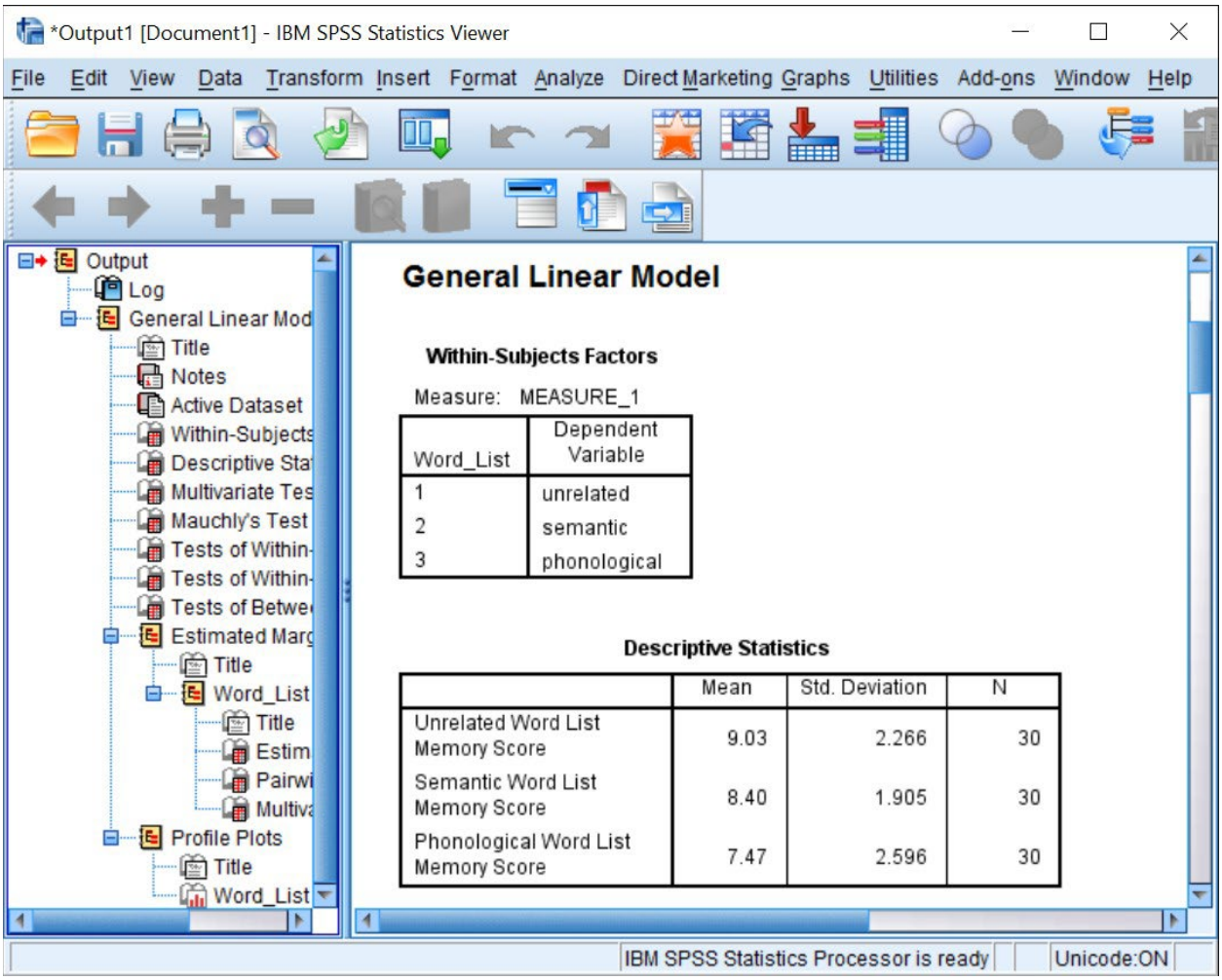
One-Way Repeated-Measures ANOVA



Within-Subjects Factors

This box is here to remind you which numbers SPSS has assigned to the different levels of your independent variable. You may find it useful to refer back to this when interpreting your output.

