

Outline for Two-Way ANOVA

1. Overview, including review of prior statistical tests & new terms
2. What hypotheses are being tested with two-way ANOVA?
 - Main effects
 - Interactions



First, an example . . .

- Drug **interaction**

(DV)

(IV #1, factor A)

- The **effect** on your health of whether you take drug A **depends on** whether you are already taking drug B.

(IV #2, factor B)

(factor B)

Whether or not you are already taking drug B for another health issue

		(factor B)	
		You already take Drug B	You don't take Drug B
(factor A)	Whether or not you take Drug A for BP	You take Drug A	
		You don't take Drug A	Poor health (high BP)
		Poor health (high BP)	Poor health (high BP)

Hypothesis testing for two-factor ANOVA

- We're essentially doing three separate (independent) hypothesis tests.
- We are learning:
 1. whether or not **Factor A** has an effect on the DV,
 2. whether or not **Factor B** has an effect on the DV,
 3. whether or not the effect of one of these factors on the DV depends on the other factor.

Hypothesis testing for two-factor ANOVA

- We're essentially doing three separate (independent) hypothesis tests.

Same meaning as prior slide, but re-stated...

- We are learning:
 1. whether there's a difference in means of the DV across the conditions of Factor A,
 2. whether there's a difference in means of the DV across the conditions of Factor B,
 3. whether or not the differences in the DV across conditions of Factor A are different across each level of Factor B.

Hypothesis testing for two-factor ANOVA

- We're essentially doing three separate (independent) hypothesis tests.

Same as prior 2 slides, but re-stated...

- We are learning:
 1. whether there's a main effect of Factor A on the DV,
 2. whether there's a main effect of Factor B on the DV,
 3. whether there's an interaction between **Factor A** and **Factor B** when predicting the DV.
 - Also called a "two-way interaction"

Two-way Interactions

- **Two**-way interactions are interactions between **two** *factors*, when predicting a **DV**
- *Two-way interaction, defined*
 - When the effect of **one factor** on the **DV** depends on the different levels of a **second factor**.

"is different across"

The **effect** on your health of whether you take drug A **is different depending on whether you are vs. are not already taking drug B.**

- When you **already take Drug B**, **taking Drug A** causes worse health than **not taking Drug A**.
- When you **are NOT already taking Drug B**, **taking Drug A** causes *better* health than **not taking Drug A**.

(factor B)

Whether or not you are already taking drug B for another health issue

Whether or not you take Drug A for BP		You already take Drug B	You don't already take Drug B
	You take Drug A	Severe risk for a heart attack	Good health (lower BP)
	You don't take Drug A	Poor health (high BP)	Poor health (high BP)

Example: Hypothesis Testing for Note-Taking Study

- DV/outcome = post-class level of understanding of material
- Factor A = note-taking method (by hand vs. laptop) *randomly assigned*
- Factor B = handwriting (neat vs. messy) *known ahead of time for all Ps*

We're essentially doing three separate (independent) hypothesis tests.

1. whether there's a main effect of **note-taking method** on **understanding**,
2. whether there's a main effect of **handwriting** on **understanding**,
3. whether there's an interaction between **note-taking method** and **handwriting** when predicting **understanding**

(DV)

You can also reverse the two factors (predictors/IVs), and this would mean the same thing.

Example: Hypothesis Testing for Note-Taking Study

- DV/outcome = post-class level of understanding of material
- Factor A = note-taking method (by hand vs. laptop) *randomly assigned*
- Factor B = handwriting (neat vs. messy) *known ahead of time for all Ps*

We're essentially doing three separate (independent) hypothesis tests.

1. whether or not **note-taking method** has an effect on **understanding of material**, and
2. whether or not **handwriting** has an effect on the **understanding of material**, and
3. whether or not the effect of **note-taking method** on **understanding of material** depends on **handwriting**.^(DV)



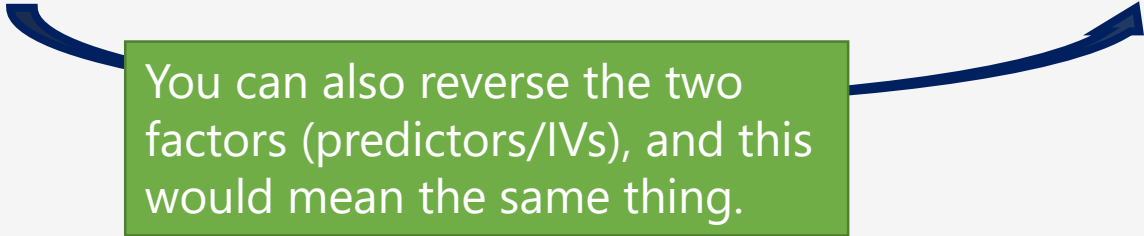
You can also reverse the two factors (predictors/IVs), and this would mean the same thing.

