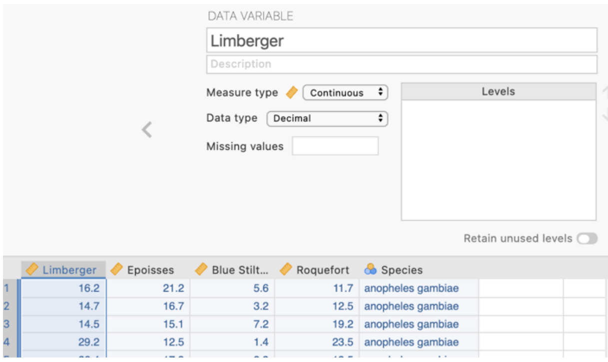
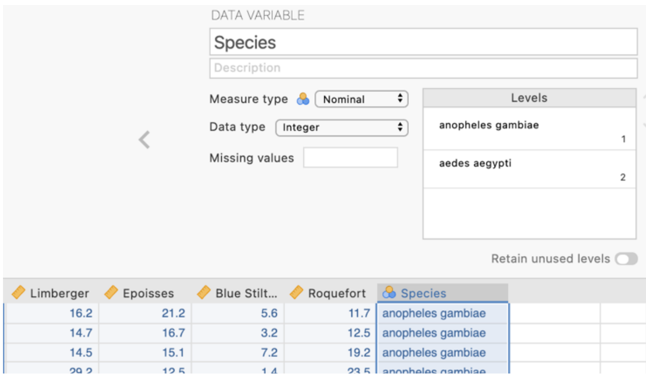
The work of medical entomologist Bart Knols revealed that a species of mosquito known for its penchant for sucking blood from people's feet and ankles also quite likes the stinky German cheese, Limberger. Bemused by this discovery upon watching Dr Knols' TED talk[1], a researcher decides to try to extend this research by assessing mosquito preferences for a range of stinky cheeses. Some species of mosquitoes are known transmitters, or vectors, for a range of diseases. The researcher decides to explore the potential viability of stinky cheeses as a form of mosquito repellent/distraction with two vector mosquito species: the aedes aegypti mosquito, a vector for several tropical fevers including dengue fever and yellow fever, and anopheles gambiae, a vector for malaria. The researcher obtains 10 individual mosquitoes from the two species and releases them one by one into four sealed plastic boxes (in random order), each containing one of the four cheeses for 30 seconds. Sensors built into the boxes record the amount of time each mosquito spends within a 1cm radius of the cheeses. The researcher is presented with data that reveals how long each mosquito spent hovering over each cheese variety. A mixed-design ANOVA is required to assess mosquito cheese preferences and how that may differ by mosquito species.

Step 1 – Taking a look at the data.



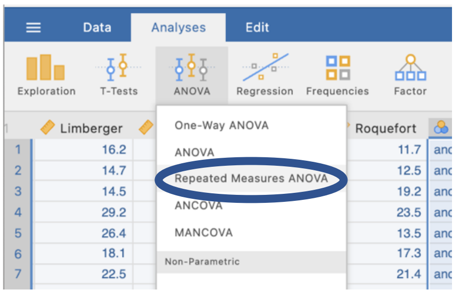
We have four continuous variables that represent the number of seconds spent by each mosquito hovering within 1cm of each of four stinky cheese varieties, namely German Limberger, French Epoisses and Roquefort and British Blue Stilton. The variables are designated continuous.



In addition our between-groups or between-mosquitoes variable Species is designated nominal and has two levels/groups which are the two species of mosquito used in the study, anopheles gambiae and aedes aegypti.

[1] You can view Dr Knols' TED talk here https://ed.ted.com/lessons/cheese-dogs-and-a-pill-to-kill-mosquitoes-and-end-malaria-bart-knols.

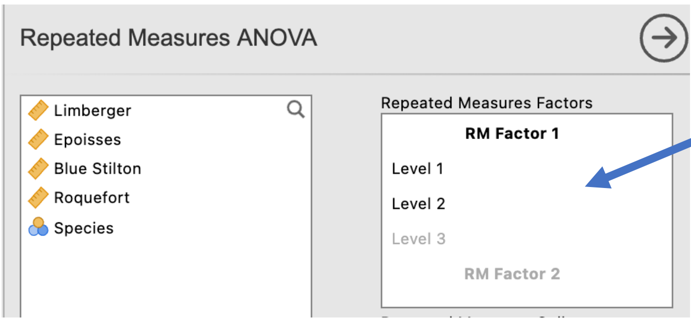
Step 3 – Navigating to the Repeated Measures ANOVA analysis menu.



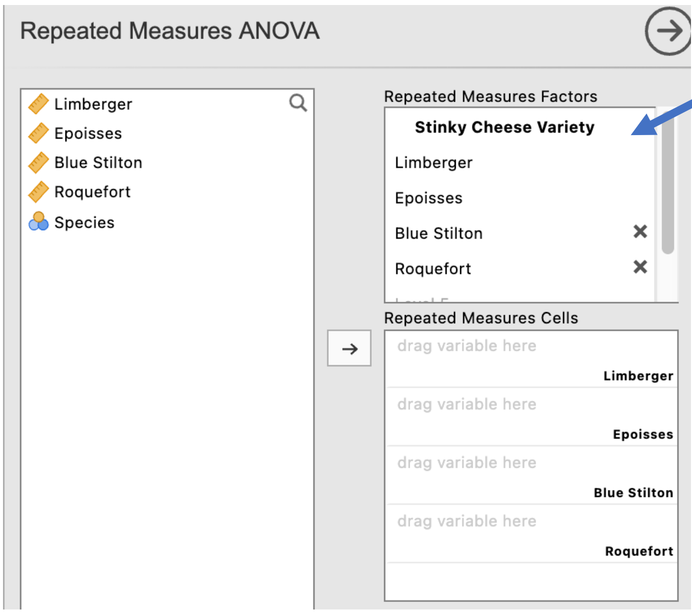
On the Analyses tab select the ANOVA menu, then select Repeated Measures ANOVA.

Step 4a – Selecting analysis options to get the output we need for our omnibus results

The first thing we will do is to let *jamovi* know that these four cheese variables represent levels of our repeated measures factor. This set up is somewhat more complex than a between groups ANOVA.

