Conrad

School of Entrepreneurship and Business

Agenda

01

Recap

02

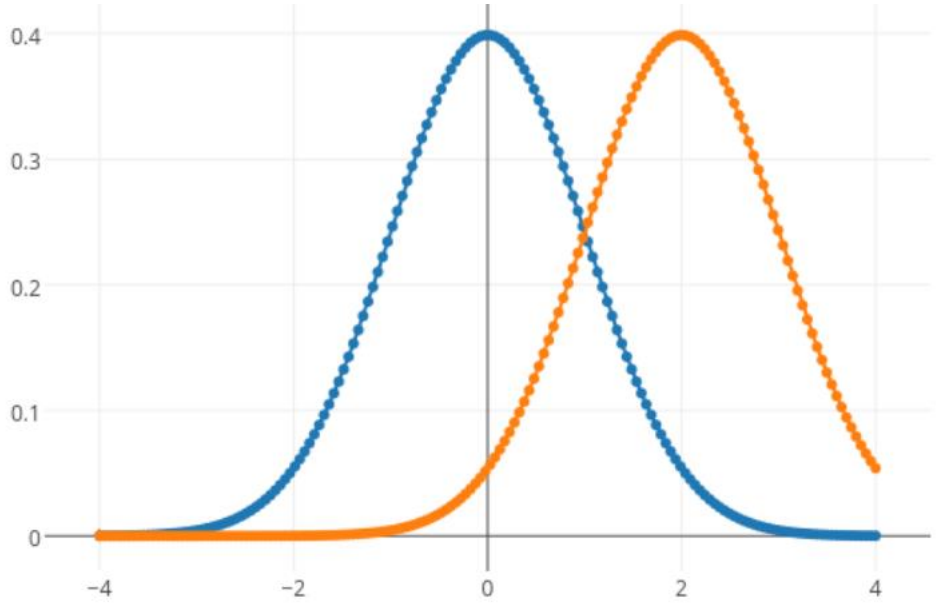
Comparing more than 2 populations

03

Correlation Analysis

Statistical Inference About Difference in Two Populations

Statistical Inference About Means of Two Populations



Inferences About the Difference Between Two Population Means: σ_1 and σ_2 Known

Inferences About the Difference Between Two Population Means: σ_1 and σ_2 Unknown

Hypothesis Tests About $\mu_1 - \mu_2$: σ_1 and σ_2 Known

Hypotheses

$H_0: \mu_1 - \mu_2 \geq D_0$ $H_a: \mu_1 - \mu_2 < D_0$	$H_0: \mu_1 - \mu_2 \leq D_0$ $H_a: \mu_1 - \mu_2 > D_0$	$H_0: \mu_1 - \mu_2 = D_0$ $H_a: \mu_1 - \mu_2 \neq D_0$
Left-tailed	Right-tailed	Two-tailed

Test Statistic

$$z = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Hypothesis Tests About $\mu_F - \mu_M$ σ_F and σ_M Unknown

Hypotheses

Left-tailed	Right-tailed	Two-tailed
$H_0: \mu_1 - \mu_2 \geq D_0$ $H_a: \mu_1 - \mu_2 < D_0$	$H_0: \mu_1 - \mu_2 \leq D_0$ $H_a: \mu_1 - \mu_2 > D_0$	$H_0: \mu_1 - \mu_2 = D_0$ $H_a: \mu_1 - \mu_2 \neq D_0$

Test Statistic

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Statistical Inference About Proportions of Two Populations

Hypothesis Tests about $p_1 - p_2$

Hypotheses

$H_0: p_1 - p_2 \geq 0$ $H_a: p_1 - p_2 < 0$	$H_0: p_1 - p_2 \leq 0$ $H_a: p_1 - p_2 > 0$	$H_0: p_1 - p_2 = 0$ $H_a: p_1 - p_2 \neq 0$
Left-tailed	Right-tailed	Two-tailed

Hypothesis Tests about p_1 - p_2

Test Statistic

$$z = \frac{(\bar{p}_1 - \bar{p}_2)}{\sqrt{\bar{p}(1-\bar{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where:

$$\bar{p} = \frac{n_1\bar{p}_1 + n_2\bar{p}_2}{n_1 + n_2}$$

Group Work

- Since we have 79 registered students, 20 groups will be created with students being randomly assigned
- Please submit your work no later than 10:00pm EST. There is no drop box, work needs to be submitted via email to harvir.bansal@uwaterloo.ca
- Please ensure that you clearly outline the steps taken in your analysis as well as the results.
- As I have said multiple times, data analysis is not a spectator sport so PLAY and have fun

7.5/7.5

For all those who submitted the in-class exercise

Hands-on Analysis

- **All questions below refer to the brand tracking questionnaire and data made available for this class on LEARN**
  1. Are there any stores where males and females different in their commitment to the brand? Explain via analysis
  2. Are Kohl's customers equally likely to purchase a product within the next 9 months as compared to TJ Maxx's customers?
  3. As compared to Amazon's NPS score which retailer must work hardest to compete?

Hands-on Analysis

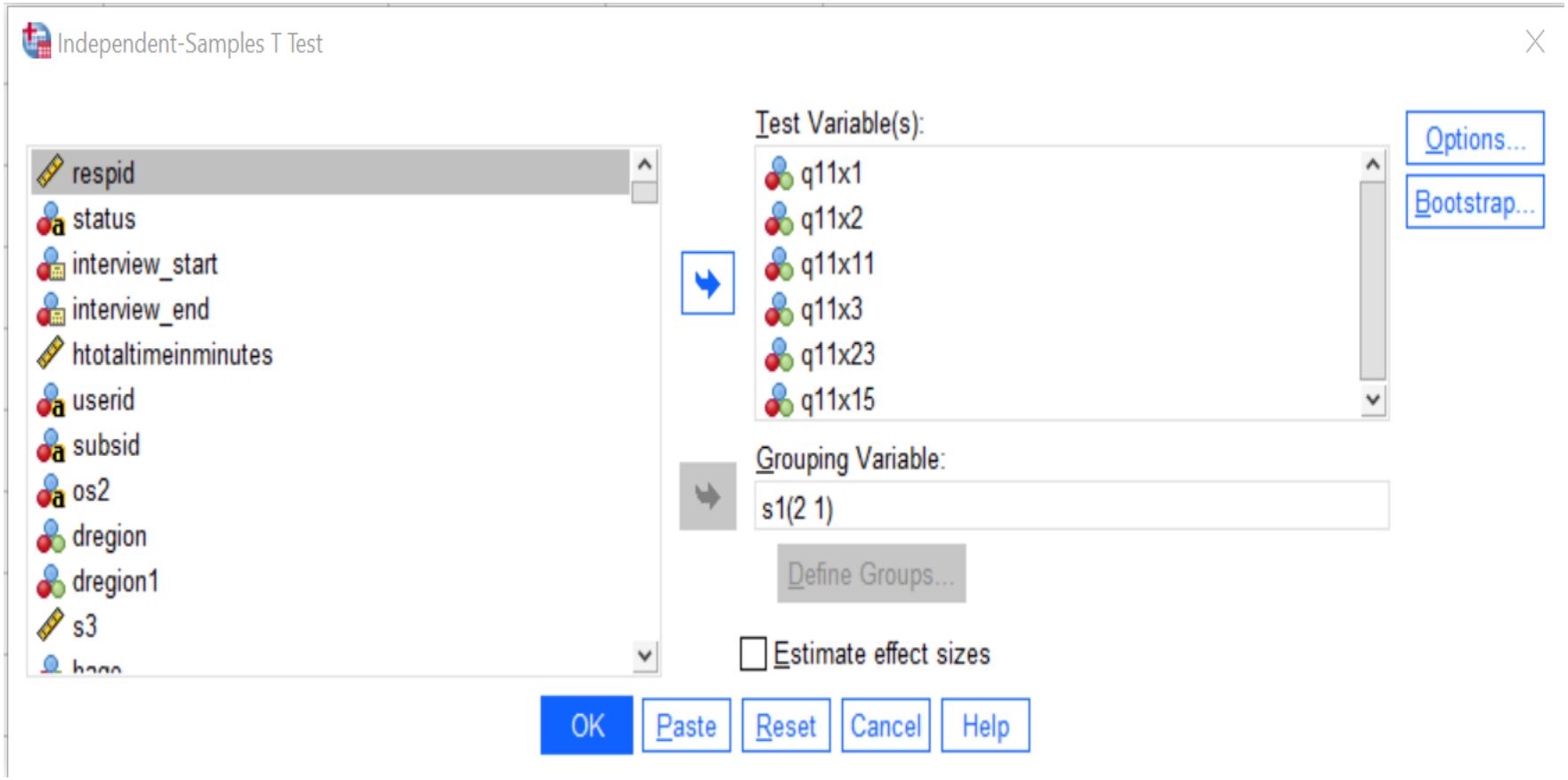
- **All questions below refer to the brand tracking questionnaire and data made available for this class on LEARN**
  1. **Are there any stores where males and females different in their commitment to the brand? Explain via analysis**

S1 Are you…	**GO TO**
Male	S2
Female	

SPSS *Analyze | Compare Means| Independent-Samples T Test*

	Brand Commitment					
	Q11 Imagine you had to shop at a retail store, which of these statements best describes how much you would consider shopping at each of these stores? (Please select one answer for each brand)					
	1 PROGRAMMER: ALLOW ONLY ONE ANSWER PER BRAND. ACCEPT ONLY ONE ANSWER IN FIRST ROW "ONLY STORE WOULD CONSIDER"					
	Brand X	**JC Penney**	**Kohl's**	**Nordstrom**	**Amazon**	**TJ Maxx**
Favorite store; only one I consider	○	○	○	○	○	○
Store I prefer and consider highly	○	○	○	○	○	○
Store I consider equally with others	○	○	○	○	○	○
Store I might consider, less so than others	○	○	○	○	○	○
Not a store I usually consider	○	○	○	○	○	○
Store I would never consider	○	○	○	○	○	○

SPSS *Analyze | Compare Means| Independent-Samples T Test*



Group Statistics

	Are you...	N	Mean	Std. Deviation	Std. Error Mean
Brand X	Female	3044	3.06	1.146	.021
	Male	1287	2.98	1.140	.032
JC Penney	Female	77	2.99	1.006	.115
	Male	21	2.67	.966	.211
Kohl's	Female	1117	2.97	1.183	.035
	Male	493	2.86	1.065	.048
Nordstrom	Female	1165	3.04	1.192	.035
	Male	425	3.06	1.148	.056
Amazon	Female	1140	2.26	.822	.024
	Male	468	2.11	.789	.036
TJ Maxx	Female	1233	3.15	1.129	.032
	Male	370	3.29	1.083	.056

