

# How can I explain a three-way interaction in ANOVA?

Authored by  
**stats writer**

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## RECOMMENDED CITATION

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A three-way interaction in ANOVA (analysis of variance) refers to the simultaneous effect of three independent variables on a dependent variable. It occurs when the interaction between two variables is further influenced by a third variable. This means that the relationship between the two variables is not consistent across the different levels of the third variable. In order to explain a three-way interaction, one must consider the individual effects of each variable as well as the combined effect of all three variables. This can be done by examining the patterns and differences in means across the different combinations of the three variables. A visual representation, such as a graph, can also aid in understanding and explaining the three-way interaction.

## **How can I explain a three-way interaction in ANOVA? | SPSS FAQ**

**NOTE: This page was created using SPSS version 16. Some of the syntax may not work in earlier versions of SPSS.**

**NOTE: We would like to thank David Nicholas from SPSS for assistance in developing the syntax shown in some of the examples below.**

**First off, let's start with what a significant three-way interaction means. It means that there is a two-way interaction that varies across levels of a third variable. Say, for example, that a  $b*c$  interaction differs across various levels of factor  $a$ .**

One way of analyzing the three-way interaction is through the use of tests of simple main-effects, e.g., the effect of one variable (or set of variables) across the levels of another variable.

We will use a small artificial dataset called threeway that has a statistically significant three-way interaction to illustrate the process. In our example data set, variables a, b and c are categorical. The techniques shown on this page can be generalized to situations in which one or more variables are continuous, but the more continuous variables that are involved in the interaction, the more complicated things get.

We need to select a two-way interaction to look at more closely. For the purposes of this example we will examine the b\*c interaction. We can use the plot subcommand of the unianova command to graph the b\*c interaction for each of the two levels of a. We use the emmeans subcommands to get

**the numeric**

**values that are displayed on the graphs.**

**unianova y by a b c**

**/plot = profile(c\*b\*a)**

**/emmeans=tables(a\*b\*c)**

**/design = a b c a\*b a\*c b\*c a\*b\*c.**

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## Univariate Analysis of Variance

E:\threeway.sav

### Between-Subjects Factors

		N
a	1	12
	2	12
b	1	12
	2	12
c	1	8
	2	8
	3	8

### Tests of Between-Subjects Effects

Dependent Variable: y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	497.833 <sup>a</sup>	11	45.258	33.943	.000
Intercept	5460.167	1	5460.167	4095.125	.000
a	150.000	1	150.000	112.500	.000
b	.667	1	.667	.500	.493
c	127.583	2	63.792	47.844	.000
a * b	160.167	1	160.167	120.125	.000
a * c	18.250	2	9.125	6.844	.010
b * c	22.583	2	11.292	8.469	.005
a * b * c	18.583	2	9.292	6.969	.010
Error	16.000	12	1.333		
Total	5974.000	24			
Corrected Total	513.833	23			

a. R Squared = .969 (Adjusted R Squared = .940)

## Estimated Marginal Means

**a \* b \* c**

### Estimates

Dependent Variable: v

a	b	c	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
1	1	1	11.000	.816	9.221	12.779
		2	15.000	.816	13.221	16.779
		3	19.000	.816	17.221	20.779
	2	1	10.500	.816	8.721	12.279
		2	10.500	.816	8.721	12.279
		3	9.500	.816	7.721	11.279
2	1	1	10.500	.816	8.721	12.279
		2	15.500	.816	13.721	17.279
		3	18.500	.816	16.721	20.279
	2	1	16.500	.816	14.721	18.279
		2	20.500	.816	18.721	22.279
		3	24.000	.816	22.221	25.779

