Mediation of Within-Person Fluctuation in SAS PROC MIXED vs. Mplus v. 7.11

Although multilevel models (MLM) with observed variables (such as in SAS MIXED) are useful for many things, they have some limitations that are addressed by moving to "multilevel structural equation models" (MSEM), such as in Mplus. The primary difference is that rather than obtaining separate between and within effects after adding observed variable predictors in MLM, in MSEM the between and within variances of any level-1 predictor can be partitioned into level-2 random intercept variances and level-1 residual variances directly within the model, the same as for the single DV in the usual MLM. So this is truly multivariate model in which a given variable can be both a predictor and an outcome simultaneously, as is necessary to do mediational analysis of direct and indirect effects. Here is our example from chapter 8 of fluctuation across 5 days for 105 older adults in stress, negative mood, and physical symptoms:



In treating predictors as outcomes (either by predicting them or just by letting the model partition their variance), their means and variances become part of the model likelihood. In this way, modeling predictors as outcomes in MSEM allows them to have **missing case-wise data**, because any case that has at least one of the "DVs" (now including the former "predictors") will still be included. This trick does not work as easily for categorical predictors, though, as Mplus has restrictions about those that limit how they can included. As a result, for now we will treat stressors as an observed variable that has been partitioned into its WP and contextual effects by including observed predictors for binary stressors at level 1 and its person mean (centered at .40) at level 2.

For the model- partitioned variables (e.g., negative mood here), if using the "direct" level-1 effect syntax, their level-2 effect will be a BP effect, but if using the level-1 placeholder syntax to create random slopes (regardless of whether their random slope variances are actually estimated!), then their level-2 effect will be a contextual effect instead. Based on the results from previous analyses for these data, the **WP effects in this example will be specified as fixed only** (the same results were obtained within MSEM as well).

However, MSEM is not a panacea for everything. It currently cannot readily be as readily expanded to include other sources of variance (e.g., crossed effects, three-level nested models) the way MLM can. And as we will see later, it is between cumbersome and impossible to estimate interactions among the model variables, which become **latent variable interactions** for which estimation is very complicated (i.e., requiring numeric integration). In addition, although MLM has been shown to have downwardly biased level-2 effects relative to MSEM, the level-2 effects from MSEM have greater inconsistency, especially when the level-2 sample size and the ICC are small. Finally, there is no REML within MSEM, so **all level-2 variances (and thus fixed effect SEs) may be downwardly biased** for small level-2 sample sizes. To make the models are comparable as possible, we are using ML for the corresponding SAS examples.

We will begin by examining each component of the overall model ($X \rightarrow M, X \rightarrow Y, M \rightarrow Y$) and then examine the full mediation model and indirect effects.

Step 1: Fitting the Between-Person and Within-Person Stress (X) \rightarrow Mood (M) Relationship

```
In SAS, decomposing stress into level-1 WP vs. level-2
                                                                   In Mplus, doing the same thing:
contextual effects by brute force (observed variables):
                                                                   TITLE: Predicting latent mood from OBSERVED stress (X --> M);
TITLE1 "WP and Contextual Stress Predicting Mood: X --> M";
                                                                   DATA: FILE = symptoms.csv; ! Can just list file if in same directory;
PROC MIXED DATA=example COVTEST NOCLPRINT NOITPRINT NOINFO
                                                                          FORMAT = free; ! FREE or FIXED format;
IC NAMELEN=50 METHOD=ML;
                                                                          TYPE = individual; ! Individual or matrix data as input;
       CLASS ID;
       MODEL mood = female age80 female*age80
                                                                   VARIABLE:
                                                                   ! List of ALL variables in stacked data file, in order;
                    PMstress40 TVstress
                                                                   ! Mplus does NOT know what they used to be called, though;
              / SOLUTION DDFM=SATTERTHWAITE NOTEST;
                                                                       NAMES ARE PersonID symptom female age mood WPmood PMmood TVstres
