

Calculating Advanced Statistics: Part II

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C O N N E X I O N S

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Table of Contents

1	Multivariate Analysis of Variance: Part I	1
2	Multivariate Analysis of Variance: Part II	29
3	Multiple Analysis of Variance: Part III	43
4	Discriminant Analysis: Assumptions	55
5	Discriminant Analysis: Part I	63
6	Discriminant Analysis: Part II	73
7	Discriminant Analysis: Part III	85
8	Multiple Regression: Assumptions	95
9	Multiple Regression: Part I	105
10	Multiple Regression: Part II	115
	Attributions	129

Chapter 1

Multivariate Analysis of Variance: Part I¹



NOTE: This chapter is published by NCPEA Press² and is presented as an NCPEA/Connexions publication "print on demand book." Each chapter has been peer-reviewed, accepted, and endorsed by the National Council of Professors of Educational Administration (NCPEA) as a significant contribution to the scholarship and practice of education administration.

About the Authors

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In this set of steps, readers will calculate a multivariate analysis of variance procedure, following the determination of the extent to which data for the dependent variables reflect normal distributions. Although a parametric statistical procedure requires that its data be reflective of a normal curve, the multivariate analysis of variance procedure is

¹This content is available online at <<http://cnx.org/content/m40728/1.2/>>.

²<http://www.ncpeapublications.org/books.html>

³<http://cnx.org/content/m40728/latest/www.writingandstatisticalhelp>

regarded as being sufficiently robust that it can withstand most violations. For detailed information regarding the assumptions underlying the multivariate analysis of variance (MANOVA) procedure, readers are referred to the Hyperstats Online Statistics Textbook at <http://davidmlane.com/hyperstat/>⁴; to the *Electronic Statistics Textbook* (2011) at <http://www.statsoft.com/textbook/>⁵; or to Andy Field's (2009) *Discovering Statistics Using SPSS* at http://www.amazon.com/Discovering-Statistics-Introducing-Statistical-Method/dp/1847879071/ref=sr_1_1?s=books&ie=UTF8&qid=1304967862&sr=1-1⁶.

Research questions for which a MANOVA procedure is appropriate involve asking for differences in multiple dependent variables by group membership (i.e., more than two groups may be present). In addition to multiple dependent variables being present, multiple independent variables can be present as well. That is, differences in several achievement variables could be analyzed by student gender, student ethnicity, student socioeconomic status, and the like. A specific research question that could be addressed is, "What is the difference in academic achievement among elementary school students as a function of ethnic membership, gender, and grade level?" Academic achievement in this example could be reading, math, science, and social studies scores. The independent variables are ethnicity, gender, and grade level.

For this particular chapter, the research question on which we will conduct a MANOVA will be: What is the difference in verbal aptitude among elementary reading groups? Verbal aptitude consists of Verbal 1 (inf), Verbal 2 (sim), Verbal 3 (ari), and Verbal 4 (voc).

modified SPSS database for advanced statistics book.sav [DataSet1] - SPSS Statistics Data Editor

	group	pc	inf	cod	sim	pa	ari	bd	voc	oa	Gender
1	3	8	12	6	12	9	9	8	8	8	
2	3	8	12	6	12	9	9	8	8	8	
3	3	9	5	6	5	11	6	10	4	7	
4	3	3	4	11	4	7	6	3	4	10	1.00
5	3	5	7	17	6	8	10	7	5	9	1.00
6	3	2	5	8	8	9	7	10	3	5	1.00
7	3	9	6	10	6	9	8	4	5	8	1.00
8	3	5	9	7	10	9	12	11	7	8	1.00
9	3	6	7	5	8	7	7	7	4	7	1.00
10	3	7	8	11	6	8	4	3	3	4	1.00
11	3	6	6	8	12	9	9	9	10	6	1.00
12	3	7	8	3	1	9	8	5	10	3	1.00
13	3	12	8	7	8	13	10	11	7	6	1.00
14	3	10	9	10	10	11	11	14	11	11	1.00
15	3	3	4	4	8	7	7	5	6	7	1.00
16	3	3	4	4	8	7	7	5	6	7	1.00
17	3	8	4	9	7	9	8	10	7	7	1.00
18	3	5	9	6	6	5	7	9	4	4	1.00
19	3	6	8	11	8	10	11	2	8	4	1.00
20	3	3	6	8	6	6	8	3	2	6	1.00
21	3	11	8	8	10	9	9	12	11	9	1.00
22	3	17	11	6	11	13	9	14	11	13	1.00
23	3	9	12	6	11	11	7	9	9	12	1.00
24	1	7	10	11	4	8	7	11	7	10	1.00
25	3	7	8	7	10	11	10	7	9	8	1.00
26	3	5	5	8	6	6	8	4	8	4	1.00
27	3	8	7	7	7	2	8	8	6	11	1.00
28	3	9	2	6	8	10	7	4	6	6	1.00
29	3	14	8	8	8	12	8	8	8	9	1.00
30	3	8	8	7	10	11	11	3	9	8	1.00
31	3	11	3	4	7	8	8	10	4	10	1.00
32	3	10	7	9	8	10	8	10	5	11	1.00
33	3	4	11	9	6	13	11	9	4	7	1.00
34	3	12	12	7	8	4	8	9	9	8	1.00
35	3	11	9	7	8	10	11	9	11	9	1.00
36	3	8	5	9	1	7	9	11	8	8	1.00
37	3	7	6	6	7	6	11	6	7	6	1.00

