Quiz #3 Research Hypotheses that Involve Comparing Non-Nested Models

The researcher also wanted to test the hypothesis that students with internal versus external locus of control could be better distinguished using scholastic performance differences than using measures of motivation and self concept. Testing this hypothesis involved comparing two non-nested models, one including self concept and motivation scores and the other including the set of five performance measures.

These data from the TALENT data set. "External" and "internal" students are again identified following the procedure offered in the manual.

SPSS Code:

```
compute ext_int = locus.                                    ← categorizing based on IE score
recode ext_int (lo thru -.25 = 0) (.25 thru hi = 1).

dscriminant group = ext_int (0,1)                           ← obtaining the motivation &
           /variables = concpt motv                              self concept model
           /statistics = 13 14 .
```

SPSS Output:

```
                    Canonical Discriminant Functions
                Pct of    Cum  Canonical  After  Wilks'
 Fcn Eigenvalue Variance   Pct     Corr      Fcn  Lambda  Chisquare    DF  Sig
                                           :    0   .9696      6.091     2  .0476
   1*     .0314  100.00  100.00    .1745 :
```

```
Standardized Canonical          Structure Matrix:               Group Centroids
Discriminant Function
Coefficients
             FUNC  1                          FUNC  1           Group      FUNC   1
CONCPT        .40722              MOTV          .92492              0       -.15628
MOTV          .77895             CONCPT         .68644              1        .19891
```

```
 Case   0Mis        Actual      Highest
Number  Val  Sel    Group       Group
     1                1           1      ← this case was correctly classified
     2                0           0
     3                1 **        0      ← this case was misclassified
     4                0           0
     5                0           0
     6                1 **        0
     7                1 **        0
     8                1           1
     9                0           0
    10                0 **        1
     .                .           .
   199                0 **        1
   200                0 **        1
```

```
Classification Results -
                     No. of    Predicted Group Membership
   Actual Group       Cases          0          1
-------------------  ------   --------   --------
Group       0            97         52         45
                                   53.6%      46.4%
Group       1            88         36         52
                                   40.9%      59.1%
Ungrouped Cases          15
Percent of "grouped" cases correctly classified:  56.22%
```

SPSS Code:

```
dscriminant group = ext_int (0,1)
          /variables = rdg wrtg math sci civ
          /statistics = 13 14 .
```

← obtaining the scholastic performance model

SPSS Output:

Canonical Discriminant Functions

Fcn	Eigenvalue	Pct of Variance	Cum Pct	Canonical Corr	After Fcn	Wilks' Lambda	Chisquare	DF	Sig
					: 0	.8932	15.418	5	.0214
1*	.0457	100.00	100.00	.3044	:				

Standardized Canonical Discriminant Function Coefficients

	FUNC 1
RDG	.47121
WRTG	-.21184
MATH	.06087
SCI	.12247
CIV	.47712

Structure Matrix:

	FUNC 1
WRTG	.58854
SCI	.55748
MOTV	.39968
CONCPT	.41147
MATH	.25521

Group Centroids

Group	FUNC 1
0	-.16247
1	.21115

Case Number	Mis Val	Sel	Actual Group	Highest Group
1			1	0
2			0	0
3			1 **	0
4			0	0
5			0	0
6			1 **	0
7			1	1
8			0 **	1
9			0 **	1
10			0	0
.			.	.
199			0	1
200			0 **	1

← Notice that the classification results are somewhat different than for the other model.

Classification Results -

Actual Group	No. of Cases	Predicted Group Membership 0	1
Group 0	97	58	39
		59.8%	40.2%
Group 1	88	33	55
		37.5%	62.5%
Ungrouped Cases	15		

Percent of "grouped" cases correctly classified: 61.15%

Comparing the Non-Nested Models

There are not as many options are there are for comparing nested models.

Don't Compare Nested Models using the Sphericity Test Information

One can not compute the difference in the fit of the two non-nested models by looking at the difference between the X^2 values used to test each. Since the models are not nested, neither are the X^2 values, and there is no accepted significance test for comparing non-nested X^2 values. When the two non-nested models have the same number of predictors (not in this case), then the X^2 values are "comparable", but there is still no significance test.

Comparing Non-Nested Models using the R^2

Hotelling's t-test can be used, but this requires obtaining the correlation between the two models (r_{12}). Using the standardized weights from the two models above …

SPSS Code (Note: Newer versions of SPSS allow you to save ldf scores -- look under "save" or "options)

```
select if (ext_int = 0 or ext_int = 1).
```
← uses only the external and internal folks

```
descriptives variables =  concept motv rdg wrth math sci civ
              / options = 3.
```
← gets Z-score versions of each

```
compute cm_prd = (ZCONCPT * .40722) + (ZMOTV * .77895).
compute perf_prd = (ZRDG * .47121) - (ZWRTG * .21184) + (ZMATH * .06087) +
                   (ZSCI * .12247) + (ZCIV * .47712).
corr cm_prd perf_prd.
```

SPSS Output:

Let's save considerable space … **r = .876**

Applying Hotelling's t-test and the Meng & Rosenthal Z-test reveals that the R_c from the concept & motivation model (.1745) was less than the R_c from the performance model (.3044), based on the sample (N=185).

Z = 3.42 Z-critical = 1.96, so H0: is rejected & t = 3.53 t-critical = 1.95, so H0: is rejected

Comparing Nested Models using the % correct reclassification

If one model is "better" than the other then it should lead to better reclassification. This can be tested by a Chi-square analysis (a different one that used to for the sphericity tests). We have to determine which folks were misclassified by each of the models.

Build a new data file from the classification output of the full and reduced model analyses. Specifically, you need to know the actual group to which each person belonged, as well as the group to which each was assigned by each of the models.