Example: Hypothesis Testing for Note-Taking Study

- DV/outcome = post-class level of understanding of material
- Factor A = note-taking method (by hand vs. laptop)
- Factor B = handwriting (neat vs. messy)

We're essentially doing three separate (independent) hypothesis tests.

1. whether there's a difference in mean **understanding** across the 2 conditions of **note-taking method**, *and*
2. whether there's a difference in mean **understanding** across the 2 conditions of **handwriting**, *and*
3. whether the differences in mean **understanding** across the conditions of **note-taking method** are different across each level of **handwriting**



You can also reverse the two factors (predictors/IVs), and this would mean the same thing.

DV = understanding of material, as measured by scores on quiz at end of class

$N = 60$

$n = 15$ per cell

Handwriting

Note-taking Method

	Neat	Messy
By hand	$M = 6$	$M = 4$
Laptop	$M = 3$	$M = 3$

Q: When handwriting is **NEAT**, how does note-taking affect quiz score?

Q: When handwriting is **MESSY**, how does note-taking affect quiz score?

If there is a two-way interaction between note-taking method & handwriting, then the effect of note-taking method on quiz score will look different depending on whether handwriting is **neat** vs. **messy**.

If the two answers are the same
→ **no interaction**

If the two answers are different
→ there **is an interaction**

DV = understanding of material, as measured by scores on quiz at end of class

$N = 60$

$n = 15$ per cell

Handwriting

Note-taking Method

	Neat	Messy
By hand	$M = 6$	$M = 4$
Laptop	$M = 3$	$M = 3$

Q: When handwriting is **NEAT**, how does note-taking affect quiz score?

Q: When handwriting is **MESSY**, how does note-taking affect quiz score?

A: *By hand* is **3 pts greater** than *laptop* when handwriting is **NEAT**

A: *By hand* is only **1 pt greater** than *laptop* when handwriting is **MESSY**

If there is a two-way interaction between note-taking method & handwriting, then the effect of note-taking method on quiz score will look different depending on whether handwriting is **neat** vs. **messy**.

The hypothesis test for the interaction reveals whether these apparent differences are *real* (i.e., *significantly different*) or produced by chance.

If the two answers are the same
→ **no interaction**

If the two answers are different
→ there **is an interaction**

Two-way ANOVA: Example study

Research Question:

Does drinking alcohol influence how attractive we find others, and does this effect (of alcohol) depend on gender of the drinker? Let's assume for this study that all recruited participants classified themselves as either male or female, and some participants drank alcohol, while others did not drink any.

Attractiveness was measured on a quantitative scale.

What are the IVs?

What is the DV?

Write the design using APA-style.

What are the three hypotheses being tested with your two-way ANOVA?

Borrow the language from the handout.

Two-way ANOVA: Example study

Research Question:

Does drinking alcohol influence how attractive we find others, and does this effect (of alcohol) depend on gender of the drinker? Let's assume for this study that all recruited participants classified themselves as either male or female, and some participants drank alcohol, while others did not drink any. Attractiveness was measured on a quantitative scale.

What are the IVs?

- Alcohol consumed (yes vs no)
- Gender of drinker (female vs male)

What is the DV?

Judgments about date's attractiveness

Design

The study has a 2 (alcohol consumed: yes vs. no) x 2 (gender: female vs. male) factorial design.

Two-way ANOVA: Example study

Research Question:

Does drinking alcohol influence how attractive we find others, and does this effect (of alcohol) depend on gender of the drinker? Let's assume for this study that all recruited participants classified themselves as either male or female, and some participants drank alcohol, while others did not drink any. Attractiveness was measured on a quantitative scale.

Whether there is a main effect of alcohol consumption on attractiveness ratings.

Whether there is a main effect of gender on attractiveness ratings.

Whether there is an interaction between alcohol consumption and gender when predicting attractiveness ratings.

Two-way ANOVA: Example study

Research Question:

Does drinking alcohol influence how attractive we find others, and does this effect (of alcohol) depend on gender of the drinker? Let's assume for this study that all recruited participants classified themselves as either male or female, and some participants drank alcohol, while others did not drink any. Attractiveness was measured on a quantitative scale.

whether or not alcohol consumption has an effect on attractiveness ratings

whether or not gender has an effect on attractiveness ratings

whether or not the effect of alcohol consumption on attractiveness ratings depends on gender.

Two-way ANOVA: Example study

Research Question:

Does drinking alcohol influence how attractive we find others, and does this effect (of alcohol) depend on gender of the drinker? Let's assume for this study that all recruited participants classified themselves as either male or female, and some participants drank alcohol, while others did not drink any. Attractiveness was measured on a quantitative scale.

whether there's a difference in mean attractiveness ratings across the 2 levels of alcohol consumption

whether there's a difference in mean attractiveness ratings across the 2 levels of gender (i.e., across females and males)

whether the differences in mean attractiveness ratings across the levels of alcohol consumption are different across the two levels of gender (i.e., across females and males)