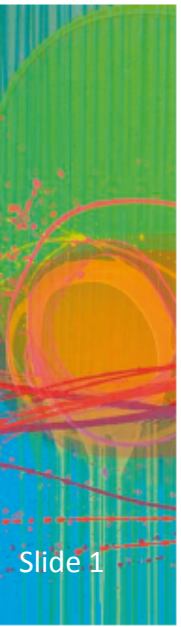
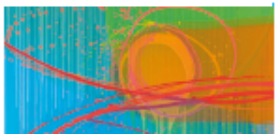
DISCOVERING STATISTICS USING SPSS THIRD EDITION



Two-Way Independent ANOVA (GLM 3)

Lecture 11

ANDY FIELD



Aims

- Rationale of Factorial ANOVA
- Partitioning Variance
- Interaction Effects
  - Interaction Graphs
  - Interpretation

What is Two-Way Independent ANOVA?

- Two Independent Variables
  - Two-way = 2 Independent variables
  - Three-way = 3 Independent variables
- Different participants in *all* conditions.
  - Independent = 'different participants'
- Several Independent Variables is known as a factorial design.

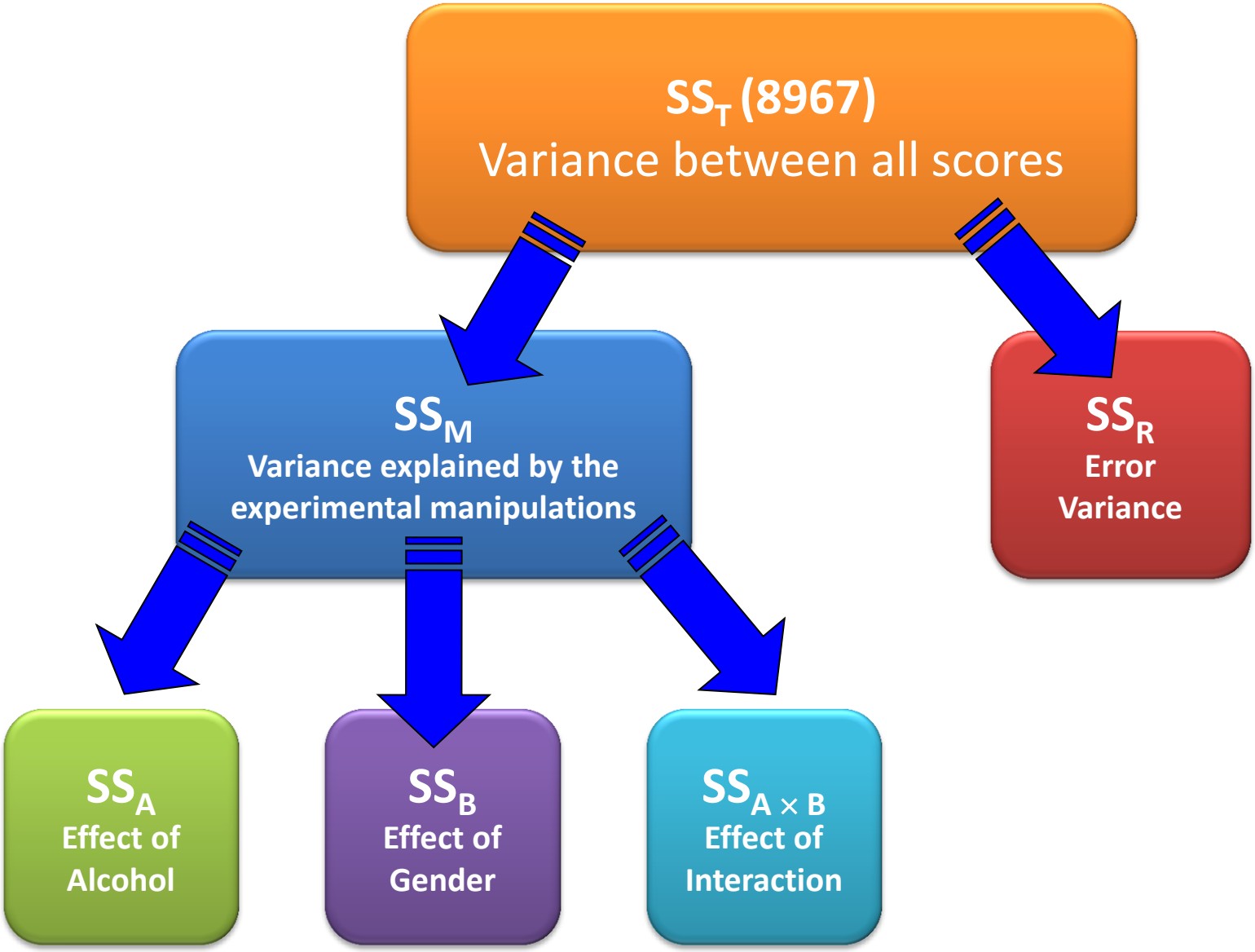
Benefit of Factorial Designs

- We can look at how variables *Interact*.
- Interactions
  - Show how the effects of one IV might depend on the effects of another
  - Are often more interesting than main effects.
- Examples
  - Interaction between hangover and lecture topic on sleeping during lectures.
    - A hangover might have more effect on sleepiness during a stats lecture than during a clinical one.

An Example

- Field (2009): Testing the effects of Alcohol and Gender on 'the beer-goggles effect':
  - IV 1 (Alcohol): None, 2 pints, 4 pints
  - IV 2 (Gender): Male, Female
- Dependent Variable (DV) was an objective measure of the attractiveness of the partner selected at the end of the evening.

Alcohol	None		2 Pints		4 Pints	
Gender	Female	Male	Female	Male	Female	Male
	65	50	70	45	55	30
	50	55	65	60	65	30
	70	80	60	85	70	30
	45	65	70	65	55	55
