

How many regression lines are needed for the REDUCED MODEL of the one-way ancova?

How many regression lines are needed for the FULL MODEL of the one-way ancova?

Which Sum of Squares (Type I, Type II, Type III) should be used when there are unequal sample sizes in a two-way anova design? Why?

A researcher wants to determine whether a history of playing team sports (yes, no) and age (thirties, forties, fifties) influence the amount of time per week spent engaging in physical activity. The researcher wants to have .80 power for the interaction test. What is the *total sample size needed* to have .80 power for the interaction test with an alpha of .05? Show your work.

**Sample Size Needed for .80 Power**

ANOVA	Alpha = .01			Alpha = .05		
	Sm	Med	Lg	Sm	Med	Lg
<b>2g</b>	586	95	38	393	64	26
<b>3g</b>	464	76	30	322	52	21
<b>4g</b>	388	63	25	274	45	18
<b>5g</b>	336	55	22	240	39	16
<b>6g</b>	299	49	20	215	35	14
<b>7g</b>	271	44	18	195	32	13



A researcher wanted to determine whether the level of alcohol consumption (0 drinks, 2 drinks, 4 drinks) was related to the number of mistakes in a driving simulator. The researcher has conducted some of the analyses.

**Conduct** the statistical tests that are needed to complete the analyses—show your work.

**Complete** the results section that was started below.

Table 1

*Descriptive Statistics for Number of Driving Mistakes.*

Alcohol Consumption	<i>n</i>	<i>M</i>	<i>SD</i>	<i>Variance</i>
0 Drinks	16	5.00	2.00	4.00
2 Drinks	16	8.00	3.00	9.00
4 Drinks	16	20.00	6.00	36.00

## Results

A one-way anova was conducted to determine whether level of alcohol consumption (0 drinks, 2 drinks, 4 drinks) was related to the number of driving mistakes in a driving simulator. \_\_\_\_\_ was used to control the familywise alpha to .05. \_\_\_\_\_ was conducted as follow-up tests. The level of alcohol consumption was a significant predictor of driving mistakes,  $F(2, 45) = 61.71$ ,  $MSE = 16.33$ ,  $p < .001$ ,  $\omega^2 = .72$ .

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A psychologist wanted to know whether the type of math problem (easy, hard) and the level of anxiety (low, medium, high) was a significant predictor of the average time (seconds) it took the students to complete several math problems. The output is shown on **SPSS PAGES 5 through 9**.

Interpret the SPSS output; include the following in your interpretation:

- statistical procedure(s) used;
  - alpha level used to determine significance;
  - interpretation sentence(s) of the relevant output;
    - include statistical information in the sentences (e.g.,  $F$ ,  $p$ , etc.);
    - do not worry about  $M$ ,  $SD$ , or  $\omega^2$  in the sentences.
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**Regression**

**Variables Entered/Removed<sup>b</sup>**

Model	Variables Entered	Variables Removed	Method
1	Stress Before <sup>a</sup>	.	Enter

- a. All requested variables entered.
- b. Dependent Variable: Stress After

**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.290 <sup>a</sup>	.084	.068	6.28692

- a. Predictors: (Constant), Stress Before

**ANOVA<sup>b</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	210.186	1	210.186	5.318	.025 <sup>a</sup>
	Residual	2292.469	58	39.525		
	Total	2502.655	59			

- a. Predictors: (Constant), Stress Before
- b. Dependent Variable: Stress After

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	8.121	4.196		1.935	.058	-.278	16.520
	Stress Before	.389	.169	.290	2.306	.025	.051	.727

- a. Dependent Variable: Stress After

## Univariate Analysis of Variance

### Between-Subjects Factors

	Value Label	N
Condition 1.00	Control	30
2.00	Biofeedback	30

### Descriptive Statistics

Dependent Variable: Stress After

Condition	Mean	Std. Deviation	N
Control	18.0514	7.26117	30
Biofeedback	17.1775	5.76011	30
Total	17.6145	6.51290	60

### Tests of Between-Subjects Effects

Dependent Variable: Stress After

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	235.994 <sup>a</sup>	3	78.665	1.943	.133
Intercept	139.785	1	139.785	3.454	.068
COND	1.746	1	1.746	.043	.836
STRESS1	218.931	1	218.931	5.409	.024
COND * STRESS1	5.040	1	5.040	.125	.726
Error	2266.661	56	40.476		
Total	21118.792	60			
Corrected Total	2502.655	59			

a. R Squared = .094 (Adjusted R Squared = .046)

## Univariate Analysis of Variance

### Between-Subjects Factors

	Value Label	N
Condition 1.00	Control	30
2.00	Biofeedback	30

### Descriptive Statistics

Dependent Variable: Stress Before

Condition	Mean	Std. Deviation	N
Control	24.0253	4.89937	30
Biofeedback	24.7941	4.85878	30
Total	24.4097	4.85310	60