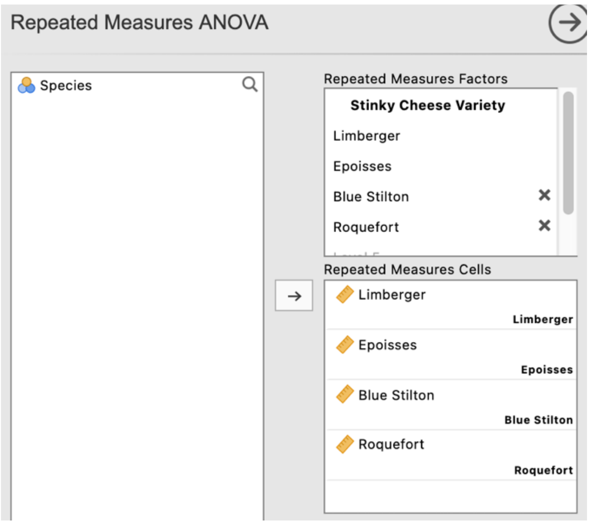


Within the Repeated Measures Factors box we need to type in the labels of our factor and its four levels.

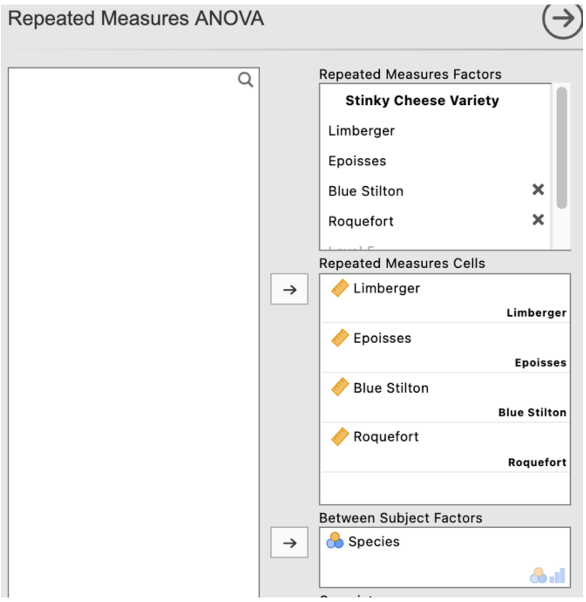


By clicking in each line you can edit and add in the variable name and its levels. Label the RM Factor 1 as Stinky Cheese Variety. Then click in each Level and type the four cheeses in. Note that once you hit the default last level (Level 3), hitting return will create an additional slot to type in our fourth cheese.

You'll notice that the four cheese varieties now appear down the right hand side of the Repeated Measures Cells box. The next stage is to drag the variables across to these slots.



The final set up for your Repeated Measures Factors and Repeated Measures Cells should now look like this.



Underneath the Repeated Measures set up you will see a box for Between Subject Factors. Moving our Species variable across to this box now makes our analysis a mixed design ANOVA.

At the bottom of this menu we can also give our Dependent Variable a label to neaten our output, and ask for effect sizes while we are at it.

Repeated Measures ANOVA

Within Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η²
Cheese Variety	2147.45100	3	715.81700	37.80404	<.00001	0.44435
Cheese Variety ✻ Species	474.10250	3	158.03417	8.34617	0.00012	0.09810
Residual	1022.48650	54	18.93494			

Note. Type 3 Sums of Squares

[3]

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η²
Species	733.26050	1	733.26050	28.97681	0.00004	0.15173
Residual	455.49150	18	25.30508			

Note. Type 3 Sums of Squares

The output provided by our set up so far gives us the omnibus test results for the repeated measures main effect for Stinky Cheese Variety and the interaction test in the Within Subjects Effects table. The Between Subjects Effects table has given us the main effect for Mosquito Species. All three *p* values are significant suggesting both main effects are significant but are qualified by a significant interaction.

There are a couple of extra things we need to ask for from some of the drop down menus in our one-way repeated ANOVA. These are found under the Assumption Checks menu and the Estimated Marginal Means menu.

NB – We are not going to ask for our post hoc pairwise comparisons here as a pooled error term is used for all comparisons. It is preferable to use error terms that relate only to the two levels being compared for repeated measures comparisons. We will get to this soon.

Under Assumption Checks we are going to ask for “Sphericity tests” as well as a “Greenhouse-Geisser correction” under Sphericity corrections. This will enable us to check whether the sphericity assumption has been breached and to report corrected/adjusted results if a breach is present.

Assumptions

Tests of Sphericity

	Mauchly's W	p	Greenhouse-Geisser ε	Huynh-Feldt ε
Stinky Cheese Variety	0.63597	0.18234	0.76342	0.88088

Within Subjects Effects

	Sphericity Correction	Sum of Squares	df	Mean Square	F	p	η²
Stinky Cheese Variety	None	2147.45100	3	715.81700	37.80404	<.00001	0.44435
	Greenhouse-Geisser	2147.45100	2.29026	937.64314	37.80404	<.00001	0.44435
Stinky Cheese Variety ✻ Species	None	474.10250	3	158.03417	8.34617	0.00012	0.09810
	Greenhouse-Geisser	474.10250	2.29026	207.00773	8.34617	0.00056	0.09810
Residual	None	1022.48650	54	18.93494			
	Greenhouse-Geisser	1022.48650	41.22476	24.80272			

Note. Type 3 Sums of Squares

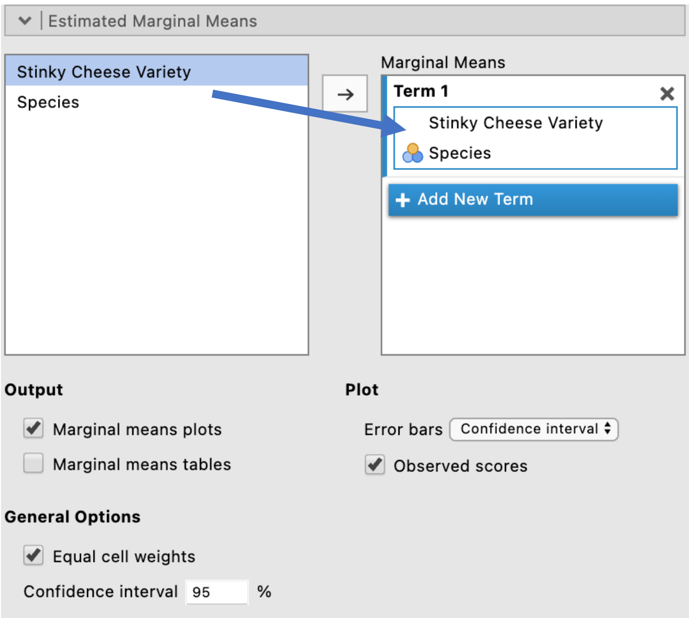
[3]

Our output now contains Mauchly’s test of sphericity, and our ANOVA table now includes results with a Greenhouse-Geisser correction if needed

In our case the *p* value for Mauchly’s test of sphericity is greater than .05 so we can say the sphericity assumption has not been breached. This means we can move forward with uncorrected results.

