



LCDB7011 Quantitative Research Methods

Week 8&9
T tests and ANOVA

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Agenda of the lecture

i. T test

- Independent sample t test
- One way sample t test

ii. ANOVA

- One-way ANOVA
- Two-way ANOVA

Independent Samples t Test



Independent Samples t Test

- The Independent Samples t Test compares the means of two independent (separate) groups to find out if the associated population means are statistically significantly different.
- This involves two variables. The variable being tested (test variable or dependant variable) and the grouping variable (independent variable)
- If you want to know how the maths works, have a look here:

[T-test formula](#) – look at the independent samples test.



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Independent Samples t Test - Assumptions

When should you use it?

Use it when:

1. **You have two different groups** (e.g., Group A and Group B).
2. Your **outcome** (what you're measuring) is a **number** (like height, score, satisfaction, etc.).
3. Each person is in **only one group** (no repeated measures).
4. The data in each group is:
 1. From a **random sample**
 2. **Roughly normal** (bell-shaped curve) — this matters more for small samples
 3. Has **similar spread (variance)** in both groups
5. There are **no extreme outliers** (very unusual values).

Example:

Imagine you want to know if **two departments** in a company have different job satisfaction levels.

You collect **satisfaction scores** from employees in **Department A** and **Department B**.

You compare their averages using the Independent Samples t-test.

[T test ➤ Independent sample t test ➤ One way sample t test SPSS - Google Search](#)

Independent Samples t Test

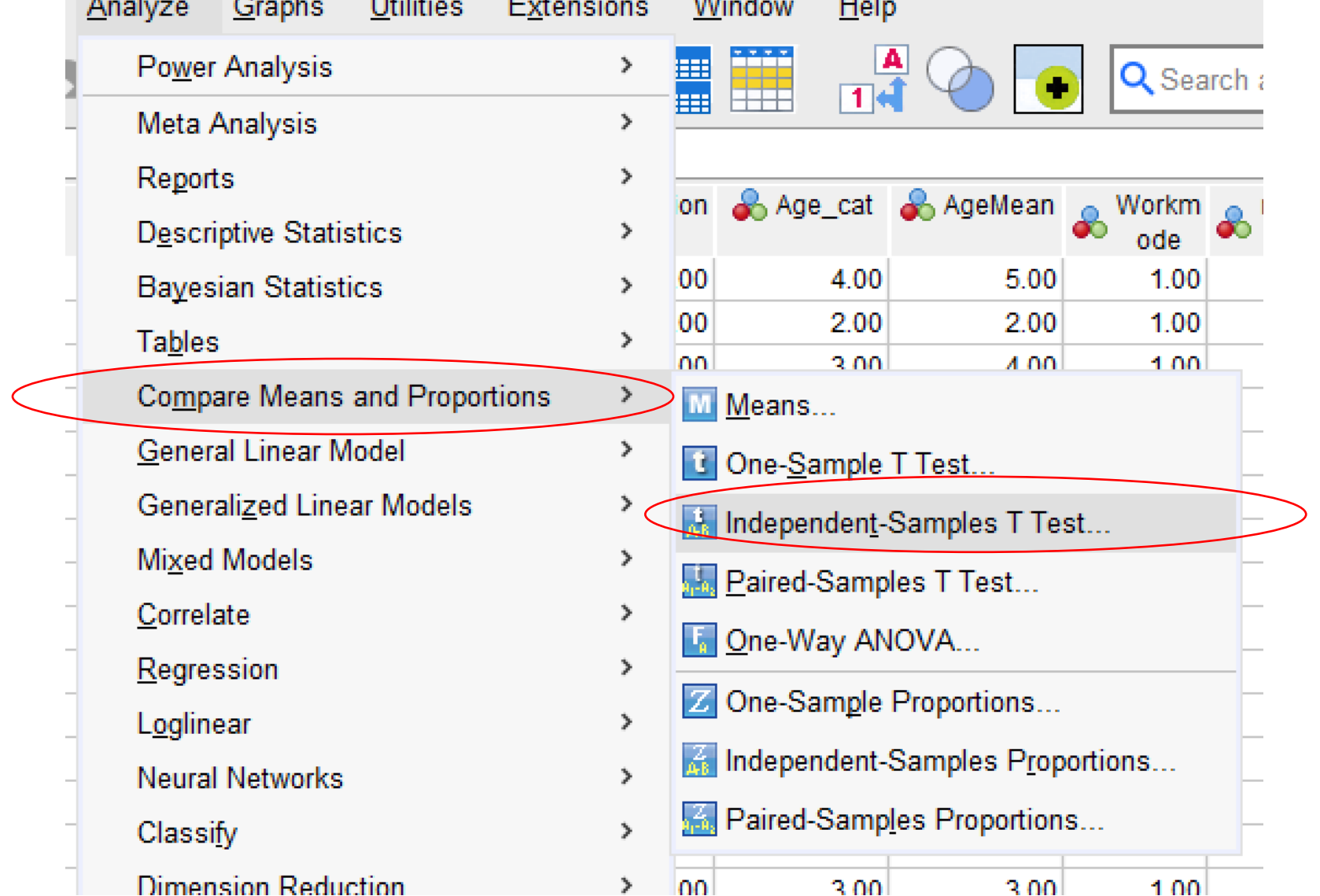
H0 : No difference in job satisfaction between male and female