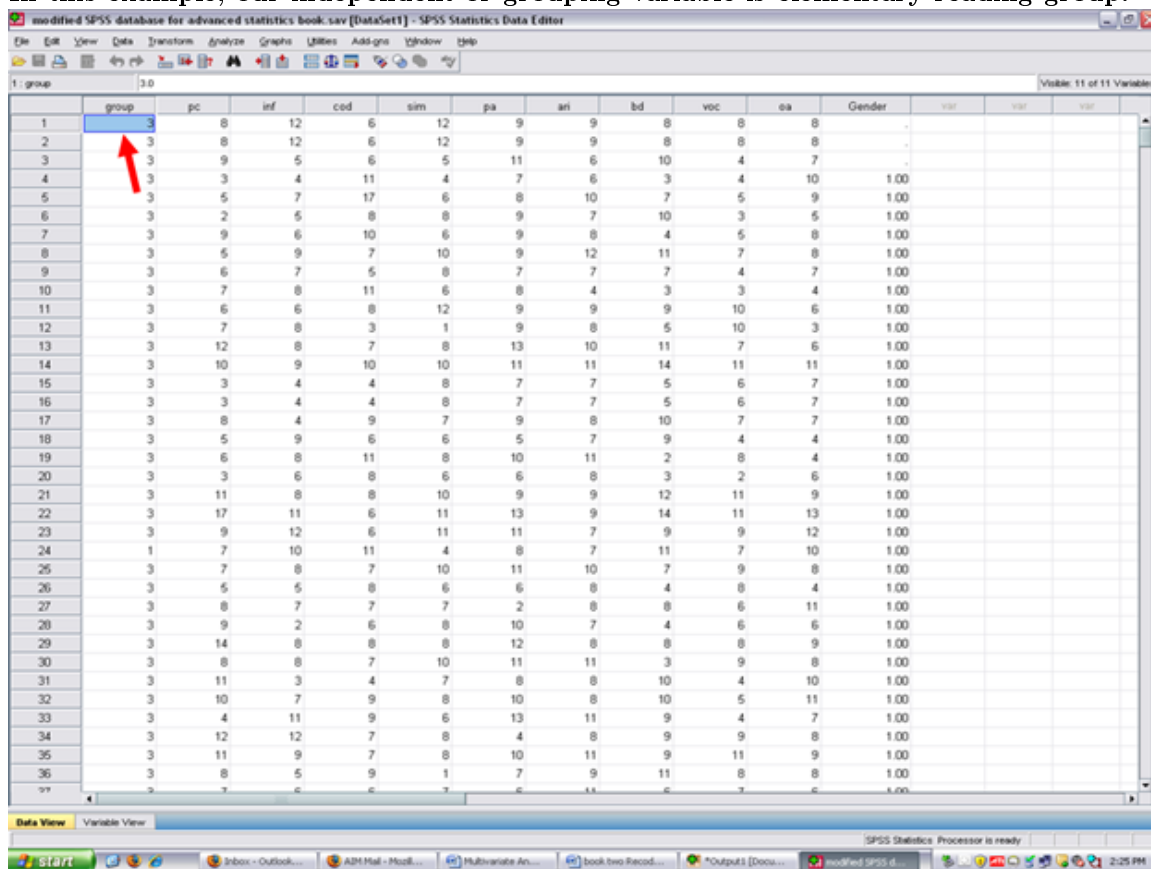
⁴<http://davidmlane.com/hyperstat/>

⁵<http://www.statsoft.com/textbook/>

⁶http://www.amazon.com/Discovering-Statistics-Introducing-Statistical-Method/dp/1847879071/ref=sr_1_1?s=books&ie=UTF8&qid=1304967862&sr=1-1

⁷<http://cnx.org/content/m40728/latest/10.1.png/image>

In this example, our independent or grouping variable is elementary reading group.



