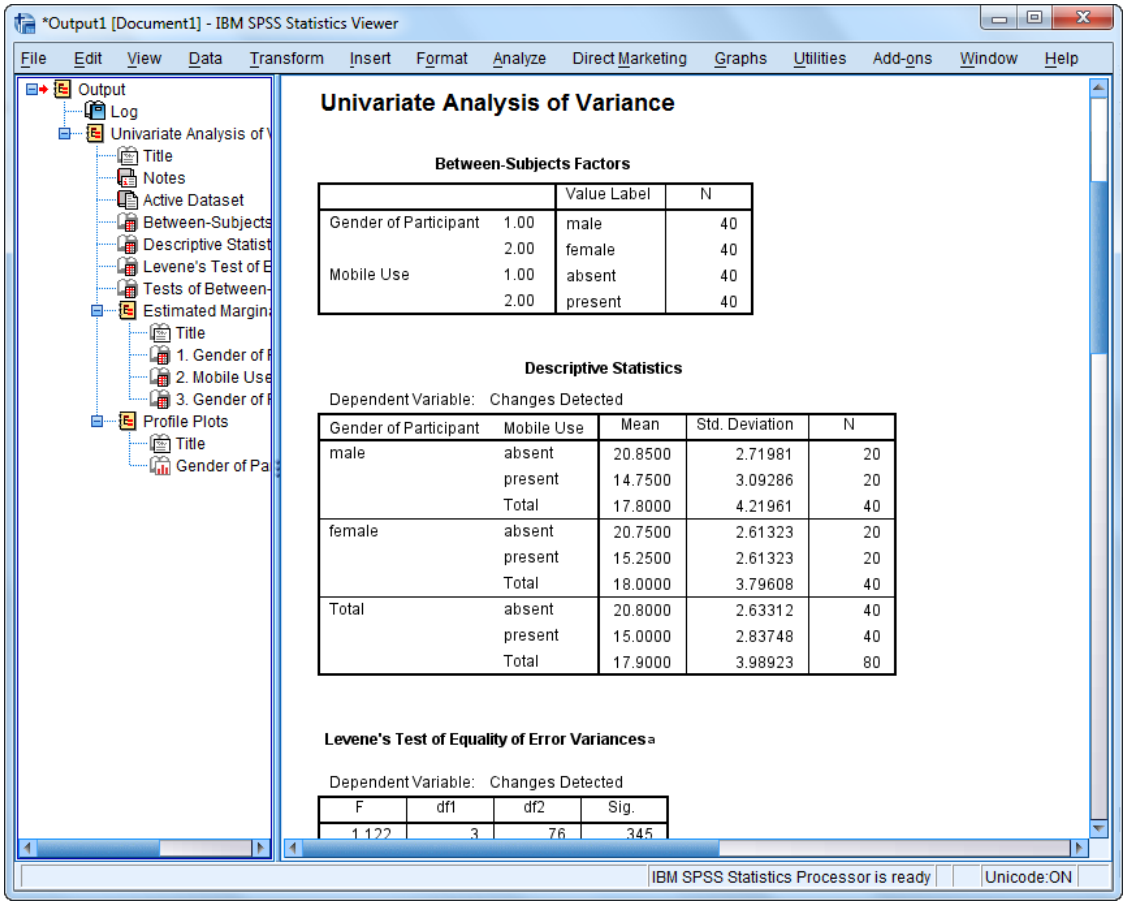
Two-Way Independent ANOVA



But what does this show you? Let's look at the output tables one at a time.

Between-Subjects Factors

Between-Subjects Factors

		Value Label	N
Gender of Participant	1.00	male	40
	2.00	female	40
Mobile Use	1.00	absent	40
	2.00	present	40

The first box in your output is just here to remind you what values you have assigned the different levels of your variables, and what they mean. You may find it useful to refer back to this when interpreting your output.