       RANDOM INTERCEPT / TYPE=UN SUBJECT=ID;
                                                                                WPstres PMstres;
       REPEATED / TYPE=VC SUBJECT=ID;
                                                                   ! List of ALL variables used in model (DEFINED variables at end);
       ESTIMATE "Between Effect" TVstress 1 PMstress40 1;
                                                                       USEVARIABLES ARE mood female age TVstres PMstres agefem;
RUN;
                                                                   ! Missing data codes (here, -999);
                                                                       MISSING ARE ALL (-999);
                                                                   ! Identify person-level nesting;
                                                                       CLUSTER = PersonID;
                                                                   ! Predictor variables with variation ONLY within-persons at level 1;
* How to export to .csv for use in Mplus;
                                                                       WITHIN = TVstres;
PROC EXPORT DATA=work.ForMplus
                                                                   ! Predictor variables with variation ONLY between-persons at level 2;
       OUTFILE= "&filesave.\symptoms.csv"
                                                                       BETWEEN = age female agefem PMstres;
       DBMS=CSV REPLACE; PUTNAMES=NO; RUN;
                                                                   DEFINE:
                                                                                                     ! Creating level-2 interaction term;
                                                                              agefem = age*female;
                                                                   ANALYSIS:
                                                                              TYPE IS TWOLEVEL RANDOM; ! 2-level model with random slopes;
                                                                              ESTIMATOR IS ML;
                                                                                                      ! Can use MLR for non-normality;
                                                                   MODEL: !!!!! X Stress --> Y Symptoms Model;
                                                                   ! Level-1, time-level model;
                                                                   %WTTHTN%
                                                                                                      ! Residual level-1 mood variance:
                                                                          mood :
                                                                          WPXtoM | mood ON TVstres;
                                                                                                     ! Level-1 effect of stress on mood:
                                                                   ! Level-2, person-level model;
                                                                   %BETWEEN%
                                                                          mood;
                                                                                                       ! Random mood intercept variance;
                                                                          [mood];
                                                                                                       ! Fixed intercept for mood;
                                                                          [WPXtoM] (WPXtoM);
                                                                                                      ! WP effect of stress on mood:
                                                                          WPXtoM@0;
                                                                                                       ! No random stress effect on mood;
                                                                          mood ON female (femtoM);
                                                                                                       ! BP effect of female on mood;
                                                                                                       ! BP effect of age on mood;
                                                                          mood ON age (agetoM);
                                                                          mood ON agefem (agefemM);
                                                                                                       ! BP effect of age*female on mood;
                                                                          mood ON PMstres(conXtoM);
                                                                                                       ! Context effect of stress on mood;