	55	70	65	70	55	35
	30	75	60	70	60	20
	70	75	60	80	50	45
	55	65	50	60	50	40
Total	485	535	500	535	460	285
Mean	60.625	66.875	62.50	66.875	57.50	35.625
Variance	**24.55**	**106.70**	**42.86**	**156.70**	**50.00**	**117.41**


SS_T (8967)
Variance between all scores
SS_M
Variance explained by the experimental manipulations
SS_R
Error Variance
SS_A
Effect of Alcohol
SS_B
Effect of Gender
$SS_{A \times B}$
Effect of Interaction

Step 1: Calculate SS_T

65	50	70	45	55	30
50	55	65	60	65	30
70	80	60	85	70	30
45	65	70	65	55	55
55	70	65	70	55	35
30	75	60	70	60	20
70	75	60	80	50	45
55	65	50	60	50	40

Grand Mean = 58.33

$$SS_T = s^2_{grand}(N-1)$$
$$= 190.78(48-1)$$
$$= 8966.66$$

Step 2: Calculate SS_M

$$SS_M = \sum n_i \left(\bar{x}_i - \bar{x}_{grand}\right)^2$$

$$\begin{aligned}
SS_M &= 8(60.625 - 58.33)^2 + 8(66.875 - 58.33)^2 + 8(62.5 - 58.33)^2 \\
&\quad + 8(66.875 - 58.33)^2 + 8(57.5 - 58.33)^2 + 8(35.625 - 58.33)^2 \\
&= 8(2.295)^2 + 8(8.545)^2 + 8(4.17)^2 + 8(8.545)^2 + 8(-0.83)^2 + 8(-22.705)^2 \\
&= 42.1362 + 584.1362 + 139.1112 + 584.1362 + 5.5112 + 4124.1362 \\
&= 5479.167
\end{aligned}$$

Step 2a: Calculate SS_A

A_1: Female		
65	70	55
70	65	65
60	60	70
60	70	55
60	65	55
55	60	60
60	60	50
55	50	50

Mean Female = 60.21

A_2: Male		
50	45	30
55	60	30
80	85	30
65	65	55
70	70	35
75	70	20
75	80	45
65	60	40

Mean Male = 56.46

$$
\begin{aligned}
SS_{Gender} &= 24(60.21 - 58.33)^2 + 24(56.46 - 58.33)^2 \\
&= 24(1.88)^2 + 24(-1.87)^2 \\
&= 84.8256 + 83.9256 \\
&= 168.75
\end{aligned}
$$