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File Edit View Data Transform Analyze Graphs Utilities Add-ons Window Help

1: group 3.0 Visible: 11 of 11 Variables

	group	pc	inf	cod	sim	pa	ari	bd	voc	oa	Gender	var	var	var
1	3	8	12	6	12	9	9	8	8	8				
2	3	8	12	6	12	9	9	8	8	8				
3	3	9	5	6	5	11	6	10	4	7				
4	3	3	4	11	4	7	6	3	4	10	1.00			
5	3	5	7	17	6	8	10	7	5	9	1.00			
6	3	2	5	8	8	9	7	10	3	5	1.00			
7	3	9	6	10	6	9	8	4	5	8	1.00			
8	3	5	9	7	10	9	12	11	7	8	1.00			
9	3	6	7	5	8	7	7	7	4	7	1.00			
10	3	7	8	11	6	8	4	3	3	4	1.00			
11	3	6	6	8	12	9	9	9	10	6	1.00			
12	3	7	8	3	1	9	8	5	10	3	1.00			
13	3	12	8	7	8	13	10	11	7	6	1.00			
14	3	10	9	10	10	11	11	14	11	11	1.00			
15	3	3	4	4	8	7	7	5	6	7	1.00			
16	3	3	4	4	8	7	7	5	6	7	1.00			
17	3	8	4	9	7	9	8	10	7	7	1.00			
18	3	5	9	6	6	5	7	9	4	4	1.00			
19	3	6	8	11	8	10	11	2	8	4	1.00			
20	3	3	6	8	6	6	8	3	2	6	1.00			
21	3	11	8	8	10	9	9	12	11	9	1.00			
22	3	17	11	6	11	13	9	14	11	13	1.00			
23	3	9	12	6	11	11	7	9	9	12	1.00			
24	1	7	10	11	4	8	7	11	7	10	1.00			
25	3	7	8	7	10	11	10	7	9	8	1.00			
26	3	5	5	8	6	6	8	4	8	4	1.00			
27	3	8	7	7	7	2	8	8	6	11	1.00			
28	3	9	2	6	8	10	7	4	6	6	1.00			
29	3	14	8	8	8	12	8	8	8	9	1.00			
30	3	8	8	7	10	11	11	3	9	8	1.00			
31	3	11	3	4	7	8	8	10	4	10	1.00			
32	3	10	7	9	8	10	8	10	5	11	1.00			
33	3	4	11	9	6	13	11	9	4	7	1.00			
34	3	12	12	7	8	4	8	9	9	8	1.00			
35	3	11	9	7	8	10	11	9	11	9	1.00			
36	3	8	5	9	1	7	9	11	8	8	1.00			
37	3	3	6	6	7	6	11	6	7	6	1.00			

Data View Variable View

SPSS Statistics Processor is ready

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By clicking on variable view, you can see how many groups of students are present in the reading group variable; the names of the groups; and the numbers which have been assigned to each group.

⁸<http://cnx.org/content/m40728/latest/10.2.png/image>

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1: group 3.0 Visible: 11 of 11 Variables