### Tests of Between-Subjects Effects

Dependent Variable: Stress Before

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8.867 <sup>a</sup>	1	8.867	.372	.544
Intercept	35749.929	1	35749.929	1501.734	.000
COND	8.867	1	8.867	.372	.544
Error	1380.735	58	23.806		
Total	37139.530	60			
Corrected Total	1389.601	59			

a. R Squared = .006 (Adjusted R Squared = -.011)

**Univariate Analysis of Variance**

**Between-Subjects Factors**

	Value Label	N
Condition 1.00	Control	30
2.00	Biofeedback	30

**Descriptive Statistics**

Dependent Variable: Stress After

Condition	Mean	Std. Deviation	N
Control	18.0514	7.26117	30
Biofeedback	17.1775	5.76011	30
Total	17.6145	6.51290	60

**Tests of Between-Subjects Effects**

Dependent Variable: Stress After

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	230.955 <sup>a</sup>	2	115.477	2.897	.063
Intercept	138.611	1	138.611	3.478	.067
STRESS1	219.499	1	219.499	5.508	.022
COND	20.768	1	20.768	.521	.473
Error	2271.701	57	39.854		
Total	21118.792	60			
Corrected Total	2502.655	59			

a. R Squared = .092 (Adjusted R Squared = .060)

**Estimated Marginal Means**

**Condition**

**Estimates**

Dependent Variable: Stress After

Condition	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	18.205 <sup>a</sup>	1.154	15.893	20.516
Biofeedback	17.024 <sup>a</sup>	1.154	14.712	19.336

a. Evaluated at covariates appeared in the model: Stress Before = 24.4097.

**Pairwise Comparisons**

Dependent Variable: Stress After

(I) Condition	(J) Condition	Mean Difference (I-J)	Std. Error	Sig. <sup>a</sup>	95% Confidence Interval for Difference <sup>a</sup>	
					Lower Bound	Upper Bound
Control	Biofeedback	1.180	1.635	.473	-2.094	4.455
Biofeedback	Control	-1.180	1.635	.473	-4.455	2.094

Based on estimated marginal means

a. Adjustment for multiple comparisons: Sidak.

### Between-Subjects Factors

	Value Label	N
PROBLEM	1.00 Easy	30
	2.00 Hard	30
ANXIETY	1.00 Low	20
	2.00 Medium	20
	3.00 High	20

### Descriptive Statistics

Dependent Variable: SECONDS

PROBLEM	ANXIETY	Mean	Std. Deviation	N
Easy	Low	1.0007	.49934	10
	Medium	.6586	.37836	10
	High	1.0186	.69664	10
	Total	.8927	.54846	30
Hard	Low	2.5443	.94857	10
	Medium	2.1860	.76513	10
	High	3.7631	.95324	10
	Total	2.8311	1.10196	30
Total	Low	1.7725	1.08227	20
	Medium	1.4223	.97928	20
	High	2.3908	1.62556	20
	Total	1.8619	1.30385	60

### Tests of Between-Subjects Effects

Dependent Variable: SECONDS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	70.857 <sup>a</sup>	5	14.171	25.989	.000
Intercept	207.997	1	207.997	381.450	.000
PROBLEM	56.364	1	56.364	103.366	.000
ANXIETY	9.620	2	4.810	8.821	.000
PROBLEM * ANXIETY	4.873	2	2.437	4.469	.016
Error	29.445	54	.545		
Total	308.299	60			
Corrected Total	100.302	59			

a. R Squared = .706 (Adjusted R Squared = .679)

# Oneway PROBLEM = Easy

### Descriptives<sup>a</sup>

SECONDS

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Low	10	1.0007	.49934	.15791	.6435	1.3580	.17	2.02
Medium	10	.6586	.37836	.11965	.3880	.9293	.23	1.45
High	10	1.0186	.69664	.22030	.5203	1.5169	.26	2.59
Total	30	.8927	.54846	.10013	.6879	1.0975	.17	2.59

a. PROBLEM = Easy

### ANOVA<sup>a</sup>

SECONDS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.823	2	.412	1.406	.262
Within Groups	7.900	27	.293		
Total	8.723	29			

a. PROBLEM = Easy

### Robust Tests of Equality of Means<sup>b</sup>

SECONDS

	Statistic <sup>a</sup>	df1	df2	Sig.
Welch	1.897	2	17.076	.180

a. Asymptotically F distributed.