Step 2b: Calculate SS_B

B_1: None	
65	50
70	55
60	80
60	65
60	70
55	75
60	75
55	65

Mean None = 63.75

B_2: 2 Pints	
70	45
65	60
60	85
70	65
65	70
60	70
60	80
50	60

Mean 2 Pints = 64.6875

B_3: 4 Pints	
55	30
65	30
70	30
55	55
55	35
60	20
50	45
50	40

Mean 4 Pints = 46.5625

$$
\begin{aligned}
SS_{alcohol} &= 16(63.75-58.33)^2 + 16(64.6875-58.33)^2 + 16(46.5625-58.33)^2 \\
&= 16(5.42)^2 + 16(6.3575)^2 + 16(-11.7675)^2 \\
&= 470.0224 + 646.6849 + 2215.5849 \\
&= 3332.292
\end{aligned}
$$

Step 2c: Calculate $SS_{A \times B}$

$$SS_{A \times B} = SS_M - SS_A - SS_B$$

$$\begin{aligned} SS_{A \times B} &= SS_M - SS_A - SS_B \\ &= 5479.167 - 168.75 - 3332.292 \\ &= 1978.125 \end{aligned}$$

Step 3: Calculate SS_R

$$SS_R = s^2_{group1}(n_1 - 1) + s^2_{group2}(n_2 - 1) + s^2_{group3}(n_3 - 1) \ldots s^2_{groupn}(n_n - 1)$$

$$\begin{aligned} SS_R &= s^2_{group1}(n_1 - 1) + s^2_{group2}(n_2 - 1) + s^2_{group3}(n_3 - 1) \\ &\quad + s^2_{group4}(n_4 - 1) + s^2_{group5}(n_5 - 1) + s^2_{group6}(n_6 - 1) \\ &= (24.55 \times 7) + (106.7 \times 7) + (42.86 \times 7) \\ &\quad + (156.7 \times 7) + (50 \times 7) + (117.41 \times 7) \\ &= 171.85 + 746.9 + 300 + 1096.9 + 350 + 821.87 \\ &= 3487.52 \end{aligned}$$

Summary Table

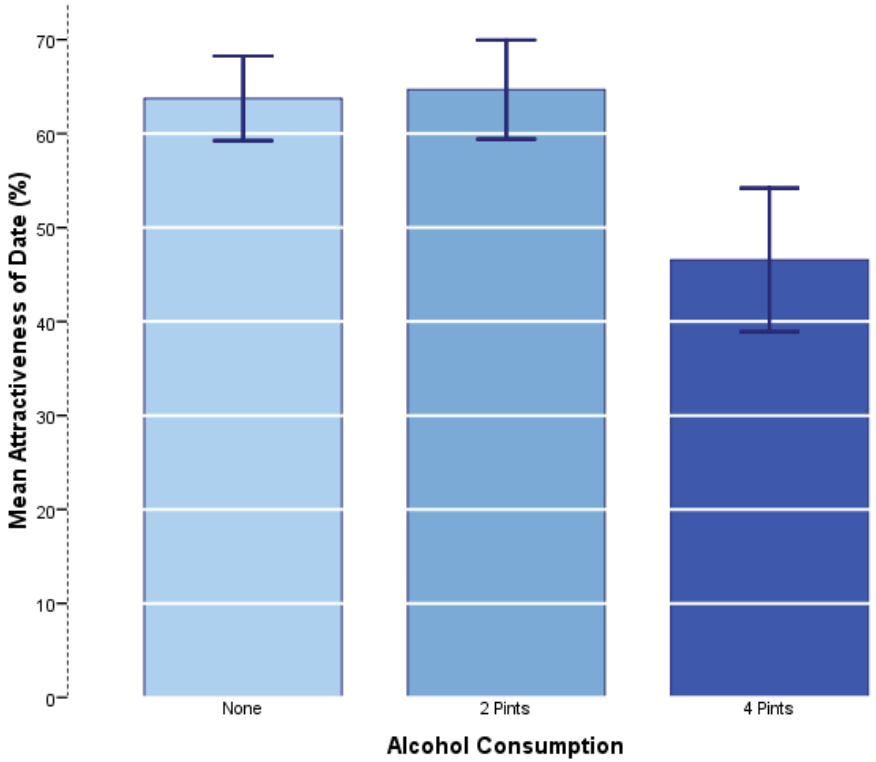
Tests of Between-Subjects Effects

Dependent Variable:Attractiveness of Date

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Gender	168.750	1	168.750	2.032	.161
Alcohol	3332.292	2	1666.146	20.065	.000
Gender * Alcohol	1978.125	2	989.062	11.911	.000
Error	3487.500	42	83.036		

