as each group will have about 1/4th the total number of participants

## 4.3 Within-Groups Design

- Much like with previous within-groups designs, this is when participants see \_\_\_\_\_ possible condition.
- One thing to watch out for is the need for \_\_\_\_\_ to prevent order effects
  - Think about how many permutations of condition orders you may need!

## 4.4 Mixed Factorial Design

- This is when one IV is \_\_\_\_\_-groups, and the other is within-group.
- This is fairly common if we have one demographic variable (between-groups) and one manipulated variable that both demographics are exposed to each level (within-groups).

## 4.5 More Conditions

- Many \_\_\_\_\_ are going to naturally have more than one level
    - E.g., race, ethnicity, gender, etc.
  - We can use these in factorial designs all the same - and we write it as:  $A \times B$  Design.
    - Where  $A$  = Number of conditions in IV 1
    - Where  $B$  = Number of conditions in IV 2
  - Statistics here get more \_\_\_\_\_ to interpret - but a good starting point is to use a line plot just like what we have done previously and see if lines cross or are parallel.
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## 4.6 More IVs

- Prof. Paul Moes: “God himself cannot interpret a 4-way interaction - neither can you”
- We can do 3 IVs, but with each additional variable the interpretation becomes exponentially more difficult and complicated.
  - One popular alternative is to do this as a multiple \_\_\_\_\_ model instead
  - *Stat sidebar:* ANOVA and linear regression are both types of the general \_\_\_\_\_ model, so, in a roundabout way, these are actually equivalent!
- Remember to think carefully about what sorts of conclusions you can draw with a design before you use it, and whether an alternative provides a more \_\_\_\_\_ conclusion.

## 5 Identify Factorial Designs

### 5.1 Reading Empirical Articles

- Look for words like ...
  - “\_\_\_\_\_ ANOVA”
  - “Factorial”
  - “Interaction” or “Main Effects”
- You may also see phrasing like “2 x 2 design”, referring to the two conditions of each IV.

### 5.2 In Popular Media

- Look for words like ...
    - “\_\_\_\_\_”
    - “Only when”
  - You may also look for demographic variables ...
    - “For males this was the results, but for females...”
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