N.B., Some argue that Greenhouse-Geisser corrected results should always be reported to be on the safe side.

Under the Estimated Marginal Means drop down menu we can ask for plots to help illustrate our findings. Since we know we have a significant interaction, and our main factor of interest is Stinky Cheese Variety and our proposed moderator is Mosquito Species we want to get a plot that illustrates the simple effect of Stinky Cheese Variety for each species.



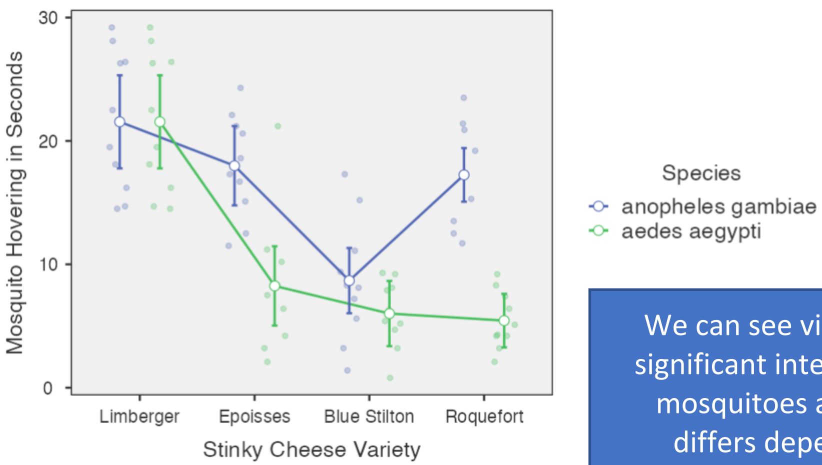
We need to move both of our factors across to the Term 1 box on the right hand side. We'll put Stinky Cheese Varieties at the top as this will mean that *jamovi* creates a plot of the simple effects of this factor with separate lines for the two mosquito species.

Tick "Marginal means plot". The 95% confidence interval error bars is selected as a default to appear on the plot but you can change this if you like to standard error.

We'll also tick observed scores so that we can see where the individual data points fall in relation to the means and error bars.

Estimated Marginal Means

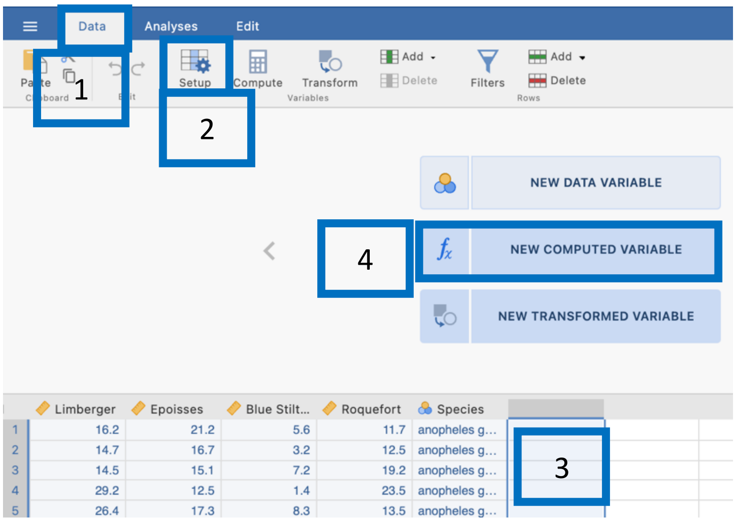
Stinky Cheese Variety ✻ Species



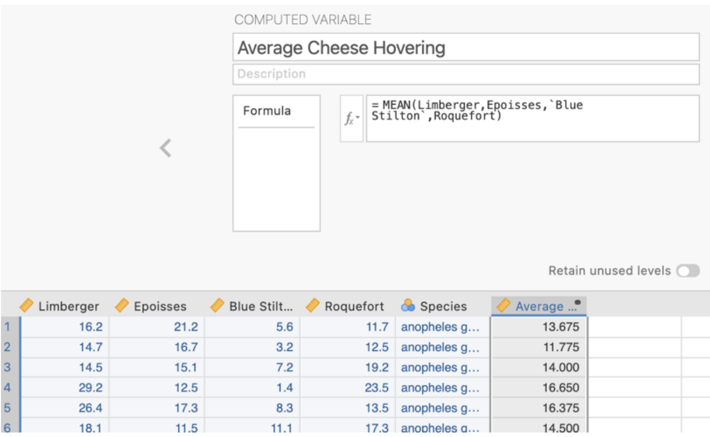
We can see visually here why there is a significant interaction. It's clear that the mosquitoes attraction to the cheeses differs depending on their species. However we need to do some further post hoc analysis to find out where the significant differences are.

Step 4b – Following up significant between-subjects main effects with main effect comparisons in a two-way mixed design ANOVA

We only have two mosquito species so technically we don't need to run any follow-up main effect comparisons here in order to report our main effect. However we do have one irritating little snag that would apply also if we had more than two groups so let's go through the motions here. While *jamovi* can supply us with both marginal and cell means for us to report with our main effects and simple effects, it only provides standard errors and not standard deviations to accompany these. Conventionally we report standard deviations. However, we don't have a variable in our data set at this point that will give us the standard deviations we need. For the main effect of Mosquito Species we need marginal means and standard deviations that are collapsed across or averaged across each of the four Stinky Cheese Varieties. So we need a variable in our data set that is each mosquito's average hovering seconds across the four cheeses.

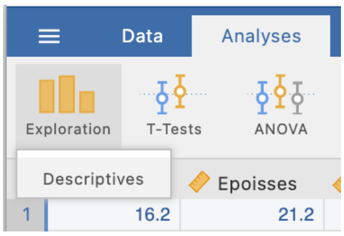


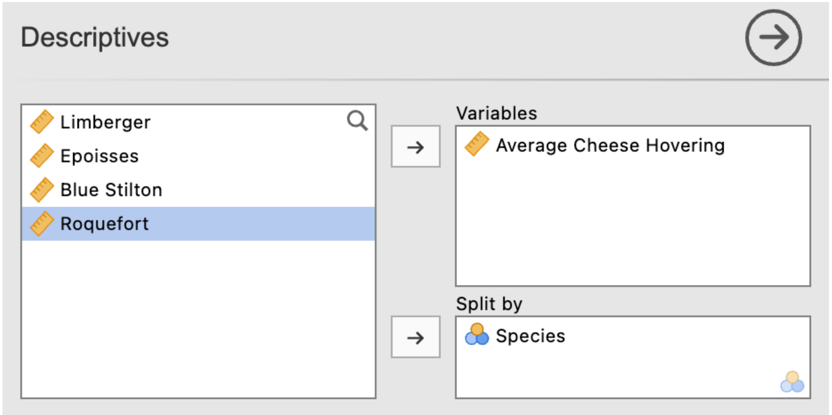
1. Go to the Data Tab along the top ribbon
2. Click on Setup to get into the data view in full.
3. Click in the first column that does not contain any data.
4. Click on New Computed Variable



In the formula cell create the formula that will average the scores for the four cheese variables. Note you can use the functions to create the MEAN formula shown or create the formula (Cheeses added)/4. Note variables with spaces in their names need to have single quotation marks around their names. Give the variable an appropriate name like Average Cheese Hovering.

