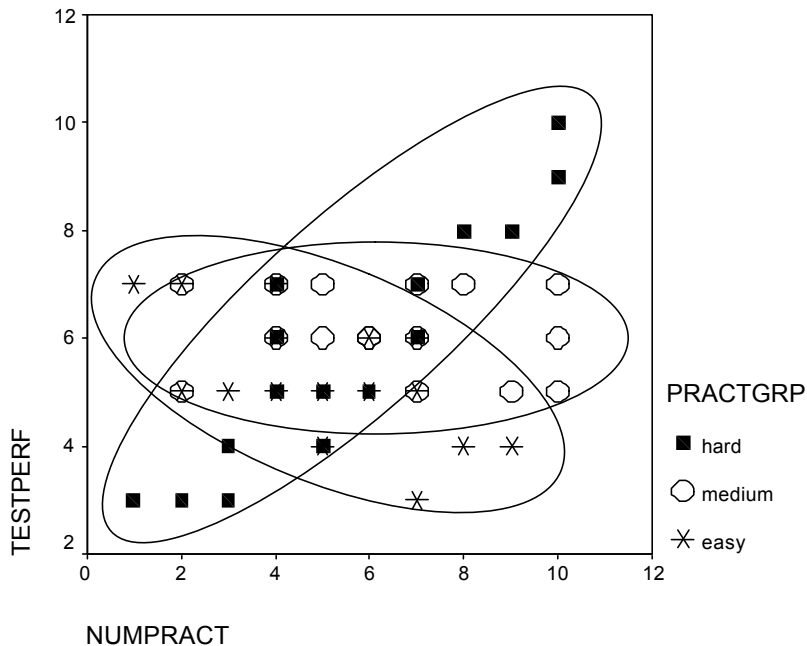


Interactions between Binary & Quantitative Predictors

The purpose of the study was to examine the possible joint effects of the difficulty of the practice task and the amount of practice, upon the performance of the target task. Participants were randomly assigned to receive a practice that was either "easy" (easier than the target task), "medium" (same difficulty as the target task), or "hard" (harder than the target task). Each participant was permitted to practice the appointed task as many times as they wanted, and then all were given the same target task and the performance recorded.

Here's the plot of the data...



Here are the basic stats for the groups and the syntax to produce the dummy codes (2 codes for 3 groups), centered covariate and the interaction terms (2 -- each a product of the centered covariate and one of the group dummy codes)

Report

PRACTGRP		TESTPERF	NUMPRACT
easy	Mean	5.2500	5.0000
	N	16	16
	Std. Deviation	1.18322	2.30940
medium	Mean	6.1250	6.3750
	N	16	16
	Std. Deviation	.80623	2.62996
hard	Mean	5.8125	5.5000
	N	16	16
	Std. Deviation	2.19754	2.78089
Total	Mean	5.7292	5.6250
	N	48	48
	Std. Deviation	1.52622	2.58987

```

Syntax1 - SPSS Syntax Editor
File Edit View Analyze Graphs Utilities Run Window Help
if (practgrp = 1) pract_d1 = 1.
if (practgrp = 2) pract_d1 = 0.
if (practgrp = 3) pract_d1 = 0.

if (practgrp = 1) pract_d2 = 0.
if (practgrp = 2) pract_d2 = 1.
if (practgrp = 3) pract_d2 = 0.

compute npract_c = numpract - 5.625.

compute int1 = npract_c * d1.
compute int2 = npract_c * d2.
    
```

Below are three analyses of these data:

- Full model regression
- Hierarchical regression
- ANCOVA using GLM

Full Model Regression

This involves including both dummy codes, the centered covariate and the two interaction terms in a single model.