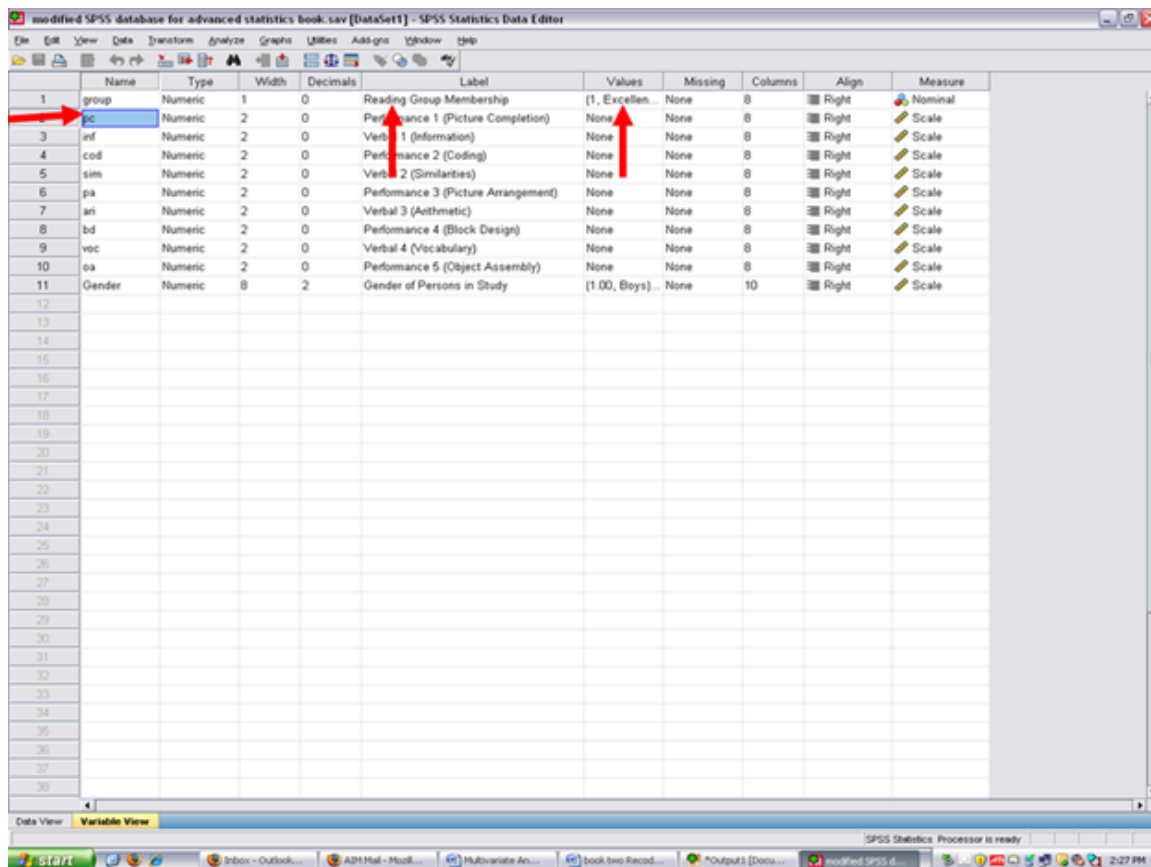
	group	pc	inf	cod	sim	pa	an	bd	voc	oa	Gender
1	3	8	12	6	12	9	9	8	8	8	1.00
2	3	8	12	6	12	9	9	8	8	8	1.00
3	3	9	5	6	5	11	6	10	4	7	1.00
4	3	3	4	11	4	7	6	3	4	10	1.00
5	3	5	7	17	6	8	10	7	5	9	1.00
6	3	2	5	8	8	9	7	10	3	5	1.00
7	3	9	6	10	6	9	8	4	5	8	1.00
8	3	5	9	7	10	9	12	11	7	8	1.00
9	3	6	7	5	8	7	7	7	4	7	1.00
10	3	7	8	11	6	8	4	3	3	4	1.00
11	3	6	6	8	12	9	9	9	10	6	1.00
12	3	7	8	3	1	9	8	5	10	3	1.00
13	3	12	8	7	8	13	10	11	7	6	1.00
14	3	10	9	10	10	11	11	14	11	11	1.00
15	3	3	4	4	8	7	7	5	6	7	1.00
16	3	3	4	4	8	7	7	5	6	7	1.00
17	3	8	4	9	7	9	8	10	7	7	1.00
18	3	5	9	6	6	5	7	9	4	4	1.00
19	3	6	8	11	8	10	11	2	8	4	1.00
20	3	3	6	8	6	6	8	3	2	6	1.00
21	3	11	8	8	10	9	9	12	11	9	1.00
22	3	17	11	6	11	13	9	14	11	13	1.00
23	3	9	12	6	11	11	7	9	9	12	1.00
24	1	7	10	11	4	8	7	11	7	10	1.00
25	3	7	8	7	10	11	10	7	9	8	1.00
26	3	5	5	8	6	6	8	4	8	4	1.00
27	3	8	7	7	7	2	8	8	6	11	1.00
28	3	9	2	6	8	10	7	4	6	6	1.00
29	3	14	8	8	8	12	8	8	8	9	1.00
30	3	8	8	7	10	11	11	3	9	8	1.00
31	3	11	3	4	7	8	8	10	4	10	1.00
32	3	10	7	9	8	10	8	10	5	11	1.00
33	3	4	11	9	6	13	11	9	4	7	1.00
34	3	12	12	7	8	4	8	9	9	8	1.00
35	3	11	9	7	8	10	11	9	11	9	1.00
36	3	8	5	9	1	7	9	11	8	8	1.00
37	3	7	6	6	7	6	11	6	7	6	1.00

Data View Variable View

SPSS Statistics Processor is ready

After clicking on Variable View, the following screen will appear: Arrows have been placed toward the name of the independent or grouping variable; toward the label assigned to this variable; and then toward the values of each group.