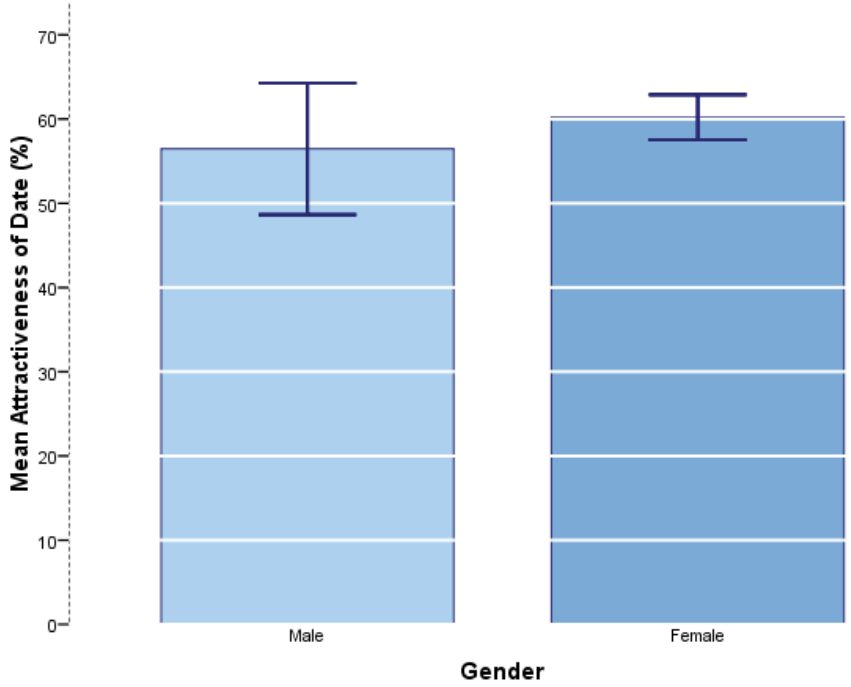
a. R Squared = .611 (Adjusted R Squared = .565)