Significant Differences

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Brand X	Equal variances assumed	3.718	.054	2.022	4329	.022	.043	.077	.038	.002	.152
	Equal variances not assumed			2.027	2432.065	.021	.043	.077	.038	.002	.151
JC Penney	Equal variances assumed	.622	.432	1.304	96	.098	.195	.320	.246	-.167	.808
	Equal variances not assumed			1.335	32.835	.096	.191	.320	.240	-.168	.809
Kohl's	Equal variances assumed	3.356	.067	1.742	1608	.041	.082	.108	.062	-.014	.230
	Equal variances not assumed			1.814	1038.285	.035	.070	.108	.060	-.009	.225
Nordstrom	Equal variances assumed	.896	.344	-.215	1588	.415	.829	-.014	.067	-.146	.117
	Equal variances not assumed			-.219	779.528	.413	.827	-.014	.066	-.143	.115
Amazon	Equal variances assumed	9.608	.002	3.203	1606	<.001	.001	.143	.045	.055	.230
	Equal variances not assumed			3.258	901.812	<.001	.001	.143	.044	.057	.229
TJ Maxx	Equal variances assumed	.596	.440	-2.164	1601	.015	.031	-.143	.066	-.273	-.013
	Equal variances not assumed			-2.214	628.995	.014	.027	-.143	.065	-.271	-.016

Hands-on Analysis

- **All questions below refer to the brand tracking questionnaire and data made available for this class on LEARN**
  1. Are there any stores where males and females different in their commitment to the brand? Explain via analysis
  2. **Are Kohl's customers equally likely to purchase a product within the next 9 months as compared to TJ Maxx's customers?**

SPSS®

Likelihood to Purchase

Q12 For the following retailers, when do you anticipate your next purchase at that store might be?
PROGRAMMER: ALLOW ONLY ONE ANSWER PER BRAND.

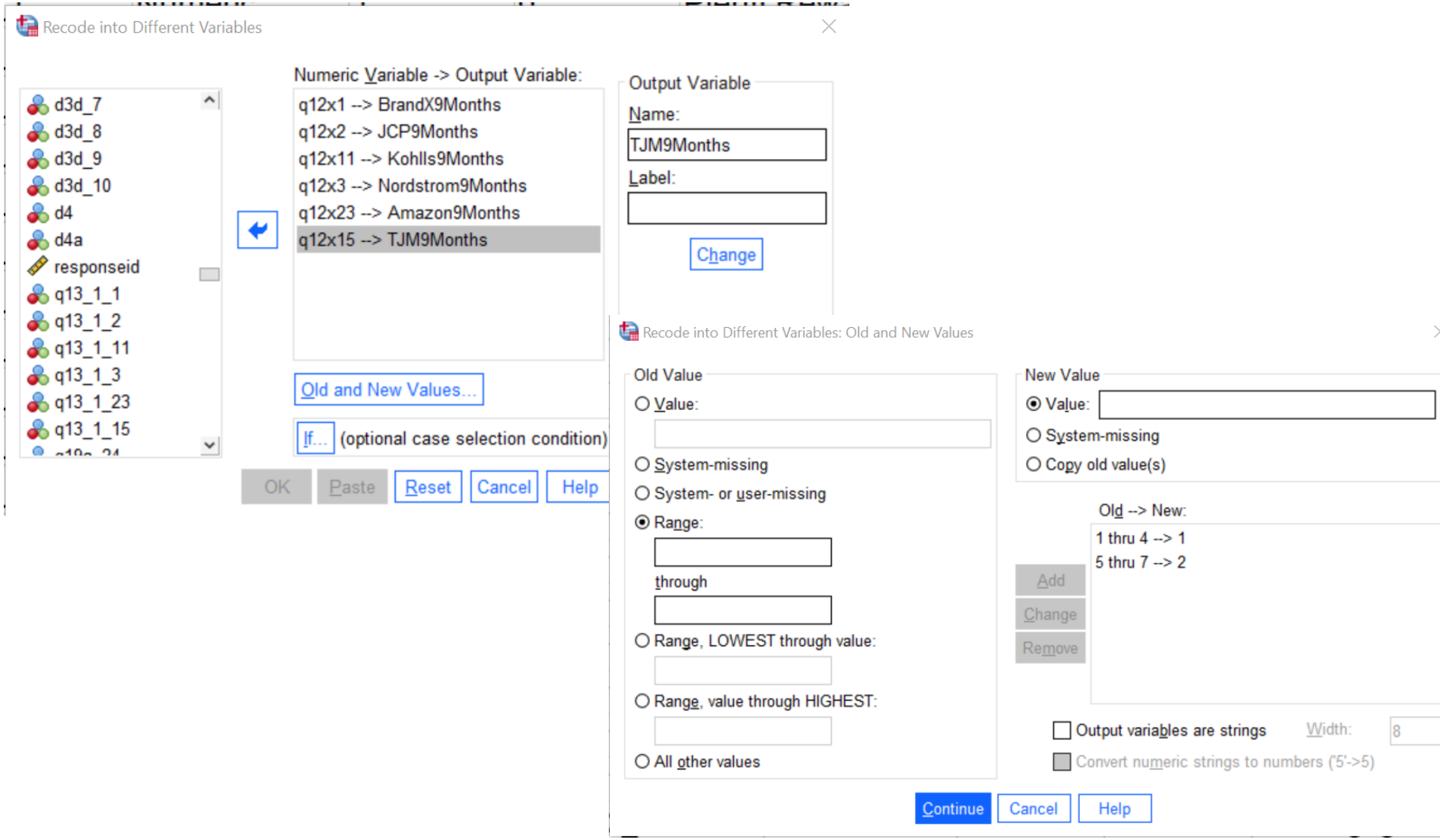
	Brand X	JC Penney	Kohl's	Nordstrom	Amazon	TJ Maxx
Within the next month	○	○	○	○	○	○
Within next 1-3 months	○	○	○	○	○	○
With next 3-6 months						
Within next 6-9 months	○	○	○	○	○	○
Within 9 months – 1 year	○	○	○	○	○	○
Longer than 1 year	○	○	○	○	○	○
I'm not sure when I will shop there again						

RECODE

Within 9 Months

Beyond 9 Months

SPSS Transform| Recode Into Different Variables



SPSS *Analyze | Descriptive Statistics| Frequencies*

KOHL'S

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Purchase Within 9 Months	1241	28.7	77.1	77.1
	Purchase Beyond 9 Months	369	8.5	22.9	100.0
	Total	1610	37.2	100.0	
Missing	System	2721	62.8		
Total		4331	100.0		

T.J.maxx

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Purchase Within 9 Months	1141	26.3	71.2	71.2
	Purchase Beyond 9 Months	462	10.7	28.8	100.0
	Total	1603	37.0	100.0	
Missing	System	2728	63.0		
Total		4331	100.0		

Z Score Calculator for 2 Population Proportions

Success!

You'll find the values for *z* and *p* below. Blue means your result is significant, red means it's not.

Sample 1 Proportion (or total number)
1241

Sample 1 Size (N_1)
1610

Sample 2 Proportion (or total number)
1141

Sample 2 Size (N_2)
1603

Significance Level:

- ○ 0.01
- ◉ 0.05
- ○ 0.10

One-tailed or two-tailed hypothesis?:

- ○ One-tailed
- ◉ Two-tailed

The value of *z* is 3.8198. The value of *p* is .00014. The result is significant at $p < .05$.

Calculate Z | Reset

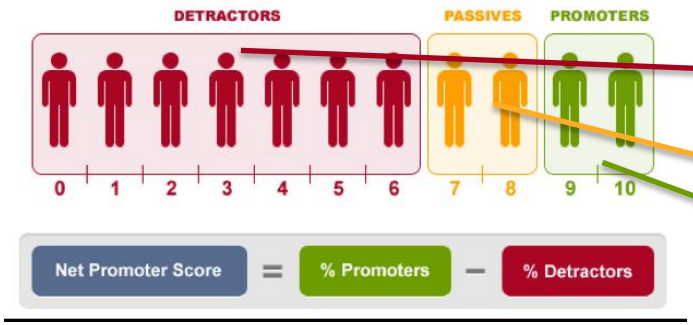
Social Science Statistics

Hands-on Analysis

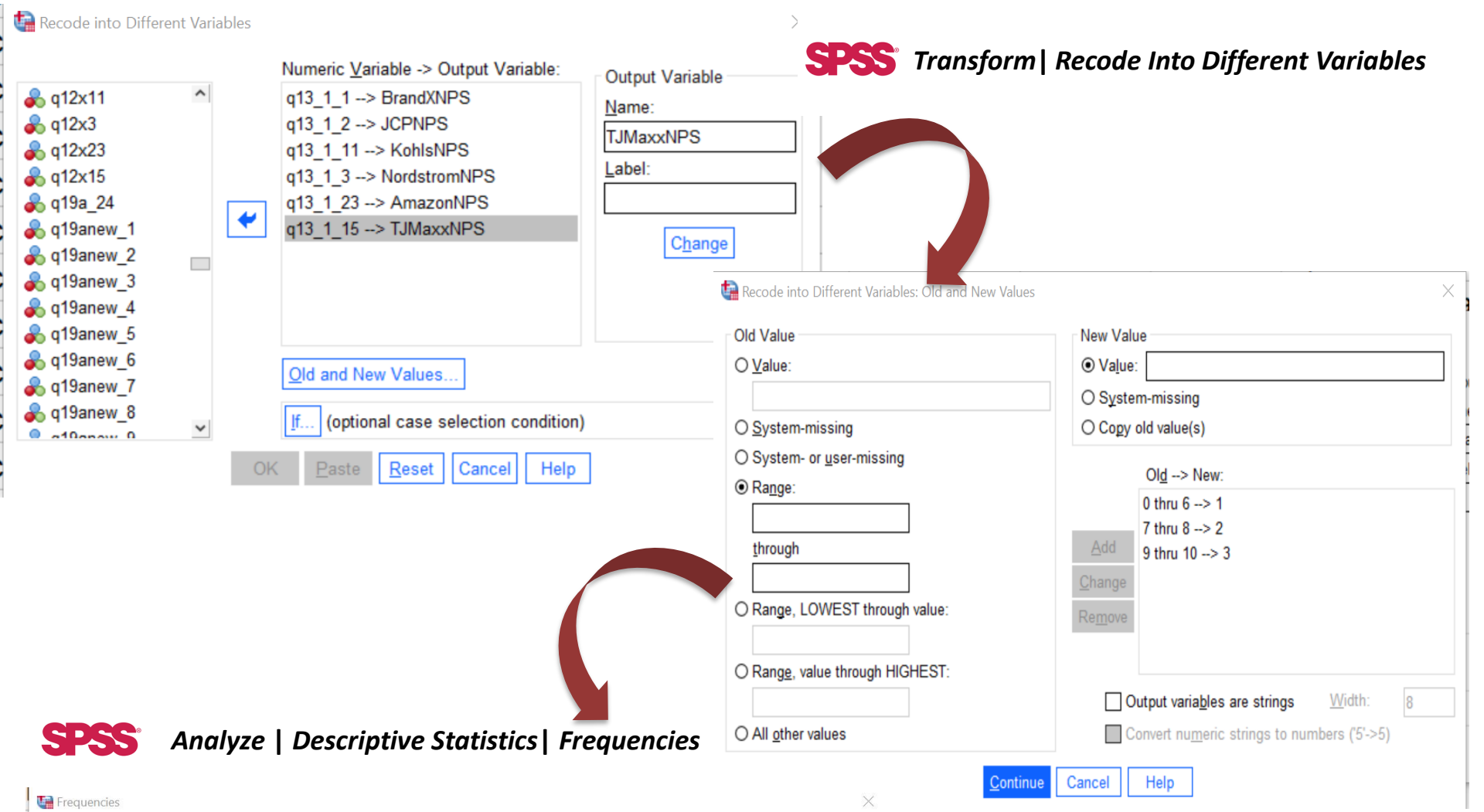
- **All questions below refer to the brand tracking questionnaire and data made available for this class on LEARN**
  1. Are there any stores where males and females different in their commitment to the brand? Explain via analysis
  2. Are Kohl's customers equally likely to purchase a product within the next 9 months as compared to TJ Maxx's customers?
  3. **As compared to Amazon's NPS score which retailer must work hardest to compete?**