                                                                   MODEL CONSTRAINT:
                                                                                                        ! Equivalent to ESTIMATE in SAS;
                                                                    NEW(BPstres);
                                                                    BPstres = WPXtoM + conXtoM;
                                                                                                        ! BP effect of stress on mood:
```

Hoffman Psyc 945 Example 5e

| SAS Results | 5: | | | Mplus Results: This is the same model | | | | | | | | | | |
|-----------------------|---------------------|---------------|------------|---------------------------------------|--------|----------|--|----------------------------|--------------|-------|-----------|------------|--|--|
| | Covaria | ance Paramete | es | | | | | | | | | | | |
| Standard Z T | | | | | | | THE MODEL ESTIMATION TERMINATED NORMALLY | | | | | | | |
| Cov Parm | Subject H | Estimate | Error | Value | Pr > Z | | | | | | | | | |
| UN(1,1) | ID | 0.04001 0 | .008296 | 4.82 | <.000 | 1 | NODER LIT THLOKMATION | | | | | | | |
| Residual | ID | 0.08899 0 | .006282 | 14.17 | <.000 | 1 | Number of H | Free Parame | eters | | 8 | | | |
| | | T | | | | | Loglikeliha | bod | | | | | | |
| | D a series a | Informatio | on Griter: | La | DIO | 0.4.7.0 | H | HO Value | | | -167.143 | | | |
| Neg2LogLike | Parms | AIC | AICC | HQIC | BIC | | | | | | | | | |
| 334.3 | 8 | 350.3 | 350.0 | 358.9 | 371.5 | 379.5 | Information | n Criteria | - | | 250 207 | | | |
| | 0 | bion for Five | | | | | | Akaike (Al(Bavesian (B | STC) | | 350.287 | | | |
| | 501u | | u Ellects | | | | 2 | Sample-Size | e Adjusted : | BIC | 358.753 | | | |
| Effoot | C atimata | Standard | DE | + \/a]a | Do N I | + 1 | | (n* = (n | + 2) / 24) | | | | | |
| ETTECL | Estimate | ELLOL | DF | t value | PI: > | ι | MODEL DEGU | та | | | | | | |
| Intercent | 1 1174 | 0.04000 | 100 | 00 60 | < 0.00 | 0.1 | MODEL RESUL | 115 | | | | Two-Tailed | | |
| famela | 1.11/4 | 0.04928 | 128 | 22.08 | <.000 | | | I | Estimate | S.E. | Est./S.E. | P-Value | | |
| Temale | 0.01118 | 0.05435 | 105 | 0.21 | 0.83 | 74 60 | Within Leve | el | | | | | | |
| ayesu fomolotogo00 | 0.01288 | 0.008360 | 100 | 1.54 | 0.120 | 02 | | | | | | | | |
| Temale^age80 | -0.00525 | 0.009473 | 108 | -0.55 | 0.5803 | | Residual N | /ariances | 0 089 | 0 006 | 14 164 | 0 000 | | |
| PMstress40 | 0.1244 | 0.07928 | 101 | 1.57 | 0.110 | 87 | MOOD | | 0.005 | 0.000 | 14.104 | 0.000 | | |
| IVSTRESS | 0.1613 | 0.03612 | 403 | 4.47 | <.000 | 01 | Between Lev | vel | | | | | | |
| | | Estimate | es | | | | MOOD | ON | | | | | | |
| | | Standard | d | | | | FEMALE | 011 | 0.011 | 0.054 | 0.206 | 0.837 | | |
| Label | Estimat | te Erro | r DF | t Value | Pr > | + | AGE | | 0.013 | 0.008 | 1.542 | 0.123 | | |
| | 2002200 | | | | | 1 - 1 | AGEFEM | ~ | -0.005 | 0.009 | -0.555 | 0.579 | | |
| Between Effec | t 0.28 | 57 0.07050 | 0 102 | 4.05 | <. | 0001 | PMSTRES | 5 | 0.124 | 0.079 | 1.568 | 0.117 | | |
| | | | | | • | | Means | | | | | | | |
| | | | | | | | WPXTOM | | 0.161 | 0.036 | 4.464 | 0.000 | | |
| | | | | | | | | | | | | | | |
| | | | | | | | Intercepts MOOD | 5 | 1 117 | 0 049 | 22 689 | 0 000 | | |
| | | | | | | | MOOD | | 1.11/ | 0.019 | 22.009 | 0.000 | | |
| | | | | | | | Variances | | | | | | | |
| | | | | | | | WPXTOM | | 0.000 | 0.000 | 999.000 | 999.000 | | |
| | | | | | | | Residual V | Variances | | | | | | |
| | | | | | | | MOOD | ar ranceb | 0.040 | 0.008 | 4.814 | 0.000 | | |
| | | | | | | | | | | | | | | |
| | | | | | | | New/Additio | onal Parame | eters | 0 050 | 4 054 | 0.000 | | |
| | | | | | | | BPSTRES | 5 | 0.286 | 0.070 | 4.054 | 0.000 | | |
| | | | | | | | | | | | | | | |

Step 2: Fitting the Between-Person and Within-Person Stress (X) → Symptoms (Y) Relationship

```
In SAS, decomposing stress into level-1 WP vs. level-2
                                                                   In Mplus, doing the same thing:
contextual effects by brute force (observed variables):
                                                                   TITLE: Predicting latent symptoms from OBSERVED stress (so X --> Y);
TITLE1 "WP and Contextual Stress Predicting Symptoms:
                                                                   DATA: FILE = symptoms.csv; ! Can just list file if in same directory;
        X --> Y'';
                                                                                                ! FREE or FIXED format;
                                                                          FORMAT = free;
PROC MIXED DATA=example COVTEST NOCLPRINT NOITPRINT NOINFO
                                                                          TYPE = individual:
                                                                                               ! Individual or matrix data as input:
IC NAMELEN=50 METHOD=ML;
       CLASS ID;