H1 : There was difference in job satisfaction between male and female

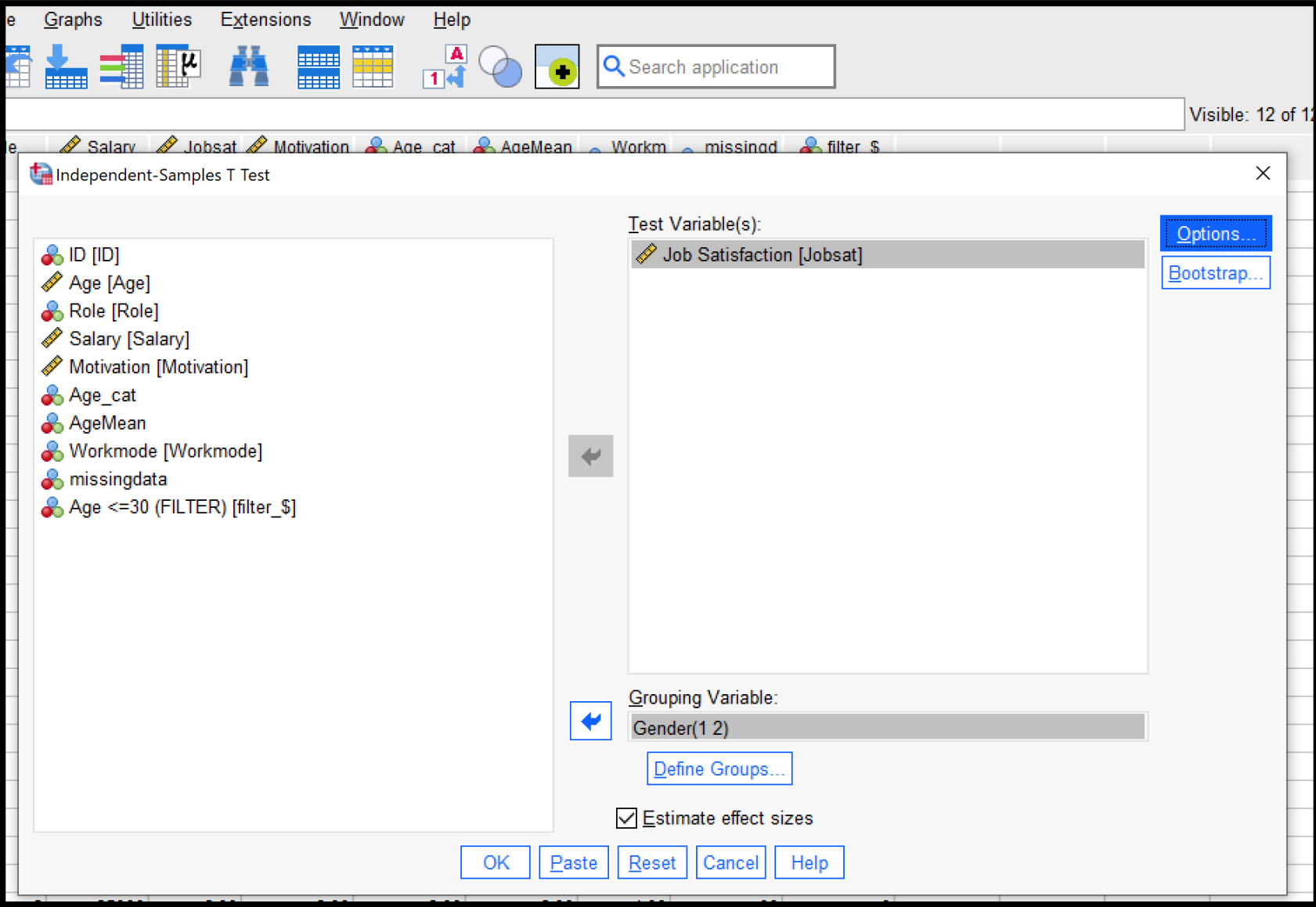


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Independent Samples t Test

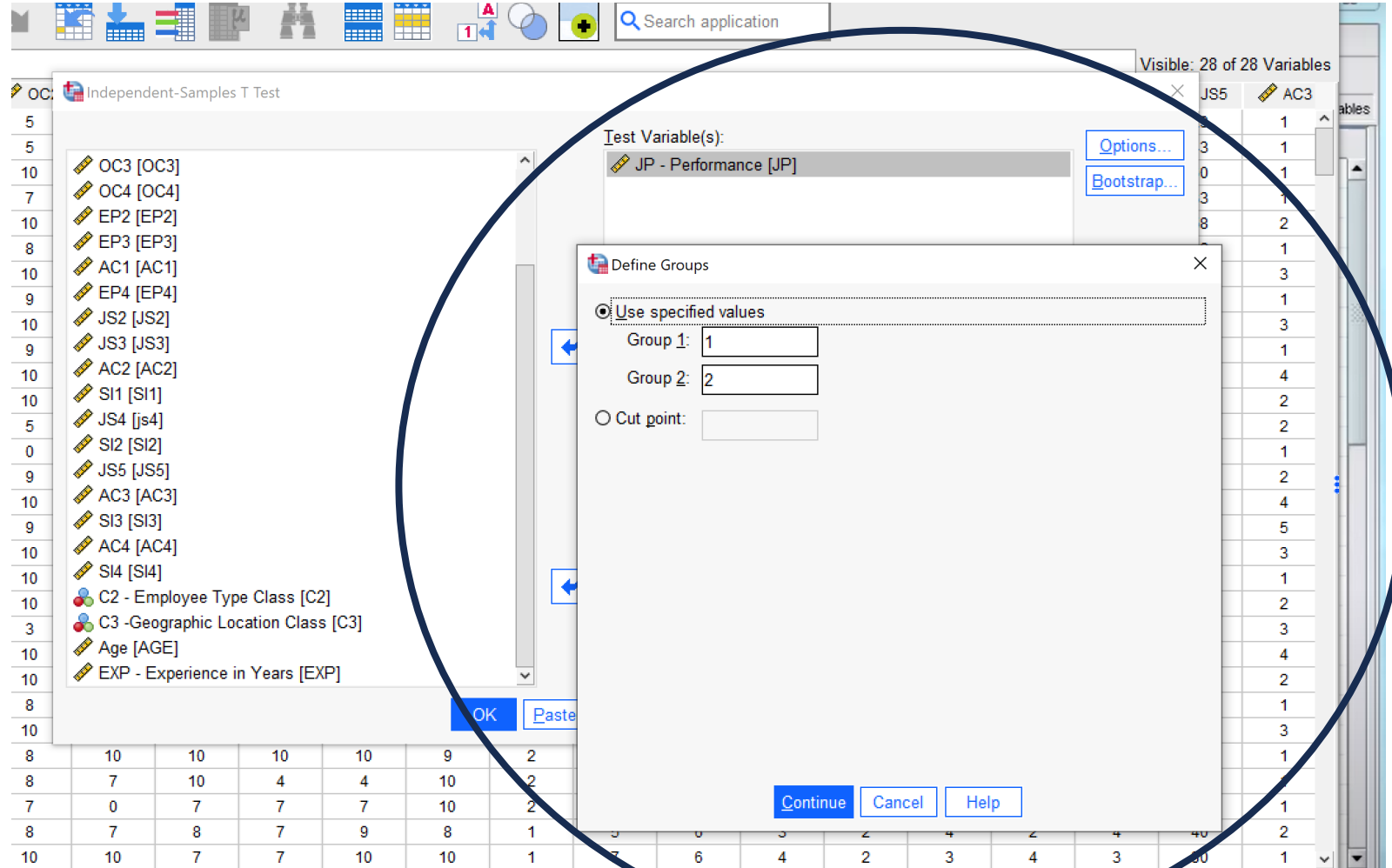


Independent Samples *t* Test



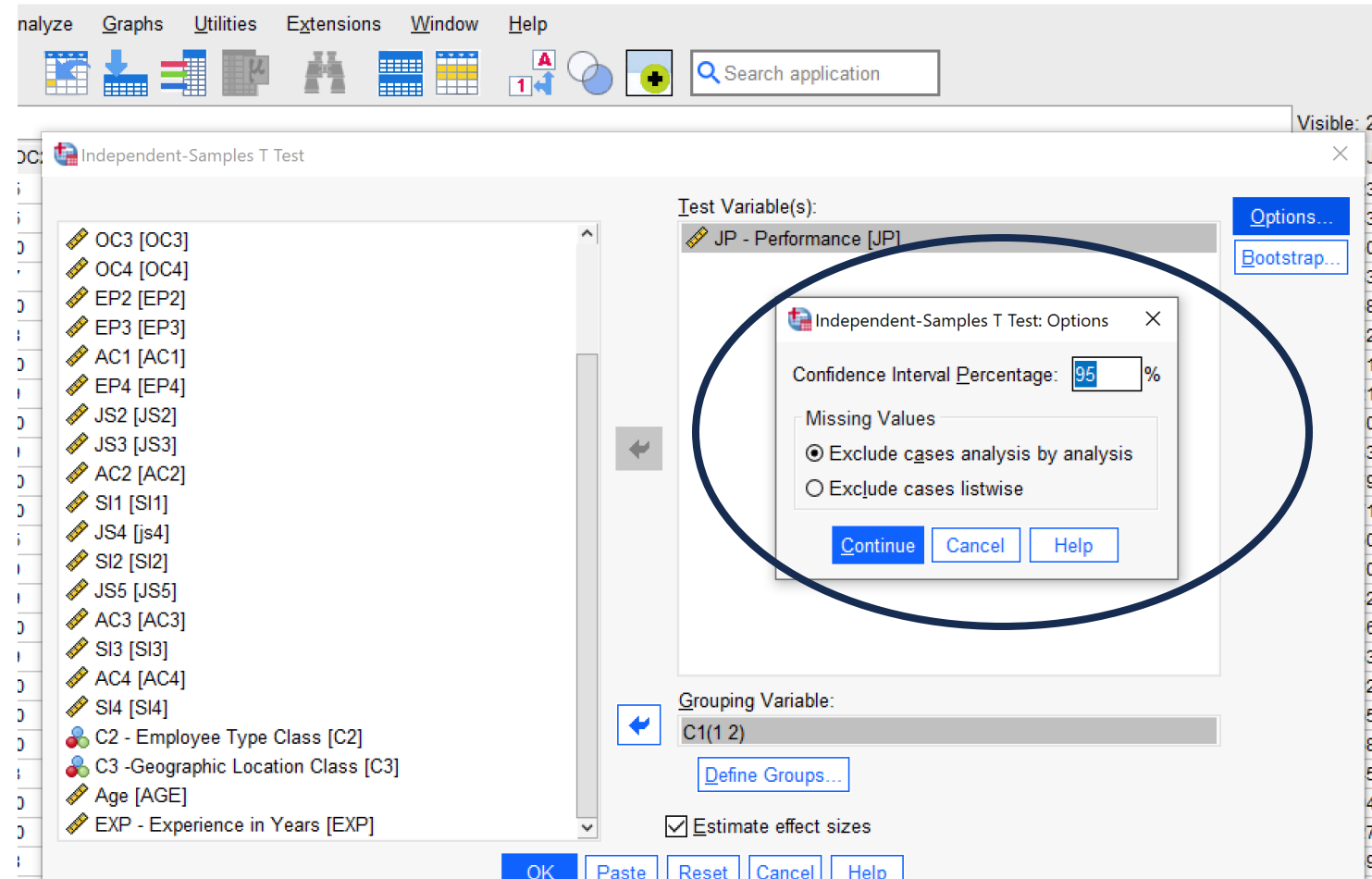
Independent Samples t Test

Define Group



Independent Samples t Test

Significant
Level



Independent Samples *t* Test

Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Job Satisfaction	Male	39	3.0256	1.06344	.17029
	Female	19	2.5263	.84119	.19298

P > .05
Then, accept H0
Equal Variance assumed

P < .05
Then, reject H0
Significant difference

Across 0
NOT Significantly different

Independent Samples

		Levene's Test for Equality of Variances						t-test for Equality of Means		95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Job Satisfaction	Equal variances assumed	.819	.369	1.789	56	.039	.079	.49933	.27905	-.05968	1.05833
	Equal variances not assumed			1.940	44.239	.029	.059	.49933	.25737	-.01929	1.01794

Independent Samples Effect Sizes

		Standardizer ^a	Point Estimate	95% Confidence Interval	
				Lower	Upper
Job Satisfaction	Cohen's d	.99742	.501	-.058	1.055
	Hedges' correction	1.01103	.494	-.057	1.040
	Glass's delta	.84119	.594	.005	1.167

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control (i.e., the second) group.



Presentation of Independent Sample T-Test results

- **For Insignificant Results** (No real difference found):
 - We ran an independent-samples t-test to compare [variable name] between [Group 1] and [Group 2].
 - The results showed no significant difference $t(df) = ___, p = ___.$ Group 1 had a mean of $___ (SD = ___)$, and Group 2 had a mean of $___ (SD = ___).$
 - The difference between the groups was small: Mean difference = $___, 95\% CI [___ \text{ to } ___]. \rightarrow$ So, the hypothesis (H1) was not supported.
- **For Significant Results** (There is a real difference):
 - We ran an independent-samples t-test to compare [variable name] between [Group 1] and [Group 2].
 - The results showed a significant difference $t(df) = ___, p = ___.$ Group 1 had a mean of $___ (SD = ___)$, which was higher/lower than Group 2's mean of $___ (SD = ___).$
 - The difference was meaningful: Mean difference = $___, 95\% CI [___ \text{ to } ___]. \rightarrow$ So, the hypothesis (H1) was supported.

Presentation of Independent Sample T-Test results: Our example:

- Example Report (Insignificant Result)
- We ran an independent-samples t-test to compare satisfaction scores between the two groups.
- The Levene's test showed that the assumption of equal variances was met, $F(1, 18) = 1.627, p = .218$, so we used the row for "equal variances assumed."
- The results showed no significant difference in satisfaction between the two groups, $t(18) = 1.151, p = .265$. Group 1 and Group 2 differed by an average of 4.90 points, but this difference was not statistically significant.
- The 95% confidence interval for the difference was $[-4.04, 13.84]$, which includes zero.
- ➤ Therefore, we did not find enough evidence to support the hypothesis (H1) that the groups differ in satisfaction.

