

W3 The GLM – one-way ANOVA

ANCOVA= continuous & categ predictors

Regression=continuous predictors

ANOVA=categorical predictors

RM ANOVA=within, categorical predictors.

Factor = categorical in Syntax IV follows 'by'

Covariate = continuous, in Syntax, IV follows 'with'

N of possible pairwise comparisons= $k*(k-1)/2$. K=n of groups.

F-test/One way ANOVA does not tell us which groups differ from others. If f is sig, there must be a sig pairwise comparison, we just don't know where.

Tests of between-subjects effects output:

MS= SS/DF , **F**= $MS_{\text{Between}}/MS_{\text{Within}}$

Type3 SS/df=MS (mean square), **MSbetween/MSwithin=F** stat of model (on between line).

Determining whether F is sig greater than 0: if $F > 1$ on 'corrected total' line, it is greater than 0.

DFerror = $N-k$ (n of p's – n of groups)

DFbetween = $k-1$ (groups -1)

Dftotal = $n-1$

MSwithin= $n*k [(SD^2 \times (n-1))] / 1000$

SS corrected total= $SD^2*(n-1)$. Relates to variation around the grand mean (as opposed to other total, which is var

around the origin = total variance in the data.

Between SS=var explained by model

Within SS=unexplained var

The '**corrected model**' is the model as a whole, including all factors. If there is only 1 factor, the between line on between subj output is the same as corrected model line.

Contrast V comparison: comparison is a simply comparison of 2 means. Contrast is the average of 2 groups versus another group – more general term.

Comparison formula = $L = 1x\mu_1 - 1x\mu_2$ (simple comparison of 2 means). **Orthogonal**

contrasts: DO NOT need to adjust alpha. No shared variance across contrasts. There will always be one less orthogonal contrast that groups. No group should occur in more than one contrast. **Non-orthogonal contrasts**: The sum of the contrast coefficients across contrasts do not =0. NEED TO ADJUST ALPHA (for planned use Bonferonni, for post-hoc use Scheffe) Some elements of model-variance are used more than once.

Rules defining contrasts 1. Choose sensible contrasts 2. Groups w. pos weight compared with neg weights 3. Within a contrast the contrast weights must add to zero 4. any group logically not involved in a contrast receives a weight of 0. 5. In contrasts comparing a combination of multiple groups with one or more other groups, the total weights for each 'chunk' should be equal.

In the **K matrix output** (as a result of **lmatrix** subcommand), we get a '**contrast estimate**'.

The value is **the sum of the positive values in the contrast, divided by the n of positive values in the contrast, minus the value of the neg value in the contrast**. E.g. If contrast estimate =1.900, and the values of our contrasts are A mean = 3.20 (.5), B mean = 5.00 (.5) & C mean = 2.20 (-1), then our contrast estimate would be: $(3.2+5/2) - 2.2 = 1.900$. If our values were A=3.200(1) B=2.20 (0) and C = 5.00 (-1), then our contrast estimate would be $(3.2/1)-5 = 1.800$

Checking for orthogonality: Multiply down and add sideways (e.g. $-1 \times 0 \times 0 = 0$, $0.5 \times 0.5 \times 1 = .25$, $.5 \times 1 \times -.5 = -.25$, $0 = .25 - .25 = 0$)

	Contrast	Placebo	Low	High
1	Active v Placebo	-1	+0.5	+0.5
2	Low v High	0	+1	-1
1 x 2	Product	0	+0.5	-0.5

= 0

Defined contrasts using GLM orthogonal contrasts: difference (each group V mean of preceding groups) (2v1, 3v12, 4v123), Helmert (each group V mean of succeeding groups) (1v234, 2v234, 3v4), polynomial (linear, quadratic, cubic). Non-orth contrasts: deviation (each group V overall mean), simple (each group v ref group), repeated (diff between consecutive groups).

REMEMBER IF NO REF CATEGORY IS SPECIFIED, THE LARGEST CODED GROUP WILL BE THE REFERENCE CATEGORY. If we want all ref groups, we need to run the contrast command twice, and specify which ref category we want in the second command.