Model Summary

Model	R	R Square
1	.817 ^a	.667

a. Predictors: (Constant), INT2, INT1, PRACT_D1, PRACT_D2, NPRACT_C

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	72.996	5	14.599	16.807	.000 ^a
	Residual	36.483	42	.869		
	Total	109.479	47			

a. Predictors: (Constant), INT2, INT1, PRACT_D1, PRACT_D2, NPRACT_C

b. Dependent Variable: TESTPERF

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	5.901	.233		25.300	.000			
	PRACT_D1	-.847	.336	-.264	-2.520	.016	-.224	-.362	-.224
	PRACT_D2	.258	.337	.081	.766	.448	.185	.117	.068
	NPRACT_C	.711	.087	.807	8.219	.000	.334	.785	.732
	INT1	-1.024	.135	-.898	-7.558	.000	-.211	-.759	-.673
	INT2	-.757	.126	-.758	-6.011	.000	.000	-.680	-.535

a. Dependent Variable: TESTPERF

Each term in the model are “corrected” for all other terms, which is part of interpreting each.

a -- the constant tells us the mean of the comparison group, after correction for the covariate and the interaction.
So, the “hard practice” group had an average performance of 5.9

PRACT_D1 -- tells the direction and extent of the difference between the mean of the comparison group and the target group for that dummy code, after correction for the covariate and the interaction. The t-test of the regression weight tests if that mean difference is statistically significant, after correction for the covariate and the interaction.
So, the “easy practice” group had an average performance $-.847$ lower than the “hard practice” group or a mean of $5.9 - .847 = 5.053$. The means of these two groups are significantly different, after correction for the covariate and the interaction.

PRACT_D2 -- tells the direction and extent of the difference between the mean of the comparison group and the target group for that dummy code, after correction for the covariate and the interaction.
So, the “medium practice” group had an average performance $.258$ higher than the “hard practice” group or a mean of $5.9 + .258 = 6.158$. The means of these two groups are not significantly different, after correction for the covariate and the interaction.

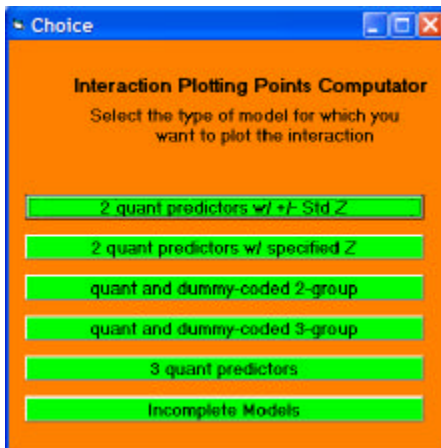
NPRACT_C -- tells the slope of the COV-DV relationship, after correcting for the IV and the interaction

INT1 -- tells about the difference in slope of the CIV-DV relationship of the target group for the related dummy code relative the slope for the comparison group, after correction for the covariate and the IV.
So, the slope of simple regression line for the “easy practice” group is “less positive” than the slope of the simple regression line for the “hard practice” group

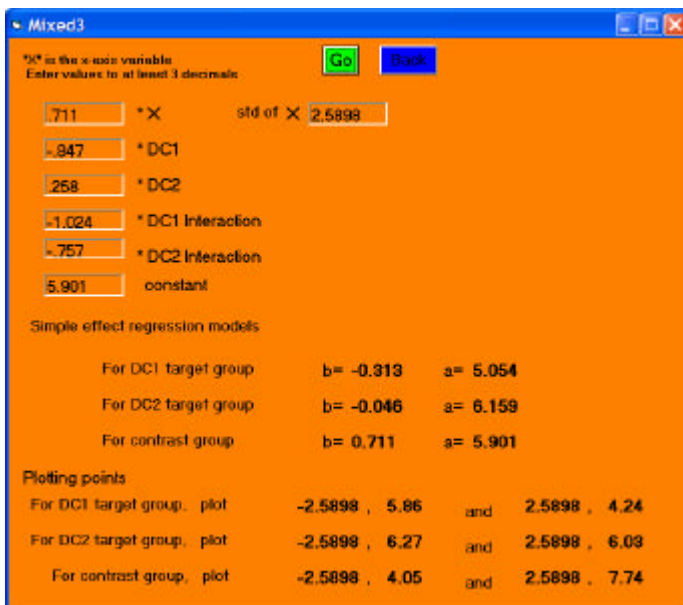
INT2 -- tells about the difference in slope of the CIV-DV relationship of the target group for the related dummy code relative the slope for the comparison group, after correction for the covariate and the IV.
So, the slope of simple regression line for the “medium practice” group is “less positive” than the slope of the simple regression line for the “hard practice” group

Remember -- if any b of any code representing an effect is significant, that effect is significant!

