TOPIC: TWO-WAY ANOVA

Intro to Two-Way ANOVA & Two-Way Tables

◆ Recall: 1-Way ANOVA compares 3+ means across 1 factor: **2-Way ANOVA** compares means across ___ factors. *(indep. var.)*

► If 1 factor _____ the other, there is an **Interaction Effect**. Test for interactions *before* testing each factor.

EXAMPLE

A team of botanists is studying how sunlight exposure & fertilizer level affect plant growth. They randomly assign 5 plants to different combinations of sunlight & fertilizer levels. The table shows the mean growth in cm after 7 weeks. A 2-way ANOVA test is done, shown to the right. Using $\alpha = 0.05$, test for an interaction effect between sunlight & fertilizer, an effect from varying fertilizer, and an effect from varying sunlight.

		Sunlight (hr / day)		
		Low (4hr)	Med (8hr)	High (12hr)
Fert. Level	1 Tbsp/wk	12.52	18.30	22.76
	3 Tbsp/wk	14.48	20.98	24.96

2-Way ANOVA Test Summary

	MS	F-stat	P-value
Fertilizer Level	38.99	377.18	< 0.0001
Sunlight Exposure	271.4	2625.57	< 0.0001
Interaction	0.336	3.26	0.0563
Error	0.103		

Interaction Effect

$$F = \frac{\text{MS(Interaction)}}{\text{MSE}}$$

H_0: There is _____

H_a: There is _____

[REJECT | FTR] H_0
[IS | IS NOT] an interaction

[DON'T DO | DO] other tests

Fertilizer Level

$$F = \frac{\text{MS(Factor)}}{\text{MSE}}$$

H_0: No difference in means from fert.

H_a: Difference in means from fert.

[REJECT | FTR] H_0
[ENOUGH | NOT ENOUGH] evidence to suggest H_a:

Sunlight Exposure

$$F = \frac{\text{MS(Factor)}}{\text{MSE}}$$

H_0: No difference in means from sunlight

H_a: Difference in means from sunlight

[REJECT | FTR] H_0
[ENOUGH | NOT ENOUGH] evidence to suggest H_a:

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PRACTICE Which of the following scenarios can be appropriately answered using a Two-Way ANOVA test?

(A) Researchers compare final exam scores between students who attended tutoring vs. who did not
(B) A psychologist compares anxiety levels among patients receiving one of two treatments
(C) A nutritionist studies how meal type (breakfast, lunch, dinner) and diet plan (low-carb, low-fat, Mediterranean) affect blood sugar levels
(D) A professor tests if average scores on a quiz are significantly different between 5 class sections

PRACTICE

A university surveys how study group size (solo, duo, group) and study environment (quiet, noisy) affect test performance. Which of the following conclusions most clearly suggests an interaction effect between the two factors?

(A) Students who study in quiet environments score higher than students who study in noisy ones, regardless of group size
(B) Students who study in groups generally perform better than those who study alone, regardless of environment
(C) Solo and group sizes produced similar, higher scores overall, but duo group sizes were overall lower
(D) Students studying in groups in noisy environments tend to perform better, whereas students studying solo in quiet environments tend to perform better

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EXAMPLE

A quality control team at a factory is testing how machine type (Type A, Type B) and operator experience (Novice, Intermediate, Expert) affect the average number of defective units produced in a month. The two-way ANOVA output is shown below. Using a 0.05 significance level, is there evidence of interaction? Is there evidence of an effect from machine type, or from operator experience?

	MS	F-stat	P-value
Machine Type	25.40	4.23	0.052
Operator Experience	2.10	0.35	0.556
Interaction	30.75	5.12	0.027
Error	6.00		

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Two-Way ANOVA: Interaction Plots

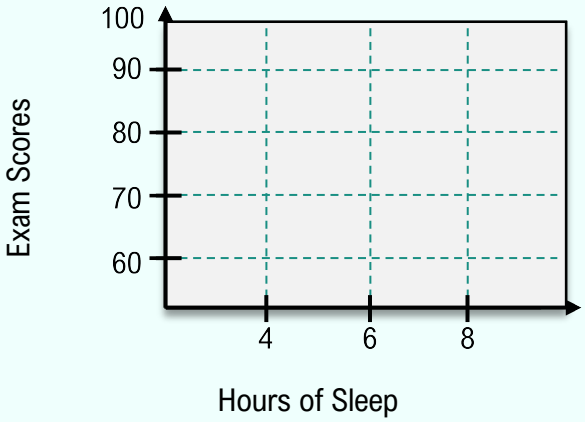
◆ **Interaction Plots:** Graphs of values & factors in 2-way ANOVA tables that can help determine interaction effects.

► Plot dependent var on __-axis, Factor 1 on __-axis, & _____ segments for each category of Factor 2.

► If segments are generally **[PARALLEL | NOT PARALLEL]**, this suggests **[NO INTERACTION | INTERACTION]**.

EXAMPLE

Researchers are interested in how study time and hours of sleep affect student performance on a nationwide exam. They collect data on a random sample of students and organize the average exam scores for different combinations of the two factors below. Complete the interaction plot. Does the graph suggest an interaction effect?



		Hours of Sleep		
		4 hrs	6 hrs	8 hrs
Study Time	Low	60	65	72
	High	64	77	92

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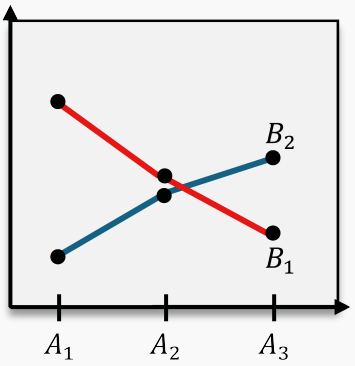
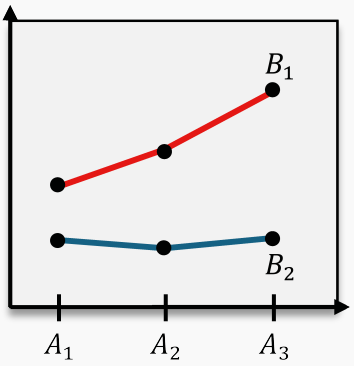
PRACTICE

Which of the following interaction plot best indicates no interaction between the two factors?

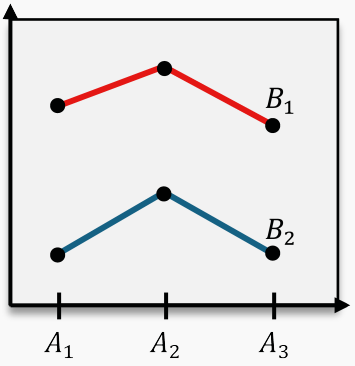
A)



B)



C)



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