SPSS Code:

```
data list free / subn  actual  r_cm  f_perf

variable labels   real  'group to which each subject truly belongs'
                / r_cm  'group assignment based on motivation & self concept model'
                / f_perf  'group assignment based on performance model'.
```

```
begin data.
     1       1   1     1
     2       0   0     0
     3       1   0     0
     4       0   1     0
     5       0   0     1
     6       1   0     0
     7       1   0     1
     .       .   .     .
   199       0   1     1
   200       0   1     1
end data.

if (actual eq r_cm) reduced = 1.
if (actual ne r_cm) reduced = 0.

if (actual eq f_perf) full = 1.
if (actual ne f_perf) full = 0.

value labels  full reduced 0 'wrong' 1 'correct'.

crosstabs tables = full by reduced.
```

← determines who was correctly and incorrectly classified by the motivation and self-concept model

← determines who was correctly and incorrectly classified by the performance model

← gets the counts needed to test the hypothesis

SPSS Output:

FULL by REDUCED

Perf \ motv & self-con	wrong	correct
	.00	1.00
.00 wrong	46	23
1.00 correct	47	69

misclassifications unique to the performance model

misclassifications unique to the motivation and self-concept model

The research hypothesis is that there will be fewer misclassifications using the full model than using the reduced model. Thus, we want to test if 23 < 47.

$$X^2 = \frac{(\text{misses unique to mot\&con model} - \text{misses unique to perf model})^2}{\text{misses unique to mot\&con model} + \text{misses unique to perf model}} = \frac{(47 - 23)^2}{47 + 23} = 8.29$$

X^2-critical (1, .05) = 3.84

Since $X^2 > X^2$-critical, we would conclude that the performance model "does better" than the personality model.

When there are more than two groups ???

Things can get ugly quickly !!! First the good news. If you have a concentrated structure, no matter how many groups, you can apply the techniques shown above.

However, if you have a diffuse structure, or worse yet, one model has a concentrated model and the other has a diffuse model, then things get more complicated. When this happens, the best approach is to compare the % correct classifications of the two models.

Write-up of a Model Comparisons

The write-up, much like that for comparing nested regression models, includes a description of the research hypotheses, the bivariate relationships between the grouping variable and the predictors (which are included below but not in the output shown above), a description of each model and the results from their comparison. The following take portions from the nested and non-neste …

As can be seen in Table 1, most of the variables showed significant mean differences between the locus of control groups. The internal group has larger means on all variables except for Math and Science (a marginal difference). The multivariate analyses included the examination and comparison of two proposed models. The first of these models included the personality variables of motivation and self-concept, while the second included the various academic performance measures.

The model including motivation and self-concept had a significant relationship with locus of control group membership (λ = .979, $X^2(2)$ = 6.091, p = .048, R_c = .175). Inspection of the standardized discriminant weights and structure weights shown in the left columns of Table 2 reveals that both variables contributed to the model, which correctly re-classified 56.2% (104/185) of the sample.

The model including the academic performance measures also had a significant relationship with locus of control group membership (λ = .893, $X^2(5)$ = 15.418, p = .021, R_c = .304). Inspection of the structure weights shown in the middle columns of Table 2 reveals that all of the variables except for math contributed to the model, however inspection of the standardized discriminant weights shows that only reading and civics had strong unique contributions. This model correctly re-classified 61.2% (113/185) of the sample.

One research hypothesis was that a model including the academic measures would do a better job of discriminating the locus of control groups than would a model including the personality measures. To test this, the two models described above were compared, revealing that the academic performance model accounted for more between group variation (R-difference = .129, t(182) = 3.53, p < .01) and reclassified more of the sample (%-difference = 5%, $X^2(1)$ = 8.29, p < .05).

A second research hypotheses was that a full model including both the personality measures and the academic performance measures would discriminate better than one including only the personality variables. To test this, a model was constructed that involved both sets of variables, and then this model was compared to one including only the two personality variables. The right columns of Table 2 show the various weights from the full model (λ = .877, $X^2(7)$ = 25.551, p = .001, R_c = .351, %-reclassification = 65.6%) indicating that while all the variables except math contributed to the model (based on a cutoff of .3), only reading and civics made substantial unique contributions. When compared to the model including only motivation and self-concept, this full model fit the data better ($X^2\Delta(5)$ = 19.46, p < .05), accounted for more between group variation ($R\Delta$ = .175, $F\Delta(2, 177)$ = 3.70, p < .01), and reclassified more of the sample ($\%\Delta$ = 9.4, $X^2(1)$ = 4.63, p < .05).

Table 1. Summary of bivariate and multivariate analyses of locus of control groups.

Variable	Group Means (std)		F(p)
	External	Internal	
Self concept	12.1 (4.2)	16.2 (3.8)	8.3 (.001)
Motivation	21.2 (7.3)	29.2 (4.1)	12.1 (.001)
Reading	49.3 (9.4)	56.8 (9.3)	9.1 (.001)
Writing	47.1 (9.8)	58.2(9.1)	10.4 (.001)
Math	49.2 (9.2)	50.2 (9.5)	1.1 (.543)
Science	48.4 (9.5)	50.4 (9.2)	3.1 (.061)
Civics	46.3 (9.2)	58.3 (9.2)	11.3 (.001)

Table 2. Summaries of the various discriminant models

	Model					
	Personality		Performance		Combined	
	Std wts	Structure	Std wts	Structure	Std wts	Structure
Variable						
Self concept	.407	.686			.238	.325
Motivation	.779	.925			.234	.437
Reading			.471	.589	.539	.743
Writing			-.213	.557	-.143	.618
Math			.061	.400	.076	.227
Science			.122	.415	.010	.607
Civics			.477	.255	.605	.801