We'll now be able to run descriptives on this variable and obtain the standard deviations we'd need to report if we were going to this main effect further.





Descriptives

Descriptives

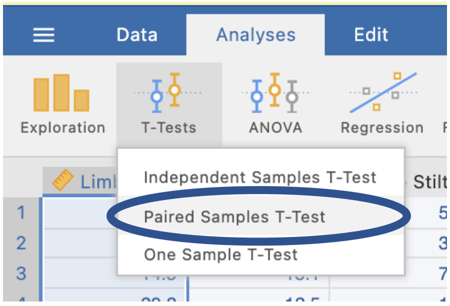
	Species	Average Cheese Hovering
N	anopheles gambiae	10
	aedes aegypti	10
Missing	anopheles gambiae	0
	aedes aegypti	0
Mean	anopheles gambiae	16.36750
	aedes aegypti	10.31250
Median	anopheles gambiae	16.11250
	aedes aegypti	10.33750
Standard deviation	anopheles gambiae	3.15788
	aedes aegypti	1.63717
Minimum	anopheles gambiae	11.77500
	aedes aegypti	8.25000
Maximum	anopheles gambiae	21.67500
	aedes aegypti	12.50000

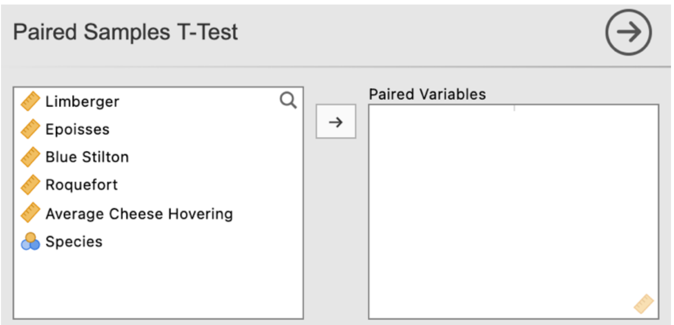
If we had three or more mosquito species in our study we would go on to conduct a one-way between-groups ANOVA with follow-up pairwise comparisons on this average cheese hovering variable to explore the main effect comparisons of species type if we needed to. In our case we don't need to do this. Our attention can turn to how we would examine the main effect of our repeated measures/within-subjects factor of stinky cheese variety.

NB. We are exploring how to dig deeper into main effects here for teaching purposes. Given that we have a significant interaction the key focus would be on exploring the simple effects and follow-up simple comparisons for this. However you now know how to obtain the variable you would need to run main effect comparisons if you needed them.

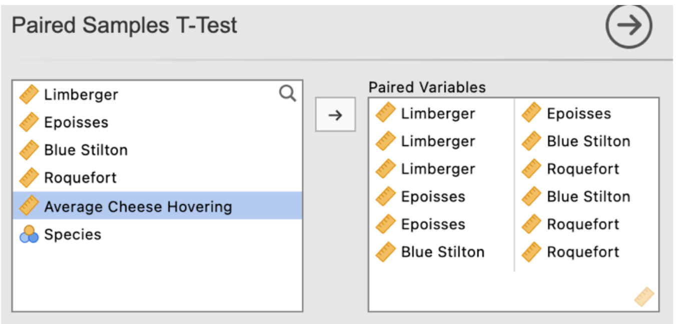
Step 4c – Following up significant repeated measures/within-subjects main effects with main effect comparisons in a two-way mixed design ANOVA

While it is possible to ask for these pairwise comparisons within the Repeated Measures ANOVA menu, the comparisons that are generated use a pooled error term (across all four of our stinky cheese conditions). However, it is preferrable to conduct these pairwise comparisons with error terms that are generated from the two levels being compared. In order to obtain these we will need to run a series of pairwise *t*-tests.



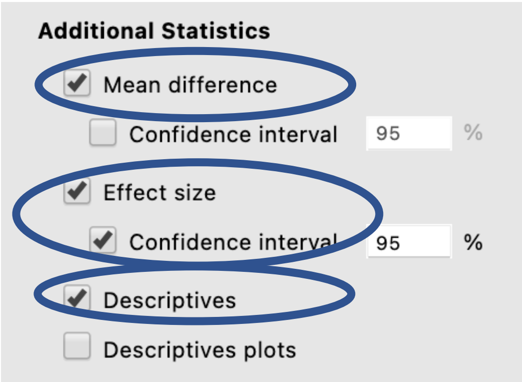


We can specify multiple paired *t*-tests at once by moving pairs over to the Paired Variables box. We want to create each combination of cheese comparisons to give us the set of comparisons we need.



Here we have specified each possible combination of comparisons. Depending on your specific research question or hypothesis you may not need to consider every combination but they have been asked for for completeness here.

In the analysis options for the paired *t*-tests output we'll select Mean difference (to illustrate a learning point only – you don't need to select this otherwise), effect sizes and associated confidence intervals and descriptives under the "Additional Statistics" heading.