From looking at this box you should be able to see that there are **three** levels to the factor **Word_List**, where:

1 = unrelated
2 = semantically related
3 = phonologically related

Within-Subjects Factors

Measure: MEASURE_1

Word_List	Dependent Variable
1	unrelated
2	semantic
3	phonological

Descriptive Statistics

Descriptive Statistics

	Mean	Std. Deviation	N
Unrelated Word List Memory Score	9.03	2.266	30
Semantic Word List Memory Score	8.40	1.905	30
Phonological Word List Memory Score	7.47	2.596	30

This table gives you your descriptive statistics. Looking at these will show you the patterns in your data. You will also need to report them in your write up.

From this table we can see that on average, the highest number of words were correctly remembered when the words on the list were unrelated (mean = 9.03; SD = 2.27), followed by the semantically related list (mean = 8.40; SD = 1.91), and fewest were recalled from the phonologically related word list (mean = 7.47; SD = 2.60).

But to find out whether these observed differences are significant,
we need to look at the inferential statistics.

Multivariate Tests

This next table is not necessary for the interpretation of the ANOVA results, so feel free to ignore it at this point!

Mauchly's Test of Sphericity

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Word_List	.859	4.240	2	.120	.877	.929	.500

This table tests whether the assumption of sphericity has been met. This is a bit like the assumption of homogeneity of variance for independent tests, but in this case it tests the assumption that the relationship between the different **pairs of conditions** is similar. As it only

deals with pairs, you only need to look at this table when you have a variable with *more than* two levels (i.e. more than one pair) - which we have in this case.

Like Levene's test for independent tests, we ***do not*** want Mauchly's test to be significant. In this case, the assumption of sphericity ***has*** been met, as the p-value is more than .05. To formally report this, we need the Chi-Square, df and p-values. Here we can say:

- *Mauchly's test of sphericity showed that this assumption was met, $\chi^2(2) = 4.24$, $p = .12$*

Tests of Within-Subjects Effects

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Word_List	Sphericity Assumed	37.267	2	18.633	6.955	.002	.193
	Greenhouse-Geisser	37.267	1.754	21.252	6.955	.003	.193
	Huynh-Feldt	37.267	1.857	20.064	6.955	.003	.193
	Lower-bound	37.267	1.000	37.267	6.955	.013	.193
Error(Word_List)	Sphericity Assumed	155.400	58	2.679			
	Greenhouse-Geisser	155.400	50.854	3.056			
	Huynh-Feldt	155.400	53.864	2.885			
	Lower-bound	155.400	29.000	5.359			

This is the most important table in the output, as it gives you the results of your ANOVA. The key columns you need to interpret your analysis are:

- **df** stands for **degrees of freedom.** Degrees of freedom are crucial in calculating statistical significance, so you need to report them. We use them to represent the size of the sample, or samples used in the test. Don't worry too much about the stats involved in this though, as SPSS automatically controls the calculations for you.

  With Repeated-Measures ANOVA, you need to report two of the **df** values:
  1. One for the to the IV itself (in the row labelled **Word_List)**
  2. And one to represent the error, which can be found in the **Error** row.

- **F** stands for **F-Ratio**. This is the test statistic calculated by the ANOVA. You need to report the F-value for your variable, which can be found in the **Word_List** row. It is calculated by dividing the mean squares for the variable by its error mean squares. Essentially, this is the systematic variance (i.e. the variation in your data that can be explained by your experimental manipulation) divided by the unexpected, unsystematic variance.

  The larger your **F-Ratio**, the more likely it is that your experimental manipulation (your IV) will have had a significant effect on the DV. If **F < 1**, your result will never be

significant, as this means there is more unexplained variance in your data than can be accounted for by your IV.

- **Sig** stands for **Significance Level.** This column gives you the probability that your results could have occurred by chance, if the null hypothesis were true.

