

### Topic 1: Between-Group Variance and Within-Group Variance

1) The following questions ask you to compare between-group variances for pairs of experiments. In each case, it is possible to answer the question without having to calculate actual variance values.

Study A		Study B	
Level A <sub>1</sub>	Level A <sub>2</sub>	Level B <sub>1</sub>	Level B <sub>2</sub>
1	2	1	3
1	2	1	3
1	2	1	3
1	2	Level Means	1

1a) Which experiment has the higher *between-group variance*?

Study A		Study B	
Level A <sub>1</sub>	Level A <sub>2</sub>	Level B <sub>1</sub>	Level B <sub>2</sub>
1	3	1	2
2	4	2	3
3	5	3	4
2	4	Level Means	2

1b) Which experiment has the higher *between-group variance*?

Study A		Study B	
Level A <sub>1</sub>	Level A <sub>2</sub>	Level B <sub>1</sub>	Level B <sub>2</sub>
2	4	0	2
2	4	1	3
2	4	2	4
2	4	Level Means	1

1c) Which experiment has the higher *between-group variance*?

Study A		Study B	
Level A <sub>1</sub>	Level A <sub>2</sub>	Level B <sub>1</sub>	Level B <sub>2</sub>
0	1	2	1
1	2	4	3
2	3	6	5
1	2	Level Means	4

1d) Which experiment has the higher *between-group variance*?

Study A		Study B	
Level A <sub>1</sub>	Level A <sub>2</sub>	Level B <sub>1</sub>	Level B <sub>2</sub>
-2	0	-1	0
-1	1	0	1
0	2	1	2
-1	1	Level Means	0

1e) Which experiment has the higher *between-group variance*?

Study A			Study B		
Level A <sub>1</sub>	Level A <sub>2</sub>	Level A <sub>3</sub>	Level B <sub>1</sub>	Level B <sub>2</sub>	Level B <sub>3</sub>
1	2	3	2	3	2
2	3	4	3	4	4
3	4	5	4	5	6
2	3	4	Level Means	3	4

1f) Which experiment has the higher *between-group variance*?

2) The following questions ask you to compare within-group variances for pairs of levels (a to d) and pairs of experiments (e/f). In each case, it is possible to answer the question without having to calculate actual variance values.

Study A		
Level	Level	
A <sub>1</sub>	A <sub>2</sub>	
0	0	
0	1	
0	0	
Level Means		0    0.3

2a) Which *level* has the higher *within-group variance*?

Level A<sub>1</sub>

Level A<sub>2</sub>

Same

Study A		
Level	Level	
A <sub>1</sub>	A <sub>2</sub>	
1	2	
3	3	
5	4	
Level Means		3    3

2b) Which *level* has the higher *within-group variance*?

Level A<sub>1</sub>

Level A<sub>2</sub>

Same

Study A		
Level	Level	
A <sub>1</sub>	A <sub>2</sub>	
1	1	
2	2	
3	4	
Level Means		2    2.3

2c) Which *level* has the higher *within-group variance*?

Level A<sub>1</sub>

Level A<sub>2</sub>

Same

Study A		
Level	Level	
A <sub>1</sub>	A <sub>2</sub>	
1	3	
2	4	
3	5	
Level Means		2    4

2d) Which *level* has the higher *within-group variance*?

Level A<sub>1</sub>

Level A<sub>2</sub>

Same

Study A		Study B	
Level	Level	Level	Level
A <sub>1</sub>	A <sub>2</sub>	B <sub>1</sub>	B <sub>2</sub>
1	7	1	1
2	8	2	3
3	9	3	5
2	8	2	3
Level Means			

2e) Which *experiment* has the higher *within-group variance*?

Study A

Study B

Same

Study A		Study B	
Level	Level	Level	Level
A <sub>1</sub>	A <sub>2</sub>	B <sub>1</sub>	B <sub>2</sub>
1	1	1	3
2	2	2	4
3	3	3	5
3	3	3	4
Level Means			

2f) Which *experiment* has the higher *within-group variance*?

Study A

Study B

Same

**Topic 1: Between-Subjects ANOVA**

1) In the following table there are data from a between-subjects design experiment with two levels. ***This is Data Set 1***

Level A <sub>1</sub>	Level A <sub>2</sub>
1	2
2	3
3	4
3	4
4	5
5	6

1a) What is the mean and standard deviation for each level?

1b) Perform an Analysis of Variance on Data Set 1 to determine whether or not there is a significant difference in means between the two levels. Fill in the details on the table.

Source	Sum of Squares	Degrees of Freedom	Variance (Mean Square)	F-value	p-value (sig. level)
<b>A</b> BETWEEN-GROUP					
<b>S/A</b> WITHIN-GROUP					
<b>TOTAL</b>					

1c) What is the value of the error term?

1d) What are the Degrees of Freedom of the F value

1e) What is the critical value for these Degrees of Freedom ( $p < .01$  and  $p < .05$ )

1f) Is F significant? At what level [Circle]?     $p > .05$      $p < .05$      $p < .01$

2) In the following table there are data from another between-subjects design experiment with two levels, this time with a larger difference between the means. Note that the scores in Level A<sub>1</sub> duplicate those of Data Set 1/Level A<sub>1</sub>. ***This is Data Set 2***

Level A <sub>1</sub>	Level A <sub>2</sub>
1	3
2	4
3	5
3	5
4	6
5	7

2a) What is the mean and standard deviation for each level?

2b) Compare Data Sets 1 and 2 [*Do not perform further calculations to answer these*]

Which will have the higher between-group variance?

Data Set 1 will be higher	Data Set 2 will be higher	Data Sets will be Identical
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Which will have the higher within-group variance?

