Appendix

The syntaxes below show SPSS syntax for running within-groups factor analysis.

```
DISCRIMINANT
  /GROUPS=groupid(1 100)
  /VARIABLES=y1 y2 y3 y4 y5 y6 y7 y8 y9 y10
  /ANALYSIS ALL
  /PRIORS EQUAL
  /STATISTICS=COV
  /CLASSIFY=NONMISSING POOLED.

*Read in Covariance matrix.

matrix data variables=rowtype_ y1 y2 y3 y4 y5 y6 y7 y8 y9 y10.
begin data
N 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000
 cov 1.786
     cov  .611 1.492
     cov .733  .613 1.773
     cov .654  .489 .650 1.552
     cov .664  .537 .614 .553 1.597
     cov .153  .120 .144 -.005 .055 1.336
     cov .159  .177 .199 .137 .126 .352 1.369
     cov .198  .130 .175 .154 .111 .554 .432 1.663
     cov .215  .233 .233 .062 .119 .553 .496 .741 1.861
     cov .111  .119 .173 .069 .053 .591 .451 .637 .636 1.677
end data.

*Run Maximum Likelihood Factor Analysis.

FACTOR
  /MATRIX = IN (COV = *)
  /MISSING LISTWISE
  /ANALYSIS y1 y2 y3 y4 y5 y6 y7 y8 y9 y10
  /PRINT INITIAL EXTRACTION ROTATION
  /PLOT EIGEN
  /CRITERIA MINEIGEN(1) ITERATE(25)
  /EXTRACTION ML
  /CRITERIA ITERATE(25)
  /ROTATION PROMAX(4).
```

Latent GOLD. The syntaxes below show the equations for specifying the different IRT and FA models used in our illustration. The equations used for IRT and FA are equivalent. The only difference is whether the indicators are specified as dichotomous or continuous.

```
//Defining the variables for IRT.
variables
   groupid groupid;
    dependent y1 2, y2 2, y3 2, y4 2, y5 2, y6 2, y7 2, y8 2, y9 2, y10
      2;
   latent
      theta1 continuous, theta2 continuous, u1 group continuous, u2
      group continuous;

//Defining the variables for FA.
variables
   groupid groupid;
    dependent y1 continuous, y2 continuous, y3 continuous, y4
      continuous, y5 continuous, y6 continuous, y7 continuous, y8
      continuous, y9 continuous, y10 continuous;
   latent
      theta1 continuous, theta2 continuous, u1 group continuous, u2
      group continuous;

//Obtaining ICCs for dichotomous indicators
variables
   groupid groupid;
   dependent y1 binomial;
   latent
   U1 continuous;
equations
   U1;
   y1 <- 1 + (1) U1;

//Obtaining ICCs for continuous indicators
variables
   groupid groupid;
   dependent y1 continuous;
   latent
   U1 continuous;
equations
   U1;
   y1 <- 1 + (1) U1;

//1 Factor model.
equations
   (1) theta1;
   y1  <- 1 + theta1;
   y2  <- 1 + theta1;
   y3  <- 1 + theta1;
   y4  <- 1 + theta1;
   y5  <- 1 + theta1;
```

```
   y6  <- 1 + theta1;
   y7  <- 1 + theta1;
   y8  <- 1 + theta1;
   y9  <- 1 + theta1;
   y10 <- 1 + theta1;
```

//2 Factor model.

```
equations
   (1)  theta1;
   (1)  theta2;
   theta1 <-> theta2;
   y1  <- 1 + theta1;
   y2  <- 1 + theta1;
   y3  <- 1 + theta1;
   y4  <- 1 + theta1;
   y5  <- 1 + theta1;
   y6  <- 1 + theta2;
   y7  <- 1 + theta2;
   y8  <- 1 + theta2;
   y9  <- 1 + theta2;
   y10 <- 1 + theta2;
```