### Pairwise Comparisons

Dependent Variable: v

b	c	(I) a	(J) a	Mean Difference (I-J)	Std. Error	Sig. <sup>a</sup>	95% Confidence Interval for Difference <sup>a</sup>	
							Lower Bound	Upper Bound
1	1	1	2	.500	1.155	.673	-2.016	3.016
		2	1	-.500	1.155	.673	-3.016	2.016
	2	1	2	-.500	1.155	.673	-3.016	2.016
		2	1	.500	1.155	.673	-2.016	3.016
	3	1	2	.500	1.155	.673	-2.016	3.016
		2	1	-.500	1.155	.673	-3.016	2.016
2	1	1	2	-6.000 <sup>*</sup>	1.155	.000	-8.516	-3.484
		2	1	6.000 <sup>*</sup>	1.155	.000	3.484	8.516
	2	1	2	-10.000 <sup>*</sup>	1.155	.000	-12.516	-7.484
		2	1	10.000 <sup>*</sup>	1.155	.000	7.484	12.516
	3	1	2	-14.500 <sup>*</sup>	1.155	.000	-17.016	-11.984
		2	1	14.500 <sup>*</sup>	1.155	.000	11.984	17.016

Based on estimated marginal means

a. Adjustment for multiple comparisons: Sidak.

\*. The mean difference is significant at the .050 level.

Univariate Tests

Dependent Variable: y			Sum of Squares	df	Mean Square	F	Sig.
1	1	Contrast	.250	1	.250	.187	.673
		Error	16.000	12	1.333		
	2	Contrast	.250	1	.250	.188	.673
		Error	16.000	12	1.333		
	3	Contrast	.250	1	.250	.188	.673
		Error	16.000	12	1.333		
2	1	Contrast	36.000	1	36.000	27.000	.000
		Error	16.000	12	1.333		
	2	Contrast	100.000	1	100.000	75.000	.000
		Error	16.000	12	1.333		
	3	Contrast	210.250	1	210.250	157.688	.000
		Error	16.000	12	1.333		

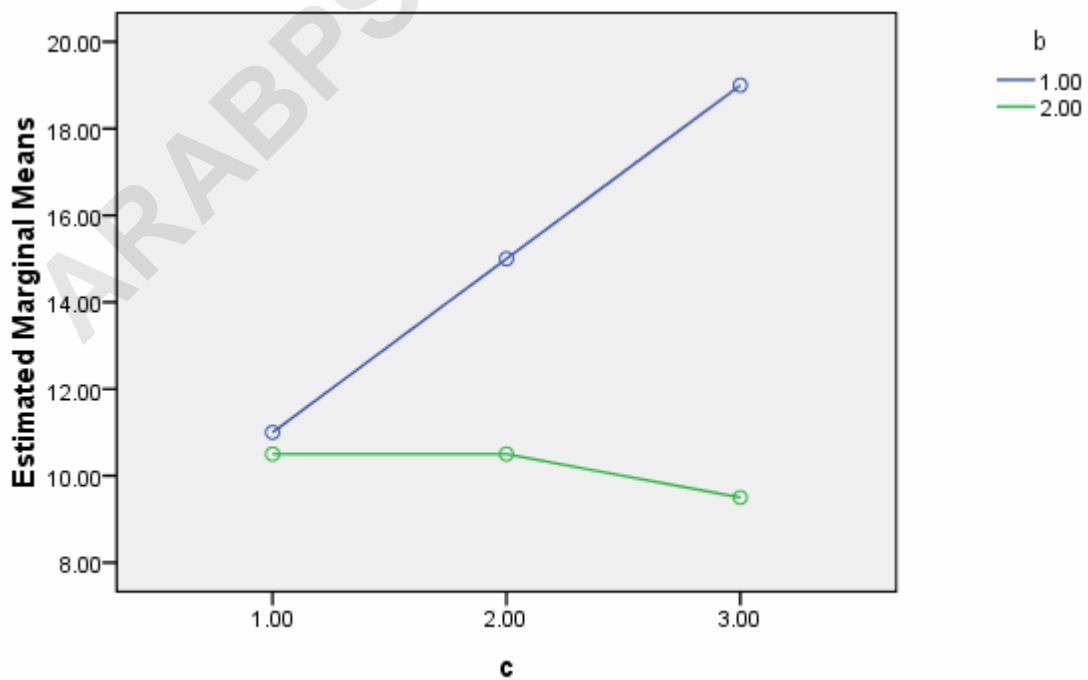
Each F tests the simple effects of a within each level combination of the other effects shown. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