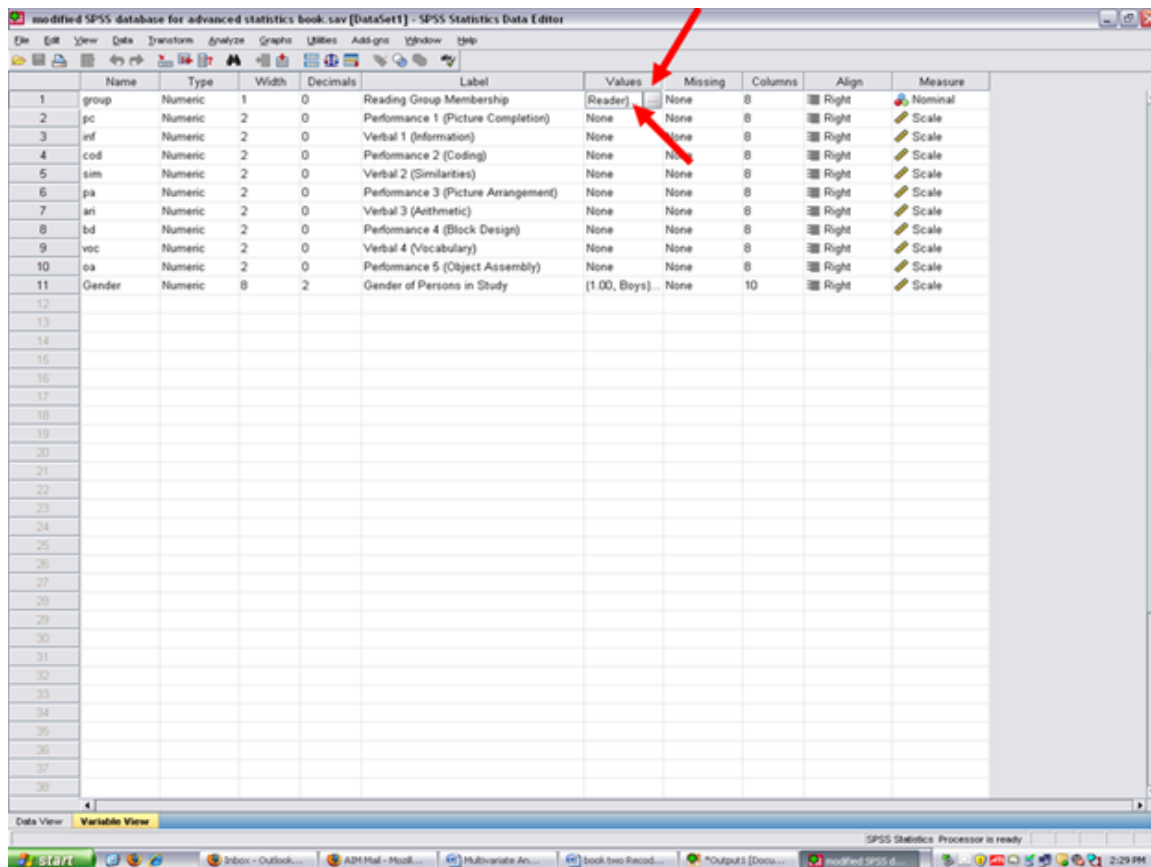
⁹<http://cnx.org/content/m40728/latest/10.3.png/image>



10

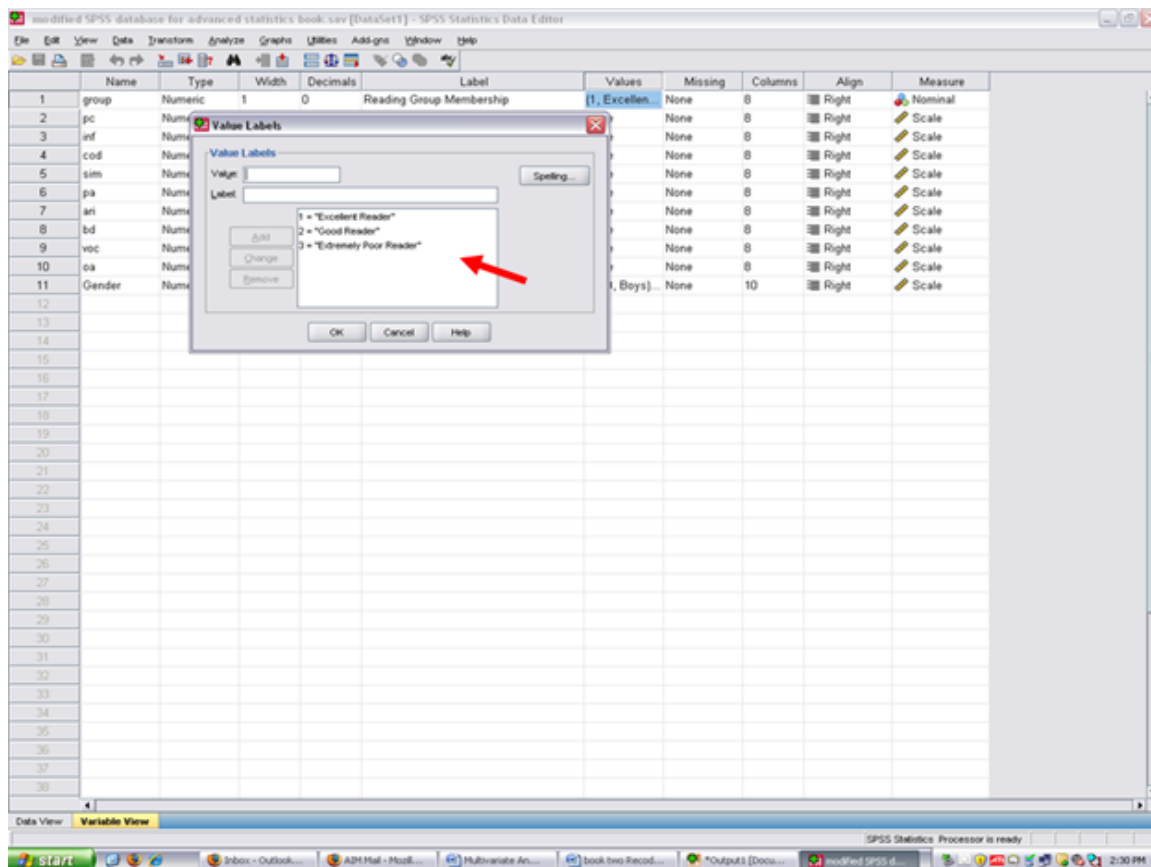
Now click on the cell for Reading Group Membership. Three dots will appear, indicating that another screen is beneath this one.