                                                                   VARIABLE:
                                                                   ! List of ALL variables in stacked data file, in order;
       MODEL symptom5 = female age80 female*age80
                                                                   ! Mplus does NOT know what they used to be called, though;
                          PMstress40 TVstress
                                                                      NAMES ARE PersonID symptom female age mood WPmood PMmood TVstres
               / SOLUTION DDFM=SATTERTHWAITE NOTEST;
                                                                                WPstres PMstres;
       RANDOM INTERCEPT / TYPE=UN SUBJECT=ID;
                                                                   ! List of ALL variables used in model (DEFINED variables at end);
       REPEATED / TYPE=VC SUBJECT=ID;
                                                                      USEVARIABLES ARE symptom female age TVstres PMstres agefem;
       ESTIMATE "Between Effect" TVstress 1 PMstress40 1;
                                                                   ! Missing data codes (here, -999);
RUN:
                                                                      MISSING ARE ALL (-999);
                                                                   ! Identify person-level nesting;
                                                                      CLUSTER = PersonID;
                                                                   ! Predictor variables with variation ONLY within-persons at level 1;
                                                                      WITHIN = TVstres:
                                                                   ! Predictor variables with variation ONLY between-persons at level 2;
                                                                      BETWEEN = age female agefem PMstres;
                                                                   DEFINE:
                                                                              agefem = age*female;
                                                                                                      ! Creating level-2 interaction;
                                                                   ANALYSIS:
                                                                              TYPE IS TWOLEVEL RANDOM; ! 2-level model with random slopes;
                                                                              ESTIMATOR IS ML;
                                                                                                      ! Can use MLR for non-normality;
                                                                   MODEL: !!!!! X Stress --> Y Symptoms Model;
                                                                   ! Level-1, time-level model;
                                                                   %WITHIN%
                                                                    symptom;
                                                                                                    ! Residual level-1 symptoms variance;
                                                                                                   ! Level-1 effect of stress on symptoms;
                                                                    WPXtoY | symptom ON TVstres;
                                                                   ! Level-2, person-level model;
                                                                   %BETWEEN%
                                                                    symptom;
                                                                                                    ! Random symptoms intercept variance;
                                                                     [symptom];
                                                                                                   ! Fixed intercept for symptoms;
                                                                     [WPXtoY]
                                                                                       (WPXtoY);
                                                                                                  ! WP effect of stress on symptoms;
                                                                    WPXtoY@0;
                                                                                                   ! No random stress effect on symptoms;
                                                                    symptom ON female (femtoY);
                                                                                                  ! BP effect of female on symptoms;
                                                                    symptom ON age
                                                                                       (agetoY);