  The convention is that the p-value should be smaller than 0.05 for the F-ratio to be significant. If this is the case (i.e. $p < 0.05$) we reject the null hypothesis, inferring that the results didn't occur by chance (or as the result of sampling error) but are instead due to the effect of the independent variable. However, if the p-value is larger than 0.05, then we have to retain the null hypothesis; that there is no difference between the conditions.

- **Partial Eta Squared.** While the *p*-value can tell you whether the difference between conditions is statistically significant, partial eta squared (η_p^2) gives you an idea of how different your samples are. In other words, it tells you about the magnitude of your effect. As such, we refer to this as a measure of **effect size**.

  To determine how much of an effect your IV has had on the DV, you can use the following cut-offs to interpret your results:

  - 0.14 or more are large effects
  - 0.06 or more are medium effects
  - 0.01 or more are small effects

So we know we need to look at the df, F, Sig and Partial Eta Squared columns... the question is which numbers do we use?

Which rows you choose depends on whether your assumption of Sphericity has been met. If your Mauchley's test was **non-significant** (i.e. the assumption had been met), *or* if you had less than 3 levels in your IV, then you would read across from the **Sphericity Assumed** rows. This is what we need to do in this example.

However, if Mauchley's test *had* been significant, then you would need to use one of the other rows (usually Greenhouse-Geisser).

As the sphericity assumption was met in this example, we can use the **Sphericity Assumed** row. As such, we can report the results as:

$$F\ (IV\ df,\ error\ df) = F\text{-}ratio,\ p = Sig,\ \eta_p^2 = Partial\ Eta\ Squared$$

...along with a sentence, explaining what we have found. In this case you might say:

There was a significant main effect of Word_List on the number of words that participants remembered ($F(2, 58) = 6.96$, $p = .002$, $\eta_p^2 = .19$).

But what does this effect mean? To explain this we need to refer back to our **Descriptive Statistics** to see what is happening in each of our different conditions.

To do this, skip over the next two output tables and go straight to your **Estimated Marginal Means.**

Estimated Marginal Means

This box shows you the breakdown of the means for the different levels of your IVs. For a one-way ANOVA, the mean values are the same as those displayed the **Descriptive Statistics** box at the beginning of your output.

Estimates

Measure: MEASURE_1

Word_List	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	9.033	.414	8.187	9.880
2	8.400	.348	7.689	9.111
3	7.467	.474	6.497	8.436

This box also gives you the Standard Error rather than the Standard Deviation for your different conditions. Sometimes you need to report this… but not in this example.

As a quick reminder of what the means tells us, we can see that the fewest number of words were remembered from the phonologically related list, followed by the semantically related and the unrelated words.

Pairwise Comparisons

The **Pairwise Comparisons** box essentially does what the title implies. It carries out multiple comparisons between every possible combination of pairs for your conditions.

Pairwise Comparisons

Measure: MEASURE_1

(I) Word_List	(J) Word_List	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	.633	.347	.236	-.249	1.516
	3	1.567*	.423	.003	.493	2.640
2	1	-.633	.347	.236	-1.516	.249
	3	.933	.486	.195	-.303	2.169
3	1	-1.567*	.423	.003	-2.640	-.493
	2	-.933	.486	.195	-2.169	.303

The Pairwise Comparisons table essentially does what the title implies. It carries out multiple comparisons between every possible combination of pairs for your conditions. While your ANOVA result tells you that there is a significant effect of **word list**, this table tells you exactly which pairs of conditions are significantly different from one another.

To remember which numbers refer to which condition, look back at your first output box. In this case: 1 = unrelated, 2 = semantically and 3 = phonologically related.

Reading this table is actually very simple. In the first column we can see the list of our three conditions. For each of the conditions, we can then read across each of the rows to see which groups are being compared.

To find out whether these comparisons are significant, we need to look at the **Sig** column (and the asterisks in the **Mean Difference** column). Remember, the *p*-value needs to be less than .05 to be significant.

Here we can see that there is only *one* significant difference between the pairs:

- between the unrelated (1) and phonologically related (3) word lists.