SPSS

SPSS *Transform| Recode Into Different Variables*

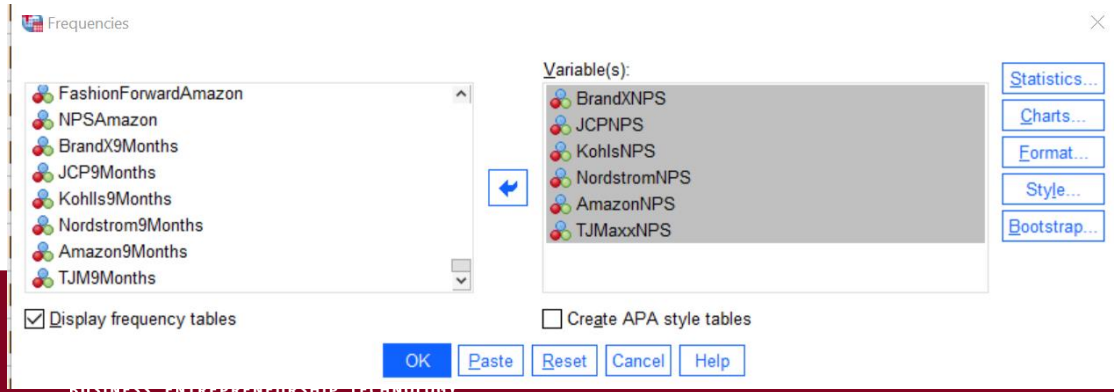


Likelihood Recommend							
Q13 How likely are you to recommend the following retailer to friends and family members, on a scale from 0-10, where 0=Not at all likely to recommend, and 10= Will definitely recommend. PROGRAMMER: ALLOW ONLY ONE ANSWER PER BRAND. SHOW EACH RETAILER ON SEPARATE SCREENS.		Brand X	JC Penney	Kohl's	Nordstrom	Amazon	TJ Maxx
	0	○	○	○	○	○	○
	1	○	○	○	○	○	○
	2	○	○	○	○	○	○
	3	○	○	○	○	○	○
	4	○	○	○	○	○	○
	5	○	○	○	○	○	○
	6	○	○	○	○	○	○
	7	○	○	○	○	○	○
	8	○	○	○	○	○	○
	9	○	○	○	○	○	○
	10	○	○	○	○	○	○



SPSS *Transform| Recode Into Different Variables*

SPSS *Analyze | Descriptive Statistics| Frequencies*



amazon.com

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Detractors	142	3.3	8.8	8.8
	Passives	410	9.5	25.5	34.3
	Promoters	1056	24.4	65.7	100.0
	Total	1608	37.1	100.0	
Missing	System	2723	62.9		
Total		4331	100.0		

JCPenney

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Detractors	36	.8	36.7	36.7
	Passives	33	.8	33.7	70.4
	Promoters	29	.7	29.6	100.0
	Total	98	2.3	100.0	
Missing	System	4233	97.7		
Total		4331	100.0		

BrandXNPS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Detractors	1639	37.8	37.8	37.8
	Passives	1494	34.5	34.5	72.3
	Promoters	1198	27.7	27.7	100.0
	Total	4331	100.0	100.0	

KOHL'S

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Detractors	529	12.2	32.9	32.9
	Passives	564	13.0	35.0	67.9
	Promoters	517	11.9	32.1	100.0
	Total	1610	37.2	100.0	
Missing	System	2721	62.8		
Total		4331	100.0		

NORDSTROM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Detractors	540	12.5	34.0	34.0
	Passives	542	12.5	34.1	68.1
	Promoters	508	11.7	31.9	100.0
	Total	1590	36.7	100.0	
Missing	System	2741	63.3		
Total		4331	100.0		

T.J.maxx

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Detractors	619	14.3	38.6	38.6
	Passives	507	11.7	31.6	70.2
	Promoters	477	11.0	29.8	100.0
	Total	1603	37.0	100.0	
Missing	System	2728	63.0		
Total		4331	100.0		

Brand	Promoters	Detractors	NPS
amazon.com	65.7	8.8	56.9
JCPenney	29.6	36.7	-7.1
KOHL'S	32.1	32.9	-0.8
NORDSTROM	31.9	34	-2.1
T.J.maxx	29.8	38.6	-8.8
BrandX	27.7	37.8	-10.1

Statistical Inference About Difference in Means of More than Two Populations


ANOVA
One Way ANOVA
Two Way ANOVA

Analysis of Variance

- Analysis of Variance (ANOVA) can be used to test for the equality of three or more population means using data obtained from observational or experimental studies.
- We want to use the sample results to test the following hypotheses.

- If H_0 is rejected, we cannot conclude that all population means are different.
- Rejecting H_0 means that at least two population means have different values.

ANOVA

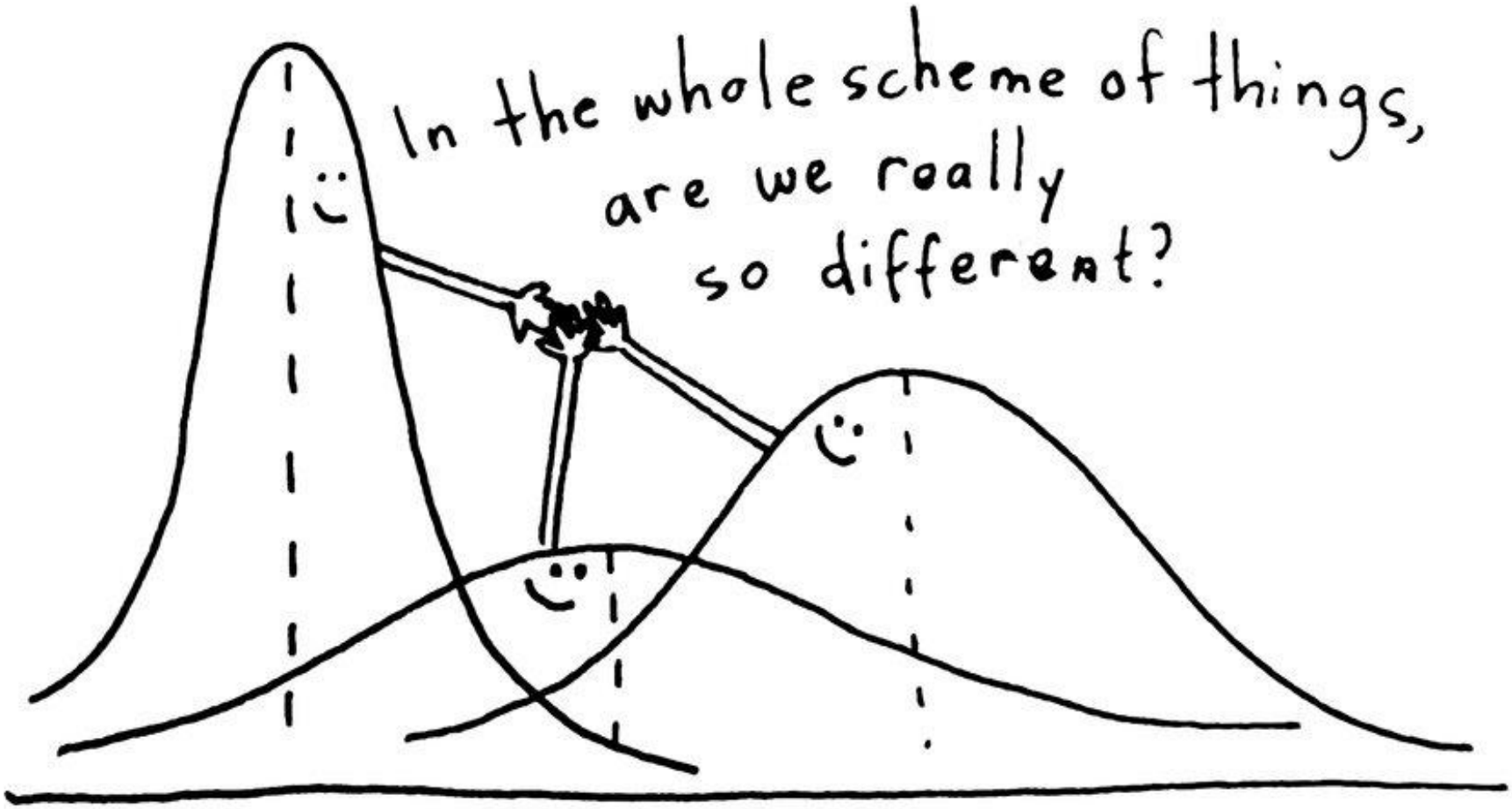
- The ***response/dependent*** variable is the variable you're comparing

- The ***factor/treatment/independent*** variable is the categorical variable being used to define the groups

- **One-way ANOVA** - to test hypotheses about the mean on one dependent variable created by one independent variable. E.g. Income – dependent and Gender (Male/Female) - independent

- **Two-way ANOVA -** Tests hypotheses about the mean on one dependent variable for groups created by two independent variables (or factors). E.g. Income – dependent and Gender (Male/Female), Level of Education (HS/College/University) - independents

ANOVA



Test for the Equality of *k* Population Means

Hypotheses

H_0: $\mu_1 = \mu_2 = \mu_3 = \cdots = \mu_k$

H_a: Not all population means are equal

Test Statistic

F = MSTR/MSE

One-way ANOVA Table

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Treatment	SSTR	k - 1	MSTR	MSTR/MSE
Error	SSE	n_T - k	MSE	
Total	SST	n_T - 1		

SST divided by its degrees of freedom n_T - 1 is simply the overall sample variance that would be obtained if we treated the entire n_T observations as one data set.

