

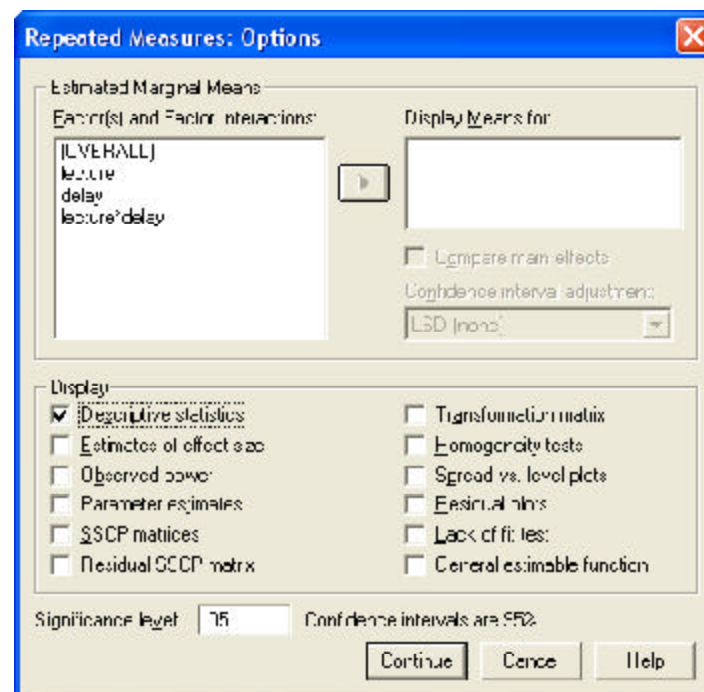
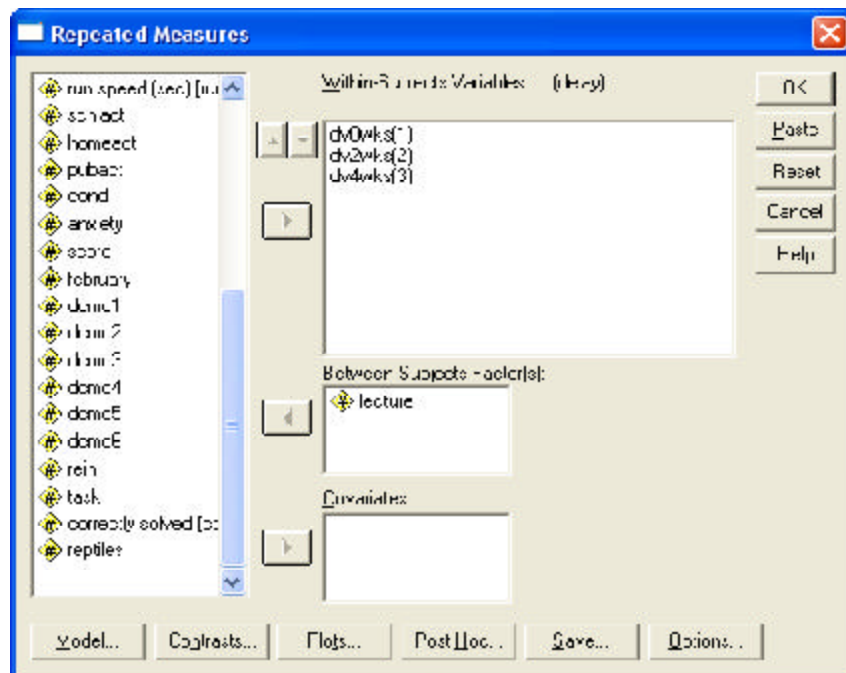
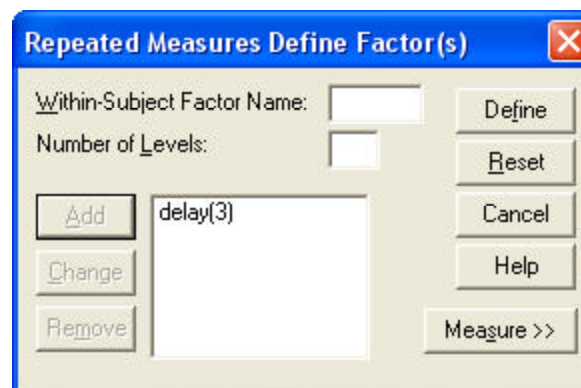
kxk Mixed Groups Factorial ANOVA

Application: Examination of main effects and interaction relating two IVs to a single quantitative DV when one of the IVs involves a between groups comparison and the second IV involves a within-groups comparison.

