2x2 Mixed Groups Factorial ANOVA

Application: Examination of the main effects and the interaction relating two independent variables to a single quantitative dependent variable when one of the independent variables involves a between-groups comparison and the other independent variable involves a within-groups comparison.

Research Hypothesis: The researcher hypothesized that there would be an interaction between dog breed (Collie or German Shepherd) and week of obedience school training (all dogs measured at 1 week and 5 weeks) as they relate to the number of times the dog growls per week. Specifically, it was hypothesized that Collies would show no difference in growls between 1 week and 5 weeks, but German Shepherds would growl less at 5 weeks than at 1 week.

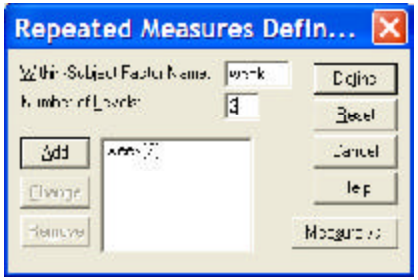
Research Design: The IVs are Breed (BG), with the conditions Collie & German Shepard and Week of Training (WG) with the conditions Week 1 & Week 2
The DV is the number of times a dog growls each week

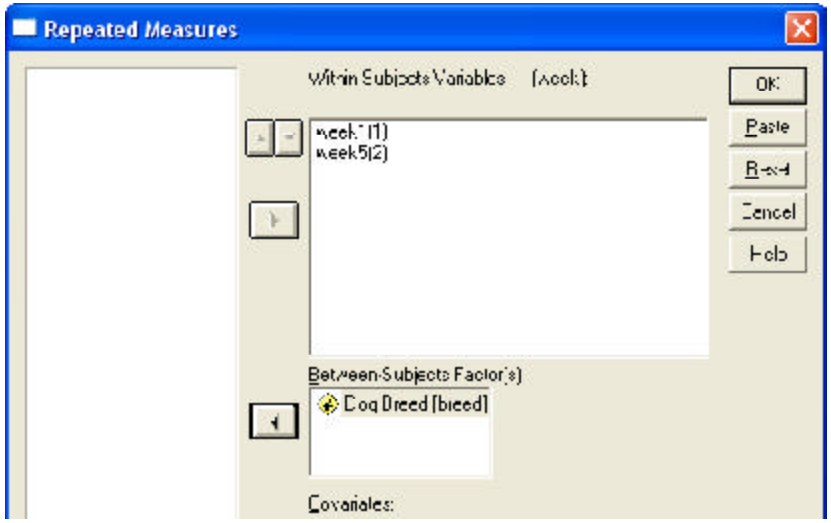
Breed (BG)	Week of Training (WG) Week 1	Week 5
Collie		
German Shepard		

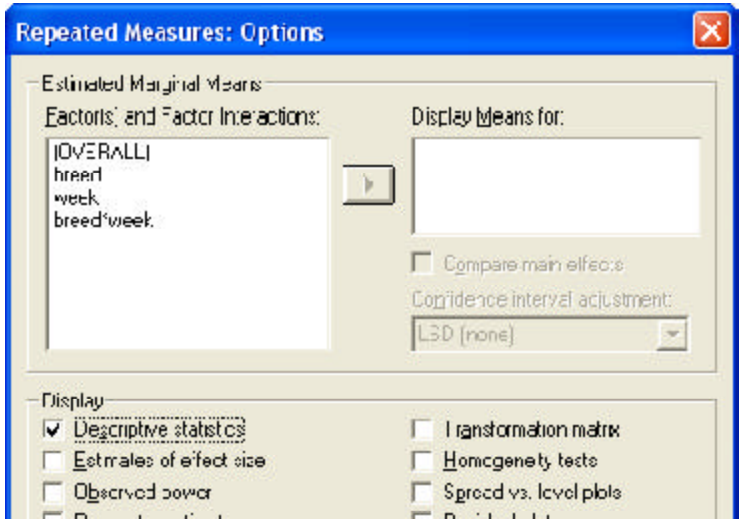
Variables in the Analysis: In a MG factorial design the variables in the analysis are the BG IV (Breed) and the variables that hold the DV scores for each IV condition (week1 & week2)

