

Two-way Analysis of Variance

(Part 1)

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Research paper

- Effects of alcohol and caffeine on driving ability
- 4 conditions:
 - No alcohol; no caffeine
 - alcohol; no caffeine
 - No alcohol; caffeine
 - Alcohol; caffeine
- 12 participants
- Driving in simulator
- Error rate

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Research paper

- Results:

A two-way ANOVA revealed a main effect of alcohol ($F(1, 11) = 577.9, p < 0.001$) and of caffeine ($F(1, 11) = 692.5, p < 0.001$). The interaction between alcohol and caffeine was significant as well ($F(1, 11) = 52.8, p < 0.001$).

- Main effect ????
- Interaction ????

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SPSS output

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Sphericity	Type III Sum of Squares	df	Mean Square	F	Sig.
CAFFEINE	Sphericity Assumed	972.000	1	972.000	577.946	.000
	Greenhouse-Geisser	972.000	1.000	972.000	577.946	.000
	Huynh-Feldt	972.000	1.000	972.000	577.946	.000
	Lower-bound	972.000	1.000	972.000	577.946	.000
Error(CAFFEINE)	Sphericity Assumed	18.500	11	1.682		
	Greenhouse-Geisser	18.500	11.000	1.682		
	Huynh-Feldt	18.500	11.000	1.682		
	Lower-bound	18.500	11.000	1.682		
ALCOHOL	Sphericity Assumed	1474.083	1	1474.083	692.452	.000
	Greenhouse-Geisser	1474.083	1.000	1474.083	692.452	.000
	Huynh-Feldt	1474.083	1.000	1474.083	692.452	.000
	Lower-bound	1474.083	1.000	1474.083	692.452	.000
Error(ALCOHOL)	Sphericity Assumed	23.417	11	2.129		
	Greenhouse-Geisser	23.417	11.000	2.129		

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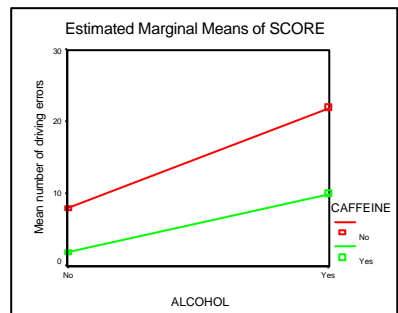
SPSS output (cont.)

Error(ALCOHOL)	Sphericity Assumed	23.417	11	2.129		
	Greenhouse-Geisser	23.417	11.000	2.129		
	Huynh-Feldt	23.417	11.000	2.129		
	Lower-bound	23.417	11.000	2.129		
CAFFEINE * ALCOHOL	Sphericity Assumed	108.000	1	108.000	52.800	.000
	Greenhouse-Geisser	108.000	1.000	108.000	52.800	.000
	Huynh-Feldt	108.000	1.000	108.000	52.800	.000
	Lower-bound	108.000	1.000	108.000	52.800	.000
Error(CAFFEINE*ALCOHOL)	Sphericity Assumed	22.500	11	2.045		
	Greenhouse-Geisser	22.500	11.000	2.045		
	Huynh-Feldt	22.500	11.000	2.045		
	Lower-bound	22.500	11.000	2.045		

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SPSS output



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Learning objectives

- (Principles of two-way ANOVA) -> next week
- Factorial design
- Interactions; main effects
- Read research papers
- Read SPSS's printouts

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Experimental design

- Two independent variables (=factors):
Caffeine, Alcohol
- Two-way factorial design:
Each factor is paired with every level of every other factor

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Advantage of factorial design

- Exploration of several factors in one experiment
- Influence between factors
- Examples:
 - High alcohol levels will impair driving ability
 - High levels of caffeine might improve driving ability due to its arousing effect
 - "Coffee helps to sober us up, we might predict that increased caffeine intake will reduce the influence of alcohol on driving ability"

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Cell

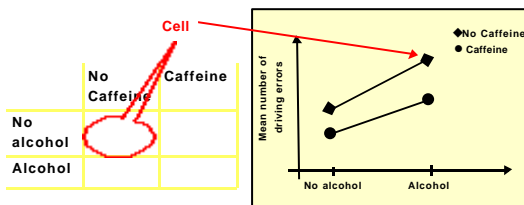
- Cell: Any combination of one level of one factor with one level of another factor

	No Caffeine	Caffeine
No alcohol		
Alcohol		

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Cell Plot



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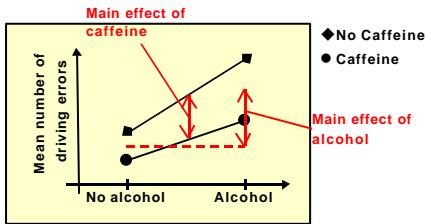
Main effect