Interpretation: Main Effect Alcohol



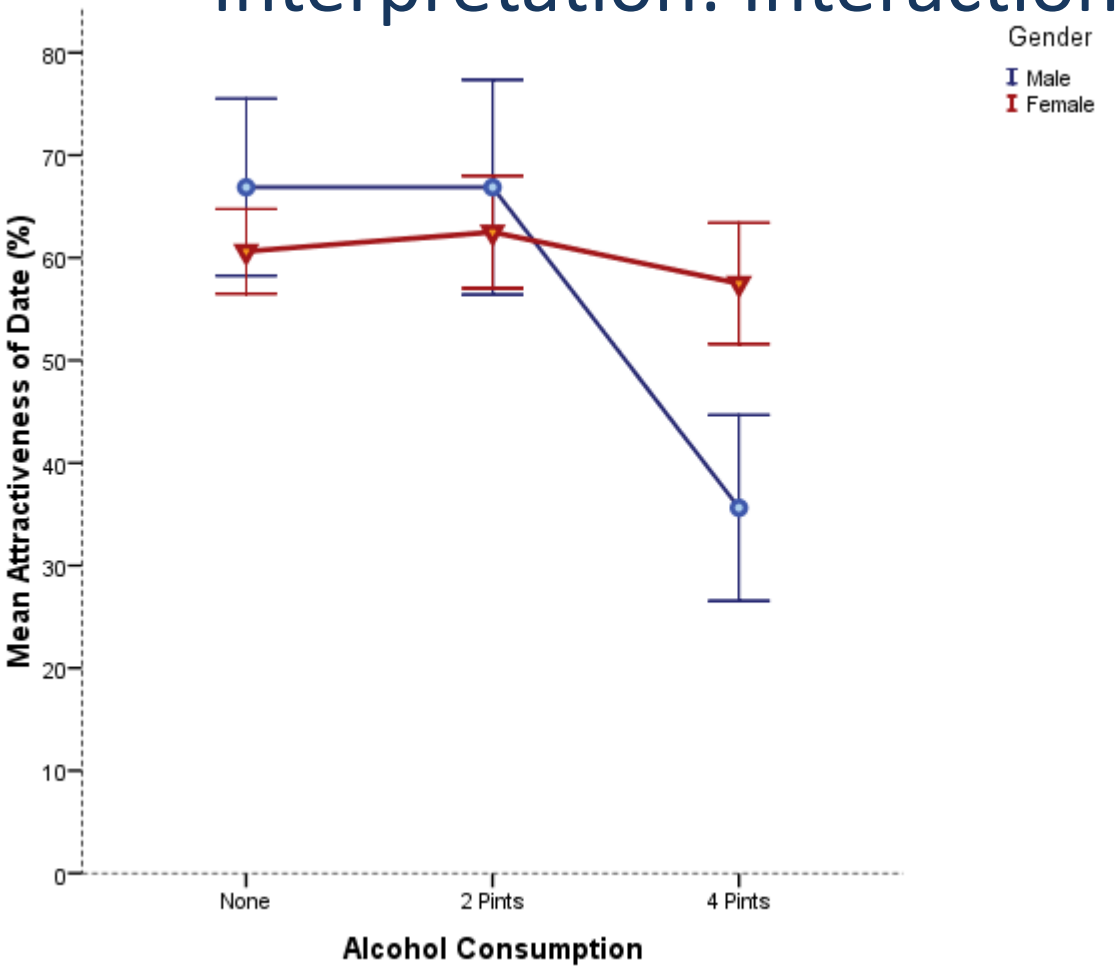
There was a significant main effect of the amount of alcohol consumed at the night-club, on the attractiveness of the mate that was selected, $F(2, 42) = 20.07$, $p < .001$.

Interpretation: Main Effect Gender



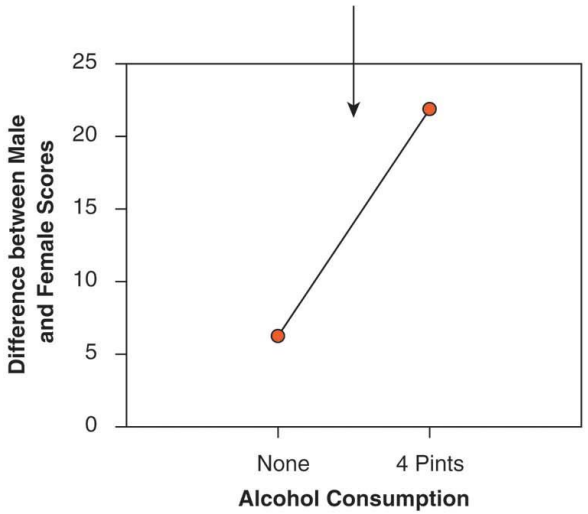
There was a nonsignificant main effect of gender on the attractiveness of selected mates, $F(1, 42) = 2.03$, $p = .161$.