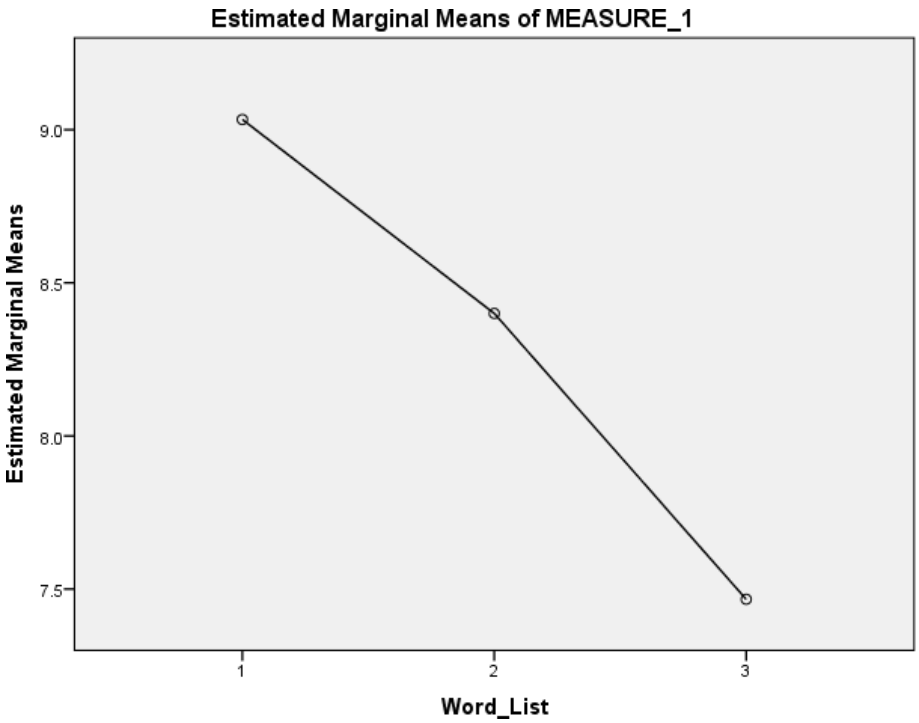
Multivariate Tests

You do not need this box to interpret your output. Skip over this and go straight to your plot.

Profile Plots

This is the **final** part of your output. The **Means Plot** graph can often be useful in helping you to visualise your results and it is a good idea to include it in your write up.

Here we can see that the most words were remembered in the unrelated condition (1), followed by the semantically related (2) and phonologically related (3) conditions.



How do we write up our results?

When writing up the findings from your analysis in APA format, you need to include **ALL** of the relevant information from the output.

- What were the inferential statistics for your IV?
    - i.e. what was the ANOVA result

- If your finding was significant, where do the significant differences lie?
    - i.e. what were the results of your post hoc tests

- What was the pattern and direction of these differences?
    - i.e. what were the means and descriptive statistics for your conditions

For this example, you might end up writing a results section that looks a bit like this:

> **The results of the one-way repeated-measures ANOVA showed that there was a significant main effect of Word List on the average number of words participants successfully remembered ($F(2, 58) = 6.96$, $p = .002$, $\eta_p^2 = .19$).**
>
> **Bonferroni post hoc tests showed that participants remembered significantly more words from the unrelated word list (mean = 9.03; SD = 2.27) compared to the phonologically related word list (mean = 7.47; SD = 2.60; p=.003). However, neither condition significantly differed from participants' performance with the semantically related word list (mean = 8.40; SD = 1.91).**
>
> **This evidence supports the hypothesis that the relatedness of words on a list affects participants' ability to remember them. Specifically, these findings suggest that it is harder to remember phonologically related words than unrelated words.**

It can also be helpful to both you and the reader to **include a table of the means and standard deviations** for all of the conditions in your results sections. Alternatively, you might want to **include a graph of your results.** You can alter your graph by double clicking on it in the output in SPSS.