We can use the IntPlot program to obtain the simple regressions for each group and the plotting points to portray this multivariate model.

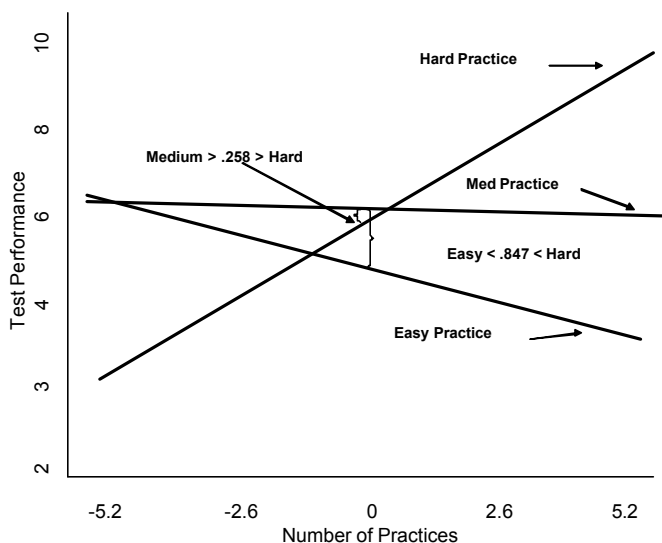


Select the one for 3 dummy-coded groups



Notice that the differences between the slopes of the simple regression lines match the regression weights for the interaction terms

Slope for the “hard practice” group = .711
 For the “easy practice” group = $.711 + (-1.024) = -.313$
 For the “medium practice group” = $.711 + (-.757) = -.046$



The relative slopes of the group’s simple regression lines match the information from the various b-values.

The corrected main effects are shown. These are made at the mean of the covariate, which is 0 because it has been centered, and also match the related b-values.

While there is small main effect, clearly the important effect in this model is the interaction!

Practice with “medium” items has no effect.
 Practice with “easy” items hinders performance.
 Practice with “hard” items improves performance,

Hierarchical Regression

The first model includes only the main effects -- the IV and the covariate. Then the interaction terms are added in the second step.

Model Summary

Model	R	R Square	Change Statistics				
			R Square Change	F Change	df1	df2	Sig. F Change
1	.377 ^a	.142	.142	2.433	3	44	.078
2	.817 ^b	.667	.524	33.053	2	42	.000

a. Predictors: (Constant), NPRACT_C, PRACT_D1, PRACT_D2

b. Predictors: (Constant), NPRACT_C, PRACT_D1, PRACT_D2, INT1, INT2

The main effects model is not significant. However there is a significant increase in R² when the interaction terms are added (showing the interaction is significant) and the resulting full model is significant.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.575	3	5.192	2.433	.078 ^a
	Residual	93.905	44	2.134		
	Total	109.479	47			
2	Regression	72.996	5	14.599	16.807	.000 ^b
	Residual	36.483	42	.869		
	Total	109.479	47			