If using **lmatrix** command, we need to manually adjust our alpha. If using contrast command, we can tell SPSS to adjust our alpha

e.g. **glm DV by IV /posthoc= IV (bonferonni)**.

If we give specify that SPSS adjusts our alpha, then we can simply compare our p-value to .05.

LSD = least significant difference

EMMEANS subcommand displays and compares marginal means. It does not let us specify contrasts. If we want to specify contrasts we should use **lmatrix**. If we only want to conduct pairwise comparisons, **EMMEANS** is good.

Polynomial contrasts – assess trends through levels of the IV. These contrasts are orthogonal. Only conduct trend analysis if it makes sense to.

partial eta² = $SS_{\text{between}} / (SS_{\text{between}} + SS_{\text{within}})$. Partial eta² measures effect sizes (proportion of variance accounted for) by predictors in model/explained variance), ANOVA's use. Partial eta squared is found in the tests of **between-subjects effects output**, and we are interested in the value on the between line.

Omega² = $SS_{\text{between}} - df_{\text{between}} \times MS_{\text{error}} / (SS_{\text{corrected total}} + MS_{\text{error}})$

Omega² is a similar concept to eta², but generally a better representation of effect size in the population, rather than the sample.

If we want to **switch values of groups to change the ref group**, to a **temporary recode command**.

Highest coded group – ref category.

Two-way ANOVA

Tests of Between-Subjects Effects

Dependent Variable: Independent rating

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3501.042 ^a	3	1167.014	9.395	.000
Intercept	163333.333	1	163333.333	1314.885	.000
alcohol	3332.292	2	1666.146	13.413	.000
gender	168.750	1	168.750	1.358	.250
Error	5465.625	44	124.219		
Total	172300.000	48			
Corrected Total	8966.667	47			

a. R Squared = .390 (Adjusted R Squared = .349)

Between1SS (3332.292) + between2SS (168.750) + error (5465.625) = corrected total (8966.667).

Between1SS/error = betweenMS

Between2SS/error = between2MS,

between1MS/error = b1 F

The interaction above indicates the the effects of alcohol on mate is moderated

by gender of the p.

*Note that the interaction SS as come entirely out of the error SS from the additive model (e.g. additive model error = 5465, InteractionSS=1978. 5465-1978.=3487(SSerror in interaction model) ↓

Tests of Between-Subjects Effects

Dependent Variable: Independent rating

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5479.167 ^a	5	1095.833	13.197	.000
Intercept	163333.333	1	163333.333	1967.025	.000
alcohol	3332.292	2	1666.146	20.065	.000
gender	168.750	1	168.750	2.032	.161
alcohol * gender	1978.125	2	989.063	11.911	.000
Error	3487.500	42	83.036		
Total	172300.000	48			
Corrected Total	8966.667	47			

a. R Squared = .611 (Adjusted R Squared = .565)

*In a balanced 2-way design, the overall main effects & interaction terms are orthogonal to each other. To get the interaction term, we multiply out the values from the main effects (for contrasts)

*The last specified variable in the GLM command line changes fastest/is on the horizontal axis, while the first specified variable goes on the vertical axis E.g.:

glm rating by gender alcohol / design=alcohol gender

gender*alcohol /matrix = "control v alcohol" gender*alcohol -1 0.5 0.5 + 1 -0.5 -0.5

Alcohol consumed				
Gender	None	2 pints	4 pints	
female	60.62	62.50	57.50	60.21
male	66.88	66.87	35.63	56.46
	63.75	64.69	46.56	58.33

$$L = \left(\frac{62.50 + 57.50}{2} - 60.62 \right) - \left(\frac{66.87 + 35.63}{2} - 66.88 \right) = 15.01$$

Contrast Results (K Matrix)^a

Contrast	Contrast Estimate	Hypothesized Value	Difference (Estimate - Hypothesized)	Std. Error	Sig.	95% Confidence Interval for Difference	Lower Bound	Upper Bound
1	15.000	0	15.000	3.540	.010	3.739	28.261	

a. In SPSS

*As alcohol was last on GLM command line, this means that all levels of alcohol are presented before gender switches levels. (e.g. above was Female alcohol none, 2, 4 + male none, 2, 4. If gender had been specified last, the contrasts would have been -1 1 .5 -.5 .5 -.5 gender*alcohol following the lmatrix command indicates an interaction contrast (this way SPSS knows to conduct the contrast on the interaction rather than main effects)

ANCOVA Not all covariates should be controlled for. Eg. If we control naturally overlapping covariates, we change the nature of naturally occurring groups.