From looking at the box you should be able to see that for the first factor, **Gender**, there are two levels where: 1 = Male 2 = Female

For **Mobile_Use**, the numbers represent whether or not participants used a mobile phone whilst undertaking the detection task: 1 = Absent and 2 = Present.

Descriptive Statistics

Descriptive Statistics

Dependent Variable: Changes Detected

Gender of Participant	Mobile Use	Mean	Std. Deviation	N
	Total	17.9000	3.98923	80

This table gives you your descriptive statistics. It's good to look at and report these, as they can give you an important insight into the pattern of your data.

From this table we can see the average (mean) change detection scores for each of the possible variable conditions. You can also see the variation in the data (i.e. spread of scores) for the different groups from the standard deviation.

From this table we can see that on average, fewer changes were detected in the mobile present condition (**mean = 15.00**) than in the mobile absent condition (**mean = 20.80**).

We can also see that the overall memory scores for the males and females were relatively similar (**means = 17.80 and 18.00** respectively).

This table also shows the breakdown of change detection scores for the males and females for each of the mobile phone conditions. **Both genders appear to perform worse in the mobile phone condition, than in the mobile absent condition**.

While this suggests that there is no interaction between the variables, we need to look at the *inferential statistics* to confirm this.

Levene's Test of Equality or Error Variances

Levene's Test of Equality of Error Variances[a]

Dependent Variable: Changes Detected

F	df1	df2	Sig.
1.122	3	76	.345

As mentioned earlier, an assumption of ANOVA is that the groups you are comparing have a similar dispersion of scores (otherwise known as homogeneity of variance). The Levene's Statistic tells us whether or not this is the case.

If the test is significant this indicates that there are statistically significant differences in the way in the data are dispersed, suggesting that the assumption of homogeneity has *not* been met.

As we want the variances to be similar, we are looking for a ***non-significant*** result here. In this example, the *Sig.* column tells us that this *is* what we have found, as p = .345, which is *greater than* 0.05. So we can say:

- *Levene's test confirmed that the assumption of homogeneity of variance has been met, F(3,76) = 1.12, p>.05*

Tests of Between-Subjects Effects

Tests of Between-Subjects Effects

Dependent Variable: Changes Detected

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	675.400[a]	3	225.133	29.409	.000	.537
Intercept	25632.800	1	25632.800	3348.389	.000	.978
Gender	.800	1	.800	.105	.747	.001
Mobile_Use	672.800	1	672.800	87.887	.000	.536
Gender * Mobile_Use	1.800	1	1.800	.235	.629	.003
Error	581.800	76	7.655			
Total	26890.000	80				
Corrected Total	1257.200	79				

a. R Squared = .537 (Adjusted R Squared = .519)

This is the most important table in the output. This is where we get our inferential statistics for the Analysis of Variance (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 Independent ANOVA, you need to report the **df** values for *all* of your variables and interactions. In this case, you would need to know the dfs in the rows labelled **Gender**, **Mobile_Use** and **Gender*Mobile_Use**. In addition, you also need to report the residual error df, which can be found in the **Error** row.

- **F** stands for **F-Ratio**. This is the test value calculated by the Independent ANOVA, you need to report the **F** values for *all* of your variables and interactions, in this case: **Gender, Mobile_Use and Gender*Mobile_Use.**

  It is calculated by dividing the mean squares for each variable or interaction by the 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. If you're looking for a significant effect, then you want there to be more systematic variance than unsystematic (error) variance. The larger your **F-Ratio** the more likely it is your effect will be significant.

- **Sig** stands for **Significance Level.** This column gives you the probability that the 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 groups.

- **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 groups 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

How do we write up our ANOVA results?

So we know which columns we need to look at, but how do we write this up and what numbers do we need to use?

