

Statistical Testing

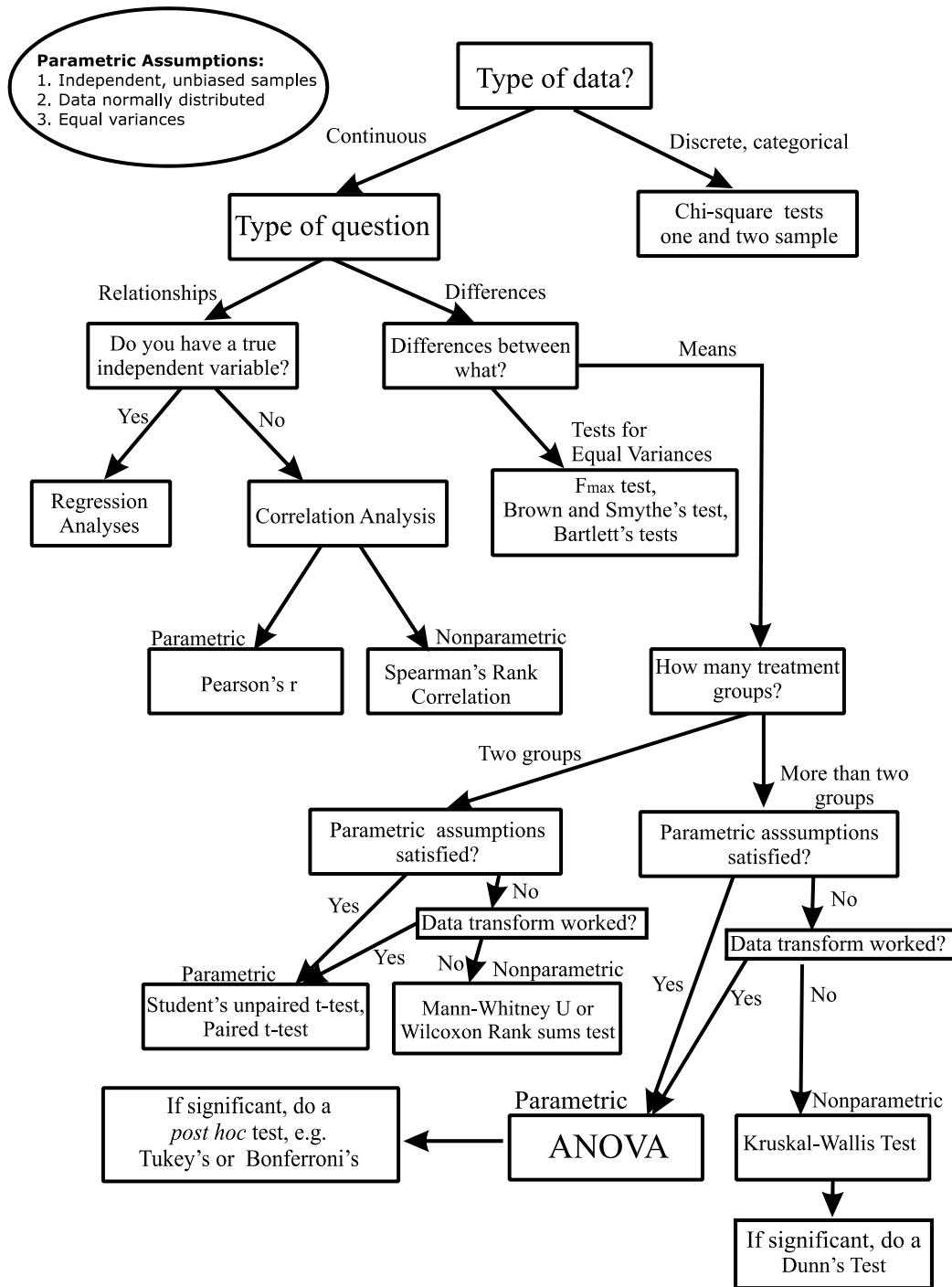
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BCBB/OCICB/NIAID

This statistical testing introduces how to do statistical testing in Prism 8. All analyses are based on the sample data provided by Prism 8. This lab will also mention the selection of statistical methods and the explanation of the statistical results. For more details, please check another BCBB workshop – [Statistical Testing](#).