Samples t Test

Compared with the average mean



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Samples t Test

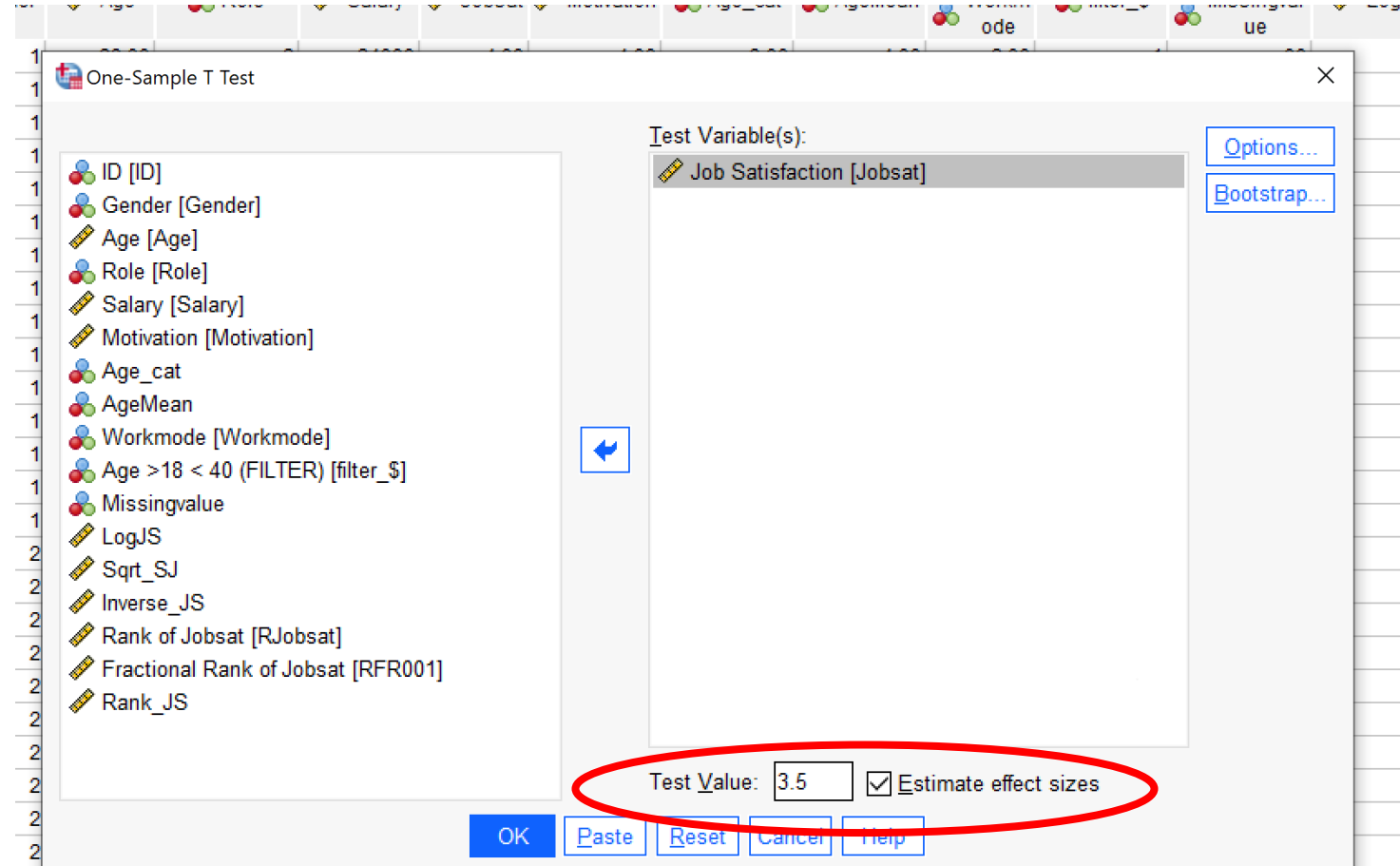
test for normality_00cases_v1.sav [Dataset] - IBM SPSS Statistics Data Editor

The screenshot displays the IBM SPSS Statistics Data Editor interface. The 'Analyze' menu is open, and the path 'Compare Means and Proportions' > 'One-Sample T Test...' is highlighted. The data editor shows a dataset with columns: ID, Gender, Age, Age_cat, AgeMean, Workmode, filter_\$, Missingvalue, and Location. The data is organized into rows, with some rows having missing values for certain variables.

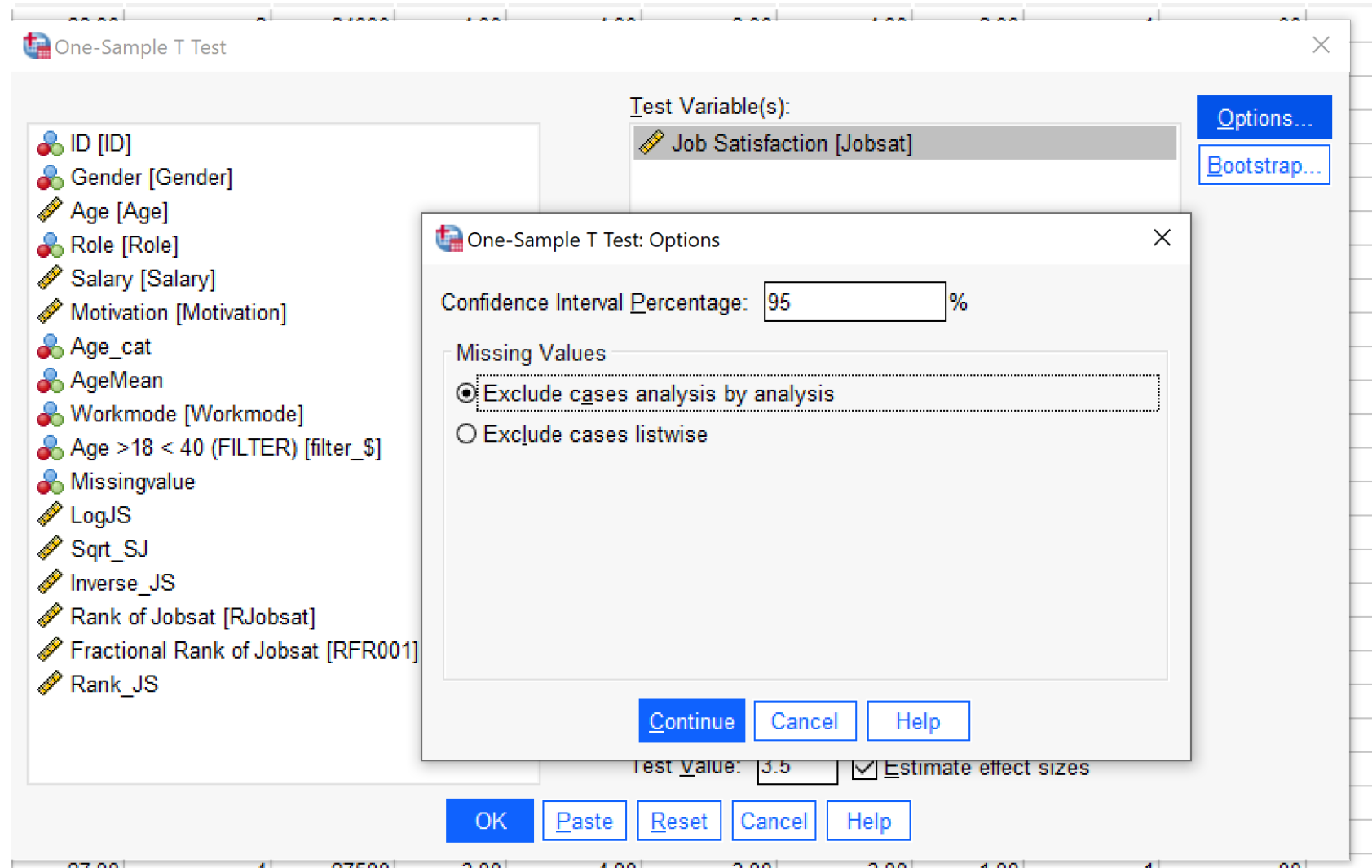
ID	Gender	Age	Age_cat	AgeMean	Workmode	filter_\$	Missingvalue	Location
40	1	18.00	1.00	2.00	1.00	1	.00	
41	1	18.00	1.00	2.00	1.00	1	.00	
42	1	18.00	1.00	2.00	1.00	1	.00	
43	2	23.00	1.00	2.00	1.00	1	.00	
44	2	45.00	1			1	.00	
45	2	63.00	1			1	.00	
46	2	55.00	1			1	.00	
47	2	26.00	1			1	.00	
48	2	30.00	1			1	.00	
49	2	42.00	1			1	.00	
50	2	27.00	1			1	.00	
51	2	37.00	1			1	.00	
52	2	42.00	1			1	.00	
53	2	27.00	1			1	.00	
54	2	37.00	1			1	.00	
55	2	27.00	1			1	.00	
56	2	37.00	1			1	.00	
57	2	42.00	1			1	.00	
58	2	27.00	1			1	.00	

Samples t Test

Assume the average
satisfaction mean = 3.5



Samples t Test



Independent Samples t Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Sat	20	73.05	9.600	2.147

One-Sample Test

Test Value = 60

	t	df	Significance		Mean Difference	95% Confidence Interval of the Difference	
			One-Sided p	Two-Sided p		Lower	Upper
Sat	6.079	19	<.001	<.001	13.050	8.56	17.54

One-Sample Effect Sizes

		Standardizer ^a	Point Estimate	95% Confidence Interval	
				Lower	Upper
Sat	Cohen's d	9.600	1.359	.737	1.964
	Hedges' correction	10.001	1.305	.707	1.885

a. The denominator used in estimating the effect sizes.

Cohen's d uses the sample standard deviation.

Hedges' correction uses the sample standard deviation, plus a correction factor.

1. t-table

If t value > critical value, then it is statistically different.

Independent Samples t Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Sat	20	73.05	9.600	2.147

One-Sample Test

Test Value = 60

	t	df	Significance		Mean Difference	95% Confidence Interval of the Difference	
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2. P value

If p value < 0.05, then it is statistically different.

Independent Samples t Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Sat	20	73.05	9.600	2.147

One-Sample Test

Test Value = 60

	t	df	Significance		Mean Difference	95% Confidence Interval of the Difference	
			One-Sided p	Two-Sided p		Lower	Upper
Sat	6.079	19	<.001	<.001	13.050	8.56	17.54

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a. The denominator used in estimating the effect sizes.

Cohen's d uses the sample standard deviation.

Hedges' correction uses the sample standard deviation, plus a correction factor.