One-way ANOVA

- **Post hoc multiple comparison tests**
- Tukey, Tukey's b, and Bonferonni most common tests
  - One-way ANOVA can only tell you if *F* ratio is significant but not which groups are significantly different form one another
  - Post hoc tests can identify pairs of groups that significantly differ
  - If F ratio for model not significant, post hoc tests are not needed

One-Way ANOVA Research Question

- **Let's revert to the brand tracking questionnaire and data made available for this class on LEARN**
  1. The brand who paid for the research (Brand X) is interested in knowing whether the satisfaction with their reward program differs by the marital status?

One-way ANOVA Research Question

S7	Which of the following statements best describes your current marital status? (*Please select one answer*)	GO TO
	Single (not living with a partner) Married/living with a partner Widowed/divorced/separated	S8

1

Independent

SPSS

Dependent

Q21. For the following programs that you are enrolled in, how satisfied are you with the value of the rewards? (only show responses of "enrolled" from previous question)

SAME ORDER AS Q20 and ONLY SHOW BRANDS ENROLLED IN	Very Satisfied	Somewhat satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Very dissatisfied
Plenti Rewards					
Brand X Star Rewards					
Amazon Prime					
TJX Rewards Access					
Nordstrom Fashion Rewards					
Bloomingdales Loyallist					
JC Penney JCP Rewards					
Kohl's Rewards					
Banana Republic/Gap/Old Navy					
Sephora Beauty Insider					
Nordstrom Fashion Rewards					
Ulta Ultamate Rewards					
DSW Rewards					
Victoria's Secret Angel Card					

Q22. Which of the following life events have taken place for you in the past year? (select all that

Research Question

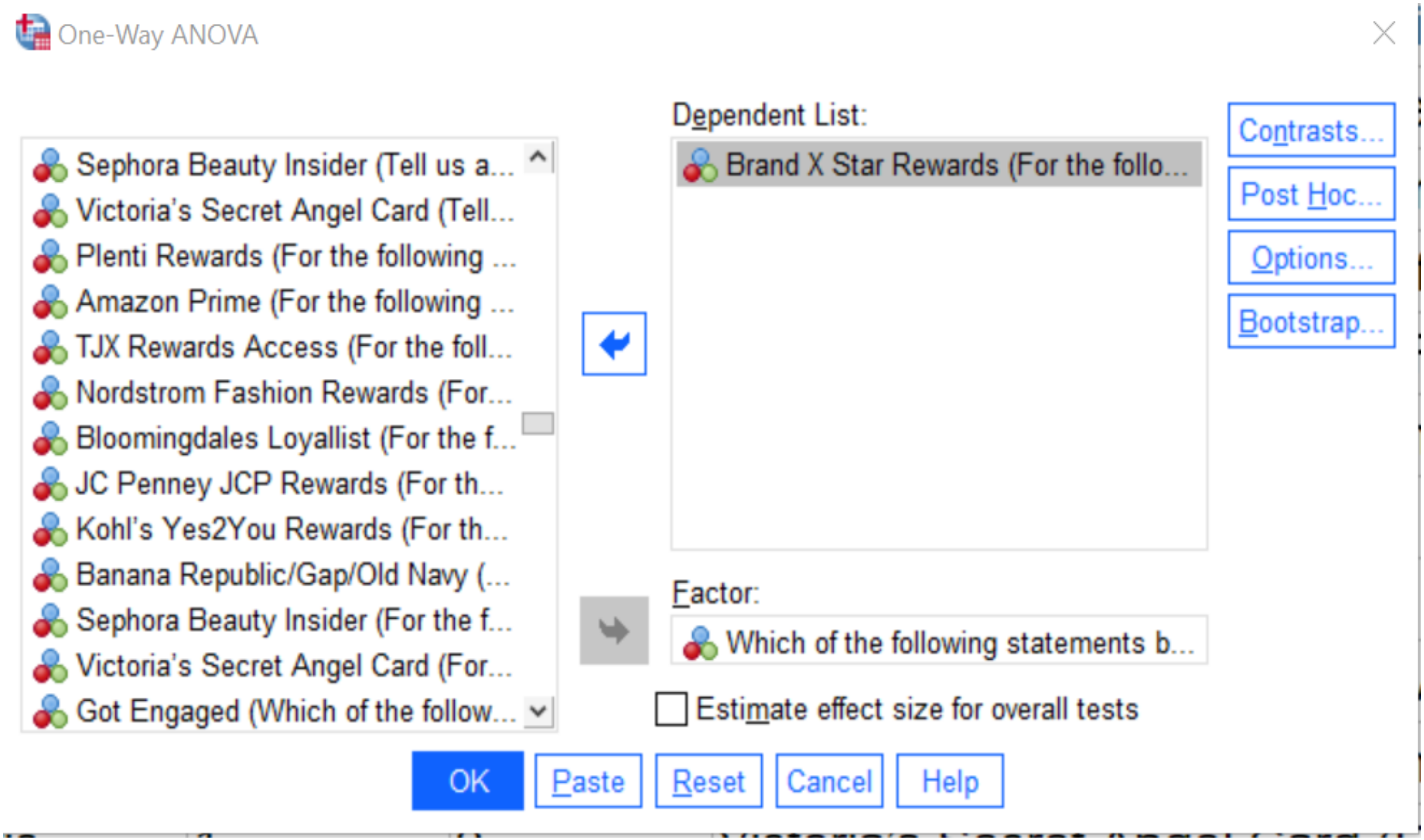
The brand who paid for the research (Brand X) is interested in knowing whether the satisfaction with their reward program differs by the marital status?

H_0: $\mu_{Single} = \mu_{Married} = \mu_{Widowed}$

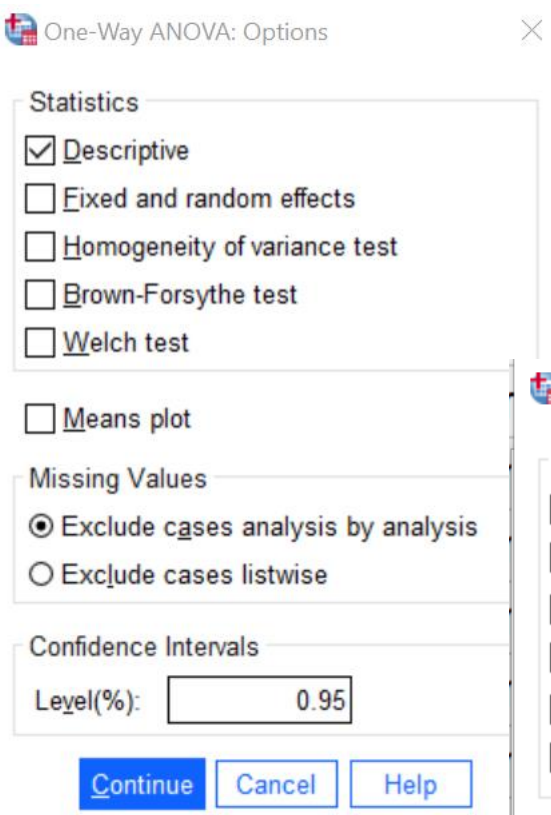
H_a: Not all population means are equal

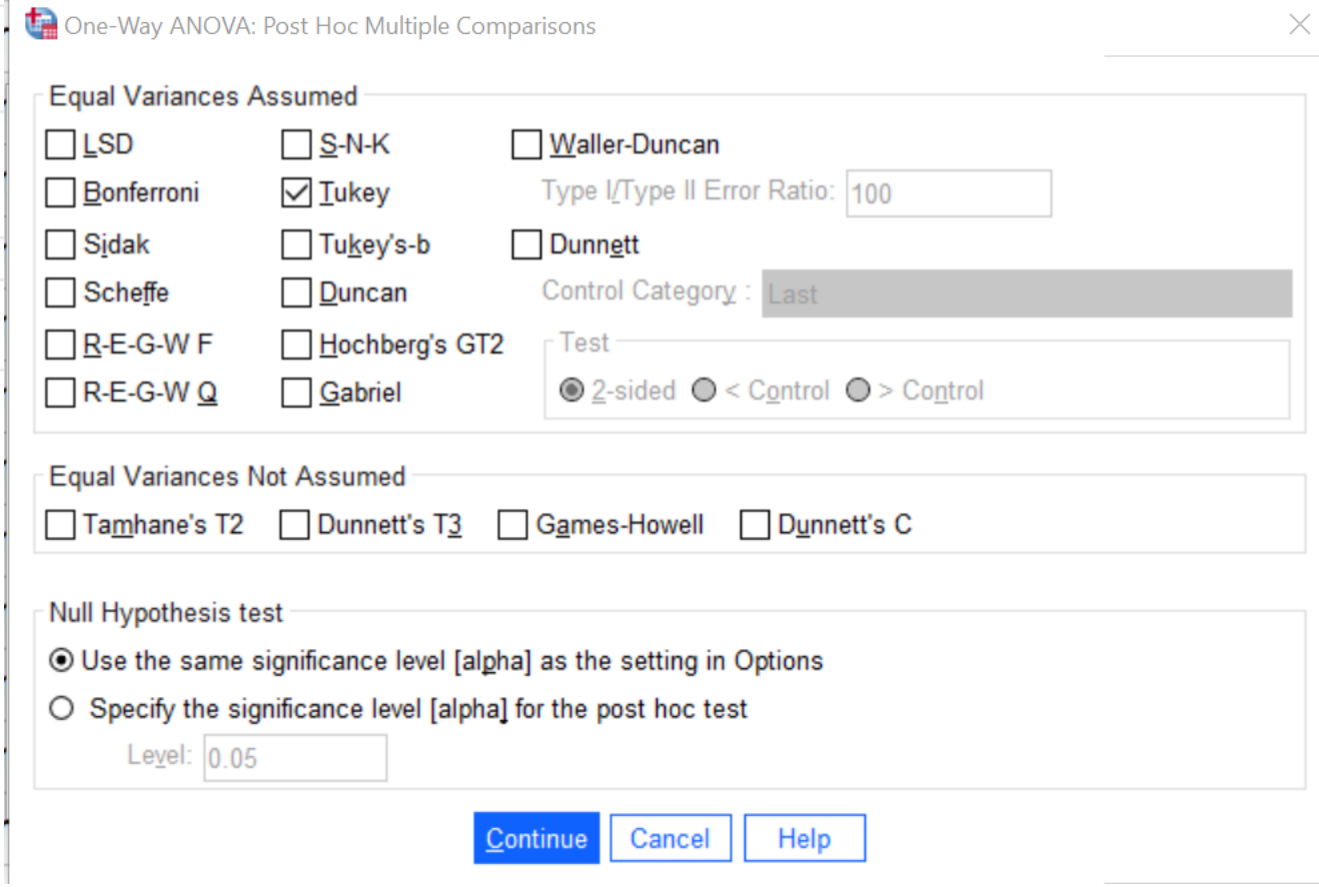
Analyze | Compare Means | One-Way ANOVA

(Use ***Post-Hoc*** to request Multiple Comparison Test)



Requesting Sample Means and Post Hoc Multiple Comparisons





Sample Means for Each Marital Status

Descriptives

Brand X Star Rewards (For the following programs that you are enrolled in, how satisfied are you with the value of the rewards?)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Single (not living with a partner)	283	1.86	.874	.052	1.76	1.96	1	5
Married/living with a partner	768	1.99	.988	.036	1.92	2.06	1	5
Widowed/divorced/separated	79	2.15	1.220	.137	1.88	2.43	1	5
Total	1130	1.97	.981	.029	1.91	2.03	1	5

Marital Status and Rewards Satisfaction

What is the probability of getting the sample results if the null hypothesis is true?