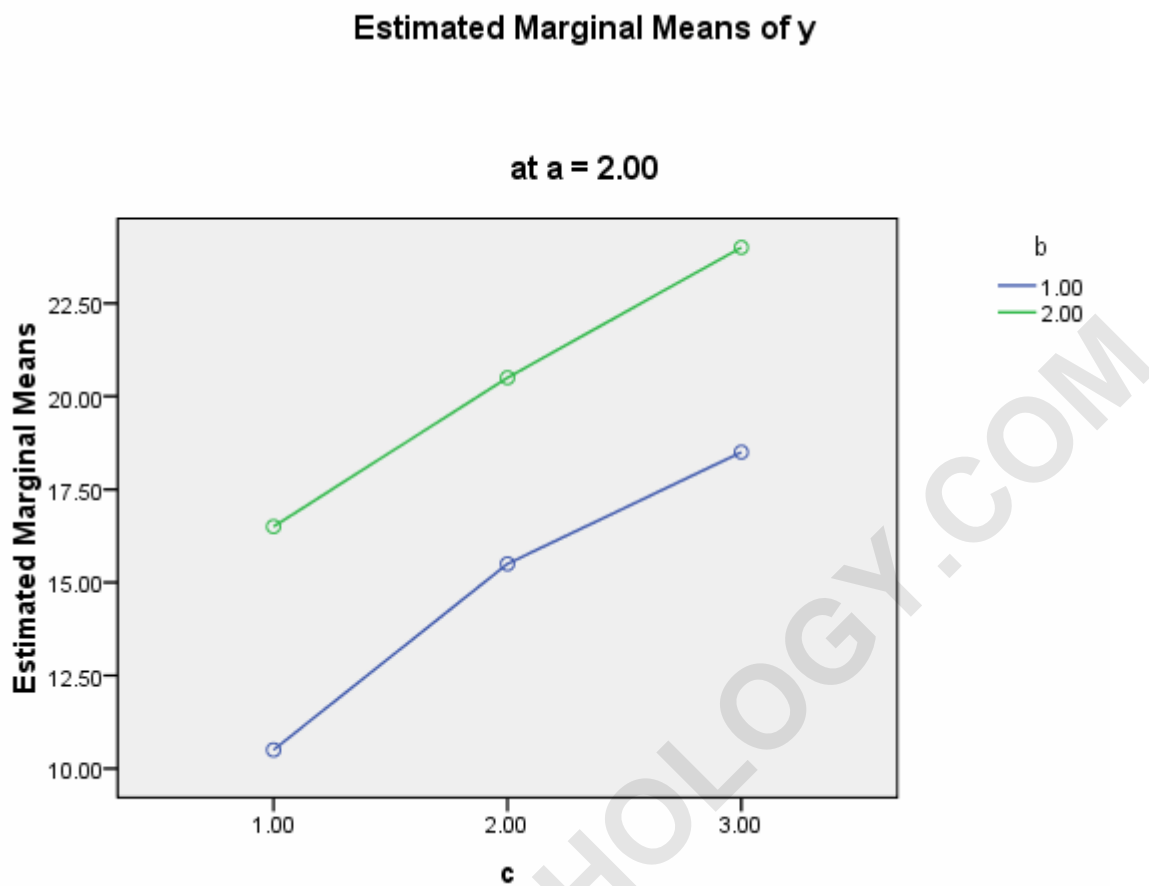
Profile Plots

c \* b \* a

Estimated Marginal Means of y

at a = 1.00





We believe from looking at the two graphs above that the three-way interaction is significant because there appears to be a "strong" two-way interaction at  $a = 1$  and no interaction at  $a = 2$ . Now, we just have to show it statistically using tests of simple main-effects.