1. Selection of Statistical Methods

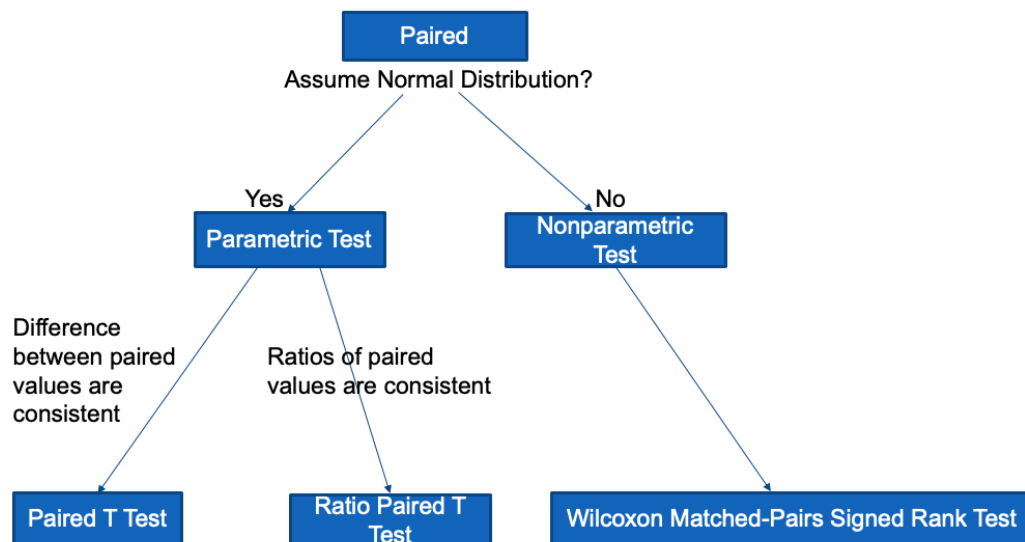
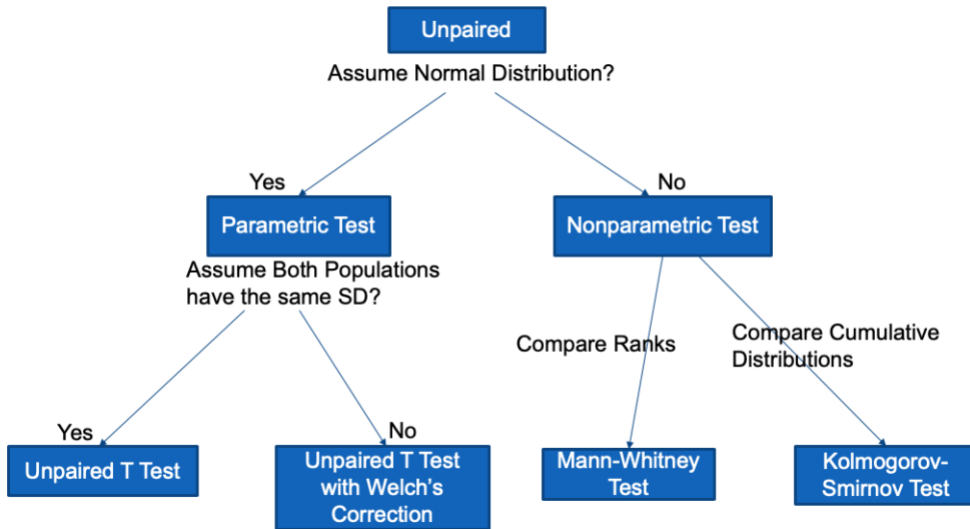
- 1) Useful References for choosing appropriate tests
 - *Choosing the Correct Statistical Test in SAS, Stata, SPSS and R* ([link](#))
 - *Summary and Analysis of Extension Program Evaluation in R* ([link](#))
 - *Analysis Data Model (ADaM) Examples in Commonly Used Statistical Analysis Methods* ([link](#))
- 2) Flow chart for selecting commonly used statistical tests