a. Predictors: (Constant), NPRACT_C, PRACT_D1, PRACT_D2

b. Predictors: (Constant), NPRACT_C, PRACT_D1, PRACT_D2, INT1, INT2

c. Dependent Variable: TESTPERF

Coefficients^a

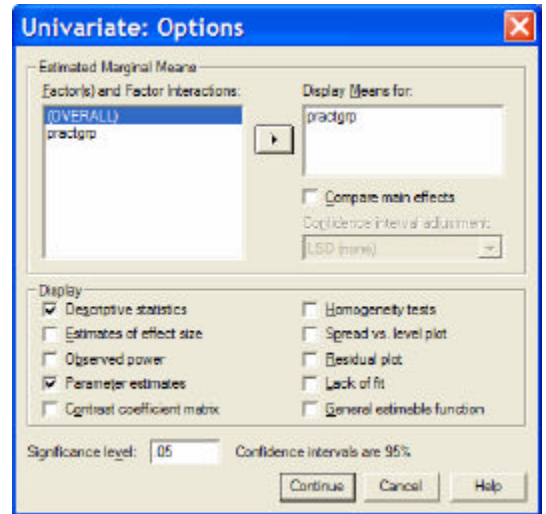
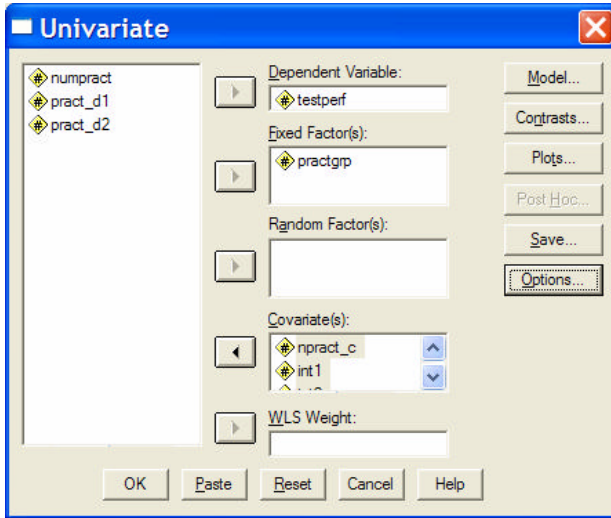
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.834	.365		15.969	.000
	PRACT_D1	-.475	.518	-.148	-.916	.365
	PRACT_D2	.159	.522	.049	.304	.763
	NPRACT_C	.176	.084	.299	2.086	.043
2	(Constant)	5.901	.233		25.300	.000
	PRACT_D1	-.847	.336	-.264	-2.520	.016
	PRACT_D2	.258	.337	.081	.766	.448
	NPRACT_C	.711	.087	.807	8.219	.000
	INT1	-1.024	.135	-.898	-7.558	.000
	INT2	-.757	.126	-.758	-6.011	.000

a. Dependent Variable: TESTPERF

The full model is the same as was found above, because entry order does not influence the inclusive model.

ANCOVA using SPSS GLM

Analyze → General Linear Model → Univariate



The results ...

Tests of Between-Subjects Effects

Dependent Variable: TESTPERF

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model ^a	72.996 ^a	5	14.599	16.807	.000
Intercept	1479.938	1	1479.938	1703.738	.000
NPRACT_C	58.675	1	58.675	67.547	.000
INT1	49.618	1	49.618	57.122	.000
INT2	31.383	1	31.383	36.129	.000
PRACTGRP	9.930	2	4.965	5.716	.006
Error	36.483	42	.869		
Total	1685.000	48			
Corrected Total	109.479	47			

a. R Squared = .667 (Adjusted R Squared = .627)

The only difference between the ANOVA table and the regression weights (below and from the regression analysis) is that the ANOVA table includes a single F-test for the IV effect instead of a t-test for each dummy code of that effect.

Parameter Estimates

Dependent Variable: TESTPERF

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	5.901	.233	25.300	.000	5.431	6.372
NPRACT_C	.711	.087	8.219	.000	.537	.886
INT1	-1.024	.135	-7.558	.000	-1.297	-.750
INT2	-.757	.126	-6.011	.000	-1.011	-.503
[PRACTGRP=1.00]	-.847	.336	-2.520	.016	-1.525	-.169
[PRACTGRP=2.00]	.258	.337	.766	.448	-.422	.938
[PRACTGRP=3.00]	0 ^a

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

PRACTGRP

Dependent Variable: TESTPERF

PRACTGRP	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
easy	5.079 ^a	.238	4.598	5.559
medium	6.183 ^a	.238	5.702	6.665
hard	5.925 ^a	.235	5.451	6.400

a. Covariates appearing in the model are evaluated at the following values: NPRACT_C = .0000, INT1 = -.2083, INT2 = .2500.

The slight differences between the corrected group means from the regression weights and this table are simply rounding differences during the various calculations.