In SPSS, we need to conduct the tests of simple main-effects in two parts. First, we begin by running the ANOVA for both

levels of a. This is easily done by sorting the data file on a, then splitting the file by a, running the ANOVA, and finally turning off the split file. To save space, we show only some of the output from the unianova command.

sort cases by a.

split file by a.

unianova y by b c

/design = b c b\*c.

split file off.

### Tests of Between-Subjects Effects

Dependent Variable: y

a	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
1.00	Corrected Model	135.417 <sup>a</sup>	5	27.083	21.667	.001
	Intercept	1900.083	1	1900.083	1520.067	.000
	b	70.083	1	70.083	56.067	.000
	c	24.667	2	12.333	9.867	.013
	b * c	40.667	2	20.333	16.267	.004
	Error	7.500	6	1.250		
	Total	2043.000	12			
	Corrected Total	142.917	11			
2.00	Corrected Model	212.417 <sup>b</sup>	5	42.483	29.988	.000
	Intercept	3710.083	1	3710.083	2618.882	.000
	b	90.750	1	90.750	64.059	.000
	c	121.167	2	60.583	42.765	.000
	b * c	.500	2	.250	.176	.842
	Error	8.500	6	1.417		
	Total	3931.000	12			
	Corrected Total	220.917	11			

a. R Squared = .948 (Adjusted R Squared = .904)

b. R Squared = .962 (Adjusted R Squared = .929)

**Next, we need to obtain the tests of the simple main-effects for each level of a. For this example, the residual mean-square is the error term for all of the effects in the model and thus, for all of the tests of simple main-effects.**

**The syntax below is annotated to explain what each part is doing.**

**Essentially, we are creating a new data set based on the results from the**

unianova command, doing some manipulations, and using the summarize command to display the results in a nice-looking table. While calculating the tests of simple main-effects, we will also calculate the critical value per family error rate. We will explain what this is and why we might want to use it later, but we are calculating it in the syntax below so that we don't have to rerun similar syntax later. To do the necessary manipulations with the output from the unianova command, we save those results into a new data set using the Output Management System, or OMS. For more information on how to use OMS, please see our SPSS FAQ: How can I output my results to a data file in SPSS? .

- \* The first command calls the current data set "data", so that it can be recalled at the end.
- \* The second command sets up an empty data set called "tmp" where the OMS calls put data.

**DATASET NAME data.**

**DATASET DECLARE tmp.**

\* OMS is used to put certain parts of the output from the command below (unianova) into a data set.

**OMS**

**/SELECT TABLES**

**/IF COMMANDS= SUBTYPES=**

**/DESTINATION**

**FORMAT=SAV**

**NUMBERED=TableNumber\_ OUTFILE='tmp'.**

**UNIANOVA y BY a b c**

**/design = a b c a\*b a\*c b\*c a\*b\*c**

**/LMATRIX 'b\*c at a=1' b\*c 1 0 -1 -1 0 1 a\*b\*c 1 0 -1 -1 0 1  
0 0 0 0 0 0;**

**b\*c 0 1 -1 0 -1 1 a\*b\*c 0 1 -1 0 -1 1 0 0 0 0 0 0**

**/LMATRIX 'b\*c at a=2' b\*c 1 0 -1 -1 0 1 a\*b\*c 0 0 0 0 0 0 1  
0 -1 -1 0 1;**

**b\*c 0 1 -1 0 -1 1 a\*b\*c 0 0 0 0 0 0 0 1 -1 0 -1 1.**

**OMSEND.**

\* This is making "tmp" the active data set so that it can be used in the merges (done by the aggregate command).