3. Confidence Interval (95%)

If Confident Interval contain 0, then the mean is not statistically different

Independent Samples t Test

1. t-value, The t-value tests whether the sample mean is significantly different from a known or hypothesized value (in this case, 60). From your output: ➤ $t(19) = 6.079$

2. p-value (< 0.05 rule) The p-value tells us if the observed difference is statistically significant. If $p < 0.05$, the difference is significant. From your output: ➤ $p < .001$

This is significant (much less than 0.05)

3. Confidence Interval (CI) The 95% Confidence Interval shows the range in which the true mean difference is likely to lie. If the CI does not include 0, the result is significant. From your output: ➤ 95% CI = [8.56, 17.54]

Since 0 is not in the interval, the result is statistically significant

Sample t-test

- 3 ways of measuring the mean statistical difference in SPSS
 - i. t-value (from t table)
 - ii. p-value < 0.05
 - iii. Confidence Interval

APA-style report for your One-Sample t-test results:

- APA-style report:
- A one-sample t-test was conducted to determine whether the sample mean of SAT scores differed significantly from the test value of 60.
- The results indicated that the mean SAT score ($M = 73.05$, $SD =$ not provided) was significantly higher than 60, $t(19) = 6.08$, $p < .001$, 95% CI [8.56, 17.54].

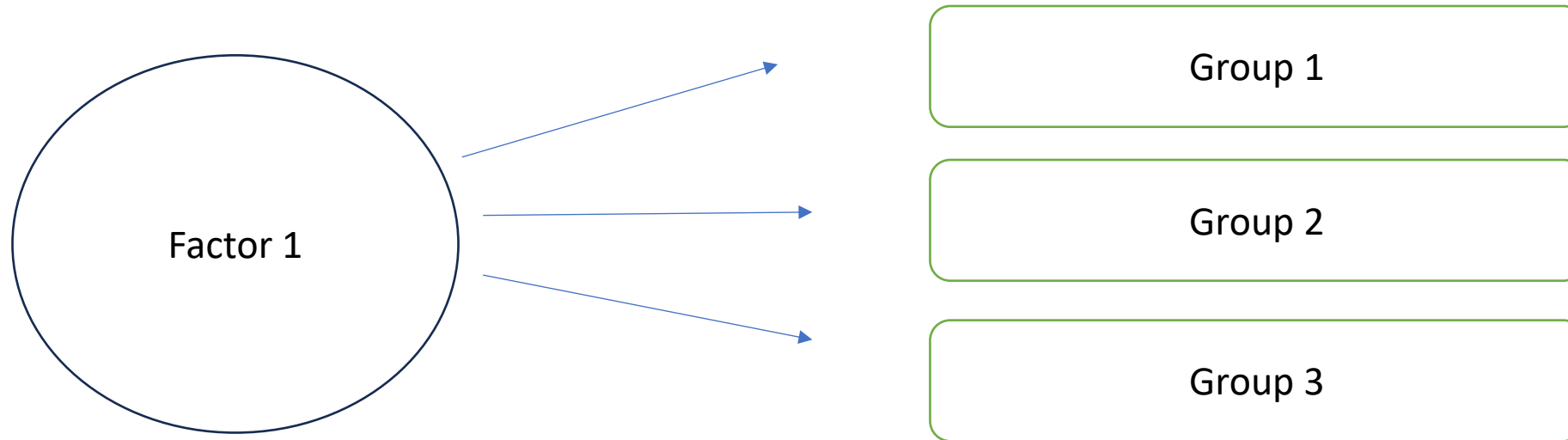
ANOVA



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One-way ANOVA

One-way ANOVA: Used to determine how one factor affects a response variable.



If you need to compare differences between several groups on the same variables

One-way ANOVA is a method used to compare the average values (means) of **more than two groups** to see if there is any difference between them.

It works by checking how much the data varies **between the groups** and how much it varies **within each group**.

- If the variation between groups is much bigger than the variation inside the groups, it suggests the group means are different.

Important: One-way ANOVA only tells us **that some differences exist** between the groups, but it does **not** tell us **which** groups are different from each other.

- To find out exactly which groups differ, we need to do extra tests called **post hoc tests** after the ANOVA.

One-way ANOVA – Assumption

For **One-way ANOVA** to work properly, your data needs to meet **three important rules**:

1. Independence of observations:

Each piece of data should be collected fairly (using proper methods), and the results from one person or item shouldn't affect another.

If there's a hidden factor affecting the results, you might need a more advanced ANOVA with something called *blocking*.

2. Normal distribution:

The values you are measuring (the outcome or dependent variable) should follow a bell-shaped curve — this means they're *normally distributed*.

3. Equal variances (Homogeneity of variance):

The amount of variation in each group should be about the same.

If the spread of data is very different between groups, then regular ANOVA may not work well.

One-way ANOVA

ANOVA (Analysis of Variance) is a test used to see if there are differences between the **averages (means)** of **three or more groups**.

A **one-way ANOVA** looks at **one independent variable** (a category like group or type) and one **dependent variable** (a number or measurement).

Use it when you have:

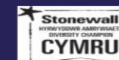
- **One categorical variable** (with at least 3 groups)
- **One number variable** you're measuring

One-way ANOVA

ANOVA shows if a **number you're measuring** (dependent variable) changes depending on the **group** (independent variable).

Example:

If your independent variable is **soda brand** (Coke, Pepsi, Sprite, Fanta), and you measure **price per 100ml**, ANOVA tells you if the **price differs by brand**. Or, if you're measuring **job satisfaction** (dependent), ANOVA can check if it changes based on different **departments or job roles** (independent).



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Post hoc tests:

After ANOVA, if you want to know **which groups are different**:

- Use **Tukey's test** if group variances are **equal**.
- Use **Games-Howell** if variances are **not equal**.
- Not sure? Run both and choose the right one.

ANOVA results:

ANOVA gives an **F ratio**.

- If groups are similar, **F is close to 1**.
- A **big F** means the group averages are likely **different**. [One-way ANOVA and Post Hoc Test Using SPSS](#)

One-way ANOVA

The screenshot shows the SPSS software interface. The 'Analyze' menu is open, and 'One-Way ANOVA...' is selected under the 'Compare Means and Proportions' submenu. The data file is '54 : Gender', and the variable 'Age' is selected for analysis. The data table shows columns for ID, Gender, and Age. The 'Analyze' menu options include: Power Analysis, Meta Analysis, Reports, Descriptive Statistics, Bayesian Statistics, Tables, Compare Means and Proportions (selected), General Linear Model, Generalized Linear Models, Mixed Models, Correlate, Regression, Loglinear, Neural Networks, Classify, Dimension Reduction, Scale, Nonparametric Tests, Forecasting, Survival, Multiple Response, Missing Value Analysis..., Multiple Imputation, Complex Samples, Simulation..., Quality Control, Spatial and Temporal Modeling..., and Direct Marketing.

ID	Gender	Age
26	1	28.00
27	1	28.00
28	1	42.00
29	1	42.00
30	1	42.00
31	1	23.00
32	1	23.00
33	1	23.00
34	1	19.00
35	1	19.00
36	1	19.00
37	1	18.00
38	1	18.00
39	1	18.00
40	2	23.00
41	2	45.00
42	2	63.00
43	2	55.00
44	2	26.00
45	2	30.00
46	2	42.00
47	2	27.00
48	2	37.00
49	2	42.00
50	2	27.00
51	2	37.00
52	2	27.00
53	2	37.00
54	2	42.00

One-way ANOVA

One-Way ANOVA

Dependent List:

Job Satisfaction [Jobsat]

Factor:

Role [Role]

☒ Estimate effect size for overall tests

OK Paste Reset Cancel Help

One-Way ANOVA: Options

Statistics

☐ Descriptive

☐ Fixed and random effects

☒ Homogeneity of variance test

☐ Brown-Forsythe test

☐ Welch test

☐ Means plot

Missing Values

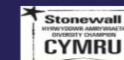
☒ Exclude cases analysis by analysis

☐ Exclude cases listwise

Confidence Intervals

Level(%): 0.95

Continue Cancel Help



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One-Way ANOVA: Post Hoc Multiple Comparisons

Equal Variances Assumed

☐ LSD ☐ S-N-K ☐ Waller-Duncan
☐ Bonferroni ☒ Tukey Type I/Type II Error Ratio: 100
☐ Sidak ☐ Tukey's-b ☐ Dunnett
☐ Scheffe ☐ Duncan Control Category: Last
☐ R-E-G-W F ☐ Hochberg's GT2
☐ R-E-G-W Q ☐ Gabriel

Test
☒ 2-sided ☐ < Control ☐ > Control

Equal Variances Not Assumed

☐ Tamhane's T2 ☐ Dunnett's T3 ☒ Games-Howell ☐ Dunnett's C

Null Hypothesis test

☒ Use the same significance level [alpha] as the setting in Options
☐ Specify the significance level [alpha] for the post hoc test
Level: 0.05

Continue Cancel Help

One-Way ANOVA: Options

Statistics

☒ Descriptive
☐ Fixed and random effects
☒ Homogeneity of variance test
☐ Brown-Forsythe test
☐ Welch test

☒ Means plot

Missing Values

☒ Exclude cases analysis by analysis
☐ Exclude cases listwise

Confidence Intervals

Level(%): 0.95



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One-way ANOVA

Descriptives

Job Satisfaction

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Temporary	10	1.6000	.51640	.16330	1.2306	1.9694	1.00	2.00
Operator	36	3.0556	.79082	.13180	2.7880	3.3231	2.00	4.00
Secretary	2	1.5000	.70711	.50000	-4.8531	7.8531	1.00	2.00
Team leader	8	3.3750	.51755	.18298	2.9423	3.8077	3.00	4.00
Management	2	5.0000	.00000	.00000	5.0000	5.0000	5.00	5.00
Total	58	2.8621	1.01650	.13347	2.5948	3.1293	1.00	5.00

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Job Satisfaction	Based on Mean	1.588	4	53	.191
	Based on Median	1.190	4	53	.326
	Based on Median and with adjusted df	1.190	4	50.910	.327
	Based on trimmed mean	1.629	4	53	.180

Levene Test is non-significant. The variance is equal
Group variances are homogeneous

One-way ANOVA

ANOVA

Job Satisfaction

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	32.233	4	8.058	16.017	<.001
Within Groups	26.684	53	.503		
Total	58.897	57			

$$F(4, 53) = 16.017, p < .05, \eta^2 p = .547$$

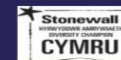
$\eta^2 p$ is an effect size

One-way ANOVA

ANOVA Effect Sizes^a

		Point Estimate	95% Confidence Interval	
			Lower	Upper
Job Satisfaction	Eta-squared	.547	.322	.647
	Epsilon-squared	.513	.271	.620
	Omega-squared Fixed-effect	.509	.268	.616
	Omega-squared Random-effect	.206	.084	.286

a. Eta-squared and Epsilon-squared are estimated based on the fixed-effect model.