ANOVA

Brand X Star Rewards (For the following programs that you are enrolled in, how satisfied are

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.281	2	3.140	3.278	.038
Within Groups	1079.756	1127	.958		
Total	1086.036	1129			

Conventions*

$P > 0.10 \Rightarrow$ non-significant evidence against H_0

$0.05 < P \leq 0.10 \Rightarrow$ marginally significant evidence

$0.01 < P \leq 0.05 \Rightarrow$ significant evidence against H_0

$P \leq 0.01 \Rightarrow$ highly significant evidence against H_0

Reject or do not reject null hypothesis.

p = .038, **Reject** null hypothesis, there is a significant evidence against null. Which groups are different?

See post-hoc multiple test (next slide)

Marital Status and Rewards Satisfaction

Descriptives

Brand X Star Rewards (For the following programs that you are enrolled in, how satisfied are you with the value of the rewards?)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
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Widowed/divorced/separated	79	2.15	1.220	.137	1.88	2.43	1	5
Total	1130	1.97	.981	.029	1.91	2.03	1	5

Multiple Comparisons

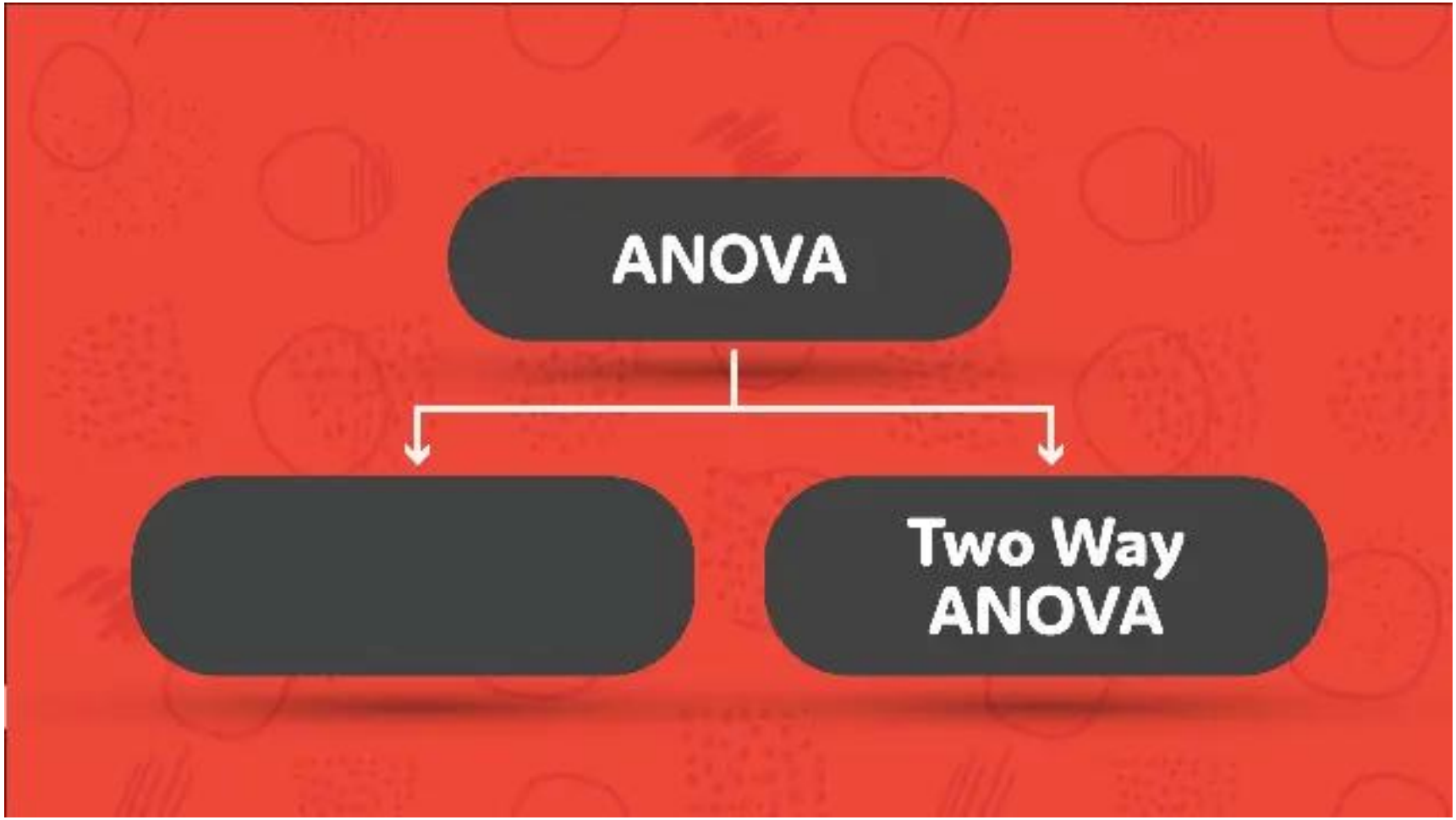
Dependent Variable: Brand X Star Rewards (For the following programs that you a

Tukey HSD

(I) Which of the following statements best describes your current marital status?	(J) Which of the following statements best describes your current marital status?	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Single (not living with a partner)	Married/living with a partner	-.130	.068	.136	-.29	.03
	Widowed/divorced/separated	-.290	.125	.053	-.58	.00
Married/living with a partner	Single (not living with a partner)	.130	.068	.136	duplicate	.29
	Widowed/divorced/separated	-.160	.116	.351	-.43	.11
Widowed/divorced/separated	Single (not living with a partner)	.290	.125	.053	duplicate	.58
	Married/living with a partner	.160	.116	.351	duplicate	.43

The brand who paid for the research (Brand X) is interested in knowing whether the satisfaction with their reward program differs by the marital status?

Single people are significantly more satisfied than widowed/divorced/seperated people with Brand X's rewards programs.


ANOVA
Two Way ANOVA

What if more that two factors/independent variables are involved?

Two-way ANOVA Table

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Factor A	SSA	$a - 1$	$\text{MSA} = \frac{\text{SSA}}{a-1}$	$\frac{\text{MSA}}{\text{MSE}}$
Factor B	SSB	$b - 1$	$\text{MSB} = \frac{\text{SSB}}{b-1}$	$\frac{\text{MSB}}{\text{MSE}}$
Interaction	SSAB	$(a - 1)(b - 1)$	$\text{MSAB} = \frac{\text{SSAB}}{(a-1)(b-1)}$	$\frac{\text{MSAB}}{\text{MSE}}$
Error	SSE	$ab(n_T - 1)$	$\text{MSE} = \frac{\text{SSE}}{ab(n_T - 1)}$	
Total	SST	$n_T - 1$		

Two-way ANOVA Research Question

- **Let's revert to the brand tracking questionnaire and data made available for this class on LEARN**
  1. The brand who paid for the research (Brand X) is interested in knowing whether the satisfaction with their reward program differs by the marital status and Gender?

Two-way ANOVA Research Question

S1 Are you…	GO TO
Male	S2
Female	

1

Independent

S7 Which of the following statements best describes your current marital status? (*Please select one answer*)	GO TO
Single (not living with a partner) Married/living with a partner Widowed/divorced/separated	S8