Interpretation: Interaction

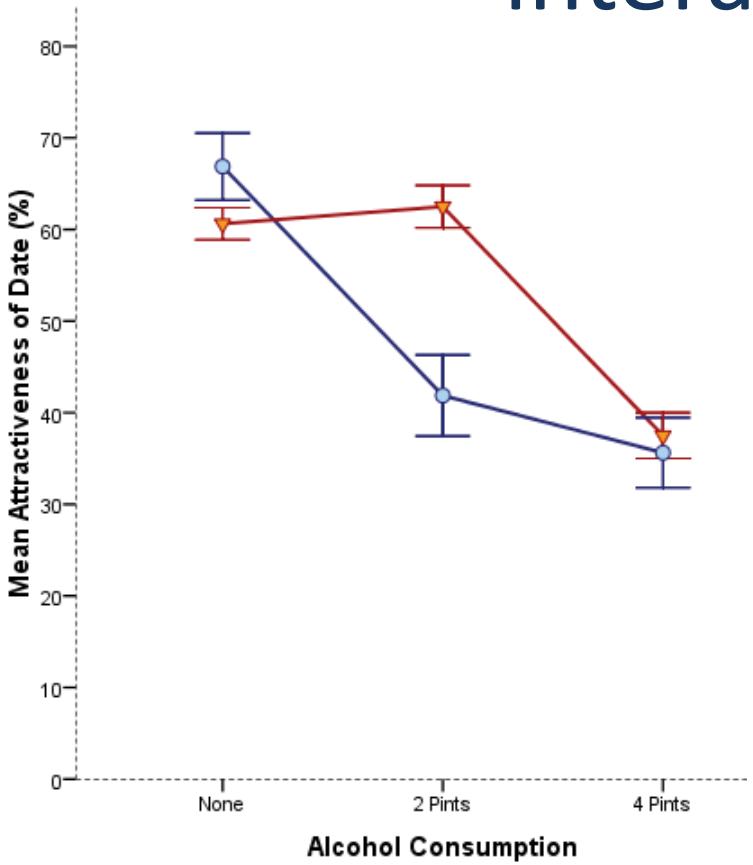


There was a significant interaction between the amount of alcohol consumed and the gender of the person selecting a mate, on the attractiveness of the partner selected, $F(2, 42) = 11.91$, $p < .001$.

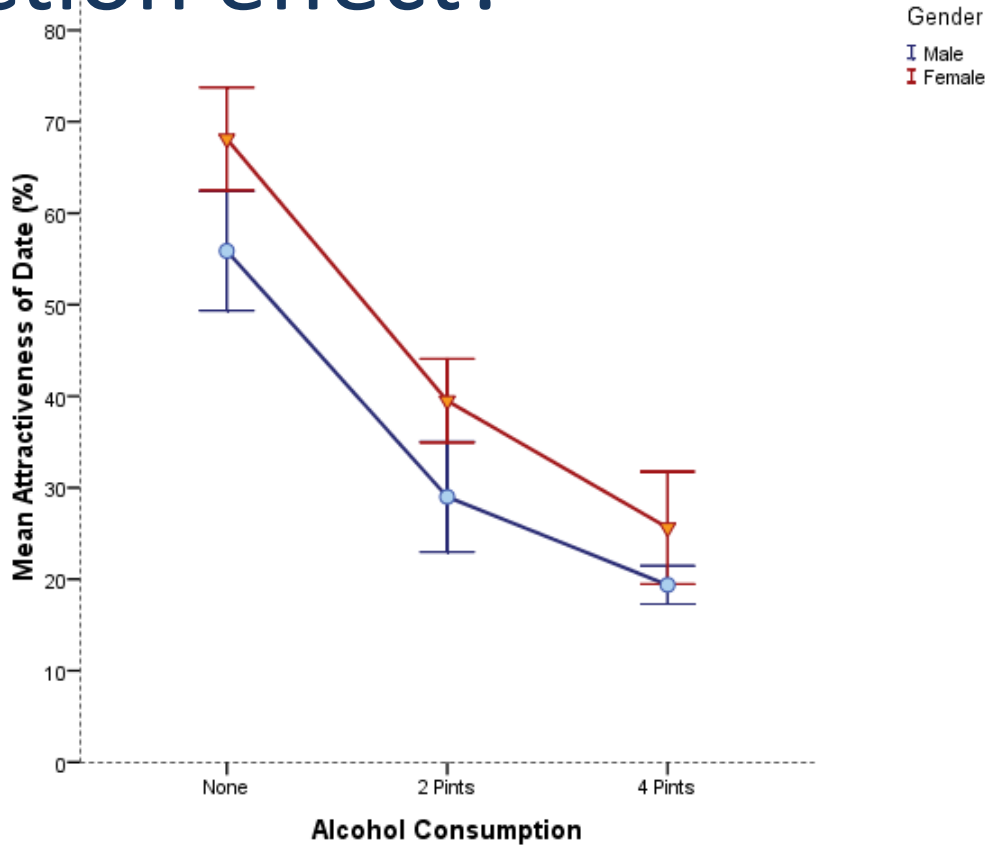
What is an Interaction?