Flow Chart for Selecting Commonly Used Statistical Tests



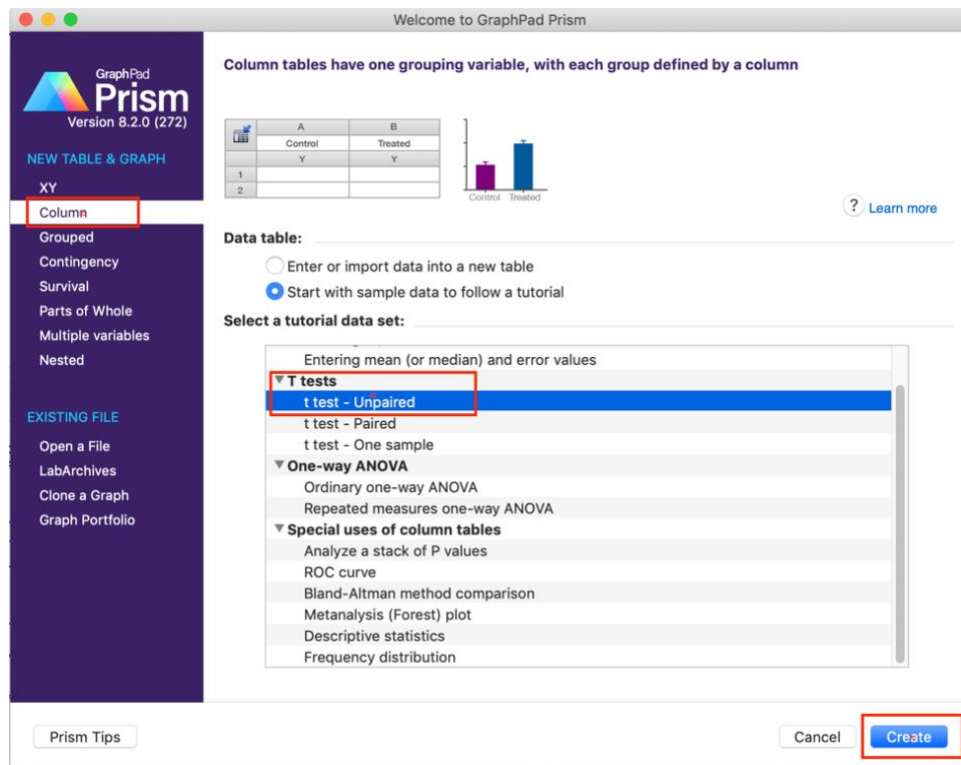
2. Two-sample t-test

1) The decision tree of two-sample comparisons



2) Unpaired t test

From the Welcome dialog, **choose the Column tab** on the left and **choose the sample data with “t test - Unpaired”** on the right. Then click **“Create”**.



In the sample data, there are two groups, the male group which includes 5 subjects while the female group includes 6 subjects. Click “Analyze” on the toolbar.

File Sheet Undo Clipboard Analysis Change Import Draw Write

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Search

▼ Data Tables

Unpaired t test data

⊕ New Data Table...

▼ Info

Project info 1

⊕ New Info...

▼ Results

⊕ New Analysis...

▼ Graphs

Unpaired t test data

⊕ New Graph...

▼ Layouts

⊕ New Layout...

	Group A	Group B	Group C	Group D	Group E
	Male	Female	Title	Title	Title
	Y	Y	Y	Y	Y
1	54	43			
2	23	34			
3	45	65			
4	54	77			
5	45	46			
6		65			

How the data are organized

The two columns define two groups. Note that, unlike many statistics programs, Prism does not define groups using a grouping variable. Instead, the groups are defined by columns.