- The effect of one independent variable averaged across the levels of the other independent variable(s)
- Examples:
 - High alcohol levels will impair driving ability
 - High levels of caffeine might improve driving ability due to its arousing effect

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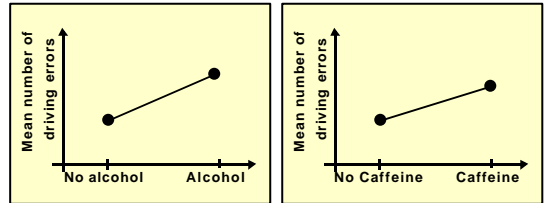
Illustration of main effect



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Illustration of main effect



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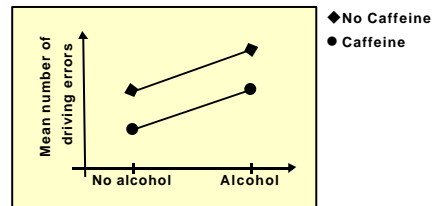
Interaction

- A situation in a (two-way) factorial design in which the effects of one independent variable depend on the level of another independent variable
- Example:
 - Increased caffeine intake might reduce the influence of alcohol on driving ability

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Illustration of Interaction

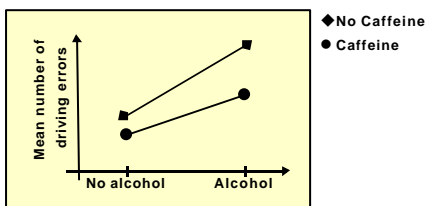


→ No interaction
Additive effect

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Illustration of Interaction



→ Interaction

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Interactions

- If lines in cell plots are not parallel, we've got an interaction.
- If lines in cell plots are parallel, we've not got an interaction.

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SPSS output

Main effect of caffeine

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Error(CAFFEINE*ALCOHOL)	Sphericity Assumed	23.417	11	2.129		
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Main effect of alcohol

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SPSS output

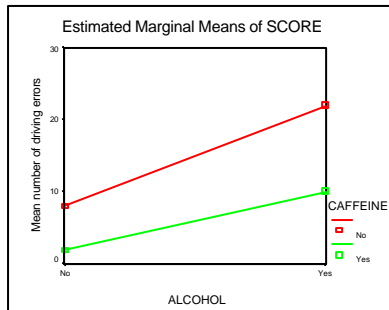
Interaction between caffeine and alcohol

Error(ALCOHOL)	Sphericity Assumed	23.417	11	2.129		
	Greenhouse-Geisser	23.417	11.000	2.129		
	Huynh-Feldt	23.417	11.000	2.129		
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Cell Plot



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Research paper

- **Results:**
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Interpretation of main effects when there are interactions

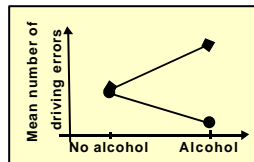
- Controversial
- Careful
- Has to be meaningful
- Important: Plotting data

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Interpretation of main effects when there are interactions

- ◆ No Caffeine
- Caffeine



Two-way ANOVA:

- Significant main effect of caffeine
- No significant main effect of alcohol
- Significant interaction

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Interpretation of main effects when there are interactions

- Main effect of caffeine stems only from the effect of caffeine in the alcohol condition. Meaningful?
- No main effect of alcohol results from the fact that effect of alcohol in the caffeine condition is cancelled out by the opposite effect in the no caffeine condition.

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Simple Effects

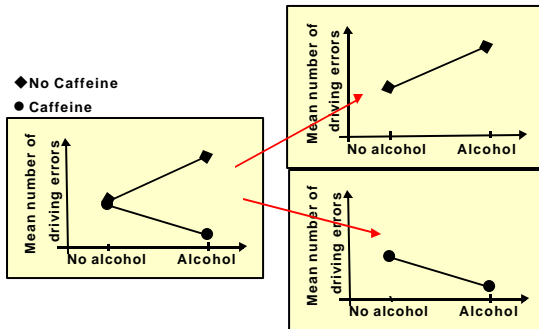
- The effect of one factor at one level of the other factor.
- Important technique for analyzing data with significant interactions
- Example:
The effect of alcohol in the no caffeine condition

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Simple Effects

- ◆ No Caffeine
- Caffeine

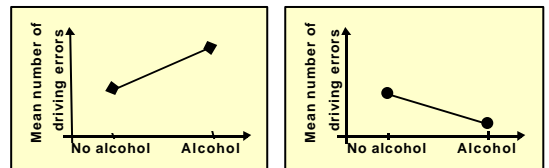


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Simple Effects

- ◆ No Caffeine
- Caffeine



Possible to apply t-tests to both sets of data

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