**DATASET ACTIVATE tmp.**

\* The variable n\_tests is added to the active data set.

**AGGREGATE****/OUTFILE=\* MODE=ADDVARIABLES****/PRESORTED****/BREAK=Label\_****/n\_tests=MAX(TableNumber\_).**

**\* The variables are added dfh and dfe to the active data set.**

**AGGREGATE****/OUTFILE=\* MODE=ADDVARIABLES****/PRESORTED****/BREAK=TableNumber\_****/dfh=FIRST(df)****/dfe=LAST(df).**

**\* Creating a new variable Adj\_Sig that will be will be the minimum of 1 and  $n\_tests * Sig$  if F is not missing.**

**\* There are still four cases in the data set.**

**If NOT SYSMIS(F) Adj\_Sig=MIN(1, $n\_tests * Sig$ ).**

**\* Creating a new variable called "cvpfer" that will be the familywise critical value.**

**\* 0.975 is used because we want half of alpha, which is .05, so  $1 - (.05/2) = .975$ .**

```
COMPUTE cvpfer = idf.F(.975, dfh, dfe).
```

**\* Formatting and labeling variables.**

```
FORMATS dfh dfe (F8.0) F cvpfer Adj_Sig (F8.4).
```

```
VARIABLE LABELS dfh 'dfh' dfe 'dfe' Adj_Sig 'Adjusted  
Sig.' fwcv 'Crit. Value Per Family Error Rate'.
```

**\* Recoding the variable Subtype\_ and renaming it.**

```
IF TableNumber_=1 Subtype_='c at a=1 & b=1'.
```

```
IF TableNumber_=2 Subtype_='c at a=1 & b=2'.
```

```
RENAME VARIABLES Subtype_=Effect.
```

**\* This is making the summary table at the end of the output.**

**\* The step below fills in the values for the Adj\_Sig and cvpfer variables for the two contrasts.**

**\* missing = table option in the summarize command omits lines with cells with missing values,**

**\* so only two of the four lines in the data set are used.**

**\* The cells = none subcommand is necessary so that the N, mean and sd are not displayed in the output.**

```
OMS
```

```
/SELECT TABLES
```

```
/IF COMMANDS= SUBTYPES=
```

```
/DESTINATION VIEWER=NO.
```

**OMS**

**/SELECT TABLES**

**/IF COMMANDS= SUBTYPES=**

**/DESTINATION VIEWER=YES.**

**SUMMARIZE**

**/TABLES=Effect F dfh dfe Adj\_Sig cvpfer**

**/FORMAT=VALIDLIST NOCASENUM NOTOTAL**

**/TITLE='Tests of Simple, Simple Main Effects with  
Adjusted Significance Levels'**

**/MISSING=TABLE**

**/CELLS=NONE.**

**OMSEND.**

**DATASET ACTIVATE data.**

**DATASET CLOSE ALL.**

**We have omitted most of the output generated by the  
commands above, as this  
last table is the one in which we are interested.**

## Summarize

Tests of Simple, Simple Main Effects with Adjusted Significance Levels

	Effect	F	dfh	dfe	Adjusted Sig.	Crit. Value Per Family Error Rate
1	b*c at a=1	15.2500	2	12	.0010	5.0959
2	b*c at a=2	.1875	2	12	1.0000	5.0959

The F-ratio of 15.25 is the test of simple main-effects that the two-way interaction, b\*c, and it is statistically significant at  $\alpha = 1$ . The F-ratio of 0.187 is the test of simple main-effects that the two-way interaction of b\*c at  $\alpha = 2$  is not statistically significant.

While the program above provides a p-value for the tests of simple main-effects, there are at least four different methods of determining the critical value of tests of simple main-effects. There is a method related to Dunn's multiple comparisons, a method attributed to Marascuilo and Levin, a method called the simultaneous test procedure (very conservative and related to the Scheffé

post-hoc test) and a per family error rate method.