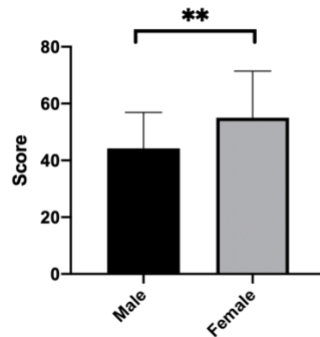
The goals

- To determine if the differences between the two group means is greater than you'd expect to see by chance.
- To determine the 95% confidence interval for the difference between the two means.

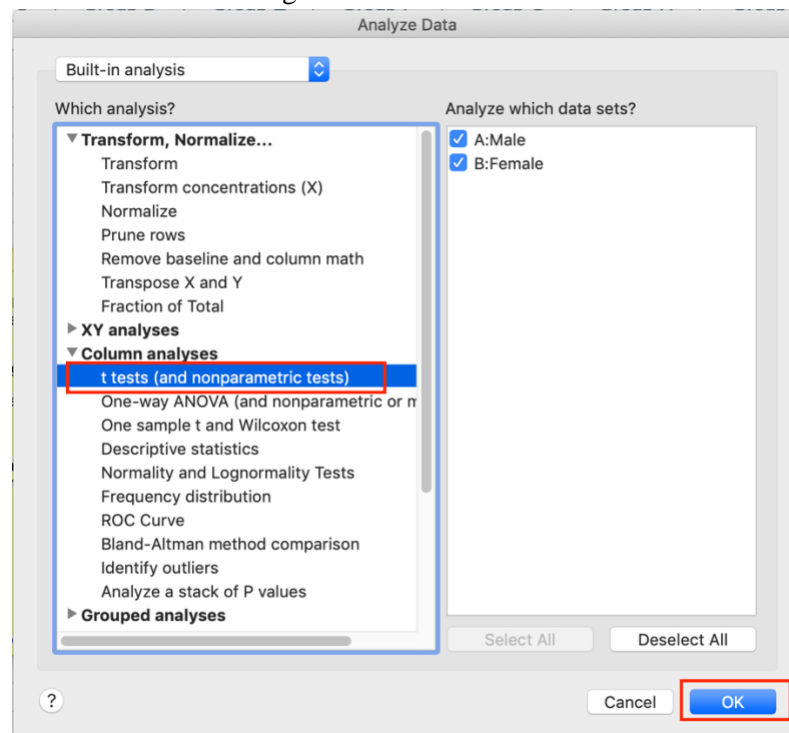
How to perform an unpaired t test

Click Analyze, choose t test from the list of column analyses, then choose an unpaired t test on the dialog. Click the link below for detailed instructions.

At the same time, Prism 8 generates a graph for the dataset. Try to customize the graph like this:



Choose “t tests (and nonparametric tests)” from the list of column analyses then click “OK” on the bottom right.



On the first (Experimental Design) tab of t test dialog, **make these choices:**

- Experimental design: **Unpaired**
- Assume Gaussian distribution: **Yes**.
- Choose test: **Unpaired t test**. Choose the Welch's correction if you don't want to assume the two sets of data are sampled from populations with equal variances, and you are willing to accept the loss of power that comes with that choice. That choice is used rarely, so don't check it unless you are quite sure.

Parameters: t Tests (and Nonparametric Tests)

Experimental Design Residuals Options

Experimental design

☒ Unpaired

☐ Paired

	Group A	Group B
	Control	Treated
	Y	Y
1		
2		
3		
4		
5		

Assume Gaussian distribution?

☒ Yes. Use parametric test.

☐ No. Use nonparametric test.

Choose test

☒ Unpaired t test. Assume both populations have the same SD

☐ Unpaired t test with Welch's correction. Do not assume equal SDs

?