Research Hypothesis: The researcher hypothesized that there would be an interaction between Type of Lecture (what topic was used to introduce the words) and Delay (how long between that introduction and the “test”). Specifically, the expected pattern was that there would be no effect of Delay for physical science or history but only for social science introductions. There were no main effect hypotheses.

Analyze → General Linear Model → Repeated Measures

- Specify WG IV
 - Type name of WG IV in “Within-Subject Factor Name” window (e.g., delay)
 - Type number of conditions of 1st IV (e.g., 3)
 - Press “Add” button
- Press “Define” button
 - Highlight the variable holding the DV score in each of the WG IV conditions and press the arrow, in turn (e.g., dv0wks into (1), dv2wks into (2), dv4wks into (3))
- Specify the BG IV
 - Highlight the BG IV and press the arrow to put it in the “Between Subject Factor(s)” window (e.g., lecture)
- Click “Options” button
 - Check “Descriptives”



Descriptive Statistics

	type of lecture given	Mean	Std. Deviation	N
DV measured immediately after lecture	physical science	47.7500	4.5735	4
	social science	41.2500	4.3493	4
	history	40.0000	3.9158	4
	Total	43.0000	5.2570	12
DV measured 2 weeks after lecture	physical science	44.2500	7.4106	4
	social science	20.0000	13.8323	4
	history	38.5000	5.8023	4
	Total	34.2500	13.8965	12
DV measures 4 weeks after lecture	physical science	41.7500	4.6458	4
	social science	10.7500	4.1130	4
	history	36.5000	10.3763	4
	Total	29.6667	15.4939	12

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 !!

Lecture	0 weeks	2 weeks	4 weeks	
Physical Sci.	47.75	44.25	41.75	44.58
Social Sci.	41.25	20.00	10.75	24.00
History	40.00	38.50	36.50	38.33
	43.00	34.25	29.67	

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
DELAY	Sphericity Assumed	1101.389	2	550.694	12.994	.000
	Greenhouse-Geisser	1101.389	1.800	611.792	12.994	.001
	Huynh-Feldt	1101.389	2.000	550.694	12.994	.000
	Lower-bound	1101.389	1.000	1101.389	12.994	.006
DELAY * LECTURE	Sphericity Assumed	952.444	4	238.111	5.619	.004
	Greenhouse-Geisser	952.444	3.601	264.529	5.619	.006
	Huynh-Feldt	952.444	4.000	238.111	5.619	.004
	Lower-bound	952.444	2.000	476.222	5.619	.026
Error(DELAY)	Sphericity Assumed	762.833	18	42.380		
	Greenhouse-Geisser	762.833	16.202	47.082		
	Huynh-Feldt	762.833	18.000	42.380		
	Lower-bound	762.833	9.000	84.759		

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

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

df(cond), F and p-values for Delay x Lecture interaction

df(error), MSE for **both** the Delay main effect & the Delay x Lecture interaction

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

df(error), MSE for the Lecture main effect

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	40401.000	1	40401.000	459.683	.000
LECTURE	1194.000	2	597.000	6.793	.016
Error	791.000	9	87.889		

We will use LSD minimum mean differences to further analyze the data. There are three significant effects (main effect of Practice Type, main effect of List Number and the interaction), so we will need three d_{LSD} values. One for cell means to explore the pattern of the interaction, a second for the marginal means of the main effect of Lecture (which as 3 IV conditions), and a third for the marginal means of the main effect of Delay (which has 3 IV conditions)

For the Interaction

based on $df(error) = 18$, $t = 2.10$ also $n = 4$ $MS(error) = 42.38$

$$d_{LSD} = \frac{t * \sqrt{(2 * MS_{Error})}}{\sqrt{n}} = \frac{2.10 * \sqrt{(2 * 42.38)}}{\sqrt{4}} = 9.67$$