These selections will return the following output:

Paired Samples T-Test

Paired Samples T-Test

			statistic	df	p	Mean difference	SE difference		Effect Size	95% Confidence Interval Lower	Upper
Limberger	Epoisses	Student's t	4.05080	19.00000	0.00068	8.43000	2.08107	Cohen's d	0.90579	0.37410	1.42075
	Blue Stilton	Student's t	9.61579	19.00000	<.00001	14.20500	1.47726	Cohen's d	2.15016	1.33399	2.94914
	Roquefort	Student's t	5.68264	19.00000	0.00002	10.20500	1.79582	Cohen's d	1.27068	0.66740	1.85561
Epoisses	Blue Stilton	Student's t	3.91762	19.00000	0.00092	5.77500	1.47411	Cohen's d	0.87601	0.34952	1.38601
	Roquefort	Student's t	1.34875	19.00000	0.19327	1.77500	1.31603	Cohen's d	0.30159	−0.15066	0.74631
Blue Stilton		Student's t	−2.75337	19.00000	0.01264	−4.00000	1.45277	Cohen's d	−0.61567	−1.08838	−0.12948

Descriptives

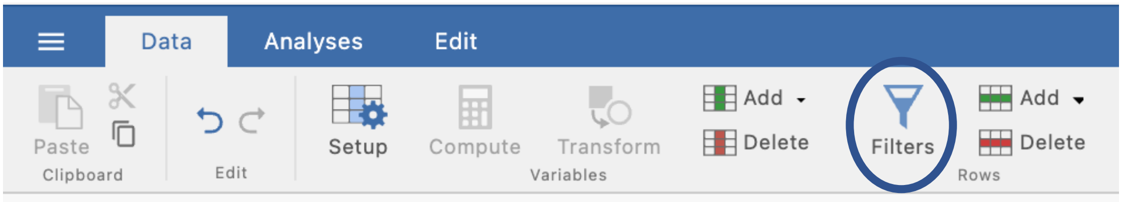
	N	Mean	Median	SD	SE
Limberger	20	21.55000	21.00000	5.52282	1.23494
Epoisses	20	13.12000	12.00000	6.86414	1.53487
Limberger	20	21.55000	21.00000	5.52282	1.23494
Blue Stilton	20	7.34500	7.55000	4.10923	0.91885
Limberger	20	21.55000	21.00000	5.52282	1.23494
Roquefort	20	11.34500	10.45000	6.84324	1.53020
Epoisses	20	13.12000	12.00000	6.86414	1.53487
Blue Stilton	20	7.34500	7.55000	4.10923	0.91885
Epoisses	20	13.12000	12.00000	6.86414	1.53487
Roquefort	20	11.34500	10.45000	6.84324	1.53020
Blue Stilton	20	7.34500	7.55000	4.10923	0.91885
Roquefort	20	11.34500	10.45000	6.84324	1.53020

Note that having run these comparisons as separate *t*-tests the standard errors associated with each comparison are different. They are based on errors derived from each pairing rather than the whole model.

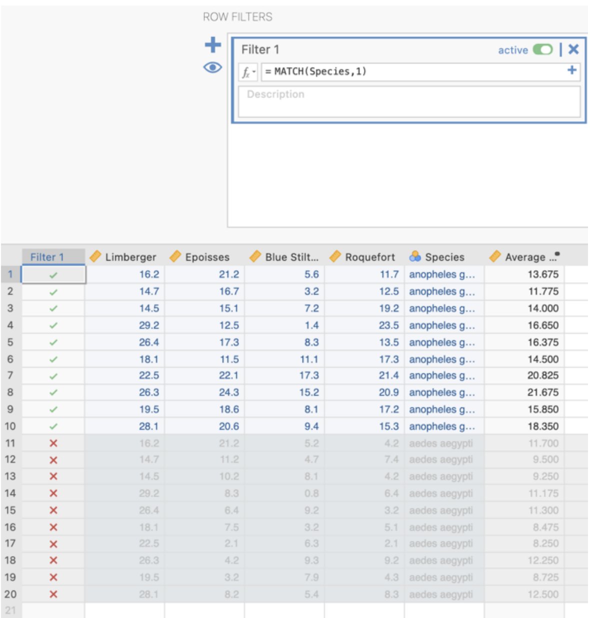
Step 4d – Following up significant interactions with simple effects

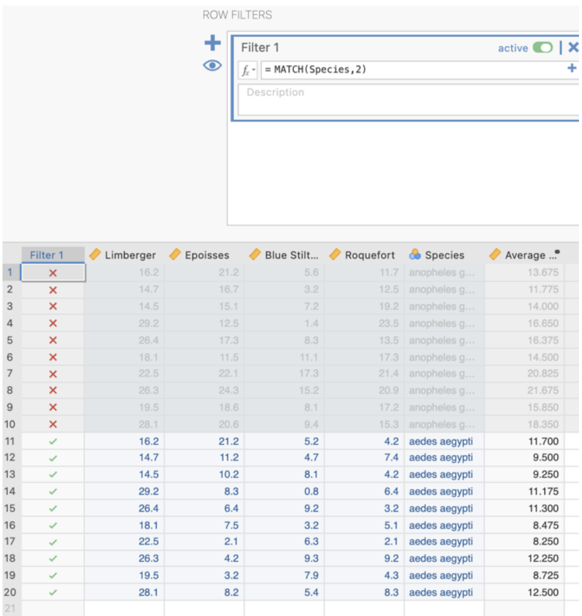
When we obtain a significant interaction our next step is to consider simple effects. In this instance we are going to examine the simple effects of Stinky Cheese Variety for each mosquito species separately. To do this we will run two separate one-way repeated measures ANOVAs, using a filter to split our file by mosquito species.

To apply a filter in order to run our repeated measures ANOVAs for one mosquito species at a time go to the Data ribbon and select filters.

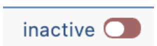


A new column will appear in the far left of your data file called Filter 1. We want to create a filter that will filter out each of our mosquito species one at a time. To do this we specify Species as the variable to use to filter. We can then specify to filter out either species by specifying the code of the species/group we want to use. On the left side below we have chosen species code 1, and you can see ticks appear against all mosquitos in that species and crosses against the other group. If we change that value to a 2 in the filter you can see the ticks and crosses have switched over. Cases with a tick against them will be used in the analysis and cases with a cross against them will be filtered out of that analysis.





We can turn our filter on and off by sliding across the active versus inactive button in the Filter specification box.

or


One-way repeated measures ANOVA 1 – The simple effect of Stinky Cheese Variety for anopheles gambiae mosquitoes.

Repeated Measures ANOVA

Within Subjects Effects

	Sphericity Correction	Sum of Squares	df	Mean Square	F	p	η²
Stinky Cheese Variety	None	893.67275	3	297.89092	17.84432	<.00001	0.52464
	Greenhouse-Geisser	893.67275	2.39817	372.64847	17.84432	0.00001	0.52464
Residual	None	450.73475	27	16.69388			
	Greenhouse-Geisser	450.73475	21.58349	20.88331			

Note. Type 3 Sums of Squares

[3]

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η²
Residual	359.00025	9	39.88892			

Note. Type 3 Sums of Squares

Assumptions

Tests of Sphericity

	Mauchly's W	p	Greenhouse-Geisser ε	Huynh-Feldt ε
Stinky Cheese Variety	0.65375	0.65890	0.79939	1.00000

We'll follow this up with pairwise *t*-tests for the simple comparisons (with the filter still on).