2

Independent

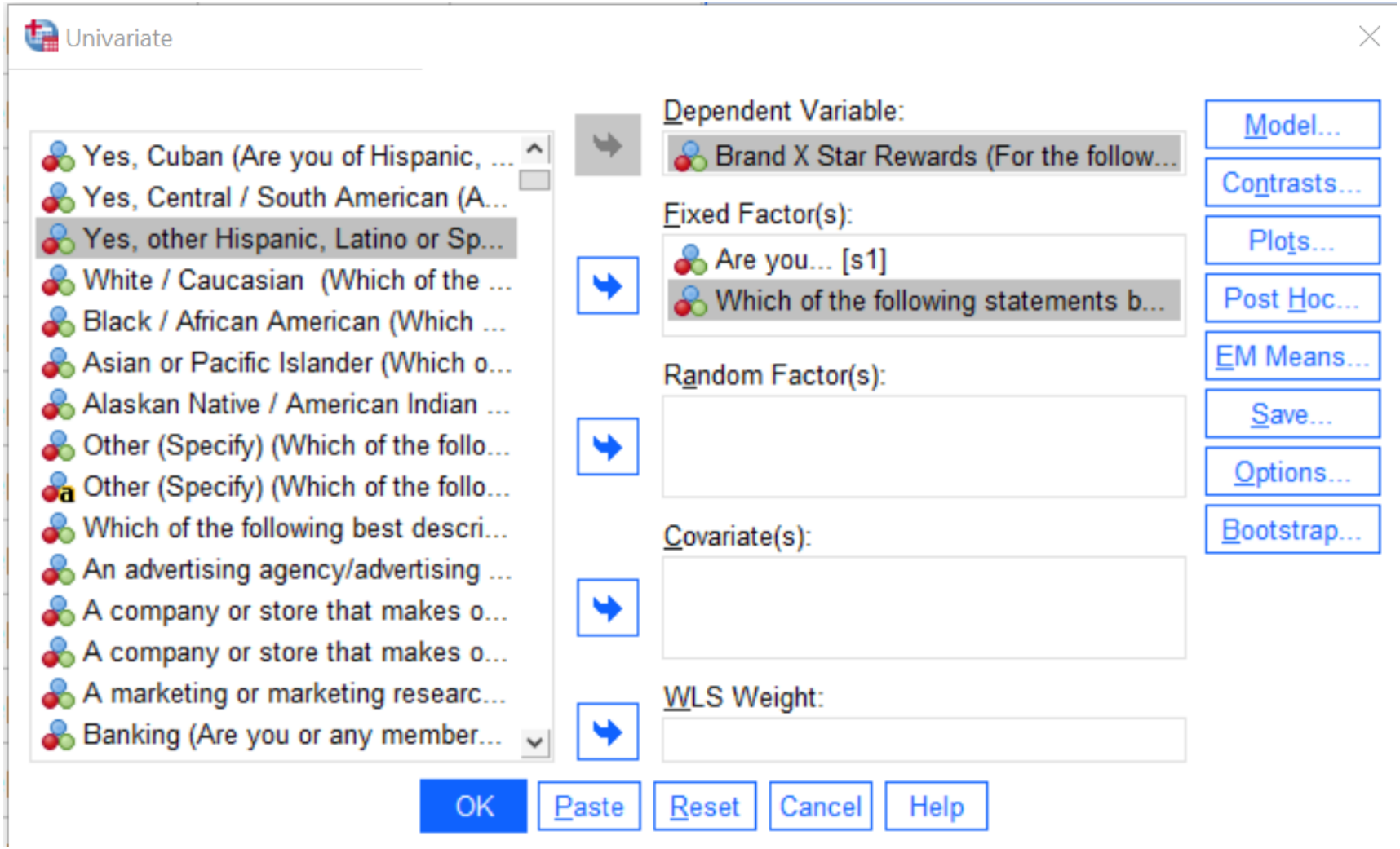
Dependent

Q21. For the following programs that you are enrolled in, how satisfied are you with the value of the rewards? (only show responses of "enrolled" from previous question)

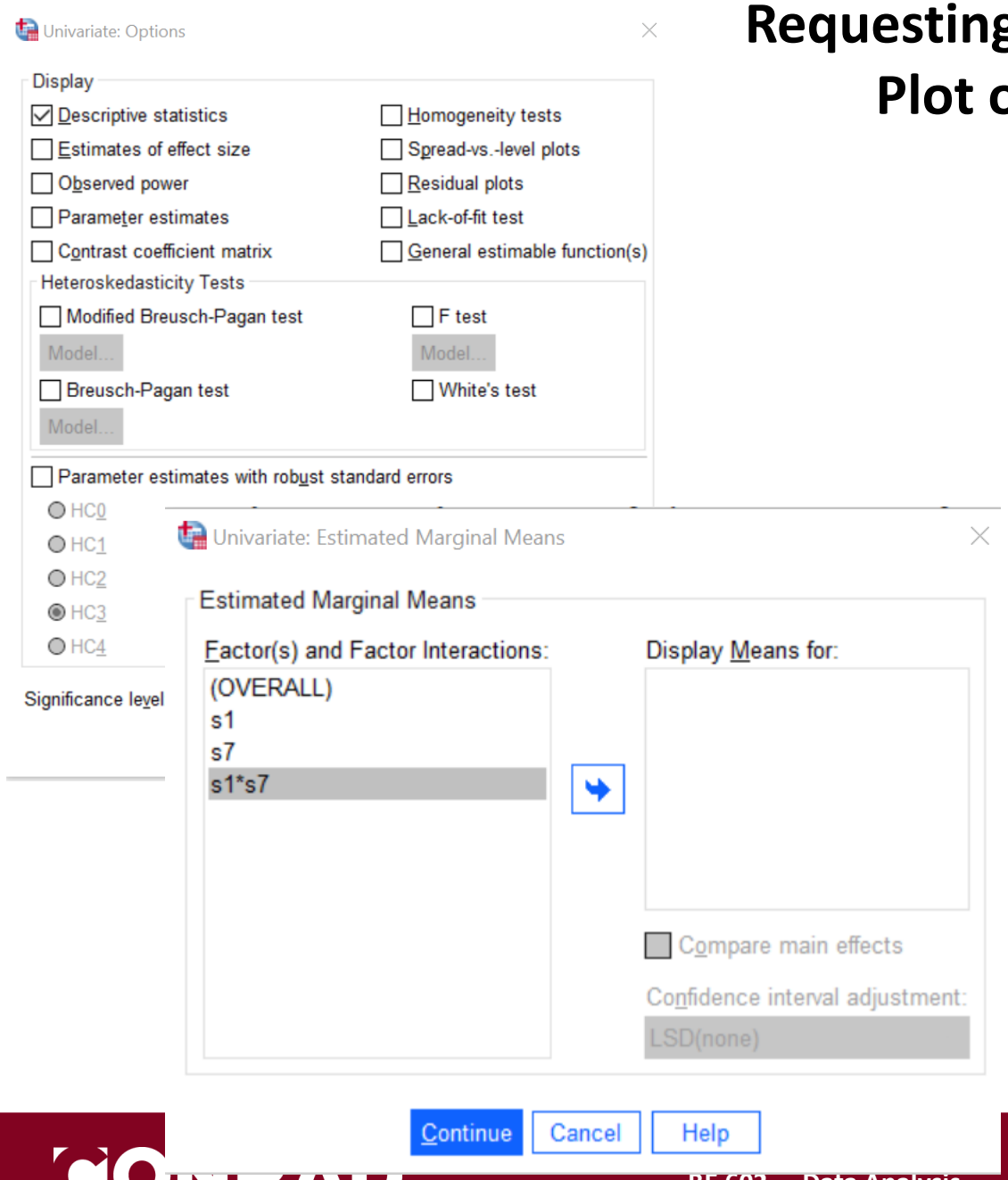
SAME ORDER AS Q20 and ONLY SHOW BRANDS ENROLLED IN	Very Satisfied	Somewhat satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Very dissatisfied
Plenti Rewards					
Brand X Star Rewards					
Amazon Prime					
TJX Rewards Access					
Nordstrom Fashion Rewards					
Bloomingdales Loyallist					
JC Penney JCP Rewards					
Kohl's Rewards					
Banana Republic/Gap/Old Navy					
Sephora Beauty Insider					
Nordstrom Fashion Rewards					
Ulta Ultamate Rewards					
DSW Rewards					
Victoria's Secret Angel Card					

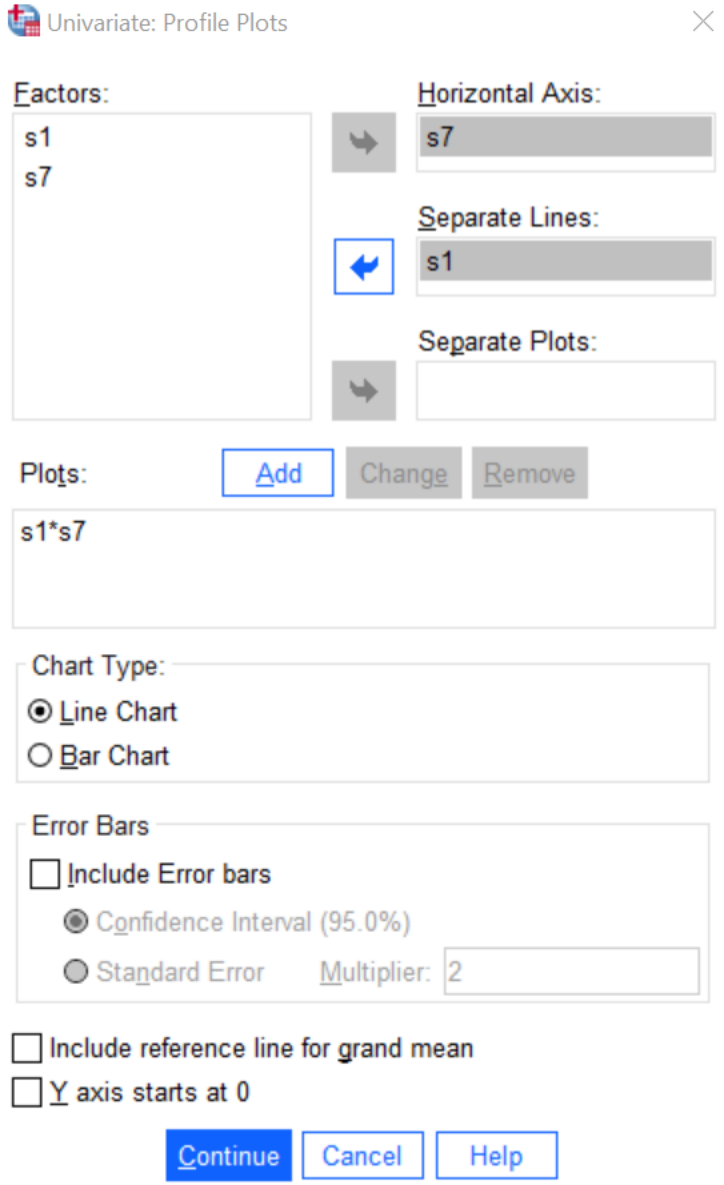
Analyze | General Linear Model| Univariate

(Use ***Plots*** and ***Post-Hoc*** to request Subgroup Means and a Plot of Subgroup Means)



Requesting Subgroup Means and a Plot of Subgroup Means





Significance Tests

1. Overall Model: **significant**
2. Gender Effect: **irrelevant**
3. Interaction Effect: **significant**

Tests of Between-Subjects Effects

Dependent Variable: Brand X Star Rewards (For the following programs that you are enrolle

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	
Corrected Model	12.881[a]	5	2.576	2.698	.020	1
Intercept	1178.558	1	1178.558	1234.396	.000	
s1	5.792	1	5.792	6.067	.014	2
s7	2.322	2	1.161	1.216	.297	
s1 * s7	4.599	2	2.300	2.409	.090	3
Error	1073.156	1124	.955			
Total	5475.000	1130				
Corrected Total	1086.036	1129				

a. R Squared = .012 (Adjusted R Squared = .007)