                                                                                                  ! BP effect of age on symptoms;
                                                                    symptom ON agefem (agefemY); ! BP effect of age*female on symptoms;
                                                                    symptom ON PMstres (conXtoY); ! Context effect of stress on symptoms;
                                                                   MODEL CONSTRAINT:
                                                                                                    ! Equivalent to ESTIMATE in SAS;
                                                                   NEW(BPstres);
                                                                   BPstres = WPXtoY + conXtoY;
                                                                                                   ! BP effect of stress on symptoms;
```

| SAS Result | s: | | | | Mplus Results: This is the same model | | | | | | | | |
|--------------|------------|-------------|-------------|-----------------|--|-------------------------|-----------------------|--------|-----------|------------|--|--|--|
| | Covari | ance Parame | ter Estimat | es | THE MODEL ESTIMATION TERMINATED NORMALLY | | | | | | | | |
| | Standard Z | | | | | MODEL ETT INFORM | α Ω Π Τ Γ | | | | | | |
| Cov Parm | Subject | Estimate | Error | Value | Pr > Z | MODET LII TULOKMALION | | | | | | | |
| UN(1,1) | ID | 0.8376 | 0.1344 | 6.23 | <.0001 | Number of Free P | Parameters | | 8 | | | | |
| Residual | ID | 0.6134 | 0.04322 | 14.19 | <.0001 | | | | | | | | |
| | | | | | | Loglikelihood HO Val | 110 | | -704 243 | | | | |
| | | Informa | tion Criter | ia | | 110 Vai | uc | | /01.215 | | | | |
| | | | | | 570 0470 | Information Crit | eria | | | | | | |
| Neg2LogLike | Parms | AIC | AICC | HQIC | BIC CAIC | Akaike | e (AIC) | | 1424.486 | | | | |
| 1408.5 | 8 | 1424.5 | 1424.8 | 1433.1 | 1445.7 1453.7 | Sample | -Size Adjusted F | BIC | 1432.953 | | | | |
| | 0.01.0 | tion for Fi | | | | (n* | = (n + 2) / 24) | | | | | | |
| | 501U | Standan | NEU EFTECTS | • | | | | | | | | | |
| Effect | Estimato | Frro | n DE | t Value | Pr > t | MODEL RESULTS | | | | | | | |
| Intercent | 1 5828 | 0 193 | 6 115 | 2 VALUE 8 18 | < 0001 | | | | | Two-Tailed | | | |
| female | -0 5149 | 0.130 | B 105 | -2.34 | 0.0210 | | Estimate | S.E. | Est./S.E. | P-Value | | | |
| ade80 | 0 09720 | 0.0335 | 3 108 | 2.04 | 0.0045 | Within Level | | | | | | | |
| female*age80 | -0.1069 | 0.0381 | 1 107 | -2.81 | 0.0060 | Residual Varian | nces | | | | | | |
| PMstress40 | 1.3367 | 0.301 | 9 127 | 4.43 | <.0001 | SYMPTOM | 0.613 | 0.043 | 14.192 | 0.000 | | | |
| TVstress | 0.1100 | 0.0948 | 7 403 | 1.16 | 0.2469 | | | | | | | | |
| | | | | | | Between Level | | | | | | | |
| | | Estim | ates | | | SYMPTOM ON | | | | | | | |
| | | Stand | ard | | | FEMALE | -0.515 | 0.220 | -2.342 | 0.019 | | | |
| Label | Estima | te Er | ror DF | t Value | Pr > t | AGE | 0.097 | 0.034 | 2.898 | 0.004 | | | |
| Between Effe | ct 1.44 | 68 0.2 | 865 104 | 5.05 | <.0001 | PMSTRES | -U.IU/ 1 337 | 0.038 | -2.805 | 0.005 | | | |
| | | | | | | 11.011.00 | 1.007 | 0.502 | 11120 | 01000 | | | |
| | | | | | | Means | | | | | | | |
| | | | | | | WPXTOY | 0.110 | 0.095 | 1.160 | 0.246 | | | |
| | | | | | | Intercepts | | | | | | | |
| | | | | | | SYMPTOM | 1.583 | 0.194 | 8.176 | 0.000 | | | |
| | | | | | | Variances | | | | | | | |
| | | | | | | WPXTOY | 0.000 | 0.000 | 999.000 | 999.000 | | | |
| | | | | | | | | | | | | | |
| | | | | | | Residual Varian | lces | 0 10 1 | c | 0.000 | | | |
| | | | | | | SYMPTOM | 0.838 | 0.⊥34 | 6.233 | 0.000 | | | |
| | | | | | | New/Additional P | Parameters | | | | | | |
| | | | | | | BPSTRES | 1.447 | 0.286 | 5.050 | 0.000 | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

Step 3: Fitting the Between-Person and Within-Person Mood (M) → Symptoms (Y) Relationship

```
In SAS, decomposing mood into level-1 WP vs. level-2
                                                                  In Mplus, decomposing mood into WP vs. Contextual in the MODEL:
contextual effects by brute force (observed variables):
                                                                   TITLE: Predicting latent symptoms from latent mood (so M --> Y);
TITLE1 "TV and Contextual Mood Predicting Symptoms:
                                                                   DATA: FILE = symptoms.csv; ! Can just list file if in same directory;
        M --> Y'';
                                                                          FORMAT = free;
                                                                                                ! FREE or FIXED format;
PROC MIXED DATA=example COVTEST NOCLPRINT NOITPRINT NOINFO
                                                                          TYPE = individual; ! Individual or matrix data as input;
IC NAMELEN=50 METHOD=ML;
       CLASS ID;
                                                                   VARIABLE:
                                                                   ! List of ALL variables in stacked data file, in order;
       MODEL symptom5 = female age80 female*age80
                                                                   ! Mplus does NOT know what they used to be called, though;
                          PMmood2 TVmood2
                                                                       NAMES ARE PersonID symptom female age mood WPmood PMmood TVstres
               / SOLUTION DDFM=SATTERTHWAITE NOTEST;
                                                                                WPstres PMstres;
       RANDOM INTERCEPT / TYPE=UN SUBJECT=ID;
                                                                   ! List of ALL variables used in model (DEFINED variables must go at end);
       REPEATED / TYPE=VC SUBJECT=ID;
                                                                       USEVARIABLES ARE symptom female age mood agefem;
       ESTIMATE "Between Effect" TVmood2 1 PMmood2 1;
                                                                   ! Missing data codes (here, -999);
RUN:
                                                                       MISSING ARE ALL (-999);
                                                                   ! Identify person-level nesting;
                                                                       CLUSTER = PersonID;
                                                                   ! Predictor variables with variation ONLY within-persons at level 1;
                                                                       WITHIN = ;
                                                                   ! Predictor variables with variation ONLY between-persons at level 2;
                                                                      BETWEEN = age female agefem;
                                                                   DEFINE:
                                                                              agefem = age*female;
                                                                                                       ! Creating level-2 interaction;
                                                                   ANALYSIS:
                                                                              TYPE IS TWOLEVEL RANDOM: ! 2-level model with random slopes:
                                                                              ESTIMATOR IS ML;
                                                                                                      ! Can use MLR for non-normality;
                                                                   MODEL: !!!!! X Stress --> Y Symptoms Model;
                                                                   ! Level-1, time-level model;
                                                                   %WITHIN%
                                                                     symptom;
                                                                                                  ! Residual level-1 symptoms variance;
                                                                     mood;
                                                                                                  ! Residual level-1 mood variance;
                                                                     WPMtoY | symptom ON mood;
                                                                                                  ! Level-1 effect of mood on symptoms;
                                                                   ! Level-2, person-level model;
                                                                   %BETWEEN%
                                                                                                  ! Random symptoms intercept variance;
                                                                     symptom;
                                                                                                  ! Random mood intercept variance;
                                                                     mood;
                                                                     [symptom];
                                                                                                  ! Fixed intercept for symptoms;
                                                                                                  ! Fixed intercept for mood;
                                                                     [mood];
                                                                     [WPMtoY]
                                                                                       (WPMtoY); ! WP effect of mood on symptoms;
                                                                                                  ! No random effect of mood on symptoms;
                                                                     WPMtoY@0;