¹⁰<http://cnx.org/content/m40728/latest/10.4.png/image>



Click on the three dots shown in the screen above and the value and name of each of the reading groups will be shown. Our three groups are Excellent Reader (1), Good Reader (2), and Extremely Poor Reader (3).

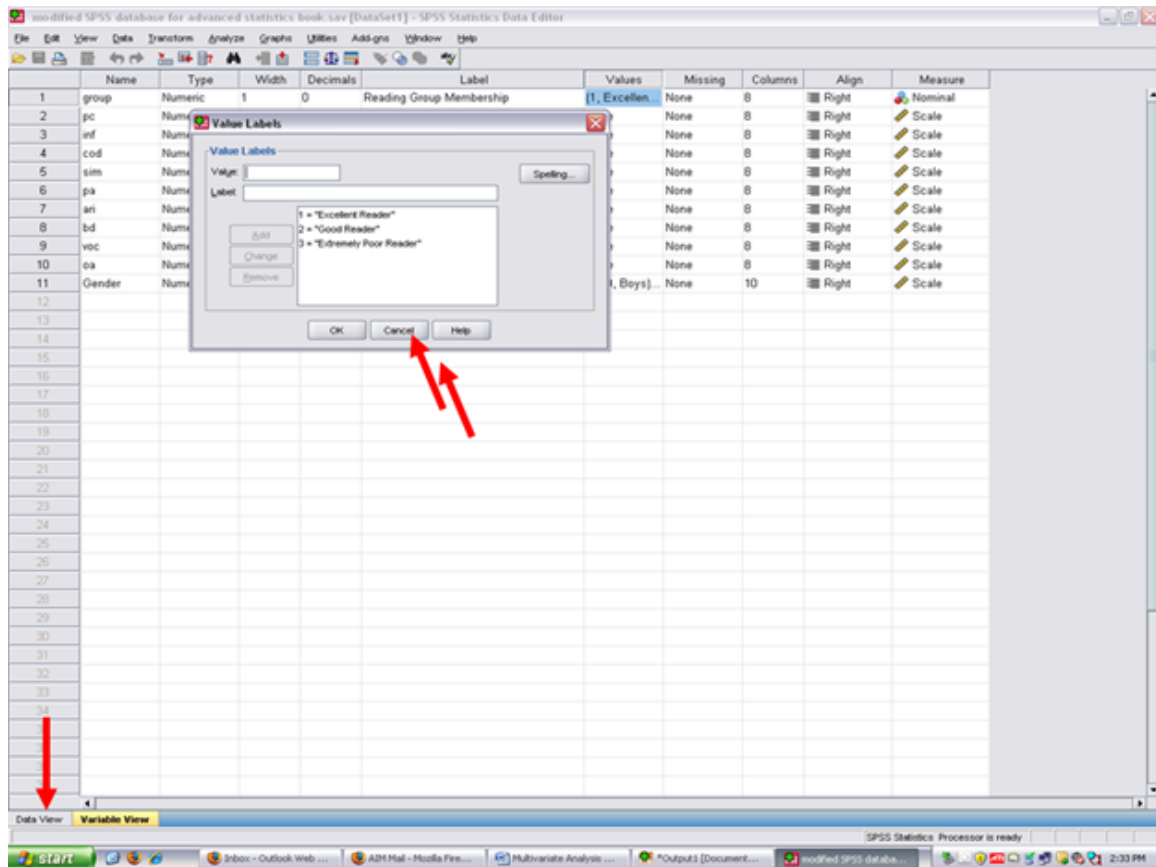
¹¹<http://cnx.org/content/m40728/latest/10.5.png/image>



12

Now that you know what your independent (grouping) variable is and your dependent variables are, it is time to determine the extent to which the dependent variable data are normally distributed. Cancel out of the screen above. Then click on data view.

¹²<http://cnx.org/content/m40728/latest/10.6.png/image>



Your screen should now look like the one below.

