

General Linear Model of an Unbalanced Factorial Design

Potato Damage Data

This is an unbalanced design as we have different numbers of replicated in the $2 \times 2 \times 2 = 8$ cells of the table.

Temperature Pre-treatment * Potato variety * Acclimatization Routine Crosstabulation

Count

Acclimatization Routine			Potato variety		Total
			Variety 1	Variety 2	
Room Temp	Temperature	-4 C	5	13	18
	Pre-treatment	-8 C	5	13	18
	Total		10	26	36
Cold Room	Temperature	-4 C	12	7	19
	Pre-treatment	-8 C	13	7	20
	Total		25	14	39

Number of parameters:
k=7

Three-way Interaction Model (COMPLETE MODEL)

Dependent Variable: Damage Score: Ion Leakage

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8842.339(a)	7	1263.191	17.033	.000
Intercept	8055.406	1	8055.406	108.619	.000
potato	1892.313	1	1892.313	25.516	.000
regime	1493.822	1	1493.822	20.143	.000
temp	803.280	1	803.280	10.831	.002
potato * regime	2087.539	1	2087.539	28.148	.000
potato * temp	48.135	1	48.135	.649	.423
regime * temp	13.891	1	13.891	.187	.667
potato * regime * temp	89.198	1	89.198	1.203	.277
Error	4968.876	67	74.162		
Total	27481.316	75			
Corrected Total	13811.215	74			

a R Squared = .640 (Adjusted R Squared = .603)

It appears that the fit is moderate (R squared = 0.640), but that there is some explanatory power in the variables.

Note that we cannot interpret the quoted F statistics, as this is an unbalanced design, and therefore the stated p-values are not in general exact. However, these results do give an indication of which terms might be omitted.

REDUCED MODEL 1

Number of parameters:
g=4

Dependent Variable: Damage Score: Ion Leakage

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8717.469(a)	4	2179.367	29.950	.000
Intercept	8060.776	1	8060.776	110.774	.000
potato	1890.703	1	1890.703	25.983	.000
regime	1492.360	1	1492.360	20.509	.000
temp	1225.714	1	1225.714	16.844	.000
potato * regime	2089.928	1	2089.928	28.721	.000
Error	5093.746	70	72.768		
Total	27481.316	75			
Corrected Total	13811.215	74			

Interaction terms omitted:

Three-way interaction:
potato*regime*temp

Two-way interactions:
potato*temp
regime*temp

a R Squared = .631 (Adjusted R Squared = .610)

REDUCED MODEL 2

Number of parameters:
g=3

Dependent Variable: Damage Score: Ion Leakage

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6627.541(a)	3	2209.180	21.834	.000
Intercept	13233.292	1	13233.292	130.792	.000
potato	1502.970	1	1502.970	14.855	.000
regime	1977.340	1	1977.340	19.543	.000
temp	1255.583	1	1255.583	12.410	.001
Error	7183.674	71	101.179		
Total	27481.316	75			
Corrected Total	13811.215	74			

Remaining interaction term
potato*regime omitted

a R Squared = .480 (Adjusted R Squared = .458)

REDUCED MODEL 3

Number of parameters:
g=3

Dependent Variable: Damage Score: Ion Leakage

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7491.755(a)	3	2497.252	28.057	.000
Intercept	8119.673	1	8119.673	91.226	.000
potato	1862.829	1	1862.829	20.929	.000
regime	1467.591	1	1467.591	16.489	.000
potato * regime	2119.797	1	2119.797	23.816	.000
Error	6319.460	71	89.006		
Total	27481.316	75			
Corrected Total	13811.215	74			

Interaction replaced,
but temp main effect
removed.

a R Squared = .542 (Adjusted R Squared = .523)

Balanced two-factor predictor, one covariate linear model

Task Distraction Data

This is a balanced design, with 15 replicates in each of the $3 \times 3 = 9$ cells of the table. For a balanced design, the quoted p-values are more reliable as indications of significance

COMPLETE MODEL

Dependent Variable: Errors

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	39671.916(a)	17	2333.642	48.240	.000
Intercept	309.723	1	309.723	6.402	.013
Group	252.027	2	126.014	2.605	.078
Task	450.584	2	225.292	4.657	.011
Distract	2790.513	1	2790.513	57.684	.000
Group * Task	172.095	4	43.024	.889	.473
Group * Distract	335.100	2	167.550	3.463	.035
Task * Distract	2535.238	2	1267.619	26.203	.000
Group * Task * Distract	142.924	4	35.731	.739	.567
Error	5660.010	117	48.376		
Total	90341.000	135			
Corrected Total	45331.926	134			

k=17

a R Squared = .875 (Adjusted R Squared = .857)

REDUCED MODEL 1

Dependent Variable: Errors

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	37704.447(a)	9	4189.383	68.656	.000
Intercept	537.895	1	537.895	8.815	.004
Group	228.483	2	114.242	1.872	.158
Task	494.293	2	247.147	4.050	.020
Distract	3575.111	1	3575.111	58.589	.000
Group * Distract	343.795	2	171.898	2.817	.064
Task * Distract	2540.469	2	1270.235	20.817	.000
Error	7627.479	125	61.020		
Total	90341.000	135			
Corrected Total	45331.926	134			

g=9

a R Squared = .832 (Adjusted R Squared = .820)

REDUCED MODEL 2

Dependent Variable: Errors

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	37360.652(a)	7	5337.236	85.034	.000
Intercept	619.535	1	619.535	9.871	.002
Group	433.379	2	216.690	3.452	.035
Task	500.794	2	250.397	3.989	.021
Distract	3796.748	1	3796.748	60.491	.000
Task * Distract	2597.561	2	1298.780	20.692	.000
Error	7971.274	127	62.766		
Total	90341.000	135			
Corrected Total	45331.926	134			

g=7

a R Squared = .824 (Adjusted R Squared = .814)

REDUCED MODEL 3

Dependent Variable: Errors

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	36927.272(a)	5	7385.454	113.357	.000
Intercept	522.634	1	522.634	8.022	.005
Task	513.356	2	256.678	3.940	.022
Distract	3565.647	1	3565.647	54.728	.000
Task * Distract	2750.062	2	1375.031	21.105	.000
Error	8404.654	129	65.152		
Total	90341.000	135			
Corrected Total	45331.926	134			

g=5

a R Squared = .815 (Adjusted R Squared = .807)

REDUCED MODEL 4

Dependent Variable: Errors

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	34177.211(a)	3	11392.404	133.791	.000
Intercept	1192.389	1	1192.389	14.003	.000
Task	23726.782	2	11863.391	139.323	.000
Distract	5515.685	1	5515.685	64.776	.000
Error	11154.715	131	85.150		
Total	90341.000	135			
Corrected Total	45331.926	134			

g=3

a R Squared = .754 (Adjusted R Squared = .748)