                                                                     symptom ON female (femtoY); ! BP effect of female on symptoms;
                                                                     symptom ON age
                                                                                       (agetoY); ! BP effect of age on symptoms;
                                                                     symptom ON agefem (agefemY); ! BP effect of age*female on symptoms;
                                                                     symptom ON mood (conMtoY); ! Context effect of mood on symptoms;
                                                                   MODEL CONSTRAINT:
                                                                                                  ! Equivalent to ESTIMATE in SAS;
                                                                   NEW(BPmood);
                                                                   BPmood = WPMtoY + conMtoY;
                                                                                                  ! BP effect of mood on symptoms
```

| Coveriance Parameter Estimates same model, because model is being treated like another DV (and so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a so its mean and two variances are model parameters). This is a solution for Fixed Effects have been corrected for WP unreliability. Information Criteria The model parameters its is a solution of fixed Effects have been corrected for WP unreliability. Solution for Fixed Effects Solution for Fixed Effects Solution for Fixed Effects Solution for Fixed Effects Colspan="2">Two-Tailed < | SAS Results | | | | | | | Mplus Results: A | Ithouah this | s is the s | same idea. | this is NOT | the | | | | | | | |
|--|---|---------|------------|-----------|---------|---------|---------|--|--|---------------------------|------------|--------------|--------------|----------|---------------------|---------|--|----|--|--|
| $ \begin{array}{ c c c c c c c c c c c c c c c c c c c$ | | Covar | iance Para | meter E | stimate | es | | same model, because mood is being treated like another DV (and | | | | | | | | | | | | |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | | | | Stan | Idard | Z | | | so its mean and t | wo variance | s aro m | odel narar | notors) This | ie | | | | | | |
| UN(1,1) ID 0.8186 0.1314 6.21 <.0001 Residual ID 0.6127 0.04317 14.19 <.0001 Information Criteria Neg2LogLike Parms AIC AICC HOIC BIC CAIC 1405.7 8 1421.7 1422.0 1430.3 1443.0 1451.0 Solution for Fixed Effects Standard Effect Estimate Error DF t Value Pr > t Information Criteria Effect 1.8124 0.3910 132 4.63 <.0001 Twood2 0.0591 0.1277 404 1.25 0.2136 Estimates Standard Estimates Standard Label Estimate Error DF t Value Pr > t Between Effect 1.9715 0.3688 105 5.35 <.0001 Twood2 0.1591 0.1277 404 1.25 0.2136 Label Estimate Error DF t Value Pr > t Between Effect 1.9715 0.3688 105 5.35 <.0001 Twood2 0.1591 0.1277 404 1.25 0.2136 Label Estimate Error DF t Value Pr > t Between Effect 1.9715 0.3688 105 5.35 <.0001 Twood2 0.093 0.007 14.157 0.000 Residual Variances Standard Label Estimate Error DF t Value Pr > t Between Effect 1.9715 0.3688 105 5.35 <.0001 Twood2 0.1591 0.1277 404 1.25 0.2136 MODEL RESULTS MODEL RESULTS MODEL RESULTS MODEL RESULTS MODEL RESULTS MODEL 2.311 0.558 0.000 Between Level STMPTOM 0.613 0.043 14.185 0.000 MODEL RESULTS MODEL RESULTS MO | Cov Parm S | Subject | Estimate | E | rror | Value | Pr > 2 | Z | advantageous in the event of missing data and because t | | | | | | | | | | | |
| Residual ID 0.6127 0.04317 14.19 <.0001 2 effects have been corrected for VVP unreliability. Veg2logLike Parms AIC AIC HOI BIC CAIC Neg2logLike Parms AIC AIC HOI BIC CAIC Neg2logLike Parms AIC AIC HOI BIC CAIC Neg2logLike Parms AIC AIC HOI BIC CAIC Number of Free Parms AIC AIC HOI BIC CAIC Number of Free Parameters 11 Information Criteria Standard Information Criteria AIC AIC AIC AIC AIC AIC AIC AIC Bayesian (BIC) 1803.635 Bayesian (BIC) 1803.635 Bayesian (BIC) 1815.276 Information Criteria Infor | UN(1,1)] | ID - | 0.8166 | 0. | 1314 | 6.21 | <.0001 | 1 | advantageous in the event of missing data and because th | | | | | e level- | | | | | | |
| THE MODEL ESTIMATION TERMINATED NORMALLY Neg2loglike 1405.7 Parms 8 Â.IC 142.7 HQIC 1420.0 BIC 1430.0 CAIC 1430.0 BIC 1430.0 CAIC 1430.0 MODEL ESTIMATION TERMINATED NORMALLY II Solution or Fixed Firsts Stander | Residual 1 | ID | 0.6127 | 0.0 | 4317 | 14.19 | <.0001 | 1 | 2 effects have be | en correcte | d for WF | ' unreliabil | lity. | | | | | | | |
| | | | | | | | | | | | NODMATIN | , | | | | | | | | |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | | | Infor | mation | Criter: | ia | | | THE MODEL ESTIMATIC | ON TERMINATED | NORMALLY | | | | | | | | | |
| 1405.7 8 1421.7 1422.0 1430.3 1443.0 1451.0 Number of Pree Parameters 11 Solution for Fixed Effects Standard Loglikelihood 100 Value -890.817 Colspan="4">Colspan= 4:4:4:Coll Cols | Neg2LogLike | Parms | AIC | AI | CC | HQIC | BIC | CAIC | MODEL FIT INFORMAT | ION | | | | | | | | | | |