We will demonstrate the per family error rate method, but you should look up the other methods in a good ANOVA book, like Kirk (1995), to decide which approach is best for your situation. The trick here is that we use 0.975 in the `idf.F` function, which is 1 minus our alpha level, .05, divided by 2, because we are doing two tests of simple main-effects.

The critical value is approximately 5.1. The first F-ratio of 15.25 is significant while the second (.1875) is not. In other words, the two-way b\*c interaction is statistically significant at  $\alpha = 1$  but is not at  $\alpha = 2$ .

In an ideal world we would be done now, but since we live in the "real" world, there is still more to do because we now need to try to understand the significant two-way interaction at  $\alpha = 1$ ; first for  $b = 1$  and then for  $b = 2$ . We will do this by creating a

filter variable (which we called filter1 for a=1 and b=1 and filter2 for a=1 and b=2) and using it to look at the differences in c at b = 1 when a = 1.

/\* look at differences in c at b==1 when a==1 \*/

compute filter1 = 0.

if b=1 and a=1 filter1 = 1.

filter by filter1.

unianova y by c.

filter off.

Tests of Between-Subjects Effects

Dependent Variable: y

a	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
1.00	Corrected Model	64.000 <sup>a</sup>	2	32.000	16.000	.025
	Intercept	1350.000	1	1350.000	675.000	.000
	c	64.000	2	32.000	16.000	.025
	Error	6.000	3	2.000		
	Total	1420.000	6			
	Corrected Total	70.000	5			

a. R Squared = .914 (Adjusted R Squared = .857)

/\* look at differences in c at b==2 when a==1 \*/

compute filter2 = 0.

if b=2 and a=1 filter2 = 1.

filter by filter2.

unianova y by c.

filter off.

Tests of Between-Subjects Effects

Dependent Variable: y

a	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
1.00	Corrected Model	1.333 <sup>a</sup>	2	.667	1.333	.385
	Intercept	620.167	1	620.167	1240.333	.000
	c	1.333	2	.667	1.333	.385
	Error	1.500	3	.500		
	Total	623.000	6			
	Corrected Total	2.833	5			

a. R Squared = .471 (Adjusted R Squared = .118)

To get the tests of simple main-effects for c when b = 1 and b = 2 (assuming a = 1, because that was the only level of a for which the b\*c interaction was statistically significant), we need to do some more programming.

DATASET NAME data.

DATASET DECLARE tmp.

OMS

/SELECT TABLES

```

/IF COMMANDS= SUBTYPES=
/DESTINATION                               FORMAT=SAV
NUMBERED=TableNumber_  OUTFILE='tmp'.
UNIANOVA y BY a b c
/LMATRIX 'c at a=1 & b=1' c 1 0 -1 a*c 1 0 -1 0 0 0 b*c 1 0
-1 0 0 0 a*b*c 1 0 -1 0 0 0 0 0 0 0 0;
c 0 1 -1 a*c 0 1 -1 0 0 0 b*c 0 1 -1 0 0 0 a*b*c 0 1 -1 0 0 0 0
0 0 0 0
/LMATRIX 'c at a=1 & b=2' c 1 0 -1 a*c 1 0 -1 0 0 0 b*c 0 0
0 1 0 -1 a*b*c 0 0 0 1 0 -1 0 0 0 0 0 0;
c 0 1 -1 a*c 0 1 -1 0 0 0 b*c 0 0 0 0 1 -1 a*b*c 0 0 0 0 1 -1 0
0 0 0 0.
OMSEND.