Data Set 1 will be higher	Data Set 2 will be higher	Data Sets will be Identical
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Which will have higher  $F$  ratio

Data Set 1 will be higher	Data Set 2 will be higher	Data Sets will be Identical
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2c) Perform an Analysis of Variance on Data Set 2 to determine whether or not there is a significant difference in means between the two levels. Fill in the details on the table.

Source	Sum of Squares	Degrees of Freedom	Variance (Mean Square)	<i>F</i> -value	<i>p</i> -value (sig. level)
<b>A</b> BETWEEN-GROUP					
<b>S/A</b> WITHIN-GROUP					
<b>TOTAL</b>					

2d) What is the value of the error term?

2e) What are the Degrees of Freedom of the *F* value

2f) What is the critical value for these Degrees of Freedom ( $p < .01$  and  $p < .05$ )

2g) Is *F* significant? At what level [Circle]?     $p > .05$      $p < .05$      $p < .01$

3) In the following table there are data from another between-subjects design experiment, this time with four levels. Note that these data duplicate the scores of Data Set 1.

***This is Data Set 3***

Level A <sub>1</sub>	Level A <sub>2</sub>	Level A <sub>3</sub>	Level A <sub>4</sub>
1	2	1	2
2	3	2	3
3	4	3	4
3	4	3	4
4	5	4	5
5	6	5	6

3a) What is the mean and standard deviation for each level?

3b) Compare Data Sets 1 and 3 *[Do not perform further calculations to answer these]*

Which will have the higher between-group variance?

Data Set 1 will be higher	Data Set 3 will be higher	Data Sets will be Identical
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Which will have the higher within-group variance?

Data Set 1 will be higher	Data Set 3 will be higher	Data Sets will be Identical
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Which will have higher *F* ratio

Data Set 1 will be higher	Data Set 3 will be higher	Data Sets will be Identical
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3c) Perform an Analysis of Variance on Data Set 3 to determine whether or not there is a significant difference in means between the levels. Fill in the details on the table.

Source	Sum of Squares	Degrees of Freedom	Variance (Mean Square)	F-value	p-value (sig. level)
<b>A</b> BETWEEN-GROUP					
<b>S/A</b> WITHIN-GROUP					
<b>TOTAL</b>					

3d) What is the value of the error term?

3e) What are the Degrees of freedom of the  $F$  value

3f) What is the critical value for these Degrees of Freedom ( $p < .01$  and  $p < .05$ )

3g) Is  $F$  significant? At what level [Circle]?  $p > .05$        $p < .05$        $p < .01$

4) In the following table there are data from another between-subjects design experiment with two levels, this time with twice as many scores per level. Note that the scores in both Level A<sub>1</sub> and Level A<sub>2</sub> duplicate those of Data Set 1. ***This is Data Set 4***

Level A <sub>1</sub>	Level A <sub>2</sub>
1	2
2	3
3	4
3	4
4	5
5	6
1	2
2	3
3	4
3	4
4	5
5	6

4a) What is the mean and standard deviation for each level?

4b) Compare Data Sets 1 and 4 [*Do not perform further calculations to answer this*]

Which do you expect to have the higher *F* ratio

Data Set 1 will be higher	Data Set 4 will be higher	Data Sets will be Identical
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4c) Perform an Analysis of Variance on Data Set 4 to determine whether or not there is a significant difference in means between the levels. Fill in the details on the table.

Source	Sum of Squares	Degrees of Freedom	Variance (Mean Square)	F-value	p-value (sig. level)
<b>A</b> BETWEEN-GROUP					
<b>S/A</b> WITHIN-GROUP					
<b>TOTAL</b>					

4d) What is the value of the error term?

4e) What are the Degrees of freedom of the *F* value

4f) What is the critical value for these Degrees of Freedom ( $p < .01$  and  $p < .05$ )

4g) Is *F* significant? At what level [Circle]?     $p > .05$      $p < .05$      $p < .01$

4h) Compare the ANOVA tables for Data Sets 1 and 4

Which has the higher between-group variance?

Data Set 1 is higher	Data Set 4 is higher	Data Sets are Identical
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Which has the higher within-group variance?

Data Set 1 is higher	Data Set 4 is higher	Data Sets are Identical
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5) Doubling up the data from Data Set 1 still did not give a significant effect, so perhaps tripling up the data will give one. In the following table there are data from another between-subjects design experiment with two levels, this time with three as many scores per level as Data Set 1. The scores in both Level A<sub>1</sub> and Level A<sub>2</sub> triplicate those of Data Set 1. ***This is Data Set 5***

Level A <sub>1</sub>	Level A <sub>2</sub>
1	2
2	3
3	4
3	4
4	5
5	6
1	2
2	3
3	4
3	4
4	5
5	6
1	2
2	3
3	4
3	4
4	5
5	6

5a) What is the mean and standard deviation for each level?

5b) This time compare **Data Sets 2 and 5**  
*[Do not perform further calculations to answer this]*

Which do you expect to have the higher *F* ratio

Data Set 2 will be higher	Data Set 5 will be higher	Data Sets will be Identical
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5c) Perform an Analysis of Variance on Data Set 5 to determine whether or not there is a significant difference in means between the levels. Fill in the details on the table.

Source	Sum of Squares	Degrees of Freedom	Variance (Mean Square)	F-value	p-value (sig. level)
<b>A</b> BETWEEN-GROUP					
<b>S/A</b> WITHIN-GROUP					
<b>TOTAL</b>					

5d) What is the value of the error term?

5e) What are the Degrees of freedom of the  $F$  value

5f) What is the critical value for these Degrees of Freedom ( $p < .01$  and  $p < .05$ )

5g) Is  $F$  significant? At what level [Circle]?  $p > .05$        $p < .05$        $p < .01$