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One-way ANOVA

Multiple Comparisons

Dependent Variable: Job Satisfaction

	(I) Role	(J) Role	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	Temporary	Operator	-1.45556 [*]	.25354	<.001	-2.1715	-.7396
		Secretary	.10000	.54941	1.000	-1.4515	1.6515
		Team leader	-1.77500 [*]	.33645	<.001	-2.7251	-.8249
		Management	-3.40000 [*]	.54941	<.001	-4.9515	-1.8485
	Operator	Temporary	1.45556 [*]	.25354	<.001	.7396	2.1715
		Secretary	1.55556 [*]	.51529	.031	.1004	3.0107
		Team leader	-.31944	.27724	.778	-1.1023	.4634
		Management	-1.94444 [*]	.51529	.004	-3.3996	-.4893
	Secretary	Temporary	-.10000	.54941	1.000	-1.6515	1.4515
		Operator	-1.55556 [*]	.51529	.031	-3.0107	-.1004
		Team leader	-1.87500 [*]	.56074	.013	-3.4585	-.2915
		Management	-3.50000 [*]	.70929	<.001	-5.5030	-1.4970
	Team leader	Temporary	1.77500 [*]	.33645	<.001	.8249	2.7251
		Operator	.31944	.27724	.778	-.4634	1.1023
		Secretary	1.87500 [*]	.56074	.013	.2915	3.4585
		Management	-1.62500 [*]	.56074	.042	-3.2085	-.0415
	Management	Temporary	3.40000 [*]	.54941	<.001	1.8485	4.9515
		Operator	1.94444 [*]	.51529	.004	.4893	3.3996
		Secretary	3.50000 [*]	.70929	<.001	1.4970	5.5030
		Team leader	1.62500 [*]	.56074	.042	.0415	3.2085



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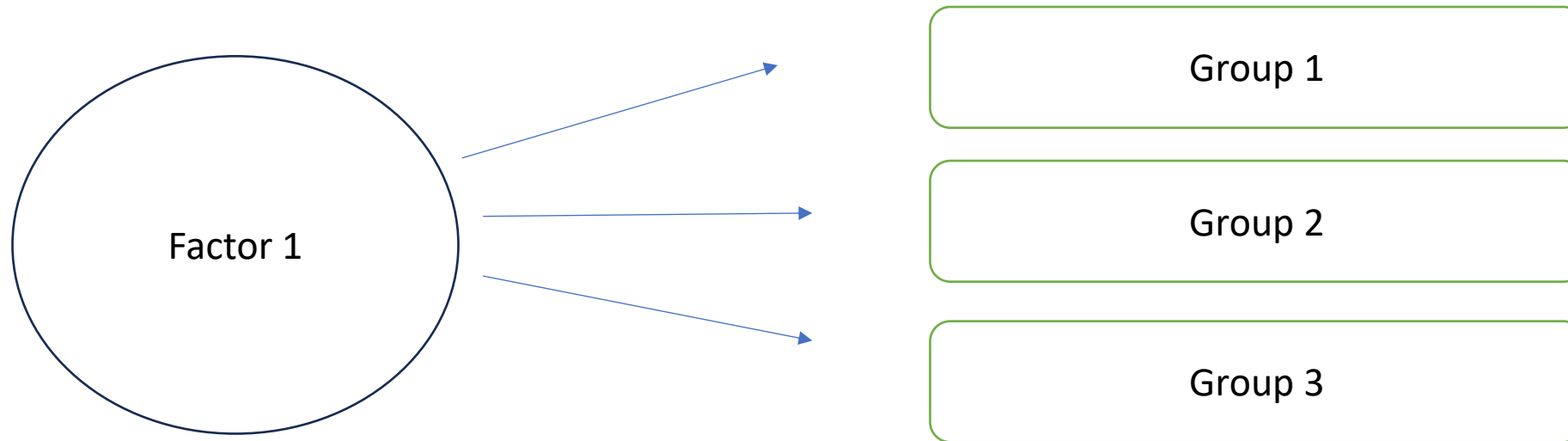
Two-way ANOVA



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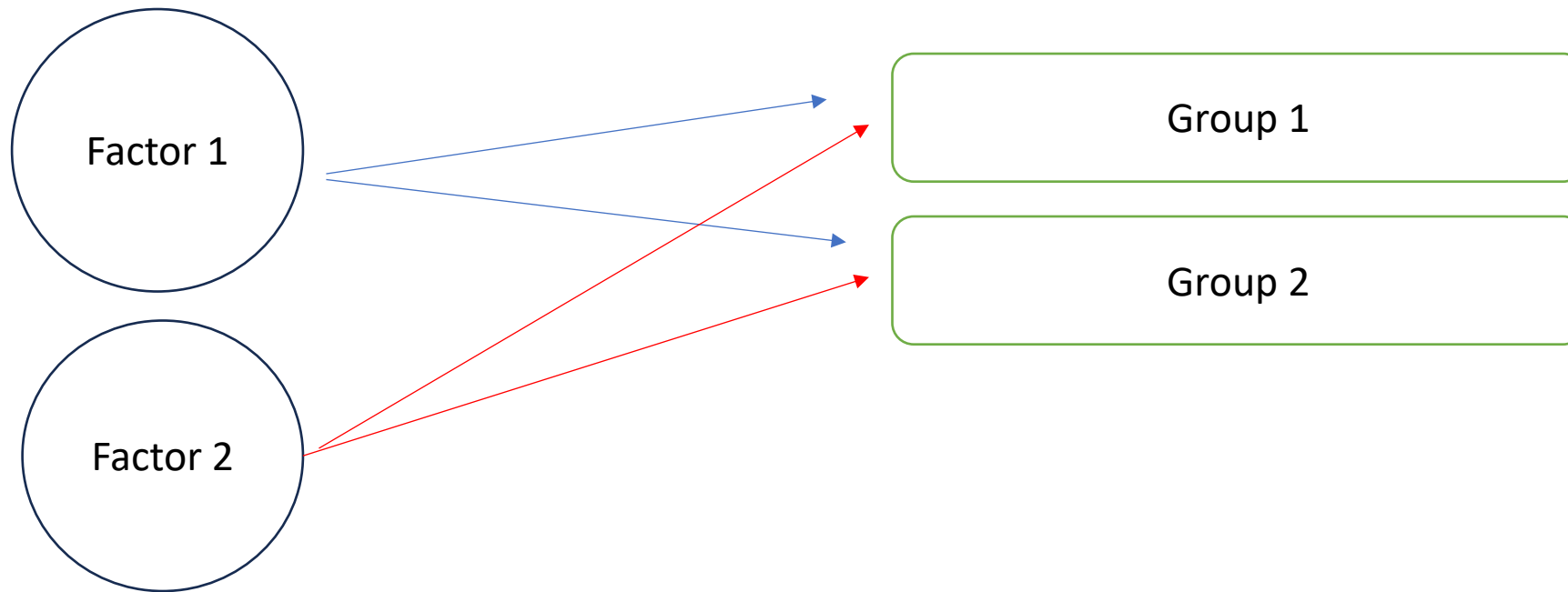
One-way ANOVA vs Two-way ANOVA

One-way ANOVA: Used to determine how one factor affects a response variable.



One-way ANOVA vs Two-way ANOVA

Two-way ANOVA: Used to determine how two factor affects a response variable. [Conducting a Two-Way ANOVA in SPSS](#)



Two-way ANOVA - Assumptions

Dependent Variable: Salary must be **continuous** (e.g. measured in numbers like \$3,000, \$4,200, etc.)

Independent Variables: **Satisfaction level**, **gender**, and **age group** should be **categorical** (e.g. Low/Med/High; Male/Female; Young/Mid/Old)

Independent Samples: Each person (data point) should be **independent**—no repeated measures or related groups

Equal Variance: The **spread of salaries** should be similar across all groups

Normal Distribution: Salary data within each group should come from a **normally distributed** population



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Two-way ANOVA – Hypothesis

Satisfaction level and salary:

H_0 : All satisfaction levels have the same average salary

H_1 : At least one satisfaction level has a different average salary

2. Gender and salary:

H_0 : Genders have the same average salary

H_1 : Genders have different average salaries

3. Age and salary:

H_0 : All age groups have the same average salary

H_1 : At least one age group has a different average salary

4. Interaction (e.g. satisfaction $\times$ gender):

H_0 : No interaction between satisfaction level and gender on salary

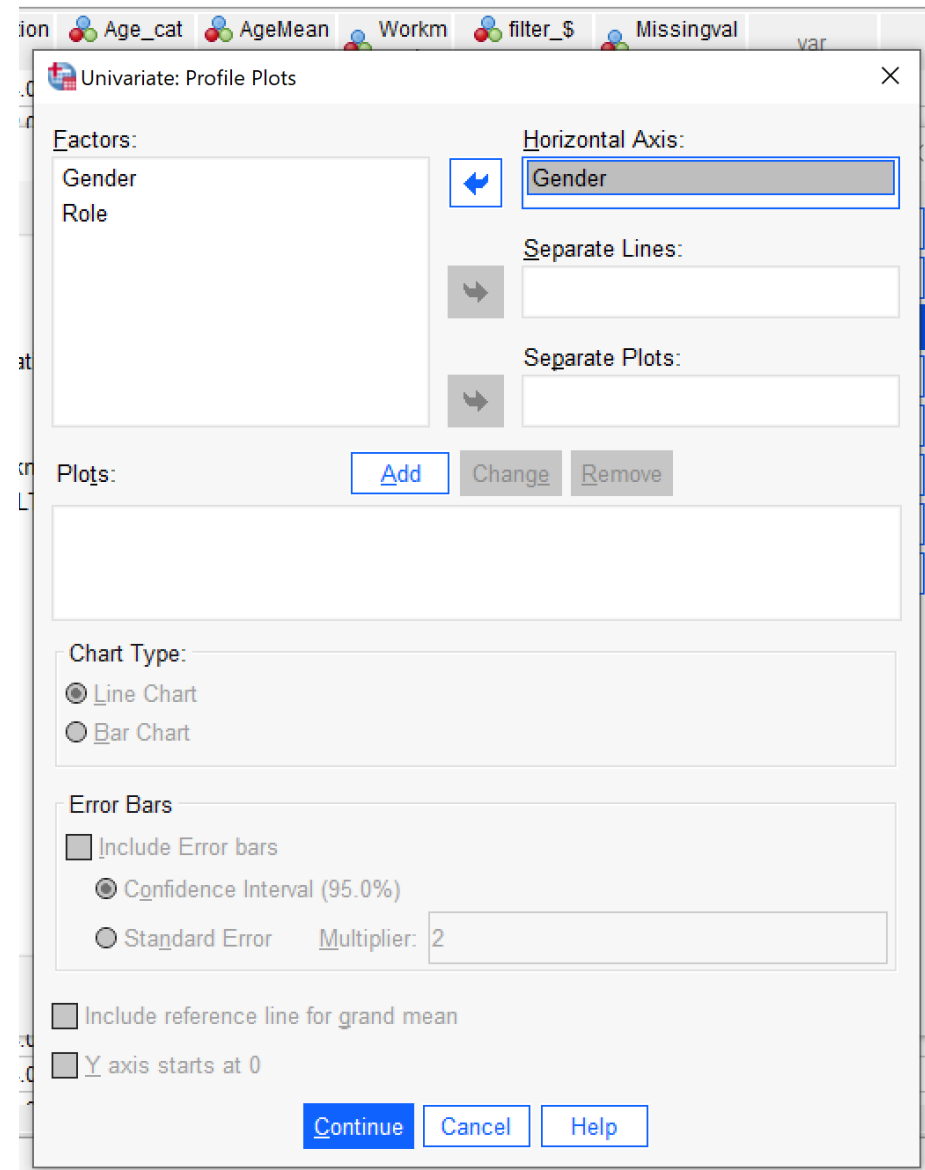
H_1 : There is an interaction between satisfaction level and gender on salary

Two-way ANOVA

SPSS menu path: **Analyze** > **General Linear Model** > **Univariate...**

	Age_cat	AgeMean	Workmode	filter_\$	Missingvalue	var
00	4.00	5.00	1.00	1	.00	
00	2.00	2.00	1.00	1	.00	
00	3.00	4.00	1.00	1	.00	
00	3.00	3.00	2.00	1	.00	
00			2.00	1	.00	
00			2.00	1	.00	
00			2.00	1	.00	
00			2.00	1	.00	
00	2.00	2.00	2.00	1	.00	
00	5.00	5.00	2.00	1	.00	
00	4.00	3.00	2.00	1	.00	
00	4.00	4.00	2.00	1	.00	
00	3.00	3.00	1.00	1	.00	
00	3.00	3.00	1.00	1	.00	
00	3.00	4.00	1.00	1	.00	
00	3.00	4.00	1.00	1	.00	
00	5.00	2.00	1.00	1	.00	

Click 'Gender' and add



The image shows the 'Univariate: Profile Plots' dialog box in SPSS. The 'Factors' list on the left contains 'Gender' and 'Role'. 'Gender' is highlighted, and a blue arrow button next to it is being clicked. The 'Horizontal Axis' field on the right contains 'Gender'. Below this, the 'Separate Lines' and 'Separate Plots' fields are empty. The 'Plots' section has an 'Add' button highlighted in blue, with 'Change' and 'Remove' buttons in grey. The 'Chart Type' section has 'Line Chart' selected with a radio button. The 'Error Bars' section has 'Include Error bars' checked, with 'Confidence Interval (95.0%)' selected and a 'Multiplier' of 2. The 'Include reference line for grand mean' and 'Y axis starts at 0' options are unchecked. At the bottom are 'Continue', 'Cancel', and 'Help' buttons.

ion Age_cat AgeMean Workm filter_\$ Missingval var

Univariate: Profile Plots

Factors:

Gender
Role

Horizontal Axis:

Gender

Separate Lines:

Separate Plots:

Plots: Add Change Remove

Chart Type:

☒ Line Chart
☐ Bar Chart

Error Bars

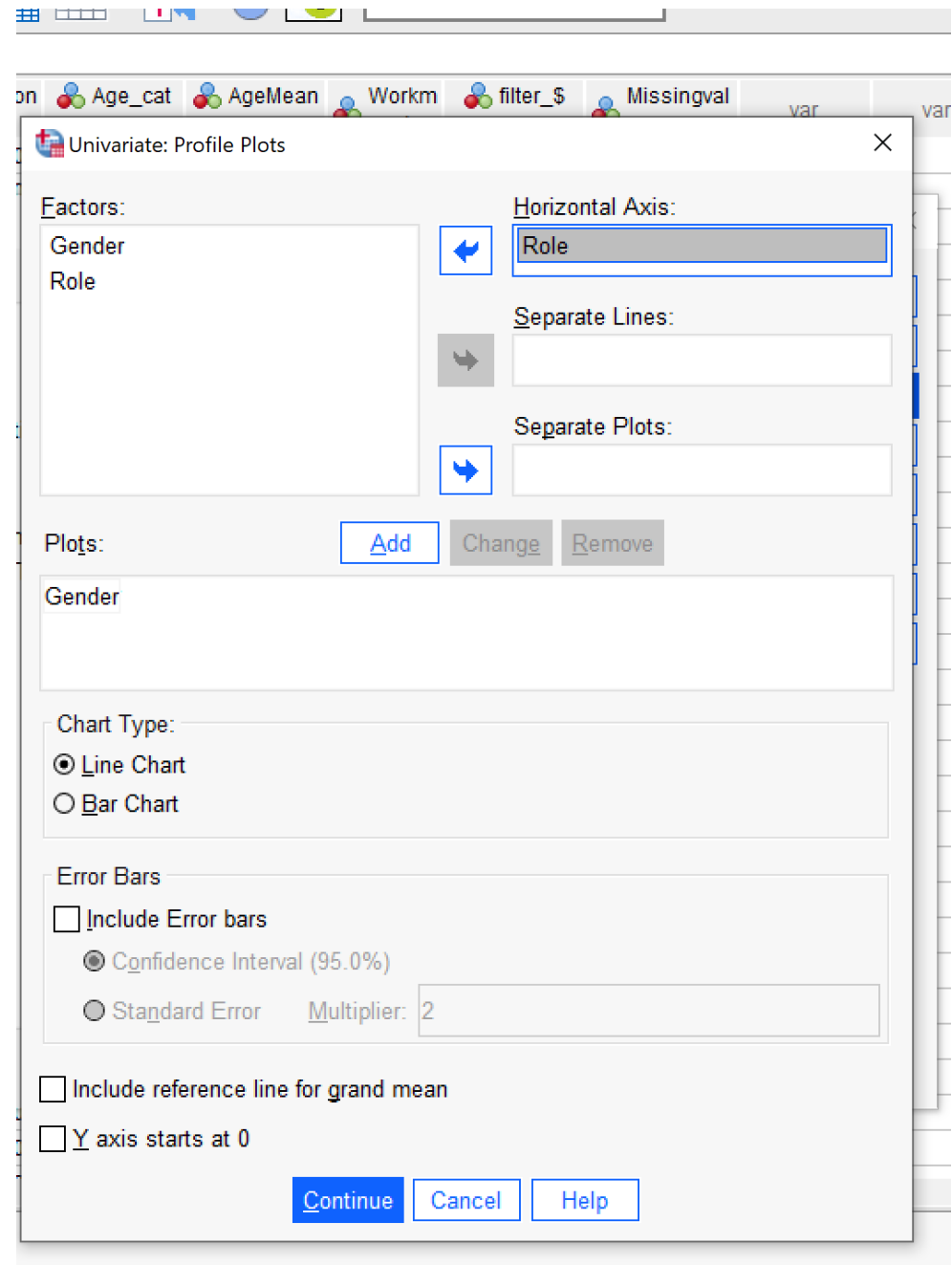
☒ Include Error bars

☒ Confidence Interval (95.0%)
☐ Standard Error Multiplier: 2

☐ Include reference line for grand mean
☐ Y axis starts at 0

Continue Cancel Help

Click 'ROLE' and add



The image shows the 'Univariate: Profile Plots' dialog box in SPSS. The 'Factors' list on the left contains 'Gender' and 'Role'. The 'Horizontal Axis' field on the right contains 'Role'. The 'Plots' section shows 'Gender' in the list. The 'Chart Type' is set to 'Line Chart'. The 'Error Bars' section has 'Include Error bars' checked, with 'Confidence Interval (95.0%)' selected and a 'Multiplier' of 2. The 'Include reference line for grand mean' and 'Y axis starts at 0' options are unchecked. The 'Continue', 'Cancel', and 'Help' buttons are at the bottom.