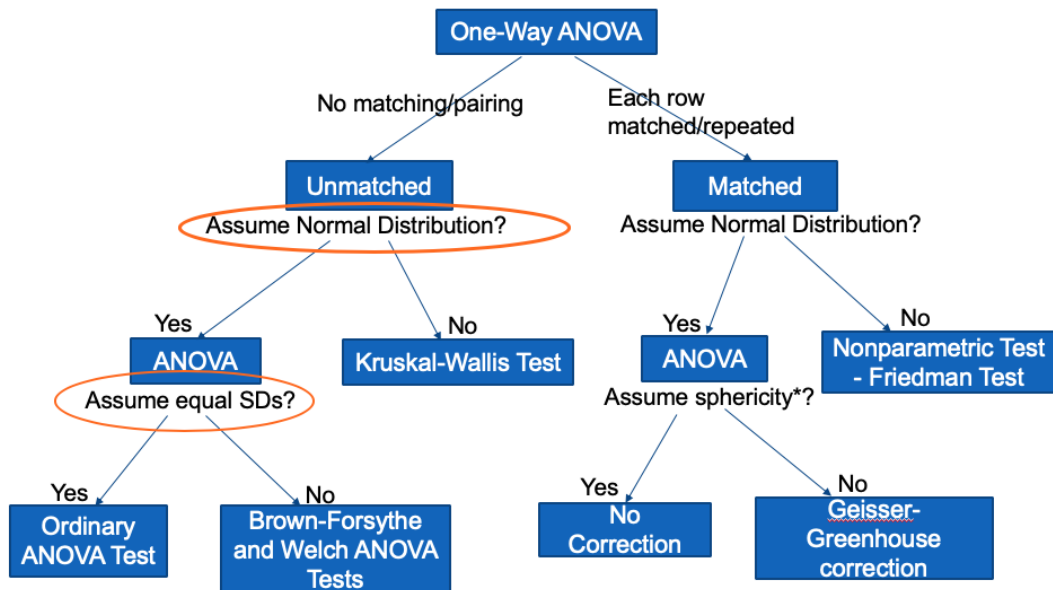
Cancel OK

Then the analysis results will be stored and shown in the results “Unpaired t test of Unpaired t test”. More information about how to interpret the results could be found at [Interpreting results: Unpaired t](#).

Q Search	Unpaired t test	
▼ Data Tables		
Unpaired t test data		
New Data Table...		
▼ Info		
Project info 1		
New Info...		
▼ Results		
Unpaired t test of Unpaired t test		
New Analysis...		
▼ Graphs		
Unpaired t test data		
New Graph...		
▼ Layouts		
New Layout...		
Family		
Unpaired t test data		
Unpaired t test		
	1	Table Analyzed
	2	
	3	Column B
	4	vs.
	5	Column A
	6	
	7	Unpaired t test
	8	P value
	9	P value summary
	10	Significantly different (P < 0.05)?
	11	One- or two-tailed P value?
	12	t, df
	13	
	14	How big is the difference?
	15	Mean of column A
	16	Mean of column B
	17	Difference between means (B - A) ± SEM
	18	95% confidence interval
	19	R squared (eta squared)
	20	
	21	F test to compare variances
	22	F, DFn, Dfd
	23	P value
	24	P value summary
	25	Significantly different (P < 0.05)?
	26	
	27	Data analyzed
	28	Sample size, column A
	29	Sample size, column B
		Unpaired t test data
		Female
		vs.
		Male
		0.2613
		ns
		No
		Two-tailed
		t=1.199, df=9
		44.20
		55.00
		10.80 ± 9.010
		-9.583 to 31.18
		0.1377
		1.680, 5, 4
		0.6354
		ns
		No
		5
		6