Analyze ➔ General Linear Model ➔ Repeated Measures

- In the **Repeated Measures Definition** window name the WG IV
- Type number of conditions of WG IV in the Number of Levels box
- Press "Add" button
- Press "Define" button
- In the **Repeated Measures** window highlight the variables holding the DV score in each of the WG IV conditions and press the arrow
- Highlight the BG IV and press the arrow
- Click "Options" button -- in the **Repeated Measures: Options** check Descriptive Statistics







Below are the descriptive statistics:

Descriptive Statistics

	Dog Breed	Mean	Std. Deviation	N
Growls at week 1	Collie	1.2000	.8944	20
	German Shepherd	6.0000	2.1521	20
	Total	3.6000	2.9247	40
Growls at week 5	Collie	1.1500	.875	20
	German Shepherd	.8500	.875	20
	Total	1.0000	.877	40

Below is a table of the type commonly used in research reports which was composed from the SPSS output table on the left -- be sure you know where all cell and marginal means came from !!

	Week of Training: Week 1	Week 5	
Breed: Collie	1.2	1.15	1.18
German Shepard	6.00	.85	3.43
	3.60	1.00	

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
WEEK	Sphericity Assumed	135.200	1	135.200	105.387	.000
	Greenhouse-Geisser	135.200	1.000	135.200	105.387	.000
	Huynh-Feldt	135.200	1.000	135.200	105.387	.000
	Lower-bound	135.200	1.000	135.200	105.387	.000
WEEK * BREED	Sphericity Assumed	130.050	1	130.050	101.372	.000
	Greenhouse-Geisser	130.050	1.000	130.050	101.372	.000
	Huynh-Feldt	130.050	1.000	130.050	101.372	.000
	Lower-bound	130.050	1.000	130.050	101.372	.000
Error(WEEK)	Sphericity Assumed	48.750	38	1.283		
	Greenhouse-Geisser	48.750	38.000	1.283		
	Huynh-Feldt	48.750	38.000	1.283		
	Lower-bound	48.750	38.000	1.283		

SPSS provides different "versions" of the ANOVA output. We will use the traditional analysis, which SPSS labels as "Sphericity Assumed"

df(cond), F and p-values for Week main effect

df(cond), F and p-values for Week x Dog Breed interaction

df(error), MSe for **both** the Week main effect & the Week x Dog Breed interaction

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	423.200	1	423.200	192.479	.000
BREED	101.250	1	101.250	46.050	.000
Error	83.550	38	2.199		

df(cond), F and p-values for Dog Breed main effect

df(error), MSe for the Dog Breed main effect

Using LSD to describe the pattern of the Interaction

From the F-test we know that there is an interaction, but we don't know if pattern predicted by the interaction RH:

To do this we need to calculate the $_{LSD}$ for the cell means -- then we can evaluate the simple effects and test the interaction RH:

based on df(error) = 38, **t = 2.02** also **n = 80/4 = 20** **MS(error) = 1.283**

$$d_{LSD} = \frac{t * \sqrt{(2 * MS_{Error})}}{\sqrt{n}} = \frac{2.02 * \sqrt{(2 * 1.283)}}{\sqrt{20}} = .7235$$

Applying this d_{LSD} to the cell means ...

SE of Dog Breed:
For Collies 1 week = 5 weeks
For German Shepherds 1 week > 5 weeks

SE of Week in training:
For 1 week Collies < German Shepherds
For 5 weeks Collies = German Shepherds

We need only one set of simple effects to describe the pattern of the interaction, but we need each set to evaluate the descriptiveness of the corresponding main effect.

t-table

df	α=.05
10	2.23
11	2.20
12	2.18
13	2.16
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19	2.09
20	2.08
22	2.07
24	2.06
26	2.06
28	2.05
30	2.04
40	2.02
60	2.00
120	1.98
∞	1.96

Reporting the Results:

A mixed-groups factorial ANOVA with follow-ups using the LSD procedure (alpha = .05) was performed to examine the effects of dog breed duration in obedience school on the number of times dogs growled per week. Table 1 shows the means for the conditions of the design. There was an interaction between dog breed and week in school F(1,38)= 101.37, MSE= 1.28, p < .001. As hypothesized, Collies showed no difference in growls between 1 week and 5 weeks, but German Shepherds growled less at 5 weeks than at 1 week (using LSD= .7235). There was a main effect for dog breed (F(1,38)= 46.05, MSE= 2.20, p < .001) with overall fewer growls for Collies than German Shepherds. However, this was only descriptive for growls at 1 week. At 5 weeks, there was no difference in growls between Collies and German Shepherds. There was a main effect of week of training (F(1,38)= 105.39, MSE= 1.28, p < .001) with overall more growls at 1 week than at 5 weeks. However, this was only descriptive for German Shepherds. For Collies, there was no difference in growls between 1 week and 5 weeks.

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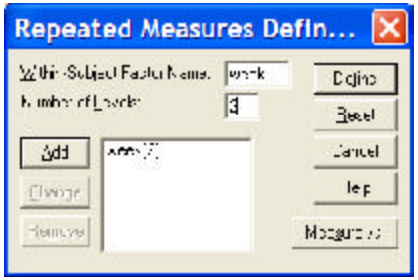

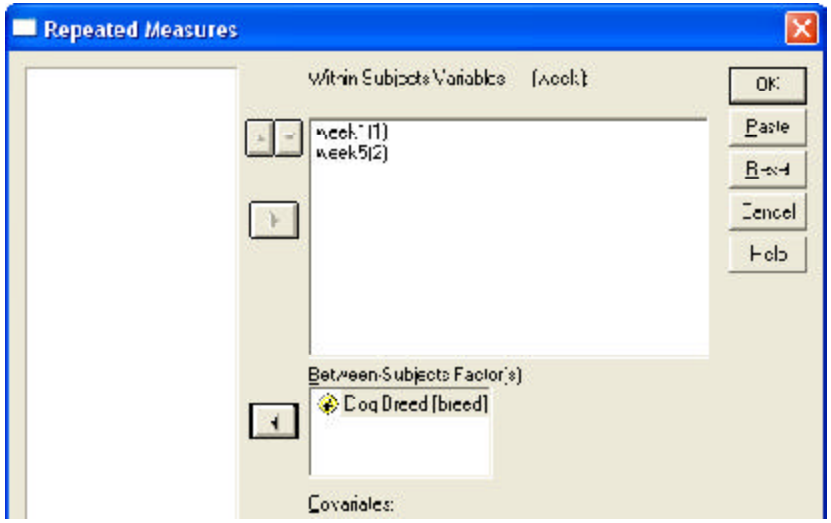

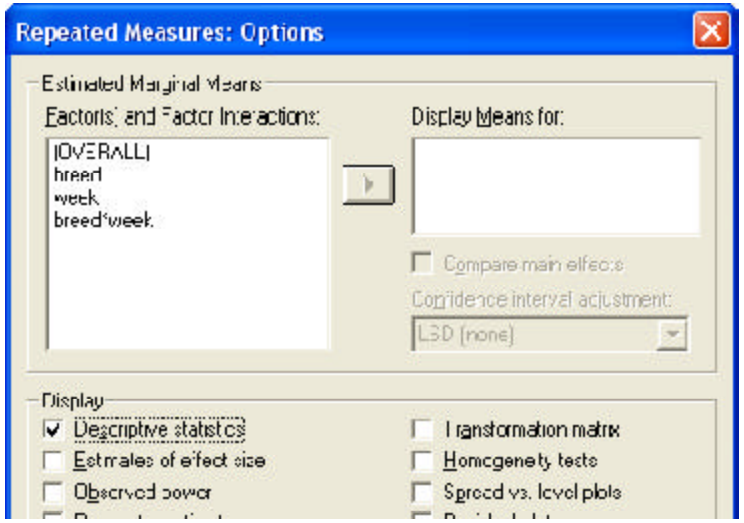

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