```

**DATASET ACTIVATE tmp.**

**AGGREGATE**

**/OUTFILE=\* MODE=ADDVARIABLES**

**/PRESORTED**

**/BREAK=Label\_**

**/n\_tests=MAX(TableNumber\_).**

**AGGREGATE**

**/OUTFILE=\* MODE=ADDVARIABLES**

**/PRESORTED**

```
/BREAK=TableNumber_  
/dfh=FIRST(df)  
/dfe=LAST(df).
```

```
If NOT SYSMIS(F) Adj_Sig=MIN(1,n_tests*Sig).
```

```
FORMATS dfh dfe (F8.0) Adj_Sig (F8.3).
```

```
VARIABLE LABELS dfh 'dfh' dfe 'dfe' Adj_Sig 'Adjusted  
Sig.'
```

```
IF TableNumber_=1 Subtype_='c at a=1 & b=1'.
```

```
IF TableNumber_=2 Subtype_='c at a=1 & b=2'.
```

```
RENAME VARIABLES Subtype_=Effect.
```

```
OMS
```

```
/SELECT TABLES  
/IF COMMANDS= SUBTYPES=  
/DESTINATION VIEWER=NO.
```

```
OMS
```

```
/SELECT TABLES  
/IF COMMANDS= SUBTYPES=  
/DESTINATION VIEWER=YES.
```

```
SUMMARIZE
```

```
/TABLES=Effect F dfh dfe Adj_Sig  
/FORMAT=VALIDLIST NOCASENUM NOTOTAL
```

**/TITLE='Tests of Simple, Simple Main Effects with  
Adjusted Significance Levels'**

**/MISSING=TABLE**

**/CELLS=NONE.**

**OMSEND.**

**DATASET ACTIVATE data.**

**DATASET CLOSE ALL.**

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**Custom Hypothesis Tests Index**

1	Contrast Coefficients (L' Matrix)	LMATRIX Subcommand 1: c at a=1 & b=1
	Transformation Coefficients (M Matrix)	Identity Matrix
	Contrast Results (K Matrix)	Zero Matrix
2	Contrast Coefficients (L' Matrix)	LMATRIX Subcommand 2: c at a=1 & b=2
	Transformation Coefficients (M Matrix)	Identity Matrix
	Contrast Results (K Matrix)	Zero Matrix

**Custom Hypothesis Tests #1**

**Contrast Results (K Matrix)<sup>a</sup>**

Contrast		Depende...	
		y	
L1	Contrast Estimate	-8.000	
	Hypothesized Value	0	
	Difference (Estimate - Hypothesized)	-8.000	
	Std. Error	1.155	
	Sig.	.000	
	95% Confidence Interval for Difference	Lower Bound	-10.516
		Upper Bound	-5.484
L2	Contrast Estimate	-4.000	
	Hypothesized Value	0	
	Difference (Estimate - Hypothesized)	-4.000	
	Std. Error	1.155	
	Sig.	.005	
	95% Confidence Interval for Difference	Lower Bound	-6.516
		Upper Bound	-1.484

a. Based on the user-specified contrast coefficients (L) matrix: c at a=1 & b=1

**Test Results**

Dependent Variable: y

Source	Sum of Squares	df	Mean Square	F	Sig.
Contrast	64.000	2	32.000	24.000	.000
Error	16.000	12	1.333		

## Custom Hypothesis Tests #2

Contrast Results (K Matrix)<sup>a</sup>

Contrast		Depende...	
		y	
L1	Contrast Estimate	1.000	
	Hypothesized Value	0	
	Difference (Estimate - Hypothesized)	1.000	
	Std. Error	1.155	
	Sig.	.403	
	95% Confidence Interval for Difference	Lower Bound	-1.516
		Upper Bound	3.516
L2	Contrast Estimate	1.000	
	Hypothesized Value	0	
	Difference (Estimate - Hypothesized)	1.000	
	Std. Error	1.155	
	Sig.	.403	
	95% Confidence Interval for Difference	Lower Bound	-1.516
		Upper Bound	3.516

a. Based on the user-specified contrast coefficients (L) matrix: c at a=1 & b=2

Test Results

Dependent Variable: y

Source	Sum of Squares	df	Mean Square	F	Sig.
Contrast	1.333	2	.667	.500	.619
Error	16.000	12	1.333		

