**One-Way ANOVA**

Used to compare the *means* between multiple groups (3 or more – typically for 2 groups, you would use a t-test). Running multiple t-tests increases your chances of type 1 error.

A one-way ANOVA is used for independent (unrelated) groups.

Looking at reaction time and task – looking at each task as a whole (not separating by sound or Stroop difficulty).

**Two-Way ANOVA**

So, a one-way ANOVA compares 3+ groups that are *unrelated.* A two-way ANOVA compares mean differences between groups *that have been split on two independent variables* to see if there is an *interaction* between the two independent variables and the dependent variable.

In our case, we are looking at reaction time (dependent variable) and two IVs – difficulty of Stroop test (easy, difficult) and noise (with sound, without).

* Set up data
	+ Two independent variables – two groups in each
		- Each variable is a column
	+ Dependent variable
* Analyze 🡪 general linear model 🡪 univariate
	+ Enter dependent variable
	+ Enter fixed factors
* Click **options**
	+ Move over three categories
	+ Check off descriptive statistics
* Don’t need to do anything with **post hoc** because you only need post hoc tests (i.e. Tukey) for variables with more than 2 groups under each IV (here we just have no noise & noise and easy & difficult)
* Read output!
* Report results!

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| **Descriptive Statistics** |
| Dependent Variable: ResponseTime  |
| Test | Noise | Mean | Std. Deviation | N |
| easy test | no noise | 16.25456 | 2.352587 | 43 |
| with noise | 18.08381 | 5.094558 | 43 |
| Total | 17.16919 | 4.050401 | 86 |
| difficult test | no noise | 37.96970 | 10.066148 | 43 |
| with noise | 40.90240 | 12.515375 | 43 |
| Total | 39.43605 | 11.385914 | 86 |
| Total | no noise | 27.11213 | 13.117779 | 86 |
| with noise | 29.49310 | 14.897109 | 86 |
| Total | 28.30262 | 14.045408 | 172 |

Descriptive Statistics tell us:

* *N*
* Means and standard deviations for each condition
* Total row for each IV allows means and SDs for groups split only by that independent variable – useful if you do not have a statistically significant interaction

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| **Tests of Between-Subjects Effects (ANOVA)** |
| Dependent Variable: ResponseTime  |
| Source | Type III Sum of Squares | df | Mean Square | **F** | **Sig.** |
| Corrected Model | 21576.820a | 3 | 7192.273 | 99.392 | .000 |
| Intercept | 137778.551 | 1 | 137778.551 | 1903.997 | .000 |
| Test | 21319.962 | 1 | 21319.962 | 294.626 | .000 |
| Noise | 243.769 | 1 | 243.769 | 3.369 | .068 |
| Test \* Noise | 13.089 | 1 | 13.089 | .181 | .671 |
| Error | 12156.948 | 168 | 72.363 |  |  |
| Total | 171512.319 | 172 |  |  |  |
| Corrected Total | 33733.768 | 171 |  |  |  |
| a. R Squared = .640 (Adjusted R Squared = .633) |

Tests of Between-Subjects Effects table

* + An F statistic is calculated based on the ratio of average variance means between each condition and within each condition (between group variance and within group variance).
	+ Read rows with our IVs for the *df, F*, and sig.
	+ Don’t need the corrected model and intercept rows
	+ Look at significance level – are any of the relationships significant?
		- Look at the interaction first, this will tell you how to determine the main effects

Reporting the Results

* + **Equation: *F*(df1, df2) = F value, *p* = p value(sig).**
	+ df: how many cells are free to vary for means to be the same
		- Back to the “one less than” rule
		- Total degrees of freedom = n – 1, where n *is total number of observations*
		- IV1: There are 2 Stroop levels, so there is 1 df for the Stroop
		- IV2: There are 2 noise conditions, so there is 1 df for the noise
		- Interaction is Stroop × noise and so we multiply df(IV1) × df(IV2) = 1 × 1 = 1 df
		- The error df is n - # of conditions. There were 4 treatment groups (2 levels in each condition, 4 possible conditions)
		- **df = (df1 = the df of the row you are reading, df2 = the error df)**
		- df1 = # of conditions you have – 1; df2 = n – # of possible conditions
* A two-way ANOVA was conducted which examined the effect of the Stroop Test and noise on response time. There was not a statistically significant interaction between the test difficulty and noise on response time (*F* (1, 168) = .181, *p* = .671). There was a statistically significant difference…

The tables below give you the same information as the Descriptive Statistics table, with the additional Confidence Interval information. The tables are given based on the independent variables.

**Estimated Marginal Means**

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| **1. Test** |
| Dependent Variable: ResponseTime  |
| Test | Mean | Std. Error | 95% Confidence Interval |
| Lower Bound | Upper Bound |
| easy test | 17.169 | .917 | 15.358 | 18.980 |
| difficult test | 39.436 | .917 | 37.625 | 41.247 |

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| **2. Noise** |
| Dependent Variable: ResponseTime  |
| Noise | Mean | Std. Error | 95% Confidence Interval |
| Lower Bound | Upper Bound |
| no noise | 27.112 | .917 | 25.301 | 28.923 |
| with noise | 29.493 | .917 | 27.682 | 31.304 |

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| **3. Test \* Noise** |
| Dependent Variable: ResponseTime  |
| Test | Noise | Mean | Std. Error | 95% Confidence Interval |
| Lower Bound | Upper Bound |
| easy test | no noise | 16.255 | 1.297 | 13.694 | 18.816 |
| with noise | 18.084 | 1.297 | 15.523 | 20.645 |
| difficult test | no noise | 37.970 | 1.297 | 35.409 | 40.531 |
| with noise | 40.902 | 1.297 | 38.341 | 43.463 |

* The means indicate that participants responded faster in the easy test condition (*M* = ) than in the difficult test condition (*M* = ).

**Summary**

* + The Descriptives table and the estimated marginal means shows information about your data, such as the means and standard deviations.
	+ The ANOVA table shows whether there is a statistically significant difference between the group means overall.
	+ An *F* statistic is calculated based on the ratio of average variance means between each condition and within each condition (between group variance and within group variance).