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Measurement Error Adjustments for Single Indicators for the Social Phobia Example

This document presents the syntax I used to adjust for measurement error for the single indicators in the social phobia example. The analyses are supplemental and I typically use them to affirm that the basic conclusions from the model without the error corrections (and that assume perfect reliability) did not change when I corrected for measurement error, i.e., that the conclusions are robust to error adjustments. I orient this way because the strategies for adjusting for measurement error for single indicators are not without their limitations; I therefore report the more traditional analyses but then supplement them with sensitivity checks. If I have considerable confidence in my reliability estimates for single indicators, I might not treat the error adjustments as supplemental but rather build them into the primary analyses.

The strategies for correcting single indicators for measurement error are described in the document on the resources tab for Chapter 3 titled *Measurement Error for Single Indicator SEM Models*. Read that document first if you have not already done so. I assume you know Mplus syntax per Chapter 11. When I created the data for the social phobia example, I created it so that the single indicators had perfect reliability. As such, for me to illustrate the process of incorporating measurement error for single indicators into the social phobia example, I must be careful about overcorrecting for unreliability to the point that I create offending estimates, per my discussion in the Chapter 3 primer. Since my main goal mainly is to illustrate the Mplus programming strategy, I will adopt high levels of reliability for each of the single indicators, namely reliabilities of 0.95; the unreliabilities are 0.05. I do not make measurement error adjustments for `TREAT` or `SEX` because these are variables that one would not normally introduce reliability corrections for. It is reasonable to assume perfect reliability for them.

The measures I adjusted were `NEGAPP1`, `NEGAPP2`, `PSKILLS1`, `PSKILLS2`, `EXTERN1`, `EXTERN2` and `HYPER`. To make the corrections, I first need to find the estimated variances for them in the model. I locate these in the `TECH4` output in the diagonal elements of the covariance matrix. The variances are 0.201, 0.624, 0.199, 0.595, 0.188, 0.290 and 0.200, respectively. To define the error variance for a measure, I multiply its variance by one minus its reliability, 1 – 0.95 = 0.05. For example, for `NEGAPP1`, it is (0.201)(0.05) = 0.10. Table 1 presents the relevant Mplus syntax (lines are numbered for reference, but in Mplus, they should not be numbered).

Table 1: Mplus Syntax for Measurement Error Adjustment

```
TITLE: EXAMPLE CHAPTER 11 ;
DATA: FILE IS c:\mplus\ret\chap11M.txt ;
VARIABLE:
NAMES ARE ID CR1 SPAI1 SPIN1 CR3 SPAI3 SPIN3
NEGAPP2 PSKILLS2 EXTERN2 NEGAPP1 PSKILLS1 EXTERN1
HYPER SEX TREAT ;
USEVARIABLES ARE CR1 SPAI1 SPIN1 CR3 SPAI3 SPIN3
NEGAPP2 PSKILLS2 EXTERN2 NEGAPP1 PSKILLS1 EXTERN1
HYPER SEX TREAT ;
MISSING ARE ALL (-9999) ;
ANALYSIS:
ESTIMATOR = MLR ;  !Robust maximum likelihood
MODEL:
!Specify latent variables
   LSP1 BY CR1 SPAI1 SPIN1 ;
   LSP3 BY CR3 SPAI3 SPIN3 ;
[CR1@0] ; [CR3@0] ; [LSP1] (mean1) ; [LSP3] (int1) ;
!Turn single indicators into latent variables
   LNEGAPP1 BY NEGAPP1@1 ;
   LNEGAPP2 BY NEGAPP2@1 ;
   LPSKILL1 BY PSKILLS1@1 ;
   LPSKILL2 BY PSKILLS2@1 ;
   LEXTERN1 BY EXTERN1@1 ;
   LEXTERN2 BY EXTERN2@1 ;
   LHYPER BY HYPER@1 ;
   NEGAPP1@0.010;   ! .201*.05
   NEGAPP2@0.031;   ! .624*.05
   PSKILLS1@0.010;  ! .199*.05
   PSKILLS2@0.030;  ! .595*.05
   EXTERN1@0.009;   ! .188*.05
   EXTERN2@0.014;   ! .290*.05
   HYPER@0.010;     ! .200*.05
!Specify equations
   LSP3 ON LSP1 LNEGAPP2 LPSKILL2 LEXTERN2 TREAT SEX (b10 p4-p7 b11) ;
   LSP3 ON LHYPER (b12) ;
   LNEGAPP2 ON TREAT LHYPER SEX LNEGAPP1 LPSKILL2 (p1 b1-b3 p8) ;
   LPSKILL2 ON TREAT LHYPER SEX LPSKILL1 (p2 b4-b6) ;
   LEXTERN2 ON TREAT LHYPER SEX EXTERN1 LPSKILL2 (p3 b7-b9 p9) ;
!Specify correlations of latent variable with exogenous variables
   LSP1 WITH LNEGAPP1 LPSKILL1 LEXTERN1 TREAT SEX LHYPER ;
 MODEL INDIRECT:
   LSP3 IND TREAT ;
   LSP3 IND LPSKILL2 ;
   LNEGAPP2 IND TREAT ;
   LEXTERN2 IND TREAT ;31. OUTPUT:
OUTPUT
   SAMP STANDARDIZED(STDYX) MOD(ALL 4) RESIDUAL CINTERVAL TECH4 ;
```

In Lines 19 to 25, I convert the observed indicators to latent variables using the `BY` keyword. I start the name of each latent variable with an L to distinguish it from the observed indicator. Each of these latent variables has a single indicator. I use the @ sign to fix the loading from the latent variable to the indicator to 1.0. This signifies the measure is the reference indicator. In Lines 26 to 32, I fix the error variances of the indicators to the values that represents 5% of the indicators variance. This builds in the unreliability that I seek. In Lines 33 to 45, wherever I originally referenced a single indicator, I now reference its latent variable.

Here is the original output from the model with no unreliability corrections as reported in Chapter 11 for the coefficients for the effects of the mediators on the outcome:

```
                                                 Two-Tailed
                    Estimate       S.E.  Est./S.E.    P-Value

 LSP3      ON
    NEGAPP2            0.390      0.095      4.100      0.000
    PSKILLS2          -0.707      0.099     -7.109      0.000
    EXTERN2           -0.002      0.091     -0.017      0.986
    TREAT             -0.488      0.136     -3.581      0.000
    SEX               -0.002      0.088     -0.026      0.979
    HYPER             -0.186      0.103     -1.803      0.071
    LSP1               0.347      0.072      4.835      0.000
```

and here is the corresponding output for the model with reliability corrections:

```
                                                 Two-Tailed
                    Estimate       S.E.  Est./S.E.    P-Value

 LSP3      ON
    LNEGAPP2           0.404      0.115      3.519      0.000
    LPSKILL2          -0.800      0.124     -6.468      0.000
    LEXTERN2          -0.032      0.099     -0.325      0.745
    TREAT             -0.375      0.145     -2.595      0.009
    SEX                0.000      0.088      0.004      0.997
    LHYPER            -0.198      0.112     -1.770      0.077
    LSP1               0.341      0.072      4.731      0.000
```

The fundamental trends in the two analyses are comparable. This also was true for the other model parameters.