To make life easier for you, SPSS groups your analysis into rows: one row for each variable and interaction. You can then report each one separately using this formula:

F (*IV df*, *error df*) = *F-Ratio*, p = *Sig*, η_p^2 = *Partial Eta Squared*

...along with a sentence, explaining what you have found. For example:

- **There was no significant effect of Gender on participants' change detection scores (F(1,76) =.11, p > .05, η_p^2 = .001).**

- **There was a significant main effect of Mobile_Use on participants' change detection scores (F(1,76) = 87.89, p < .001, η_p^2 = .54).**

- **There was no significant interaction between Gender and Mobile_Use (F(1,76) = .24, p > .05, η_p^2 = .003).**

But the question is, what does this all mean? We know we have a significant effect of mobile use, but no interaction or effect of gender... but we need to explain what this actually means in English!! To do that, we need to refer back to our **Descriptive Statistics** to see what is happening in each of our different conditions.

Estimated Marginal Means

These boxes show you the breakdown of the means for the different levels of your IVs, and all of the different conditions. For an Independent ANOVA, the mean values are the same as those displayed the **Descriptive Statistics** box at the beginning of your output.

These boxes also give you the Standard Error rather than the Standard Deviation. 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 for our IV **Gender**, the detection scores were similar for both males and females.

1. Gender of Participant

Dependent Variable: Changes Detected

Gender of Participant	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
male	17.800	.437	16.929	18.671
female	18.000	.437	17.129	18.871

Looking at the means for the **Mobile_Use** conditions, we can see that the change detection scores were worse for the mobile present condition.

2. Mobile Use

Dependent Variable: Changes Detected

Mobile Use	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
absent	20.800	.437	19.929	21.671
present	15.000	.437	14.129	15.871

Finally, the interaction table shows us that the difference in performance between mobile absent and present conditions was similar for both males and females.