Paired Samples T-Test

Paired Samples T-Test

										95% Confidence Interval	
			statistic	df	p	Mean difference	SE difference		Effect Size	Lower	Upper
Limberger	Epoisses	Student's t	1.75791	9.00000	0.11263	3.56000	2.02513	Cohen's d	0.55590	−0.12654	1.21236
	Blue Stilton	Student's t	5.95141	9.00000	0.00021	12.87000	2.16251	Cohen's d	1.88200	0.80914	2.92113
	Roquefort	Student's t	2.52350	9.00000	0.03258	4.30000	1.70398	Cohen's d	0.79800	0.06351	1.50021
Epoisses	Blue Stilton	Student's t	6.83114	9.00000	0.00008	9.31000	1.36288	Cohen's d	2.16020	0.98413	3.30482
	Roquefort	Student's t	0.38622	9.00000	0.70831	0.74000	1.91603	Cohen's d	0.12213	−0.50347	0.74110
Blue Stilton		Student's t	−5.10074	9.00000	0.00064	−8.57000	1.68015	Cohen's d	−1.61300	−2.55522	−0.63526

Descriptives

	N	Mean	Median	SD	SE
Limberger	10	21.55000	21.00000	5.67416	1.79433
Epoisses	10	17.99000	17.95000	4.17598	1.32056
Limberger	10	21.55000	21.00000	5.67416	1.79433
Blue Stilton	10	8.68000	8.20000	4.92585	1.55769
Limberger	10	21.55000	21.00000	5.67416	1.79433
Roquefort	10	17.25000	17.25000	4.00895	1.26774
Epoisses	10	17.99000	17.95000	4.17598	1.32056
Blue Stilton	10	8.68000	8.20000	4.92585	1.55769
Epoisses	10	17.99000	17.95000	4.17598	1.32056
Roquefort	10	17.25000	17.25000	4.00895	1.26774
Blue Stilton	10	8.68000	8.20000	4.92585	1.55769
Roquefort	10	17.25000	17.25000	4.00895	1.26774

One-way repeated measures ANOVA 2 – The simple effect of Stinky Cheese Variety for aedes aegypti mosquitoes (switch the filter over to use the other group).

Repeated Measures ANOVA

Within Subjects Effects

	Sphericity Correction	Sum of Squares	df	Mean Square	F	p	η²
Stinky Cheese Variety	None	1727.88075	3	575.96025	27.19874	<.00001	0.72111
	Greenhouse-Geisser	1727.88075	1.82268	947.98781	27.19874	<.00001	0.72111
Residual	None	571.75175	27	21.17599			
	Greenhouse-Geisser	571.75175	16.40414	34.85411			

Note. Type 3 Sums of Squares

[3]

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η²
Residual	96.49125	9	10.72125			

Note. Type 3 Sums of Squares

Assumptions

Tests of Sphericity

	Mauchly's W	p	Greenhouse-Geisser ε	Huynh-Feldt ε
Stinky Cheese Variety	0.31770	0.11766	0.60756	0.75362

And again follow this up with pairwise *t*-tests for the simple comparisons (with the filter still on).

Paired Samples T-Test

Paired Samples T-Test

										95% Confidence Interval	
			statistic	df	p	Mean difference	SE difference		Effect Size	Lower	Upper
Limberger	Epoisses	Student's t	4.45461	9.00000	0.00159	13.30000	2.98567	Cohen's d	1.40867	0.49925	2.28175
	Blue Stilton	Student's t	7.63602	9.00000	0.00003	15.54000	2.03509	Cohen's d	2.41472	1.14083	3.65937
	Roquefort	Student's t	9.35692	9.00000	<.00001	16.11000	1.72172	Cohen's d	2.95892	1.46791	4.42529
Epoisses	Blue Stilton	Student's t	1.05123	9.00000	0.32056	2.24000	2.13084	Cohen's d	0.33243	−0.31414	0.96186
	Roquefort	Student's t	1.52317	9.00000	0.16205	2.81000	1.84484	Cohen's d	0.48167	−0.18745	1.12741
Blue Stilton		Student's t	0.47383	9.00000	0.64690	0.57000	1.20296	Cohen's d	0.14984	−0.47774	0.76932

Descriptives

	N	Mean	Median	SD	SE
Limberger	10	21.55000	21.00000	5.67416	1.79433
Epoisses	10	8.25000	7.85000	5.41526	1.71245
Limberger	10	21.55000	21.00000	5.67416	1.79433
Blue Stilton	10	6.01000	5.85000	2.72456	0.86158
Limberger	10	21.55000	21.00000	5.67416	1.79433
Roquefort	10	5.44000	4.70000	2.30323	0.72835
Epoisses	10	8.25000	7.85000	5.41526	1.71245
Blue Stilton	10	6.01000	5.85000	2.72456	0.86158
Epoisses	10	8.25000	7.85000	5.41526	1.71245
Roquefort	10	5.44000	4.70000	2.30323	0.72835
Blue Stilton	10	6.01000	5.85000	2.72456	0.86158
Roquefort	10	5.44000	4.70000	2.30323	0.72835

Phew! We've got all we need to start reporting now so let's go through that one step at a time.

Step 5a – Finding the components for reporting the omnibus results

Firstly, let's report our omnibus results.

The components we obtain here are:

1. The *F* statistics, *df*s, *p* values and Greenhouse-Geisser ε (when reporting corrected results for sphericity breaches) – the omnibus ANOVA results for the main effects and interaction.
2. Effect sizes in the form of η^2

Tests of Sphericity

	Mauchly's W	p	Greenhouse-Geisser ε	Huynh-Feldt ε
Stinky Cheese Variety	0.63597	0.18234	0.76342	0.88088

Within Subjects Effects

	Sphericity Correction	Sum of Squares	df	Mean Square	F	p	η²
Stinky Cheese Variety	None	2147.45100	3	715.81700	37.80404	<.00001	0.44435
	Greenhouse-Geisser	2147.45100	2.29026	937.64314	37.80404	<.00001	0.44435
Stinky Cheese Variety ✻ Species	None	474.10250	3	158.03417	8.34617	0.00012	0.09810
	Greenhouse-Geisser	474.10250	2.29026	207.00773	8.34617	0.00056	0.09810
Residual	None	1022.48650	54	18.93494			
	Greenhouse-Geisser	1022.48650	41.22476	24.80272			

Note. Type 3 Sums of Squares

[3]

Between Subjects Effects

	Sum of Squares	df	Mean Square	F	p	η²
Species	733.26050	1	733.26050	28.97681	0.00004	0.15173
Residual	455.49150	18	25.30508			