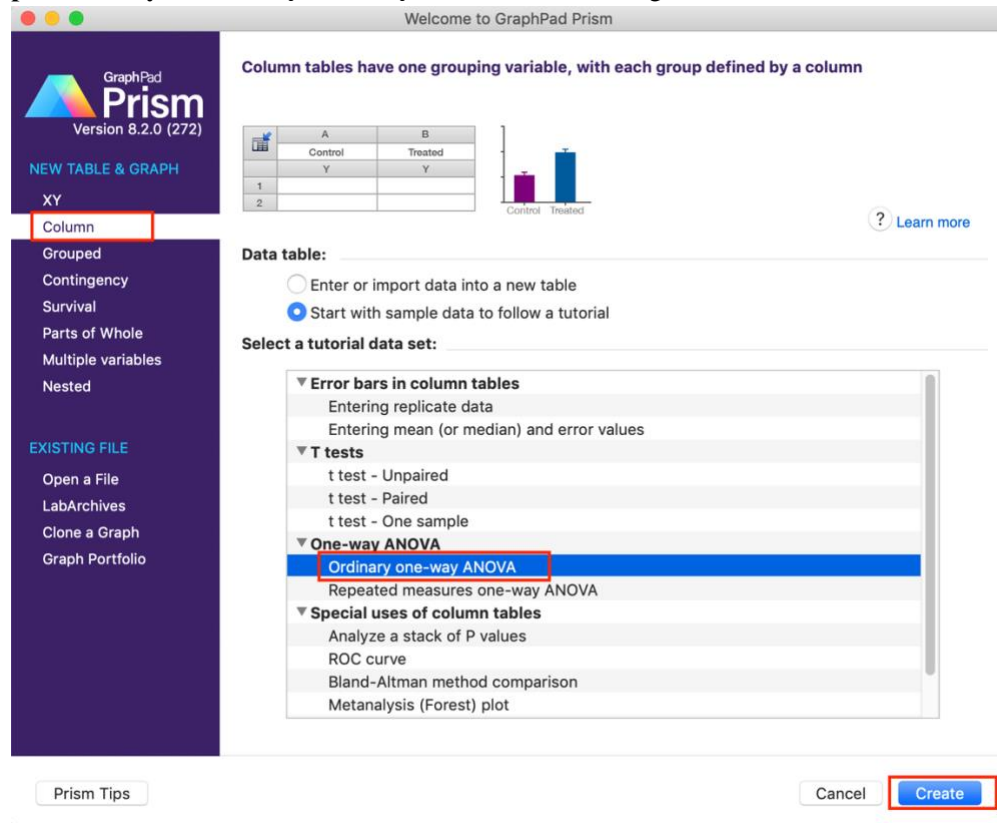
3. ANOVA

1) The decision tree of One-Way ANOVA



2) One-way ANOVA

From the Welcome dialog, choose the **Column** tab on the left then choose the sample data provided by “**Ordinary one-way ANOVA**” on the right. Click “**create**”.



Prism 8 provides a dataset with 3 groups, “Control”, “Treated” and “Treated+Antagonist”.

Search		Group A	Group B	Group C	Group D	Group E
Data Tables		Control	Treated	Treated+Antagonist	Title	Title
One-way ANOVA data		Y	Y	Y	Y	Y
1	New Data Table...	54	87	45		
2		23	98	39		
3		45	64	51		
4		54	77	49		
5		45	89	50		
6		47		55		

How the data are organized

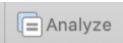
The columns define three treatments. Note that, unlike many statistics programs, Prism does not define groups by using a grouping variable. Instead, the groups are defined by the columns. Note that one value is missing. This is fine for ordinary one-way ANOVA (but not for repeated measures).