Univariate: Profile Plots

Factors:

Gender
Role

Horizontal Axis:
Role

Separate Lines:
[Empty field]

Separate Plots:
[Empty field]

Plots:
Gender

Chart Type:
☒ Line Chart
☐ Bar Chart

Error Bars
☒ Include Error bars
☒ Confidence Interval (95.0%)
☐ Standard Error Multiplier: 2

☐ Include reference line for grand mean
☐ Y axis starts at 0

Continue Cancel Help

Click 'ROLE and Gender' and add

Univariate: Profile Plots

Factors:

Gender
Role

Horizontal Axis:

Role

Separate Lines:

Gender

Separate Plots:

Plots:

Add Change Remove

Gender
Role

Chart Type:

☒ Line Chart
☐ Bar Chart

Error Bars

☐ Include Error bars

☒ Confidence Interval (95.0%)
☐ Standard Error Multiplier: 2

☐ Include reference line for grand mean
☐ Y axis starts at 0

Continue Cancel Help

Click 'ROLE and Gender' and add

Univariate: Profile Plots

Factors:
Gender
Role

Horizontal Axis:

Separate Lines:

Separate Plots:

Plots:
Gender
Role
Role*Gender

Chart Type:
☒ Line Chart
☐ Bar Chart

Error Bars
☐ Include Error bars
☒ Confidence Interval (95.0%)
☐ Standard Error Multiplier: 2

☐ Include reference line for grand mean
☐ Y axis starts at 0

Continue Cancel Help

Click 'ROLE and Gender' and add

Univariate: Profile Plots

Factors:

Gender
Role

Horizontal Axis:

Separate Lines:

Separate Plots:

Plots:

Add Change Remove

Gender
Role
Role*Gender

Chart Type:

☒ Line Chart
☐ Bar Chart

Error Bars

☐ Include Error bars

☒ Confidence Interval (95.0%)
☐ Standard Error Multiplier: 2

☐ Include reference line for grand mean

☐ Y axis starts at 0

Continue Cancel Help

Two-way ANOVA

Univariate

Dependent Variable:
Job Satisfaction [Jobsat]

Fixed Factor(s):
Gender [Gender]
Role [Role]

Random Factor(s):

Covariate(s):

WLS Weight:

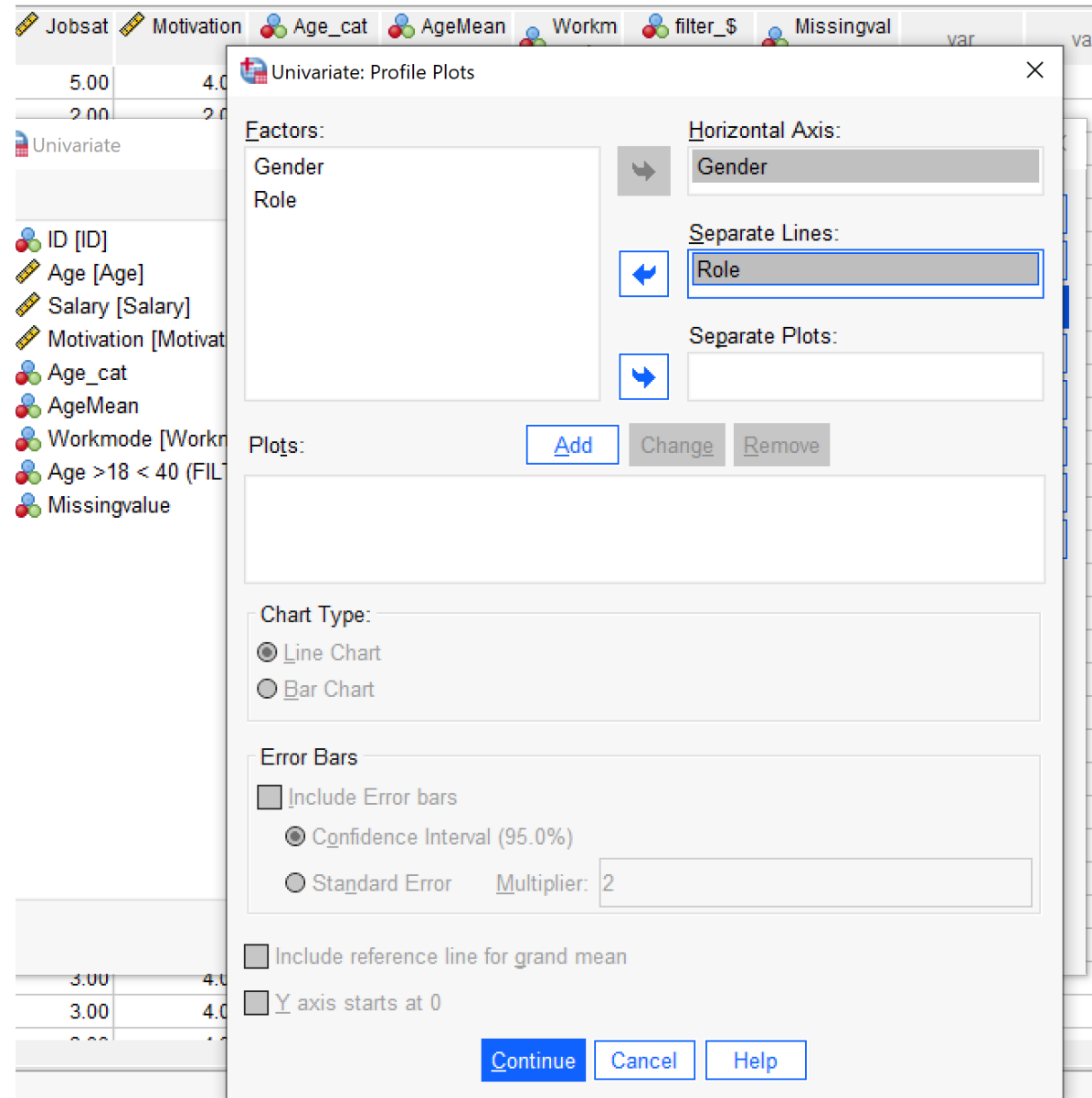
OK Paste Reset Cancel Help

Model...
Contrasts...
Plots...
Post Hoc...
EM Means...
Save...
Options...
Bootstrap...

ID [ID]
Age [Age]
Salary [Salary]
Motivation [Motivation]
Age_cat
AgeMean
Workmode [Workmode]
Age >18 < 40 (FILTER) [filter_\$]
Missingvalue

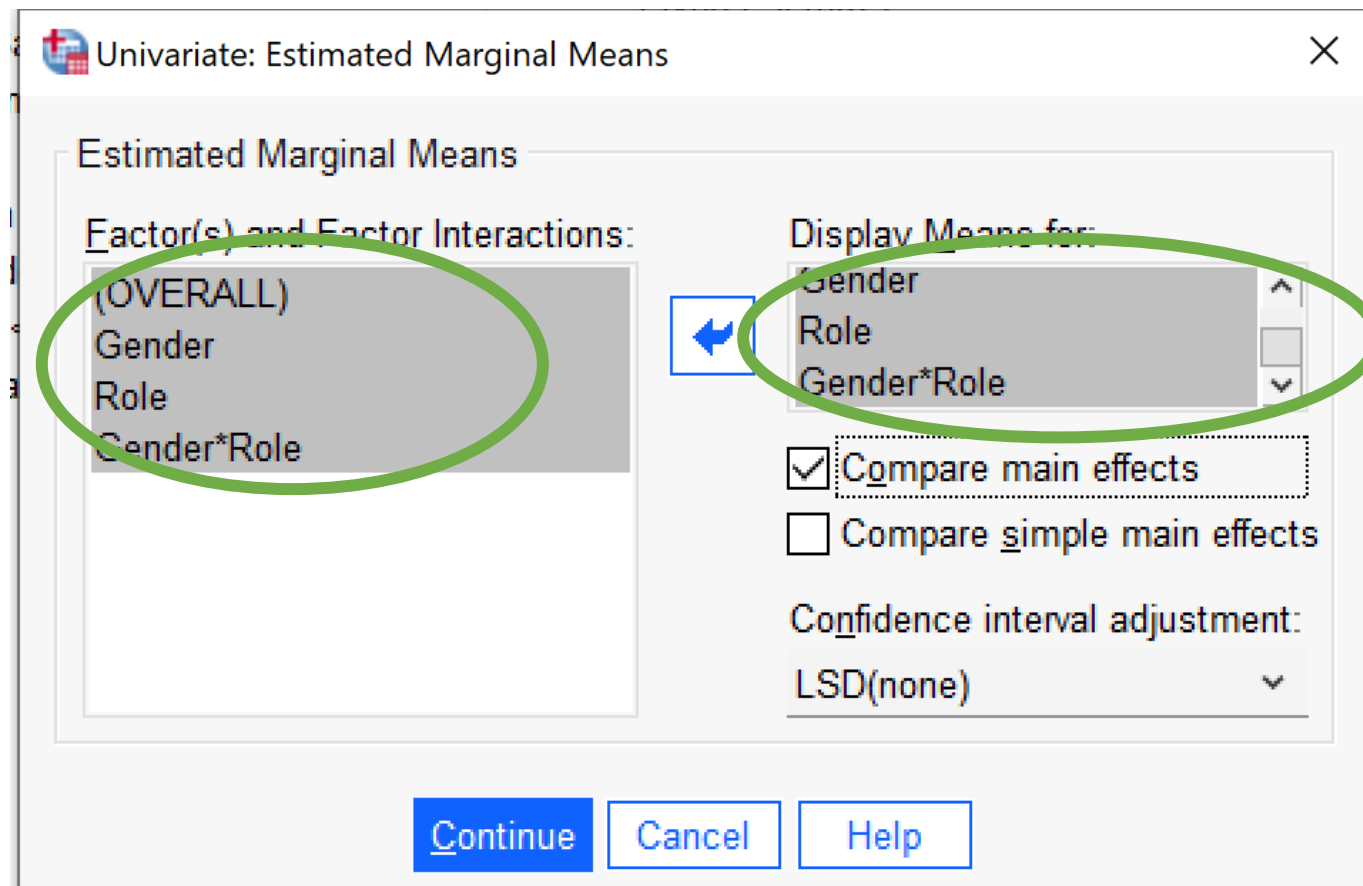
Two-way ANOVA

Go to 'plot'