Estimated Marginal Means

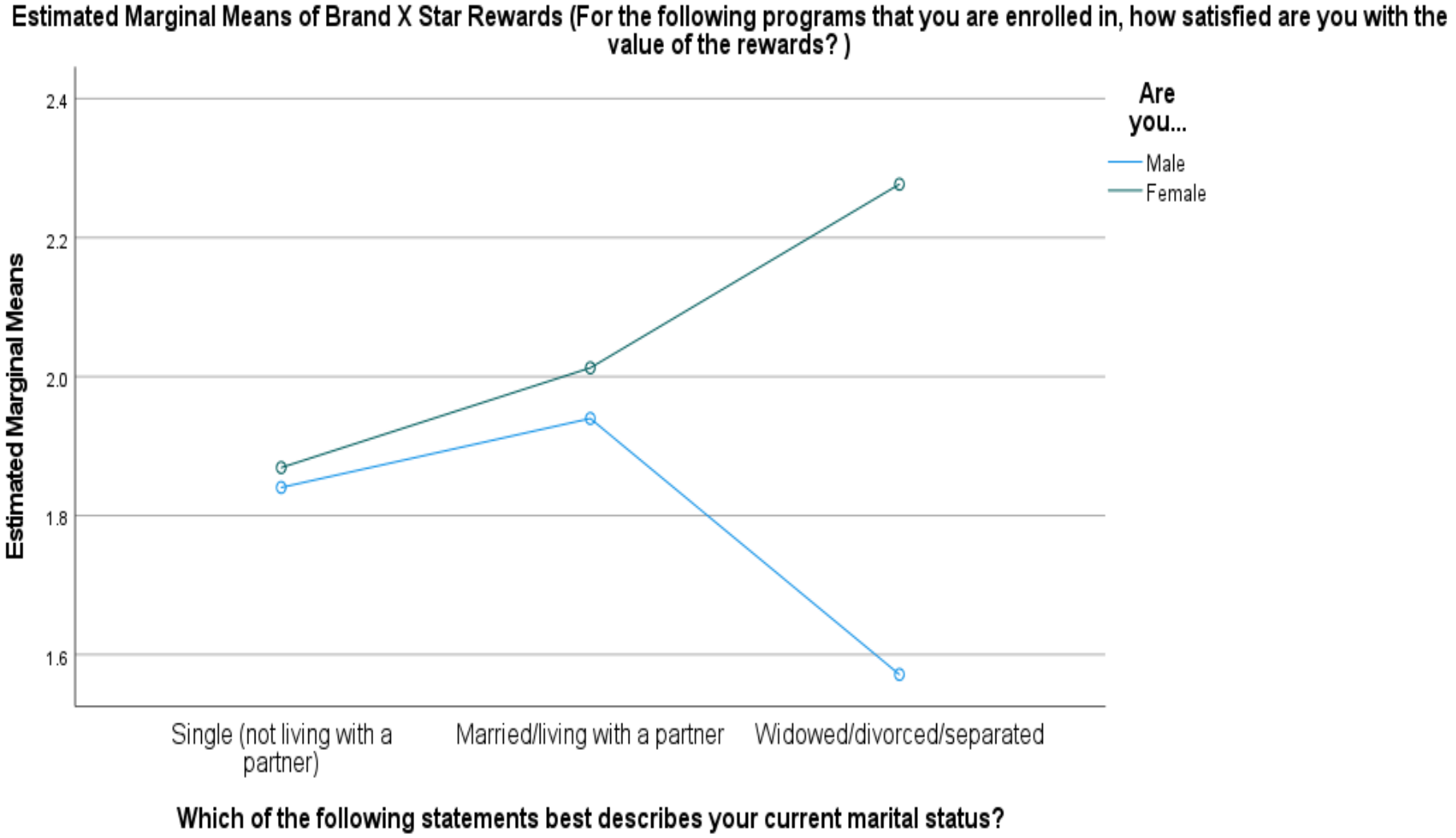
Which of the following statements best describes your current marital status? * Are you...

Dependent Variable: Brand X Star Rewards (For the following programs that you are enrolled in, how satisfied are you with the value of the rewards?)

Which of the following statements best describes your current marital status?	Are you...	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Single (not living with a partner)	Male	1.841	.118	1.610	2.071
	Female	1.869	.067	1.738	2.000
Married/living with a partner	Male	1.940	.066	1.809	2.070
	Female	2.013	.042	1.931	2.094
Widowed/divorced/separated	Male	1.571	.261	1.059	2.084
	Female	2.277	.121	2.039	2.515

Subgroup Means

Subgroup Plot



Two-Way ANOVA

- If interaction is significant, then interpret it along with means and plot.
  - This indicates that the IV's are not acting separately from one another in their effect on the DV. Main effect becomes irrelevant.
- If interaction is not significant, interpret main effects.
  - This indicates that IV effects on DV are independent of one another and that there is no significant interaction of the two IV's in the population.

Examining Relationships Among Variables

The Question

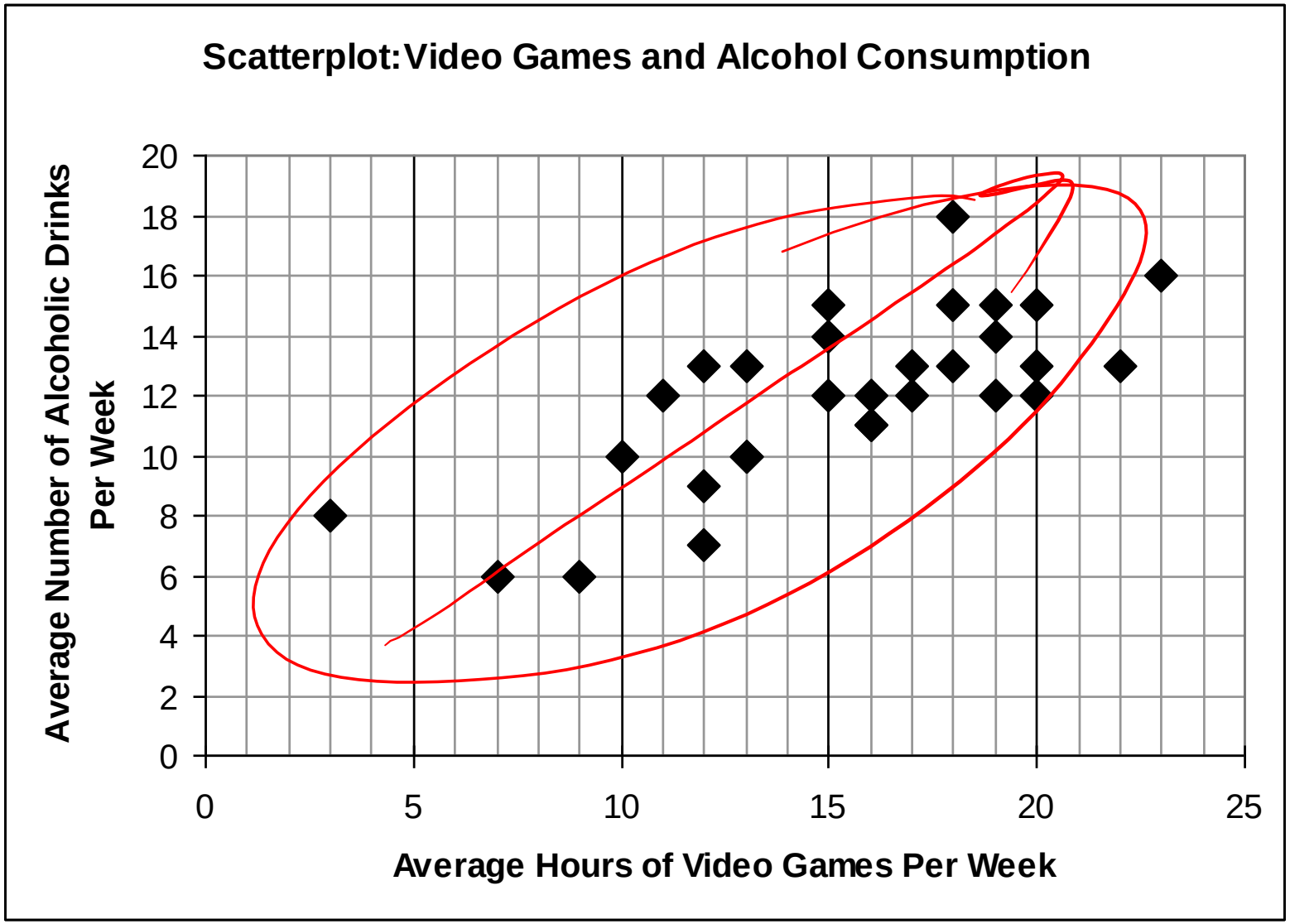
- Are two variables related?
  - Does one increase as the other increases?
    - e. g. skills and income
  - Does one decrease as the other increases?
    - e. g. nutrition and health problems

- How can we get a numerical measure of the degree of relationship?

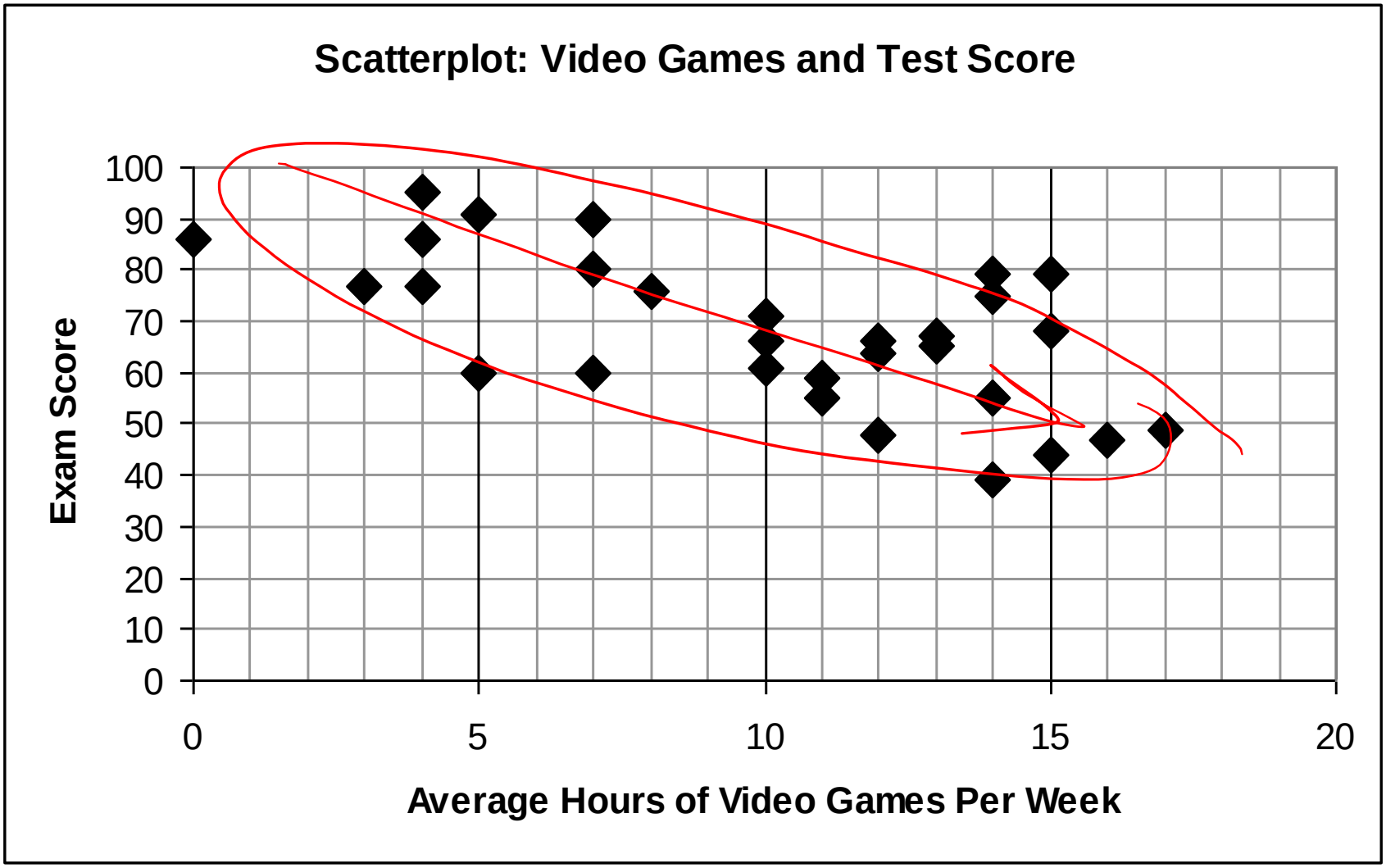
Scatter diagram or scattergram

- Graphically depicts the relationship between two variables in two-dimensional space.