¹³<http://cnx.org/content/m40728/latest/10.7.png/image>

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File Edit View Data Transform Analyze Graphs Utilities Add-ons Window Help

1: group 3.0 Visible: 11 of 11 Variables

	group	pc	inf	cod	sim	pa	an	bd	voc	ea	Gender			
1	3	8	12	6	12	9	9	8	8	8				
2	3	8	12	6	12	9	9	8	8	8				
3	3	9	5	6	5	11	6	10	4	7				
4	3	3	4	11	4	7	6	3	4	10	1.00			
5	3	5	7	17	6	8	10	7	5	9	1.00			
6	3	2	5	8	8	9	7	10	3	5	1.00			
7	3	9	6	10	6	9	8	4	5	8	1.00			
8	3	5	9	7	10	9	12	11	7	8	1.00			
9	3	6	7	5	8	7	7	7	4	7	1.00			
10	3	7	8	11	6	8	4	3	3	4	1.00			
11	3	6	6	8	12	9	9	9	10	6	1.00			
12	3	7	8	3	1	9	8	5	10	3	1.00			
13	3	12	8	7	8	13	10	11	7	6	1.00			
14	3	10	9	10	10	11	11	14	11	11	1.00			
15	3	3	4	4	8	7	7	5	6	7	1.00			
16	3	3	4	4	8	7	7	5	6	7	1.00			
17	3	8	4	9	7	9	8	10	7	7	1.00			
18	3	5	9	6	6	5	7	9	4	4	1.00			
19	3	6	8	11	8	10	11	2	8	4	1.00			
20	3	3	6	8	6	6	8	3	2	6	1.00			
21	3	11	8	8	10	9	9	12	11	9	1.00			
22	3	17	11	6	11	13	9	14	11	13	1.00			
23	3	9	12	6	11	11	7	9	9	12	1.00			
24	1	7	10	11	4	8	7	11	7	10	1.00			
25	3	7	8	7	10	11	10	7	9	8	1.00			
26	3	5	5	8	6	6	8	4	8	4	1.00			
27	3	8	7	7	7	2	8	8	6	11	1.00			
28	3	9	2	6	8	10	7	4	6	6	1.00			
29	3	14	8	8	8	12	8	8	8	9	1.00			
30	3	8	8	7	10	11	11	3	9	8	1.00			
31	3	11	3	4	7	8	8	10	4	10	1.00			
32	3	10	7	9	8	10	8	10	5	11	1.00			
33	3	4	11	9	6	13	11	9	4	7	1.00			
34	3	12	12	7	8	4	8	9	9	8	1.00			
35	3	11	9	7	8	10	11	9	11	9	1.00			
36	3	8	5	9	1	7	9	11	8	8	1.00			
37	3	7	6	6	7	6	11	6	7	6	1.00			

Data View Variable View

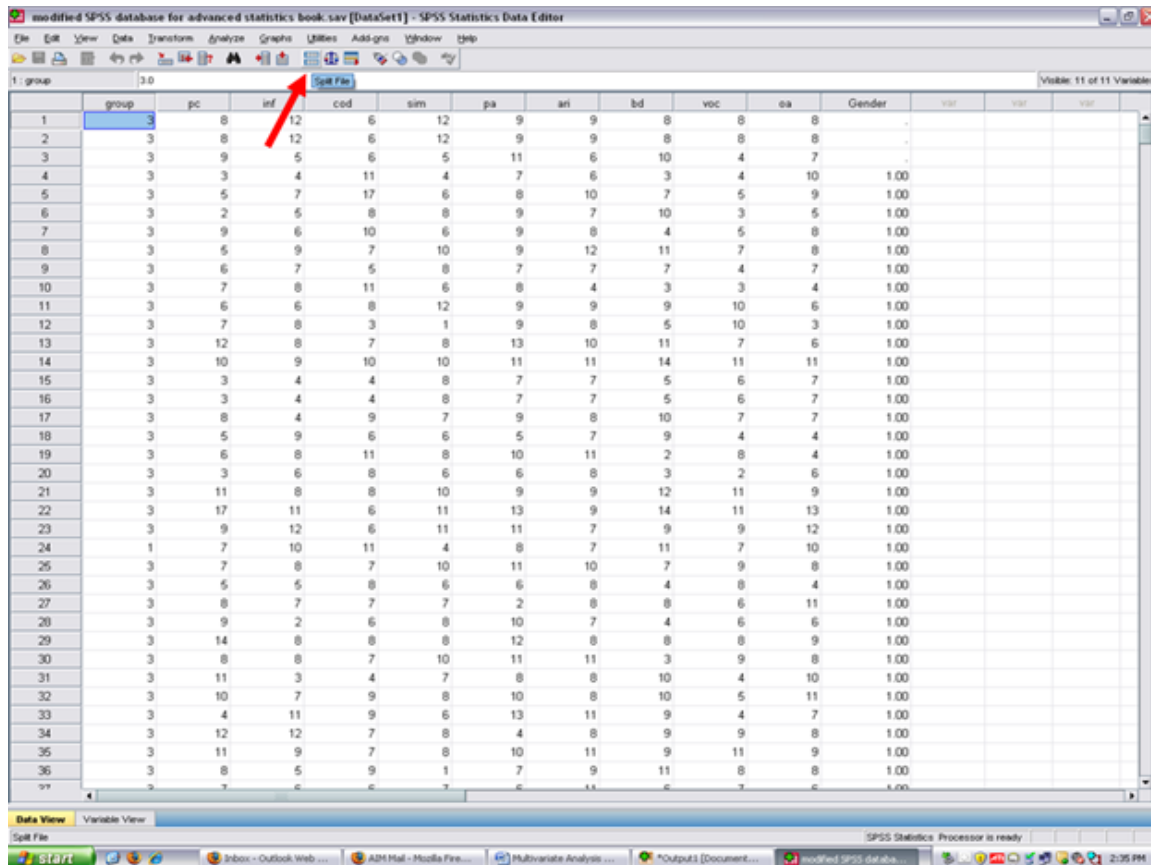
SPSS Statistics Processor is ready

14

Check for Skewness and Kurtosis values falling within/without the parameters of normality (-3 to +3). To do so, you need to obtain these values for each of your three groups for each of your four dependent variables.