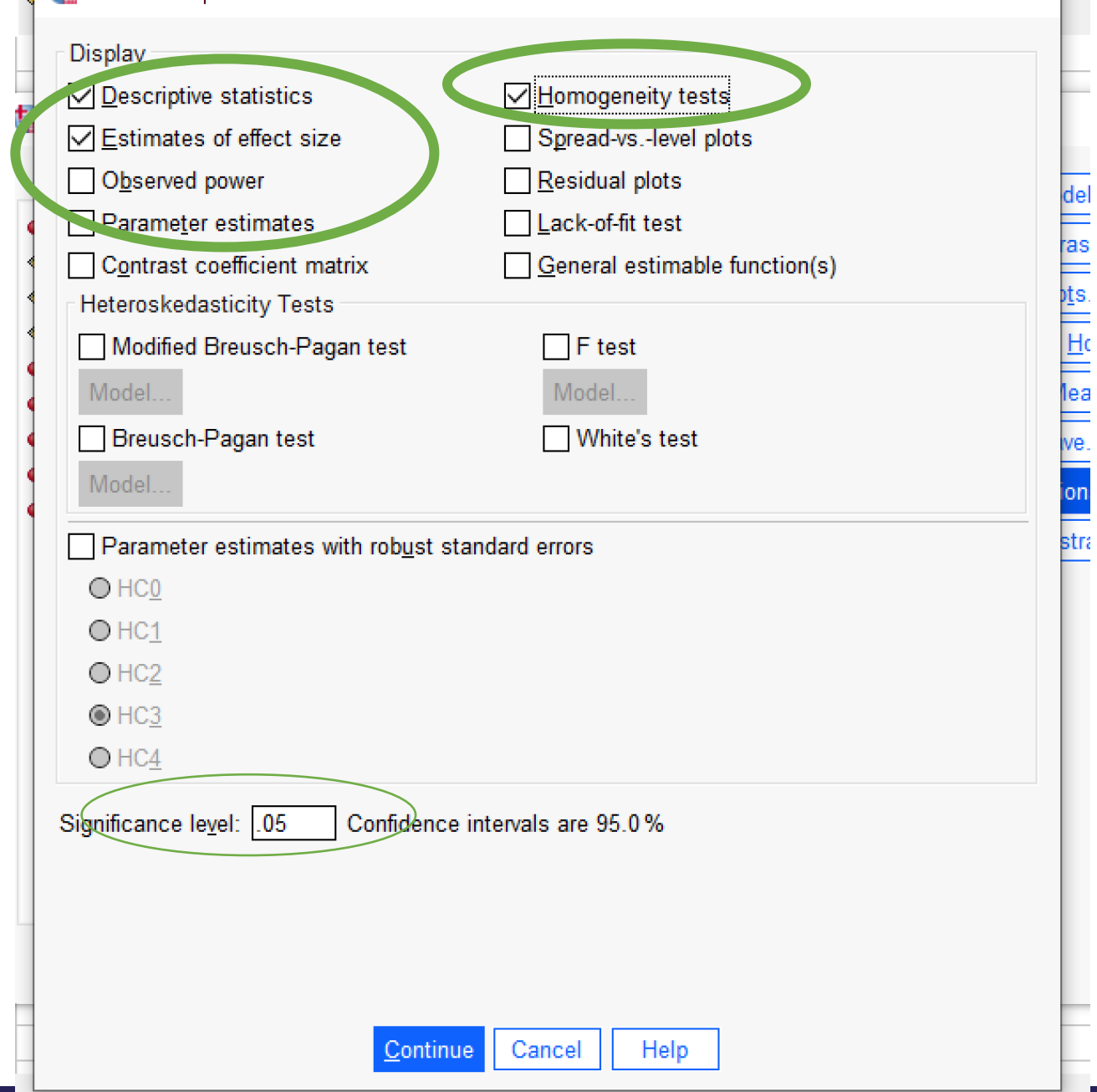
Two-way ANOVA

Go to Post Hoc
and add 'Role'



Two-way ANOVA

Go to Option
and add 'Role'



The image shows the 'Two-way ANOVA: Display' and 'Heteroskedasticity Tests' dialog box in SPSS. The 'Display' section has two columns of options. The first column includes 'Descriptive statistics', 'Estimates of effect size', 'Observed power', 'Parameter estimates', and 'Contrast coefficient matrix'. The second column includes 'Homogeneity tests', 'Spread-vs.-level plots', 'Residual plots', 'Lack-of-fit test', and 'General estimable function(s)'. The 'Homogeneity tests' option is checked. The 'Heteroskedasticity Tests' section includes 'Modified Breusch-Pagan test', 'Breusch-Pagan test', 'F test', and 'White's test'. The 'Parameter estimates with robust standard errors' section includes radio buttons for HC0, HC1, HC2, HC3, and HC4. The 'Significance level' is set to .05 and 'Confidence intervals are 95.0 %'. The 'Continue', 'Cancel', and 'Help' buttons are at the bottom.

Display

- ☒ Descriptive statistics
- ☒ Estimates of effect size
- ☐ Observed power
- ☐ Parameter estimates
- ☐ Contrast coefficient matrix
- ☒ Homogeneity tests
- ☐ Spread-vs.-level plots
- ☐ Residual plots
- ☐ Lack-of-fit test
- ☐ General estimable function(s)

Heteroskedasticity Tests

- ☐ Modified Breusch-Pagan test
- ☐ Breusch-Pagan test
- ☐ F test
- ☐ White's test

Parameter estimates with robust standard errors

- ☐ HC0
- ☐ HC1
- ☐ HC2
- ☒ HC3
- ☐ HC4

Significance level: .05 Confidence intervals are 95.0 %

Continue Cancel Help

Two-way ANOVA

SPSS Output

Between-Subjects Factors

		Value Label	N
Gender	1	Male	39
	2	Female	19
Role	1	Temporary	10
	2	Operator	36
	3	Secretary	2
	4	Team leader	8
	5	Management	2

Two-way ANOVA

Levene's Test of Equality of Error Variances^{a,b}

SPSS
Output

		Levene Statistic	df1	df2	Sig.
Job Satisfaction	Based on Mean	5.619	6	50	<.001
	Based on Median	1.604	6	50	.166
	Based on Median and with adjusted df	1.604	6	33.973	.176
	Based on trimmed mean	5.679	6	50	<.001

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

- a. Dependent variable: Job Satisfaction
- b. Design: Intercept + Gender + Role + Gender * Role

Two-way ANOVA

$P < 0.05$
Significantly different

Tests of Between-Subjects Effects

Dependent Variable: Job Satisfaction

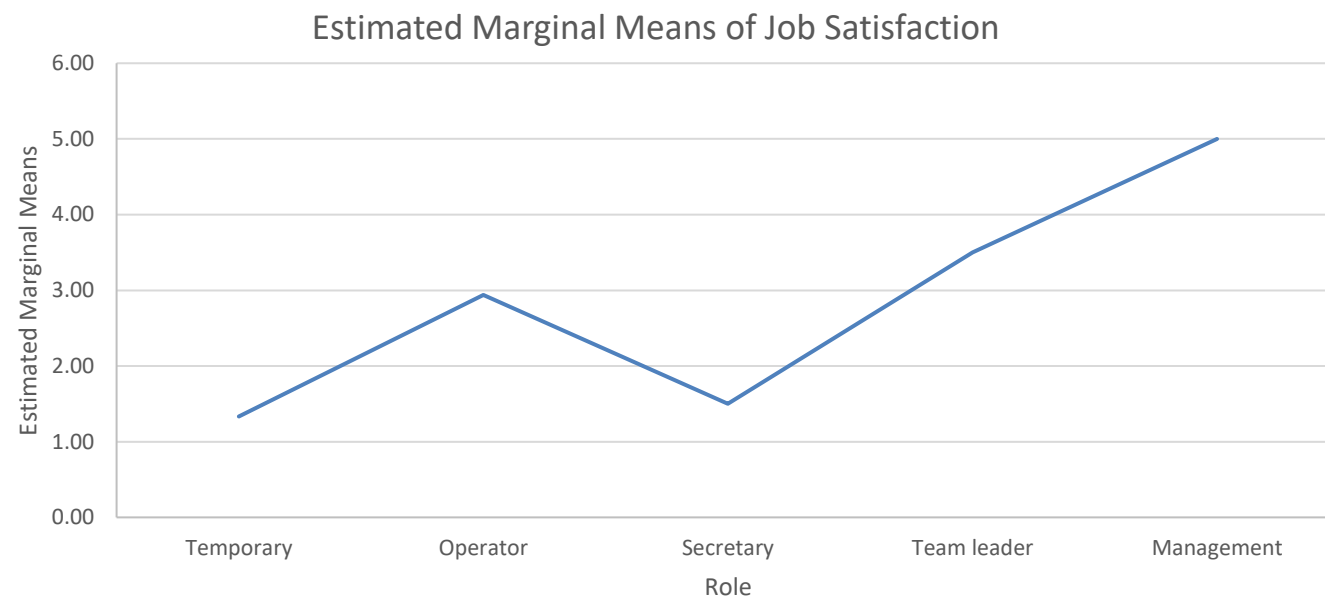
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	37.291 ^a	7	5.327	12.329	<.001	.633
Intercept	158.927	1	158.927	367.794	<.001	.880
Gender	2.903	1	2.903	6.719	.012	.118
Role	24.163	4	6.041	13.980	<.001	.528
Gender * Role	.237	2	.118	.274	.762	.011
Error	21.605	50	.432			
Total	534.000	58				
Corrected Total	58.897	57				

a. R Squared = .633 (Adjusted R Squared = .582)

SPSS
Output

Two-way ANOVA

SPSS Output



Two-way ANOVA

SPSS Output

Descriptive Statistics

Dependent Variable: Job Satisfaction

Gender	Role	Mean	Std. Deviation	N
Male	Temporary	1.6667	.50000	9
	Operator	3.2400	.72342	25
	Team leader	4.0000	.00000	3
	Management	5.0000	.00000	2
	Total	3.0256	1.06344	39
Female	Temporary	1.0000	.	1
	Operator	2.6364	.80904	11
	Secretary	1.5000	.70711	2
	Team leader	3.0000	.00000	5
	Total	2.5263	.84119	19
Total	Temporary	1.6000	.51640	10
	Operator	3.0556	.79082	36
	Secretary	1.5000	.70711	2
	Team leader	3.3750	.51755	8
	Management	5.0000	.00000	2
	Total	2.8621	1.01650	58

Q&A



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David