Direct Relationship



Inverse Relationship



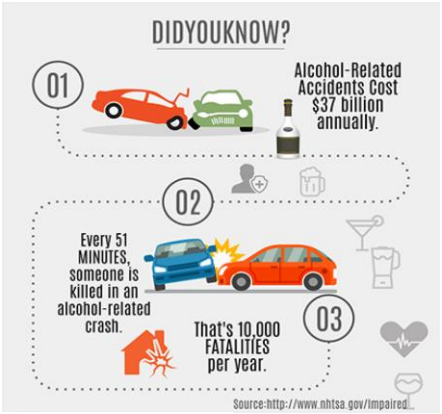
Numerical Measure of a Simple Linear Relationship

Correlation

- The relationship between two variables
- Measured with a correlation coefficient
- Most popularly seen **correlation coefficient: Pearson Product-Moment Correlation**
- Symbolized by ***r*** *(sample)* and ρ (*population*)
- A measure of degree of a **linear relationship**
- **Varies between 1 and -1**, where the sign refers to relational direction.
- **Based on covariance**
  - Measure of degree to which large scores on X go with large scores on Y, and small scores on X go with small scores on Y
- **Does not imply causation**

Types of Correlation

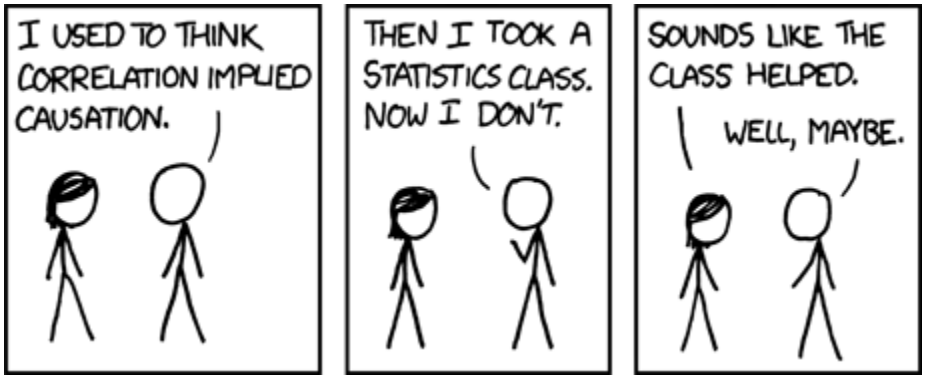
- **Positive correlation**
  - High values of X tend to be associated with high values of Y.
  - As X increases, Y increases
- **Negative correlation**
  - High values of X tend to be associated with low values of Y.
  - As X increases, Y decreases
- **No correlation**
  - No consistent tendency for values on Y to increase or decrease as X increases



Correlation Size

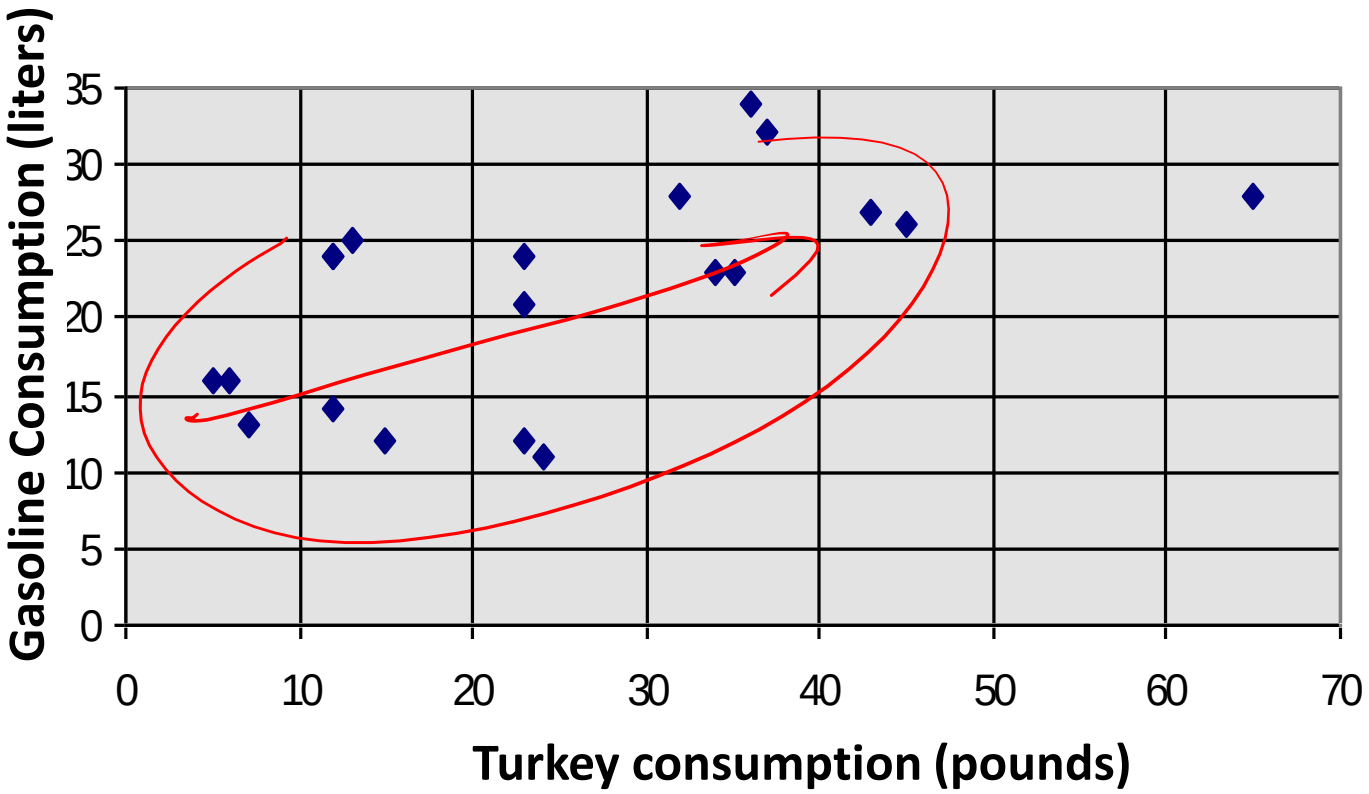
Size of Correlation	Interpretation
± 1	Perfect Positive/Negative Correlation
± .90 to ± .99	Very High Positive/Negative Correlation
± .70 to ± .90	High Positive/Negative Correlation
± .50 to ± .70	Moderate Positive/Negative Correlation
± .30 to ± .50	Low Positive/Negative Correlation
± .10 to ± .30	Very Low Positive/Negative Correlation
± .00 to ± .10	Markedly Low and Negligible Positive/ Negative Correlation

What do you mean no causality if there is a correlation?



Correlation and Causation

Relationship between turkey consumption and gasoline consumption, October, 2001-2020

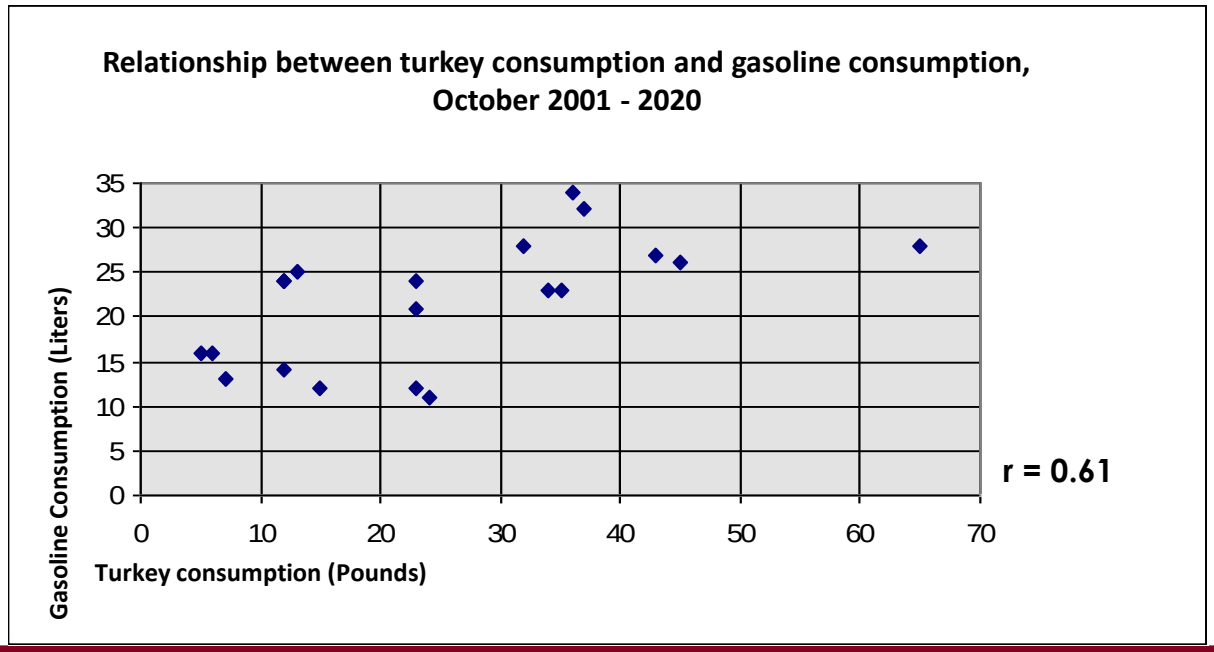


r = 0.61

Correlation and Causation

- **Does it mean** that one variable causes the other ?

- Turkey consumption and gasoline consumption are **strongly related** (r = 0.61) but that does not indicate that consuming turkeys explains increased gasoline consumption.
  - Maybe a third variable????



TILL NEXT TIME