SPSS Chapter 21 Example 2 – Factorial Study with a Randomized Block Design

Henderson, L. Simple Reaction Time, Statistical Decision Theory and the Speed – Slowness Trade Off, *Psychonomic Science*, 1970, 21, 323-324, examined how two factors influenced reaction time. One factor was loudness at 3 levels (40, 60, and 90 db) and the other factor was type of instruction (speed vs. accuracy). Six people received all treatments ($3 \times 2 = 6$) in randomized order. Reaction time in milliseconds was the dependent variable. After opening the file, the data appear in the SPSS Data Editor window just like the following (please note that for the variable entitled Loudness, 1 = 40 db, 2 = 60 db, and 3 = 90 db; and for Type, 1 = accuracy and 2 = speed):

📺 Fac	🌐 Factorial Randomized Block - SPSS Data Editor 📃 🗗 🗙							
<u>F</u> ile <u>E</u>	<u>File E</u> dit <u>V</u> iew <u>D</u> ata <u>T</u> ransform <u>S</u> tatistics <u>G</u> raphs <u>U</u> tilities <u>W</u> indow <u>H</u> elp							
Ê	<u></u>							
27:rt 119								
	subject	loudness	type	rt	var	var	var	
1	1	1	1	183.00				
2	1	2	1	154.00				
3	1	3	1	136.00				
4	1	1	2	138.00				
5	1	2	2	127.00				
6	1	3	2	131.00				
7	2	1	1	243.00				
8	2	2	1	176.00				
9	2	3	1	149.00				
10	2	1	2	179.00				
•								
		SP	SS Processor is re	ady				

Follow these steps to analyze this Randomized Block:

1. Click **Analyse**, click **General Linear Model**, and click **Univariate**. The following window will appear.

R GLM - General Facto	rial		×
subject		<u>D</u> ependent Variable:	<u>M</u> odel
 (#) loudness (#) type 	لسنسا	J	Co <u>n</u> trasts
rt 🛞			Plo <u>t</u> s
			Post <u>H</u> oc
		Handom Factor(s):	<u>S</u> ave
			Options
	F	<u>Covariate(s):</u>	
	►	<u>W</u> LS Weight:	
OK.	Paste	<u>R</u> eset Cancel Help	

- 2. Click "rt" and click the arrow to move "rt" into the box entitled **Dependent** List.
- 3. Click "**subject**" and click the arrow to move "**subject**" into the box entitled **Fixed Factors**. Repeat this step for both "**type**" and "**loudness**".

4. Click on the button entitled, Model. The following window will appear:

GLM - General Fa	ctorial: Model	×
C Full factorial	<u>Custom</u>	Continue
Eactors & Covariate	es: <u>M</u> odel:	Cancel
subject(F) loudness(F) type(F)	Build Term(s) Main effects	Help
Sum of sguares:	Type III 🔄 🔽 Include intercept in	model

- 5. Click on the circle next to the word **Custom**. Click on "**subject**" and then click on the arrow located below the words **Build Term(s)** to move "**subject**" into the box entitled **Model**. Follow this procedure to move the other two factors into the same box.
- 6. Click on the downward-pointing arrow in the **Build Terms** box to make it read **Interactions**. Click on "**Ioudness**" to highlight it, then click on "**type**" to highlight it as well. Click on the arrow in the **Build Terms** box to move this interaction into the **Model** box.
- 7. Click Continue.

8. Click on the **Save** button and the following window will appear:



- 9. To choose information on residuals, diagnostics and predicted values simply click on the circle next to the information. Click **Continue**.
- 10. Click on the **Options** button to obtain descriptives, tests for homogeneity, power, effect sizes, etc.
- 11. Using your cursor, highlight all of the factors and the factor interaction under the title, **Estimated Marginal Means** and click on the arrow to move these factors into the box entitled **Display Means For**. Click **Continue**.