Remember: n is based on the average number of data points making up each mean -- $N = 36$ and there are 9 conditions in the design, so $n = N/k = 36/9 = 4$

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

SE of Type of Lecture:

0 wks Delay	Phys(47.75) = Soc(41.25)	Soc = Hist(40.00)	Phys = Hist
2 wks Delay	Phys(44.25) > Soc(20.00)	Soc < Hist(38.50)	Phys = Hist
4 wks Delay	Phys(41.75) > Soc(10.75)	Soc < Hist(36.50)	Phys = Hist

SE of Delay

Phys. Sci.	0(47.75) = 2(44.25)	2 = 4(41.75)	0 = 4
Soc. Sci.	0(41.25) > 2(20.00)	2 = 4(10.75)	0 > 4
History	0(40.00) = 2(38.50)	2 = 4(36.50)	0 = 0

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

For the Main Effect of Delay

based on $df(\text{error}) = 18$, $t = 2.10$ also $n = 12$ $MS(\text{error}) = 42.38$

$$d_{\text{LSD}} = \frac{t * \sqrt{(2 * MS_{\text{Error}})}}{\sqrt{n}} = \frac{2.10 * \sqrt{(2 * 42.38)}}{\sqrt{12}} = 5.58$$

Remember: n is based on the average number of data points making up each mean -- $N = 36$ and there are 3 conditions of the Delay IV, so $n = N/k = 36/3 = 12$

Applying this d_{LSD} to the marginal means of Delay ...

0 wks(43.00) > 2 wks(34.25) 2 wks = 4 wks(29.67) 0 wks > 4 wks

We need to compare this pattern to those of the simple effect of Delay, to determine if the main effect is descriptive of potentially misleading.

As you can see, this main effect pattern corresponds only with the simple effect of Delay for Social Sciences, so this main effect description is potentially misleading as a general statement.

For the main effect of Lecture

based on $df(\text{error}) = 9$, $t = 2.26$ also $n = 12$ $MS(\text{error}) = 87.89$

$$d_{\text{LSD}} = \frac{t * \sqrt{(2 * MS_{\text{Error}})}}{\sqrt{n}} = \frac{2.26 * \sqrt{(2 * 87.89)}}{\sqrt{12}} = 8.65$$

Remember: n is based on the average number of data points making up each mean -- $N = 36$ and there are 3 conditions of the Lecture IV, so $n = N/k = 36/3 = 12$

Applying this d_{LSD} to the marginal means of Lecture ...

Phys(44.58) > Soc (24.00) Soc < Hist(38.33) Phys = Hist

We need to compare this pattern to those of the simple effects for TLecture, to determine if the main effect is descriptive or potentially misleading.

As you can see, the main effect pattern corresponds with both the simple effect of Lecture for 2 weeks delay and 4 weeks delay, but **not** for 0 weeks delay, so this main effect description would be potentially misleading as a general statement.

Reporting the Results:

A mixed groups factorial ANOVA with follow-up analyses using the LSD procedure ($p = .05$) was performed to examine the effects of Lecture Topic and Delay upon performance on a vocabulary learning task. Table 1 shows the means for each condition of the design.

There was an interaction of Lecture Topic and Delay as they relate to performance ($F(4, 18) = 5.619$, $p = .004$, $Mse = 42.38$). As hypothesized, the pattern of this interaction was that performance decreases across the delay intervals only for Social Science, specifically between 0 and 2 weeks of delay (LSD minimum mean difference = 9.67).

There was a main effect of Delay ($F(2, 18) = 12.994$, $p = .001$), with better overall performance after 0 weeks than after 2 weeks or 4 weeks (which were equivalent to each other (LSD minimum mean difference = 5.58)). However, this pattern was descriptive only for the Social Science condition, and so, is misleading as a general description of this effect.. There was also a main effect of Lecture Topic ($F(2,9) = 6.793$, $p = .016$), with better overall performance from Physical Science and History lectures than from Social Science lectures (LSD minimum mean difference = 8.65). However, the pattern of this main effect is descriptive for none of the Delay intervals, and so, is misleading as a general description of this effect.