## Summarize

Tests of Simple, Simple Main Effects with Adjusted Significance Levels

	Effect	F	dfn	dfe	Adjusted Sig.
1	c at a=1 & b=1	24.000	2	12	.000
2	c at a=1 & b=2	.500	2	12	1.000

Only the test of simple main-effects of c at b = 1 was significant. But we're not done yet, since there are three levels of c, we don't know where this significant effect lies. We need to test the pairwise comparisons among the three means. We will do this using the Sidak correction for multiple tests.

filter by filter1.

unianova y by c

/emmeans=tables(c) compare(c) adj(sidak) .

filter off.

## Univariate Analysis of Variance

E:\threeway.sav

### Between-Subjects Factors

		N
c	1	2
	2	2
	3	2

### Tests of Between-Subjects Effects

Dependent Variable: y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	64.000 <sup>a</sup>	2	32.000	16.000	.025
Intercept	1350.000	1	1350.000	675.000	.000
c	64.000	2	32.000	16.000	.025
Error	6.000	3	2.000		
Total	1420.000	6			
Corrected Total	70.000	5			

a. R Squared = .914 (Adjusted R Squared = .857)

## Estimated Marginal Means

c

### Estimates

Dependent Variable:

c	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	11.000	1.000	7.818	14.182
2	15.000	1.000	11.818	18.182
3	19.000	1.000	15.818	22.182

### Pairwise Comparisons

Dependent Variable:

(I) c	(J) c	Mean Difference (I-J)	Std. Error	Sig. <sup>a</sup>	95% Confidence Interval for Difference <sup>a</sup>	
					Lower Bound	Upper Bound
1	2	-4.000	1.414	.186	-10.826	2.826
	3	-8.000*	1.414	.032	-14.826	-1.174
2	1	4.000	1.414	.186	-2.826	10.826
	3	-4.000	1.414	.186	-10.826	2.826
3	1	8.000*	1.414	.032	1.174	14.826
	2	4.000	1.414	.186	-2.826	10.826

Based on estimated marginal means

a. Adjustment for multiple comparisons: Sidak.

\*. The mean difference is significant at the .050 level.

### Univariate Tests

Dependent Variable:

	Sum of Squares	df	Mean Square	F	Sig.
Contrast	64.000	2	32.000	16.000	.025
Error	6.000	3	2.000		

The F tests the effect of c. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

As shown above, only one of the comparisons is statistically significant. However, the Sidak correction can be conservative. If we had used a different correction, say the Tukey HSD, all three comparisons would be statistically significant.

**We should note**

**that the error term used in these comparisons is not the error term from the original three-way ANOVA. We would need to use syntax similar to that shown above to save that error term to a new data set and then use it in the comparisons (as shown on**

**<https://stats.idre.ucla.edu/stat/stata/faq/threeway.htm> ).**

**We might want**

**to use the error term from the original three-way ANOVA because we are going post-hoc tests of that analysis.**

**Hopefully, we now have a much better understanding of the three-way  $a*b*c$  interaction.**

**Please note that the process of investigating the three-way interactions would have be similar if we had chosen a different two-way interaction back at the beginning.**

**Summary of Steps**

- 1) Run full model with three-way interaction.**
  - 1a) Capture SS and df residual.**
- 2) Run two-way interaction at each level of third variable.**
  - 2a) Capture SS and df for interactions.**
  - 2b) Compute F-ratios for tests of simple main-effects.**
- 3) Run one-way model at each level of second variable.**
  - 3a) Capture SS and df for main effects.**
  - 3b) Compute F-ratios for tests of simple main-effects.**
- 4) Run pairwise or other post-hoc comparisons if necessary.**

## References

**Kirk, Roger E. (1995) Experimental Design: Procedures for the Behavioral Sciences, Third Edition. Monterey, California: Brooks/Cole Publishing.**