b. PROBLEM = Easy

## Post Hoc Tests

### Multiple Comparisons<sup>a</sup>

Dependent Variable: SECONDS

Games-Howell

(I) ANXIETY	(J) ANXIETY	Mean Difference (I-J)	Std. Error	Sig.	_____ Confidence Interval	
					Lower Bound	Upper Bound
Low	Medium	.3421	.19812	.225	-.2357	.9199
	High	-.0179	.27104	.998	-.8109	.7752
Medium	Low	-.3421	.19812	.225	-.9199	.2357
	High	-.3600	.25069	.350	-1.1093	.3893
High	Low	.0179	.27104	.998	-.7752	.8109
	Medium	.3600	.25069	.350	-.3893	1.1093

a. PROBLEM = Easy

Descriptives<sup>a</sup>

SECONDS

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Low	10	2.5443	.94857	.29996	1.8657	3.2229	.52	4.18
Medium	10	2.1860	.76513	.24196	1.6386	2.7333	1.32	3.81
High	10	3.7631	.95324	.30144	3.0812	4.4450	1.73	5.12
Total	30	2.8311	1.10196	.20119	2.4196	3.2426	.52	5.12

a. PROBLEM = Hard

ANOVA<sup>a</sup>

SECONDS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.670	2	6.835	8.566	.001
Within Groups	21.545	27	.798		
Total	35.215	29			

a. PROBLEM = Hard

Robust Tests of Equality of Means<sup>b</sup>

SECONDS

	Statistic <sup>a</sup>	df1	df2	Sig.
Welch	8.282	2	17.790	.003

a. Asymptotically F distributed.

b. PROBLEM = Hard

Post Hoc Tests

Multiple Comparisons<sup>a</sup>

Dependent Variable: SECONDS

Games-Howell

(I) ANXIETY	(J) ANXIETY	Mean Difference (I-J)	Std. Error	Sig.	_____ Confidence Interval	
					Lower Bound	Upper Bound
Low	Medium	.3584	.38538	.629	-.7621	1.4788
	High	-1.2188	.42526	.026	-2.4491	.0116
Medium	Low	-.3584	.38538	.629	-1.4788	.7621
	High	-1.5771*	.38654	.002	-2.7011	-.4531
High	Low	1.2188	.42526	.026	-.0116	2.4491
	Medium	1.5771*	.38654	.002	.4531	2.7011

\*. The mean difference is significant at the \_\_\_\_\_ level.

a. PROBLEM = Hard

# Oneway ANXIETY = Low

## Descriptives<sup>a</sup>

SECONDS

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Easy	10	1.0007	.49934	.15791	.6435	1.3580	.17	2.02
Hard	10	2.5443	.94857	.29996	1.8657	3.2229	.52	4.18
Total	20	1.7725	1.08227	.24200	1.2660	2.2790	.17	4.18

a. ANXIETY = Low

## ANOVA<sup>a</sup>

SECONDS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11.913	1	11.913	20.734	.000
Within Groups	10.342	18	.575		
Total	22.255	19			

a. ANXIETY = Low

## Robust Tests of Equality of Means<sup>b</sup>

SECONDS

	Statistic <sup>a</sup>	df1	df2	Sig.
Welch	20.734	1	13.632	.000

a. Asymptotically F distributed.

b. ANXIETY = Low

# ANXIETY = Medium

## Descriptives<sup>a</sup>

SECONDS

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Easy	10	.6586	.37836	.11965	.3880	.9293	.23	1.45
Hard	10	2.1860	.76513	.24196	1.6386	2.7333	1.32	3.81
Total	20	1.4223	.97928	.21897	.9640	1.8806	.23	3.81

a. ANXIETY = Medium

## ANOVA<sup>a</sup>

SECONDS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11.663	1	11.663	32.017	.000
Within Groups	6.557	18	.364		
Total	18.221	19			

a. ANXIETY = Medium

## Robust Tests of Equality of Means<sup>b</sup>

SECONDS

	Statistic <sup>a</sup>	df1	df2	Sig.
Welch	32.017	1	13.153	.000

a. Asymptotically F distributed.

b. ANXIETY = Medium

**Descriptives<sup>a</sup>**

SECONDS

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Easy	10	1.0186	.69664	.22030	.5203	1.5169	.26	2.59
Hard	10	3.7631	.95324	.30144	3.0812	4.4450	1.73	5.12
Total	20	2.3908	1.62556	.36349	1.6301	3.1516	.26	5.12

a. ANXIETY = High

**ANOVA<sup>a</sup>**

SECONDS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	37.660	1	37.660	54.034	.000
Within Groups	12.546	18	.697		
Total	50.206	19			

a. ANXIETY = High

**Robust Tests of Equality of Means<sup>b</sup>**

SECONDS

	Statistic <sup>a</sup>	df1	df2	Sig.
Welch	54.034	1	16.480	.000

a. Asymptotically F distributed.

b. ANXIETY = High