GLM - General Factorial: Optic	ons X
Estimated Marginal Means Eactor(s) and Factor Interactions (OVERALL) subject loudness type loudness*type	s: Display Means for: (OVERALL) subject loudness type
Display ✓ Descriptive statistics ✓ Estimates of effect size ✓ Observed power ← Parameter estimates ← Contrast coefficient matrix	 Homogeneity tests Spread vs. level plot <u>Residual plot</u> <u>Lack of fit</u> <u>General estimable function</u>
Significance le <u>v</u> el: .05	Confidence intervals are 95% Continue Cancel Help

The SPSS output for this example of the Randomized Block is the following:

Univariate Analysis of Variance

		Value Label	Ν
SUBJECT	1	Laber	6
	2		6
	3		6
	4		6
	5		6
	6		6
LOUDNESS	1	40 db	12
	2	60 db	12
	3	90 db	12
TYPE	1	accuracy	18
	2	speed	18

Between-Subjects Factors

Levene's Test of Equality of Error Variance's

Dependent Variable: RT

F	df1	df2	Sig.
	35	0	-

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design:

Intercept+SUBJECT+LOUDNESS+TYPE+LOUDNESS * TYPE

Tests of Between-Subjects Effects

Dependent Variable: RT

	Type III Sum of		Mean			Eta	Noncent.	Observed
Source	Squares	df	Square	F	Sig.	Squared	Parameter	Power
Corrected Model	133330.444 ^b	10	13333.044	11.408	.000	.820	114.079	1.000
Intercept	1012706.778	1	012706.78	866.486	.000	.972	866.486	1.000
SUBJECT	94426.222	5	18885.244	16.158	.000	.764	80.792	1.000
LOUDNESS	22140.389	2	11070.194	9.472	.001	.431	18.944	.964
TYPE	13533.444	1	13533.444	11.579	.002	.317	11.579	.905
LOUDNESS * TY	3230.389	2	1615.194	1.382	.270	.100	2.764	.269
Error	29218.778	25	1168.751					
Total	1175256.000	36						
Corrected Total	162549.222	35						

a.Computed using alpha = .05

b-R Squared = .820 (Adjusted R Squared = .748)

Note the blocking variable(subjects) is assumed to have an effect on reducing error. This is confirmed above with the sign p-value. The interaction is not sign but the main effects are important .If a-priori contrasts are available they could be calculated. Multiple comparisons are possible on the sign effects.

Estimated Marginal Means

1. Grand Mean

Dependent Variable: RT

		95% Confide	ence Interval	
		Lower Upper		
Mean	Std. Error	Bound	Bound	
167.722	5.698	155.987	179.457	

2. SUBJECT

Dependent Variable: RT

			95% Confidence Interval	
			Lower	Upper
SUBJECT	Mean	Std. Error	Bound	Bound
1	144.833	13.957	116.089	173.578
2	171.333	13.957	142.589	200.078
3	278.333	13.957	249.589	307.078
4	138.333	13.957	109.589	167.078
5	146.333	13.957	117.589	175.078
6	127.167	13.957	98.422	155.911

3. LOUDNESS

Dependent Variable: RT

			95% Confidence Interva	
			Lower Upper	
LOUDNESS	Mean	Std. Error	Bound	Bound
40 db	200.083	9.869	179.758	220.409
60 db	163.250	9.869	142.925	183.575
90 db	139.833	9.869	119.508	160.159

4. TYPE

Dependent Variable: RT

			95% Confidence Interval		
			Lower Upper		
TYPE	Mean	Std. Error	Bound	Bound	
accuracy	187.111	8.058	170.515	203.707	
speed	148.333	8.058	131.738	164.929	

5. LOUDNESS * TYPE

Dependent Variable: RT

				95% Confidence Interval	
				Lower	Upper
LOUDNESS	TYPE	Mean	Std. Error	Bound	Bound
40 db	accuracy	230.333	13.957	201.589	259.078
	speed	169.833	13.957	141.089	198.578
60 db	accuracy	184.000	13.957	155.255	212.745
	speed	142.500	13.957	113.755	171.245
90 db	accuracy	147.000	13.957	118.255	175.745
	speed	132.667	13.957	103.922	161.411

Note the subject means are usually not of interest. The sign. effects means are useful for reporting results. Sometimes these means are reported along with the corresponding confidence interval to obtain a measure of accuracy and an estimate of the population mean.

Dependent Variable: RT



Model: Intercept + SUBJECT + LOUDNESS + TYPE + LOUDNESS*TYPE