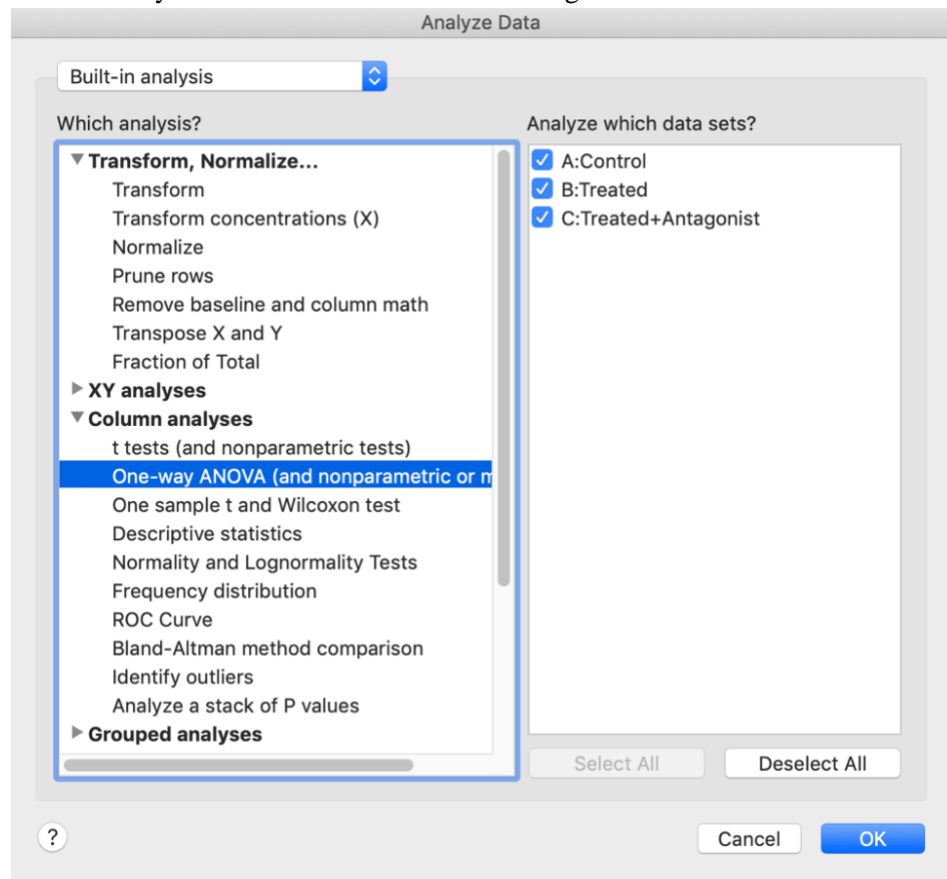
The goals

- To determine if the differences between the group means are greater than you'd expect to see by chance.
- To determine the 95% confidence interval for the difference between the pairs of group means (post tests).

How to perform one-way ANOVA

Click Analyze, choose one-way ANOVA from the list of column analyses, and then accept all the default choices on the dialog. Click the link below for detailed instructions, and to learn about one way ANOVA.

Like what we did for the unpaired t-test example, from the data table, click  on the tool bar. Then choose “one-way ANOVA (and nonparametric or mixed)” from the list of column analyses. Click “OK” on the bottom right.



In the pops-up window, on the first tab – “Experimental Design”, choose what test you want to perform. In this case, we use the default settings: “No Matching or pairing”, “Yes. Use ANOVA” and “Yes. Use ordinary ANOVA test”.

Parameters: One-Way ANOVA (and Nonparametric or Mixed)

Experimental Design Repeated Measures Multiple Comparisons Options Residuals

Experimental design

☒ No matching or pairing

☐ Each row represents matched, or repeated measures, data

	Group A	Group B	Group C	Group D
	Data Set-A	Data Set-B	Data Set-C	Title
	Y	Y	Y	Y
1				
2				
3				

Assume Gaussian distribution?

☒ Yes. Use ANOVA.

☐ No. Use nonparametric test.

Assume equal SDs?

☒ Yes. Use ordinary ANOVA test.

☐ No. Use Brown-Forsythe and Welch ANOVA tests.

Based on your choices (on all tabs), Prism will perform:

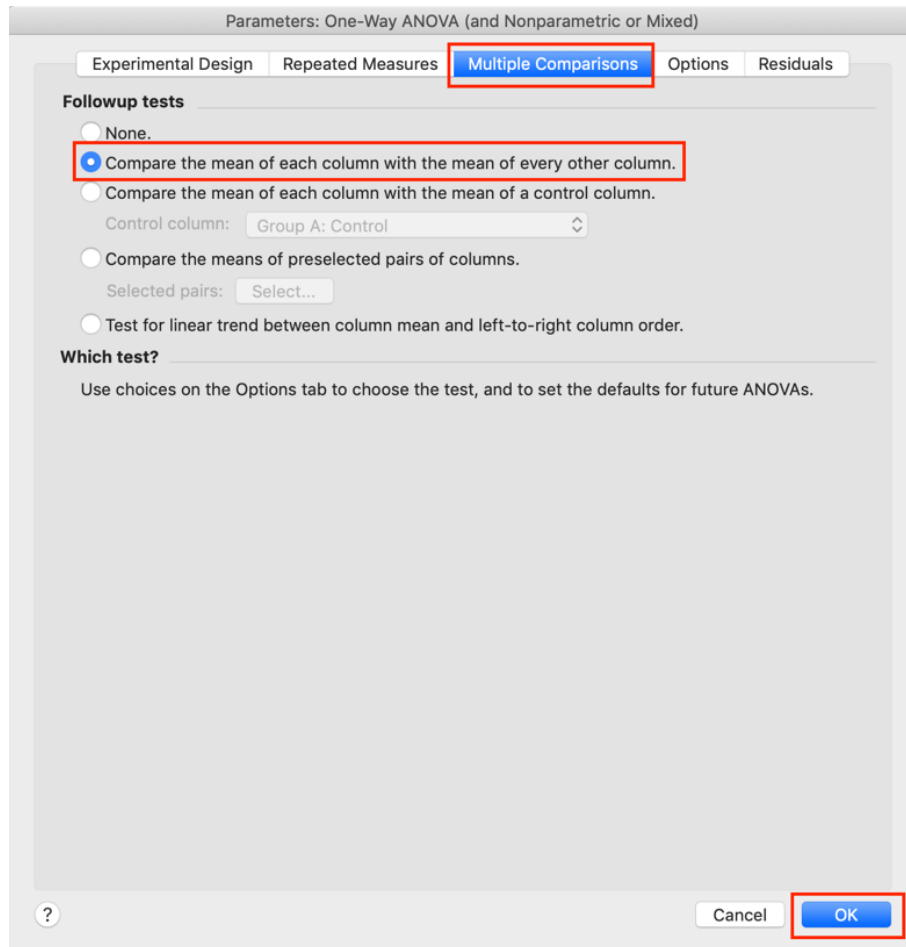
- Ordinary one-way ANOVA.

?

Cancel OK

*** More details about choosing ANOVA test could be found at: [Choose the test.](#)

Multiple comparisons could also be performed by Prism 8. In this case, on the “**Multiple Comparisons**” tab, choose “**Compare the mean of each column with the mean of every other column**”. You could also choose which test you would like to choose on the “Options” tab, in this case we just keep the default settings. Click “**OK**”.



*** More details about the options on the [Multiple Comparison](#) tab and [Options](#) tab.

Prism 8 generates the ANOVA results “Ordinary one-way ANOVA of One-way ANOVA data” which includes two sheets “ANOVA” and “Multiple Comparisons”.

Q Search

ANOVA results Multiple comparisons

Data Tables

One-way ANOVA data

New Data Table...

Info

Project info 1

New Info...

Results

Ordinary one-way ANOVA of One-way ANOVA data

New Analysis...

Graphs

One-way ANOVA data

New Graph...

Layouts

New Layout...

Family

One-way ANOVA data

Ordinary one-way ANOVA

ANOVA results

ANOVA results

Table Analyzed

One-way ANOVA data

Data sets analyzed

A-C

ANOVA summary

F

22.57

P value

<0.0001

P value summary

Significant diff. among means (P < 0.05)?

Yes

R square

0.7633

Brown-Forsythe test

F (DFn, DFd)

0.7307 (2, 14)

P value

0.4991

P value summary

ns

Are SDs significantly different (P < 0.05)?

No

Bartlett's test

Bartlett's statistic (corrected)

2.986

P value

0.2247

P value summary

ns

Are SDs significantly different (P < 0.05)?

No

ANOVA table

SS

DF

MS

F (DFn, DFd)

P value

Treatment (between columns)

4760

2

2380

F (2, 14) = 22.57

P<0.0001

Residual (within columns)

1476

14

105.4

Total

6236

16

Data summary

Number of treatments (columns)

3

Number of values (total)

17

Reference

[Statistics with Prism 8](#)