The MANOVA for Dependent Groups -- **Analysis of 2-Within-Group Data with Two or More Quantitative DVs**

Application: To compare means of two or more quantitiatve variables obtained from 2 dependent groups.

Research Hypothesis: The researcher hypothesized that there would be more errors and performance would be slower during constant noise than during intermittant noise.

H0: for this analysis: Performance during intermittant noise will yield the same mean error rates and mean task speed as during constant noise.

SPSS Code:

```
data list free / intererr consterr  interspd constspd.

variable labels       intererr 'errors during intermittent noise condition'
                    / consterr 'errors during constant noise condition'
                    / interspd 'speed  during intermittent noise condition'
                    / constspd 'speed  during constant noise condition'.
begin data.
19 24 110 114
26 31 120 112
18 27 130 132
17 29 110 103
20 33  98  86
20 25 119 125
end data.

manova intererr consterr interspd constspd
      / wsfactors noise(2)
      / measures error speed
       / print cellinfo(means) signif(multiv).
```

There are four variables for each participant -- each of two DVs measured during the completion of each of two IV conditions.

The order in which the DVs are listed is important! They must be grouped with all of one DV first, then all of the second DV, etc. The order of reference to IV conditions must be the same in each DV group. In this example there are two groups of DV (first both "error" DVs and then both "speed" DVs), and within each group the DV from the "intermittent" IV condition is given first, followed by the DV from the "constant" IV condition.

The "wsfactors" subcommand is used to provide a name for the IV (and gives the number of IV conditions in parentheses). SPSS naming conventions must be followed.

The "measures" subcommand is used to provide names for the DVs (follow SPSS naming conventions). The first DV named must correspond to the first group of DVs, the second DV name must correspond to the second group of DVs, etc.

The "statistics" subcommand requests univariate statistics and the multivariate test of mean differences between the IV conditions.

Output:

```
Cell Means and Standard Deviations
 Variable .. INTERERR          errors during intermittent noise conditi
                                              Mean  Std. Dev.          N
 For entire sample                          20.000      3.162          6

 Variable .. CONSTERR          errors during constant noise condition
                                              Mean  Std. Dev.          N
 For entire sample                          28.167      3.488          6

 Variable .. INTERSPD          speed  during intermittent noise conditi
                                              Mean  Std. Dev.          N
 For entire sample                         114.500     10.986          6

 Variable .. CONSTSPD          speed  during constant noise condition
                                              Mean  Std. Dev.          N
 For entire sample                         112.000     16.310          6
```

Univariate statistics for each of the DVs, for each IV condition.

```
EFFECT .. NOISE
Multivariate Tests of Significance (S = 1, M = 0, N = 1 )

Test Name         Value  Approx. F Hypoth. DF   Error DF  Sig. of F

Pillais          .89246   16.59763       2.00       4.00       .012
Hotellings      8.29881   16.59763       2.00       4.00       .012
Wilks            .10754   16.59763       2.00       4.00       .012
Roys             .89246
```

Multivariate significance test. SPSS provides four multivariate tests (three with an aproximate F-value and associated p-value). With two IV conditions and equal sample sizes, these F-approximations will be equal. Usually they produce equivalent decisions about whether to reject or retain H0:. Wilks is probably the most commonly reported multivariate summary statistic.

Based on these results we would reject the multivariate H0: and conclude that there is a multivariate mean difference involving these DVs, between these two IV conditions.

SPSS Code:

```
manova intererr consterr
      / wsfactors noise(2)
      / print signif(avonly).
```

Having found a multivariate effect, we then want to examine each of the DVs for a mean difference between the IV conditions. The first analysis examines the error DV for an effect; the second examines the speed DV.

Output:

```
Tests involving 'NOISE' Within-Subject Effect.

 AVERAGED Tests of Significance for MEAS.1 using UNIQUE sums of squares
 Source of Variation          SS      DF        MS         F  Sig of F

 WITHIN CELLS              34.42       5      6.88
 NOISE                    200.08       1    200.08     29.07      .003
```

We would conclude that there is a mean difference between the mean error rateS during intermittent and constant noise.

SPSS Code:

```
manova interspd constspd
      / wsfactors noise(2)
      / print signif(avonly).
```

Output:

```
Tests involving 'NOISE' Within-Subject Effect.

 AVERAGED Tests of Significance for MEAS.1 using UNIQUE sums of squares
 Source of Variation          SS      DF        MS         F  Sig of F

 WITHIN CELLS             137.75       5     27.55
 NOISE                     18.75       1     18.75       .68      .447
```

We would conclude that there is no mean difference between the speed with which that task was completed during intermittent and constant noise conditions.

Reporting the Results

Task performance under the different noise conditioms is summarized in Table 1. There was a multivariate difference between performance in the intermittent noise and constant noise condtions (Wilks = .108, F(2,4) = 16.69, p = .012). As hypothesized, there were fewer errors committed during the intermittent noise condition than during the constant noise condition (F(1,5) = 29.07, Mse = 6.88, p = .003). However, contrary to the research hypothesis, there was no difference between the mean task completion speeds for the two noise conditions (F(1,5) = .68, Mse = 27.55, p = .447).

Table 1
Mean (stdev) performance scores under the noise conditions.

	Noise Conditioin	
Performance Measure	Intermittent Noise	Constant Noise
Number of Errors	20.00 (3.16)	28.17 (3.49)
Speed of Completion	114.50 (10.99)	112.00 (16.31)