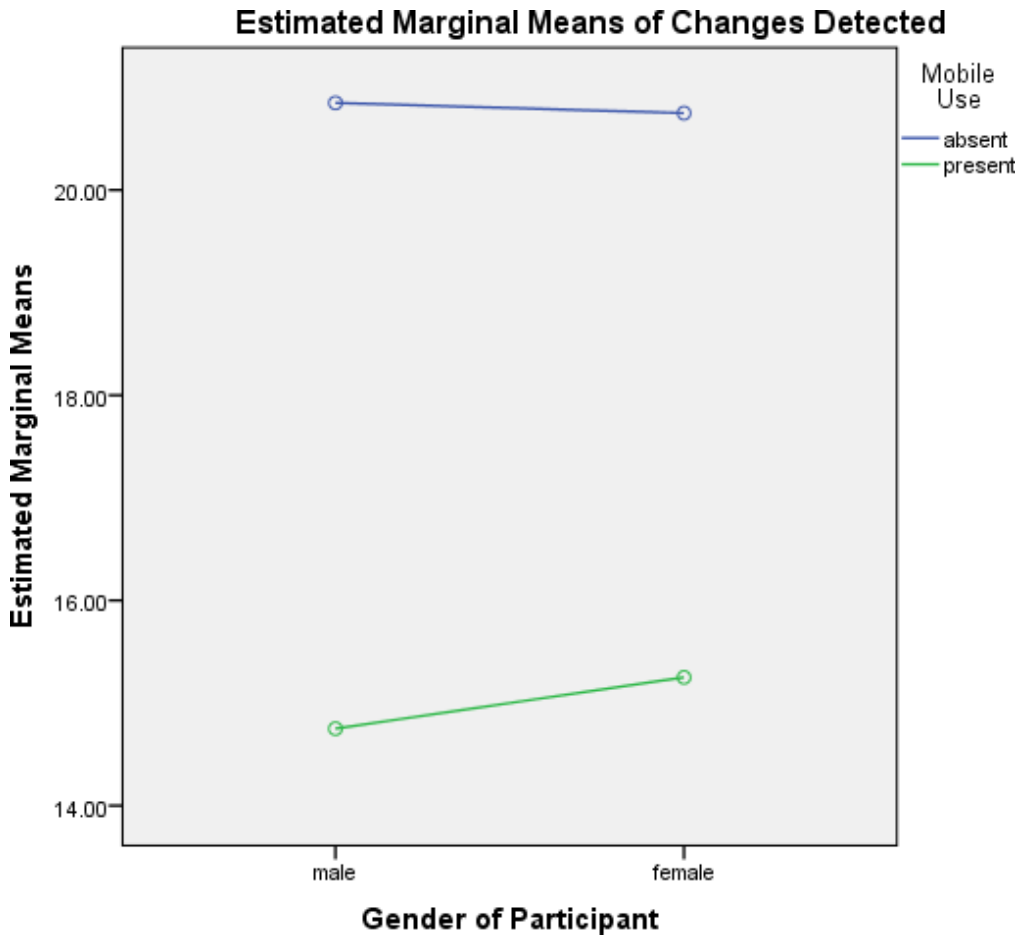
3. Gender of Participant * Mobile Use

Dependent Variable: Changes Detected

Gender of Participant	Mobile Use	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
male	absent	20.850	.619	19.618	22.082
	present	14.750	.619	13.518	15.982
female	absent	20.750	.619	19.518	21.982
	present	15.250	.619	14.018	16.482

Profile Plots

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



The flat **blue line** indicates that males and females performed similarly in the *mobile absent* condition.

The flat **green line** also suggests similar performance by the two genders in the *mobile present* condition.

You should also look at the gap between the different points on the graph. In this case, the distance between the green (mobile present) and blue (mobile absent) lines is similar for both males and females.

What have we learned?

When interpreting and reporting our results, we need to report *both* the descriptive and inferential statistics.

We know from our ANOVA table, that the effect of mobile use on change detection scores **was significant**, and that performance was best in the mobile absent condition.

We know that there was **no significant main effect** of gender, as performance was very similar for males and females.

We also know that there was no **significant interaction** between our two IVs.

This lends support to the hypothesis that:

- Mobile use can deteriorate change detection abilities

However, there was no effect of gender overall; and there is no evidence that women were less effected by mobile use than men.

How do we write up our results?

When writing up the findings for a Two-Way ANOVA in APA format, you need to include all of the relevant information covered by the previous slides. To do this, you need to answer all of the following questions that are relevant to your study (we can skip points 2 and 4 for this example, as they do not apply):

- What were the inferential statistics for your IVs and interaction
    - i.e. what were the 3 main ANOVA results

- For significant IVs with more than 2 levels, where did the significant difference(s) lie
    - i.e. what were the results of any post hoc tests you ran

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

- If the interaction term was significant, what does it mean in English
    - i.e. describe what was happening in the different conditions

It is usually helpful to the reader of your results if you *include a table of the means and standard deviations* for all of the conditions in your results. If your interaction is significant, it may also help to include a graph of your results. You can edit your graph by double clicking on it in the output in SPSS.

How do we write up our results?

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

The results of the Two Way Independent ANOVA showed that there was no significant main effect of Gender ($F(1,76) = .11$, $p > 0.05$, $\eta_p^2 = .001$) with males (mean = 17.80; SD = 4.22) and females (mean = 18.00; SD = 3.80) producing similar change detection scores.

In contrast, there was a significant main effect of Mobile_Use on memory scores ($F(2,18) = 36.255$, $p < 0.001$). Participants in the mobile present condition performed significantly worse (mean = 15.00, SD = 2.84) than those in the mobile absent condition (mean = 20.80, SD = 2.63).

In addition, no significant interaction was found between the two varaibles ($F(1,76) = 0.24$, $p > 0.05$, $\eta_p^2 = .003$).

These findings suggest that mobile phone use may impair change detection ability, and that this impairment is similar for both genders.

This brings us to the end of this tutorial. Why not download the data file from this tutorial and see if you can run the analysis yourself? Practice makes perfect!