✓ Split your file on the basis on your independent variable/fixed factor/grouping variable. To do so, click on the icon next to the scales. Holding your cursor on it will reveal Split File, as shown below.

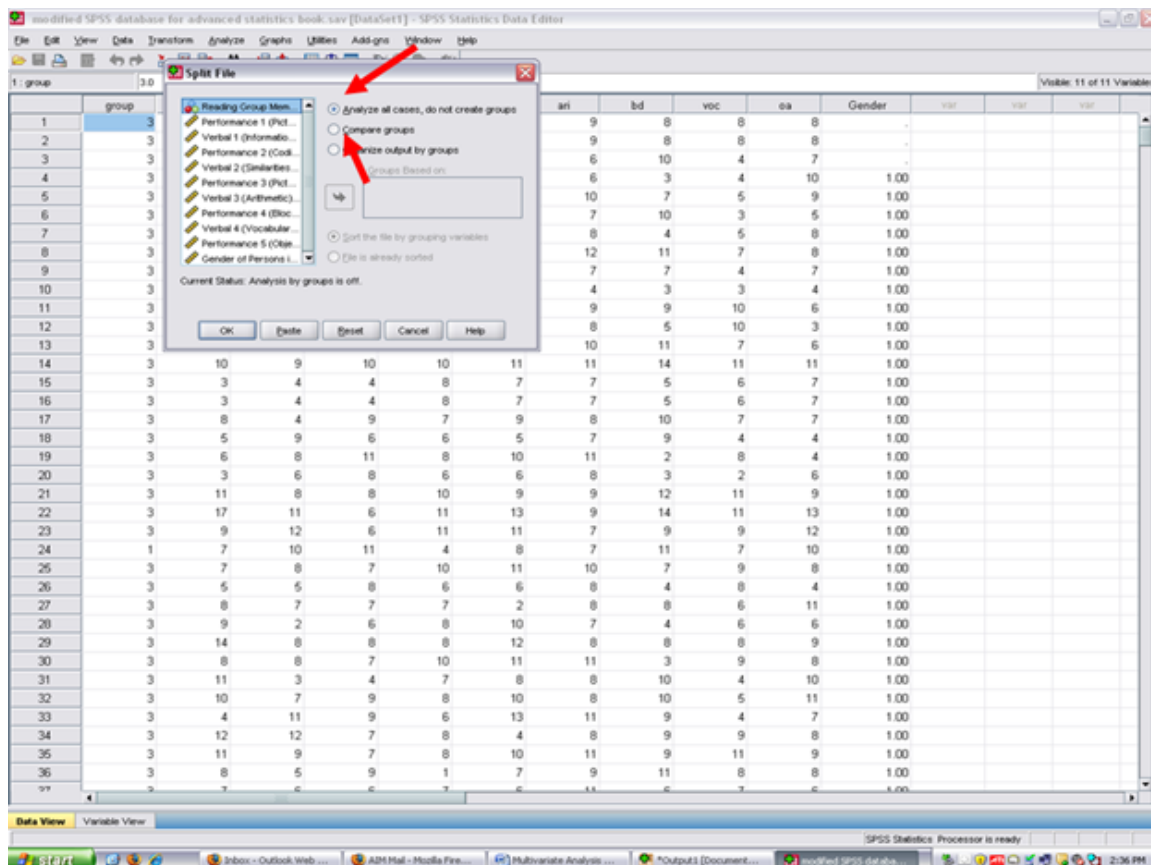
¹⁴<http://cnx.org/content/m40728/latest/10.8.png/image>



15

After clicking on the split file icon, the following screen will appear: You will note that the Analyze all cases, do not create groups is checked. This value is the default for SPSS as all cases are analyzed, unless otherwise specified. To obtain measures of normality for each of the three reading groups, the Compare groups button will need to be clicked.

¹⁵<http://cnx.org/content/m40728/latest/10.9.png/image>



16

The screen below will appear after the Compare groups button has been clicked. Note that the Groups Based on rectangle has now become active. The independent (grouping) variable should be highlighted, as it already is, and then moved to the Groups Based on cell. After highlighting the Reading Group Membership variable, then click on the arrow below.

¹⁶<http://cnx.org/content/m40728/latest/10.10.png/image>

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