Note. Type 3 Sums of Squares

The Write Up (Part 1):

Ten anopheles gambiae and ten aedes aegypti mosquitoes were exposed to randomly ordered combinations of four types of Stinky Cheese (Limberger, Epoisses, Blue Stilton and Roquefort) for thirty seconds to determine their cheese preferences and the impact of species on those preferences. The number of seconds within each thirty second block that the mosquitoes hovered within one centimetre of the cheese was recorded by sensors. A two-way mixed design ANOVA was conducted to analyse the results. No sphericity breach was noted from an examination of Mauchly's test (**$p = .182$**) for the repeated measures factor. Both a significant main effect of Stinky Cheese Variety, **$F(3,54) = 37.80$, $p < .001$**, **$\eta^2 = .44$**, and a significant main effect of Species, **$F(1,18) = 28.98$, $p < .001$**, **$\eta^2 = .15$**, were revealed, but were qualified by a significant Stinky Cheese Variety x Species interaction, **$F(3,54) = 8.35$, $p < .001$**, **$\eta^2 = .10$**.

Step 5b – Finding the components for reporting the simple effects to follow a significant interaction

These come from the two one-way repeated measures ANOVAs we ran for the simple effects of Stinky Cheese Variety separately for the two mosquito species.

The components we obtain here are:

1. The *F* statistics, *df*s, *p* values and Greenhouse-Geisser ε (when reporting corrected results for sphericity breaches) – the omnibus ANOVA results for the simple effects.
2. Effect sizes in the form of η^2

One-way repeated measures ANOVA 1 – The simple effect of Stinky Cheese Variety for anopheles gambiae mosquitoes.

Repeated Measures ANOVA

Within Subjects Effects

	Sphericity Correction	Sum of Squares	df	Mean Square	F	p	η²
Stinky Cheese Variety	None	893.67275	3	297.89092	17.84432	<.00001	0.52464
	Greenhouse-Geisser	893.67275	2.39817	372.64847	17.84432	0.00001	0.52464
Residual	None	450.73475	27	16.69388			
	Greenhouse-Geisser	450.73475	21.58349	20.88331			

Note. Type 3 Sums of Squares

[3]

Assumptions

Tests of Sphericity

	Mauchly's W	p	Greenhouse-Geisser ε	Huynh-Feldt ε
Stinky Cheese Variety	0.65375	0.65890	0.79939	1.00000

One-way repeated measures ANOVA 2 – The simple effect of Stinky Cheese Variety for aedes aegypti mosquitoes.

Repeated Measures ANOVA

Within Subjects Effects

	Sphericity Correction	Sum of Squares	df	Mean Square	F	p	η²
Stinky Cheese Variety	None	1727.88075	3	575.96025	27.19874	<.00001	0.72111
	Greenhouse-Geisser	1727.88075	1.82268	947.98781	27.19874	<.00001	0.72111
Residual	None	571.75175	27	21.17599			
	Greenhouse-Geisser	571.75175	16.40414	34.85411			

Note. Type 3 Sums of Squares

Assumptions

Tests of Sphericity

	Mauchly's W	p	Greenhouse-Geisser ε	Huynh-Feldt ε
Stinky Cheese Variety	0.31770	0.11766	0.60756	0.75362

The Write Up (Part 2):

The simple effects of Stinky Cheese Varieties were explored in light of the significant Stinky Cheese Varieties x Mosquito Species interaction. Mauchly's test of sphericity indicated no sphericity breach for either simple effect (*ps* > .12). The Stinky Cheese Varieties simple effect for anopheles gambiae mosquitoes, ***F*(3,27) = 17.84, *p* < .001**, ***η*² = .52**, and aedes aegypti mosquitoes, ***F*(3,27) = 27.20, *p* < .001**, ***η*² = .72**, were both significant necessitating examination of each respective set of simple comparisons.

Step 5c – Finding the components for reporting the simple comparisons to follow significant simple effects.

The end of the road write-up wise is drilling down into these simple comparisons within each simple effect.

These results come from our two sets of paired *t*-test results which provided us with pairwise comparisons between the four cheese varieties within the simple effect of Stinky Cheese Variety for each mosquito species.

The elements needed for the post hoc section of our write up are:

1. Simple comparison results – to determine which cell means within each simple effect are significant from each other. It is sufficient to report the *p* value for this.
2. An effect size for each post hoc comparison in the form of Cohen's *d* and its associated confidence interval.
3. Means and standard deviations – to help describe the pattern of these differences.

Paired samples *t*-tests set 1 – Simple comparisons for the simple effect of Stinky Cheese Varieties for anopheles gambiae mosquitoes.

Paired Samples T-Test

Paired Samples T-Test

			statistic	df	p	Mean difference	SE difference		Effect Size	95% Confidence Interval Lower	Upper
Fridge Limberger	Fridge Epoisses	Student's t	1.75791	9.00000	0.11263	3.56000	2.02513	Cohen's d	0.55590	−0.12654	1.21236
	Fridge Blue Stilton	Student's t	5.95141	9.00000	0.00021	12.87000	2.16251	Cohen's d	1.88200	0.80914	2.92113
	Fridge Roquefort	Student's t	2.52350	9.00000	0.03258	4.30000	1.70398	Cohen's d	0.79800	0.06351	1.50021
Fridge Epoisses	Fridge Blue Stilton	Student's t	6.83114	9.00000	0.00008	9.31000	1.36288	Cohen's d	2.16020	0.98413	3.30482
	Fridge Roquefort	Student's t	0.38622	9.00000	0.70831	0.74000	1.91603	Cohen's d	0.12213	−0.50347	0.74110
Fridge Blue Stilton	Fridge Roquefort	Student's t	−5.10074	9.00000	0.00064	−8.57000	1.68015	Cohen's d	−1.61300	−2.55522	−0.63526

Descriptives

	N	Mean	Median	SD	SE
Fridge Limberger	10	21.55000	21.00000	5.67416	1.79433
Fridge Epoisses	10	17.99000	17.95000	4.17598	1.32056
Fridge Limberger	10	21.55000	21.00000	5.67416	1.79433
Fridge Blue Stilton	10	8.68000	8.20000	4.92585	1.55769
Fridge Limberger	10	21.55000	21.00000	5.67416	1.79433
Fridge Roquefort	10	17.25000	17.25000	4.00895	1.26774
Fridge Epoisses	10	17.99000	17.95000	4.17598	1.32056
Fridge Blue Stilton	10	8.68000	8.20000	4.92585	1.55769
Fridge Epoisses	10	17.99000	17.95000	4.17598	1.32056
Fridge Roquefort	10	17.25000	17.25000	4.00895	1.26774
Fridge Blue Stilton	10	8.68000	8.20000	4.92585	1.55769
Fridge Roquefort	10	17.25000	17.25000	4.00895	1.26774

Paired samples *t*-tests set 2 – Simple comparisons for the simple effect of Stinky Cheese Varieties for aedes aegypti mosquitoes.