//1 Individual Factor 1 Group Factor model.

```
equations
   (1) theta1;
   (1) u1;
   y1  <- 1 + theta1 + u1;
   y2  <- 1 + theta1 + u1;
   y3  <- 1 + theta1 + u1;
   y4  <- 1 + theta1 + u1;
   y5  <- 1 + theta1 + u1;
   y6  <- 1 + theta1 + u1;
   y7  <- 1 + theta1 + u1;
   y8  <- 1 + theta1 + u1;
   y9  <- 1 + theta1 + u1;
   y10 <- 1 + theta1 + u1;
```

//2 Individual Factor 1 Group Factor model.

```
equations
   (1)  theta1;
   (1)  theta2;
   theta1 <-> theta2;
   (1) u1;
   y1  <- 1 + theta1 + u1;
   y2  <- 1 + theta1 + u1;
   y3  <- 1 + theta1 + u1;
   y4  <- 1 + theta1 + u1;
   y5  <- 1 + theta1 + u1;
   y6  <- 1 + theta2 + u1;
   y7  <- 1 + theta2 + u1;
   y8  <- 1 + theta2 + u1;
   y9  <- 1 + theta2 + u1;
```

```
   y10 <- 1 + theta2 + u1;
```

//2 Individual Factor 2 Group Factor model.

```
equations
    (1)   theta1;
    (1)   theta2;
   theta1 <-> theta2;
    (1)   u1;
    (1)   u2;
   u1 <-> u2;
   y1  <- 1 + theta1 + u1;
   y2  <- 1 + theta1 + u1;
   y3  <- 1 + theta1 + u1;
   y4  <- 1 + theta1 + u1;
   y5  <- 1 + theta1 + u1;
   y6  <- 1 + theta2 + u2;
   y7  <- 1 + theta2 + u2;
   y8  <- 1 + theta2 + u2;
   y9  <- 1 + theta2 + u2;
   y10 <- 1 + theta2 + u2;
```

//1 Individual Factor 1 Group Factor model: Strong metric equivalence.

```
equations
   theta1;
   u1;
   y1 <-  1 + (1)   theta1 + (1)   u1;
   y2 <-  1 + (a2)  theta1 + (a2)  u1;
   y3 <-  1 + (a3)  theta1 + (a3)  u1;
   y4 <-  1 + (a4)  theta1 + (a4)  u1;
   y5 <-  1 + (a5)  theta1 + (a5)  u1;
   y6 <-  1 + (a6)  theta1 + (a6)  u1;
   y7 <-  1 + (a7)  theta1 + (a7)  u1;
   y8 <-  1 + (a8)  theta1 + (a8)  u1;
   y9 <-  1 + (a9)  theta1 + (a9)  u1;
   y10 <- 1 + (a10) theta1 + (a10) u1;
```

Mplus. The syntaxes below show the equations for specifying the different IRT and FA models used in our illustration. The equations used for IRT and FA are equivalent.

//1 Individual Factor 1 Group Factor model.

```
ANALYSIS: TYPE = TWOLEVEL;
MODEL:
%WITHIN%
theta1 BY y1-y10;
%BETWEEN%
u1 BY y1-y10;
```

//2 Individual Factor 2 Group Factor model.

```
ANALYSIS: TYPE = TWOLEVEL;
```

```
MODEL:
%WITHIN%
theta1 BY y1-y5;
theta2 BY y6-y10;
%BETWEEN%
u1 BY y1-y5;
u2 BY y6-y10;
```

//1 Individual Factor 1 Group Factor model; Strong metric equivalence.

```
ANALYSIS: TYPE = TWOLEVEL;
MODEL:
%WITHIN%
theta1 BY y1(1);
theta1 BY y2(2);
theta1 BY y3(3);
theta1 BY y4(4);
theta1 BY y5(5);
theta2 BY y6(6);
theta2 BY y7(7);
theta2 BY y8(8);
theta2 BY y9(9);
theta2 BY y10(10);
%BETWEEN%
u1 BY y1(1);
u1 BY y2(2);
u1 BY y3(3);
u1 BY y4(4);
u1 BY y5(5);
u2 BY y6(6);
u2 BY y7(7);
u2 BY y8(8);
u2 BY y9(9);
u2 BY y10(10);
```