Is there likely to be a significant interaction effect?

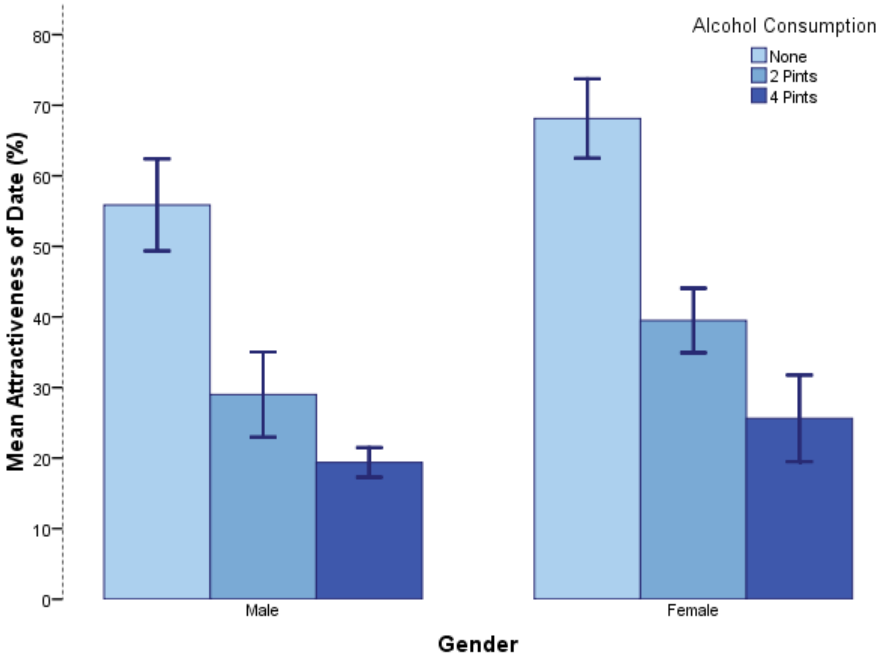


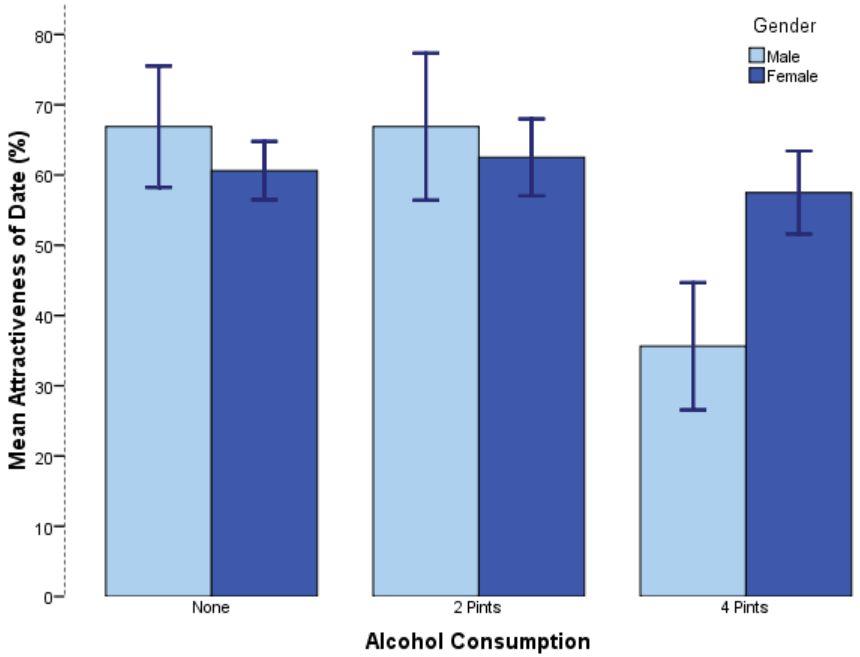
Yes



No

Is there likely to be a significant interaction effect?





No

Yes