Paired Samples T-Test

Paired Samples T-Test

			statistic	df	p	Mean difference	SE difference		Effect Size	95% Confidence Interval Lower	Upper
Limberger	Epoisses	Student's t	4.45461	9.00000	0.00159	13.30000	2.98567	Cohen's d	1.40867	0.49925	2.28175
	Blue Stilton	Student's t	7.63602	9.00000	0.00003	15.54000	2.03509	Cohen's d	2.41472	1.14083	3.65937
	Roquefort	Student's t	9.35692	9.00000	<.00001	16.11000	1.72172	Cohen's d	2.95892	1.46791	4.42529
Epoisses	Blue Stilton	Student's t	1.05123	9.00000	0.32056	2.24000	2.13084	Cohen's d	0.33243	−0.31414	0.96186
	Roquefort	Student's t	1.52317	9.00000	0.16205	2.81000	1.84484	Cohen's d	0.48167	−0.18745	1.12741
Blue Stilton		Student's t	0.47383	9.00000	0.64690	0.57000	1.20296	Cohen's d	0.14984	−0.47774	0.76932

Descriptives

	N	Mean	Median	SD	SE
Limberger	10	21.55000	21.00000	5.67416	1.79433
Epoisses	10	8.25000	7.85000	5.41526	1.71245
Limberger	10	21.55000	21.00000	5.67416	1.79433
Blue Stilton	10	6.01000	5.85000	2.72456	0.86158
Limberger	10	21.55000	21.00000	5.67416	1.79433
Roquefort	10	5.44000	4.70000	2.30323	0.72835
Epoisses	10	8.25000	7.85000	5.41526	1.71245
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Roquefort	10	5.44000	4.70000	2.30323	0.72835
Blue Stilton	10	6.01000	5.85000	2.72456	0.86158
Roquefort	10	5.44000	4.70000	2.30323	0.72835

The Write Up (Part 3):

Unadjusted post hoc simple comparisons revealed that anopheles gambiae spent significantly fewer seconds hovering over the Blue Stilton, ***M* = 8.68, *SD* = 4.93**, than the Limberger, ***M* = 21.55, *SD* = 5.67**, ***p* = .002**, ***d* = 1.88**, **95% *CI* [0.81, 2.92]**, Epoisses, ***M* = 17.99, *SD* = 4.18**, ***p* < .001**, ***d* = 2.16**, **95% *CI* [0.98, 3.30]** and Roquefort cheese, ***M* = 17.25, *SD* = 4.01**, ***p* = .001**, ***d* = 1.61**, **95% *CI* [0.64, 2.56]**. Additionally the Limberger cheese was favoured with significantly more hovering by the anopheles gambiae mosquitoes than the Roquefort cheese, ***p* = .033**, ***d* = 0.80**, **95% *CI* [0.06, 1.50]**.

The aedes aegypti mosquitoes, however, showed a distinct preference for the Limberger cheese, ***M* = 21.55, *SD* = 5.67**, over Roquefort, ***M* = 5.44, *SD* = 2.30**, Blue Stilton, ***M* = 6.01, *SD* = 2.72**, and Epoisses cheeses, ***M* = 8.25, *SD* = 5.42, *ps* < .002**, ***ds* > 1.41**. No other differences were significant, ***ps* > .162**, ***ds* < 0.48**.

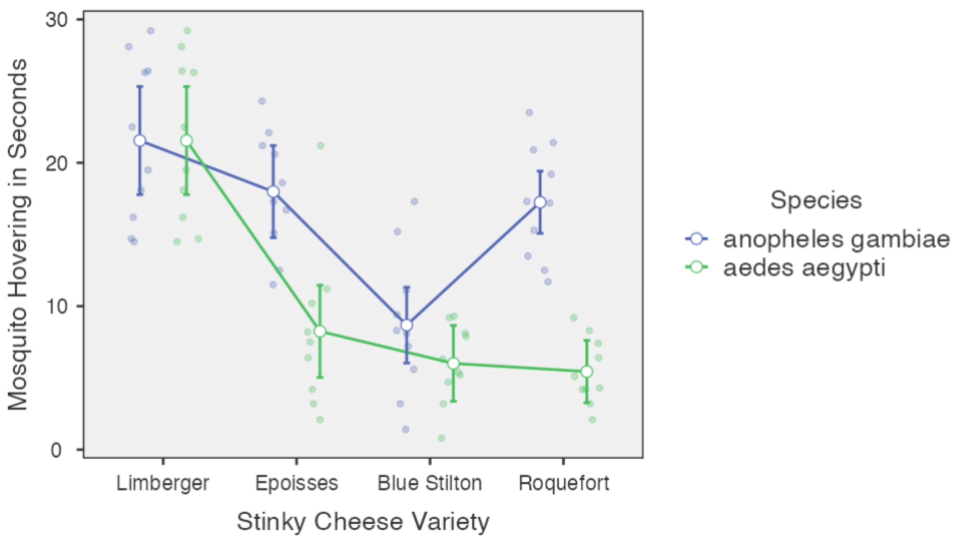
Potential addition of plot:

You could also add the plot we obtained to help illustrate the pattern of results. You might add a sentence like the following if you choose to include the plot:

Figure 1 below provides a visual demonstration of mosquito preference for Stinky Cheese Varieties as moderated mosquito species.

Figure 1

Mosquito Cheese Hovering as a function of Stinky Cheese Variety and Mosquito Species



Note. Error bars represent 95% confidence intervals.

Created by Janine Lurie in consultation with the Statistics Working Group within the School of Psychology, University of Queensland [2]

Based on *jamovi* v.1.8.4 [3]

[2] The Statistics Working Group was formed in November 2020 to review the use of statistical packages in teaching across the core undergraduate statistics unit. The working group is led by Winnifred Louis and Philip Grove, with contributions from Timothy Ballard, Stefanie Becker, Jo Brown, Jenny Burt, Nathan Evans, Mark Horswill, David Sewell, Eric Vanman, Bill von Hippel, Courtney von Hippel, Zoe Walter, and Brendan Zietsch.

[3] The jamovi project (2021). jamovi (Version 1.8.4) [Computer Software]. Retrieved from https://www.jamovi.org