If in a correlations matrix we see a negative correlation between 2 variables which are both otherwise positive, this might indicate **suppression**. An assumption of ANCOVA is that the slopes across groups are the same. We can test this assumption by testing for interaction. If the interaction is sig, we reject the hypothesis of equal sloes across groups. Sort cases by IV1. / Split files by IV1. /Glm dv with IV2/cov /print parameters. /Split files off.

To measure if there is a sig diff of slopes:

Parameter Estimates

Dependent Variable: Libido

Dose of Viagra	Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Placebo	Intercept	.594	.607	.979	.360	-.841	2.029
	Partner_Libido	.763	.153	4.976	.002	.400	1.126
Low Dose	Intercept	2.311	.286	8.089	.000	1.612	3.011
	Partner_Libido	.820	.081	10.100	.000	.622	1.019
High Dose	Intercept	5.284	.979	5.400	.000	3.130	7.437
	Partner_Libido	-.219	.385	-.568	.581	-1.066	.629

$$\beta_{plac} - \beta_{high} = 0.763 - (-0.219) = 0.982$$

$$\beta_{low} - \beta_{high} = 0.820 - (-0.219) = 1.039$$

Then to check if these values are sig diff (.982 v 1.039):

Parameter Estimates

Dependent Variable: Libido

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	5.284	.702	7.524	.000	3.834	6.733
[Dose=1]	-4.689	1.269	-3.694	.001	-7.309	-2.070
[Dose=2]	-2.972	1.393	-2.133	.043	-5.848	-.097
[Dose=3]	0 ^a	.	.	.	.	.
Partner_Libido	-.219	.276	-.792	.436	-.789	.351
[Dose=1] * Partner_Libido	.982	.384	2.554	.017	.189	1.775
[Dose=2] * Partner_Libido	1.039	.440	2.363	.027	.132	1.947
[Dose=3] * Partner_Libido	0 ^a	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

```
glm libido by dose with partner_libido
/ print parameters
/ design dose partner_libido dose*partner_libido.
```

Getting the effect size in ANCOVA using partial eta squared:(same as one-way):
effect/effect+error

W3 One way ANOVA contrasts:

Glm dv by iv

/ Imatrix = "A v B" IV -1 0.5 0.5.

Imatrix is the subcommand for contrasts. Gives 'kmatrix'

contrast values should be specified in the order of values of the IV as they are in SPSS.

When we don't want to code contrasts ourselves, we use the 'contrast' command:

/contrast (IV) = contrast_type (optional ref group).

contrast type = e.g. helmert, deviation, etc.

ref group – if we want out ref group to not be the highest coded group

Two-way ANOVA Conducting a main effect contrast in a 2-way ANOVA, ignoring the second factor:

Glm rating by IV IV / design = IV IV

Imatrix = "Level1&2 v Level 3" IV -1 0.5 0.5

Imatrix = Level 1 v 2" IV 0 -1 1.

The red IV's indicate a main effect contrast, bc another factor is being ignored.

ANCOVA If we want to conduct a follow up test (to compare the output from when we are V when we are not controlling for a factor, we can conduct EMMEANS.

Glm libido by IV with COV

/ emmeans = table(IV) compare (IV) adj (bonf) with (covar=1)

/design IV COV.

=1 makes the continuous reference point an interesting value. E.g. if measuring AUS income, no point in making income \$0, better to make it average, e.g. \$60 000.

Parameter estimates for diff's between groups w. 2 IV's:

Sort cases by IV1.

Split filed by IV1.

Glm dv with IV2/cov

/print parameters.

Split files off.

Split files command separates analyses the diff groups

Split files off turn them off, otherwise saved separately.

Eta squared:

Glm DV by IV with COV

/print = etasq.