| Solution Fixed Effects Solution Solution <th <="" colspan="6" solution<="" td=""><td>1405.7</td><td>8</td><td>1421.7</td><td>1422</td><td>2.0</td><td>1430.3</td><td>1443.0</td><td>1451.0</td><td>Number of Free Para</td><td>ameters</td><td></td><td>11</td><td></td><td></td></th> | <td>1405.7</td> <td>8</td> <td>1421.7</td> <td>1422</td> <td>2.0</td> <td>1430.3</td> <td>1443.0</td> <td>1451.0</td> <td>Number of Free Para</td> <td>ameters</td> <td></td> <td>11</td> <td></td> <td></td> | | | | | | 1405.7 | 8 | 1421.7 | 1422 | 2.0 | 1430.3 | 1443.0 | 1451.0 | Number of Free Para | ameters | | 11 | | |
| Solution for Fixed Effects Loginalization of the standard Effect Effects Loginalization of the standard Effect Effects Loginalization of the standard Effect Effects Loginalization of the standard Intercept 3.2639 0.3460 1.05 -2.37 0.0197 Addard Colspan="4">Information Criteria Adata < .0001 Adata < .0001 female*age80 0.09177 0.03785 107 -2.42 0.0170 Model 1.8124 0.3910 1.22 0.1277 4.03 Colspan="4">Two-Tailed Tymod2 1.9715 0.03688 105 5.5 Estimate Standard Two-Tailed Label Estimate STMPTOM 0. | | | | | | | | | | | | | | | | | | | | |
| Standard Standard Effect Standard Effect Standard Effect Error DF t Value Pr > t Maike (AIC) 1803.635 gag80 0.06690 0.03374 108 1.980 0.0499 1850.192 gag80 0.06690 0.0377 10.3785 107 -2.42 0.0170 (n* = (n + 2) / 24) 1815.192 PMmood2 1.8124 0.3910 132 4.63 <.0001 | <td></td> <td>Sol</td> <td>ution for</td> <td>Fixed E</td> <td>ffects</td> <td></td> <td></td> <td></td> <td>Loglikelinood H0 Value</td> <td></td> <td></td> <td>-890 817</td> <td></td> <td></td> | | Sol | ution for | Fixed E | ffects | | | | Loglikelinood H0 Value | | | -890 817 | | | | | | | |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | | | Stand | lard | | | | | no varac | | | 000.017 | | | | | | | | |
| Intercept 3.2639 0.3460 106 9.43 <.0001 | Effect | Estimat | e Er | ror | DF | t Value | Pr > t | t | Information Criter | ia | | | | | | | | | | |
| female -0.5151 0.2174 105 -2.37 0.0197 1085.192 1850.192 age80 0.06690 0.03784 108 1.98 0.0499 (n* = (n + 2) / 24) 1815.276 PMmood2 1.8124 0.3910 132 4.63 <.0001 | Intercept | 3.263 | 9 0.3 | 8460 | 106 | 9.43 | <.000 |)) | Akaike (A | AIC) | | 1803.635 | | | | | | | | |
| age80 0.06690 0.03374 108 1.98 0.0499 female*age80 -0.09177 0.03785 107 -2.42 0.0170 PMmood2 1.8124 0.3910 132 4.63 <.0001 | female | -0.515 | 1 0.2 | 2174 | 105 | -2.37 | 0.019 | 97 | Bayesian | (BIC) | DIC | 1850.192 | | | | | | | | |
| female*age80 -0.09177 0.03785 107 -2.42 0.0170 PMmood2 1.8124 0.3910 132 4.63 <.0011 | age80 | 0.0669 | 0 0.03 | 374 | 108 | 1.98 | 0.049 | 99 | (n* = | (n + 2) / 24) | DIC | 1015.270 | | | | | | | | |
| PMmod2 1.8124 0.3910 132 4.63 <.0001 MODEL RESULTS Two-Tailed TVmod2 0.1591 0.1277 404 1.25 0.2136 Estimate S.E. Est./S.E. P-Value Label Estimates Standard S.AS <.0001 | female*age80 | -0.0917 | 7 0.03 | 8785 | 107 | -2.42 | 0.017 | 70 | , , | . , , , | | | | | | | | | | |
| TVmood2 0.1591 0.1277 404 1.25 0.2136 Estimate Estimate S.E. Est./S.E. P-Value Label Estimate Error DF t Value Pr > t MOOD 0.093 0.007 14.157 0.000 Label Estimate Error DF t Value Pr > t Residual Variances SYMPTOM 0.613 0.043 14.185 0.000 Between Effect 1.9715 0.3688 105 5.35 <.0001 | PMmood2 | 1.812 | 4 0.3 | 910 | 132 | 4.63 | <.000 | 01 | MODEL RESULTS | | | | | | | | | | | |
| Estimates Baltimate S.E. Estimate Found Label Estimate From DF t Value Pr > t MOOD 0.093 0.007 14.157 0.000 Between Effect 1.9715 0.3688 105 5.35 <.0001 | TVmood2 | 0.159 | 1 0.1 | 277 | 404 | 1.25 | 0.213 | 36 | | Fatimato | с F | Fat /S F | Two-Tailed | | | | | | | |
| Estimates Standard Variances MOOD 0.093 0.007 14.157 0.000 Label Estimate Error DF t Value Pr > [t] Residual Variances SYMPTOM 0.613 0.043 14.185 0.000 Between Effect 1.9715 0.3688 105 5.35 <.0001 | | | | | | | | | Within Level | Estimate | Б.Е. | ESU./S.E. | P-Value | | | | | | | |
| Standard MOOD 0.093 0.007 14.157 0.000 Label Estimate Error DF t Value Pr > t Residual Variances SYMPTOM 0.613 0.043 14.157 0.000 Between Effect 1.9715 0.3688 105 5.35 <.0001 | | | Est | imates | | | | | Variances | | | | | | | | | | | |
| Label Estimate Error DF t Value Pr > t Between Effect 1.9715 0.3688 105 5.35 <.0001 Residual Variances SYMPTOM 0.613 0.043 14.185 0.000 Between Level SYMPTOM 0N FEMALE -0.536 0.219 -2.445 0.014 AGE 0.074 0.034 2.167 0.030 AGEFEM -0.098 0.038 -2.569 0.010 MOOD 2.341 0.558 4.199 0.000 Means MOOD 1.205 0.026 46.159 0.000 WPMTOY 0.167 0.128 1.303 0.193 Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances | | | Sta | Indard | | | | | MOOD | 0.093 | 0.007 | 14.157 | 0.000 | | | | | | | |
| Between Effect 1.9715 0.3688 105 5.35 <.0001 | Label | Estim | ate | Error | DF | t Value | Pr > | t | Regidual Variances | - | | | | | | | | | | |
| Between Level SYMPTOM ON FEMALE -0.536 0.219 -2.445 0.014 AGE 0.074 0.034 2.167 0.030 AGEFEM -0.098 0.038 -2.569 0.010 MOOD 2.341 0.558 4.199 0.000 Means 1.205 0.026 46.159 0.000 WPMTOY 0.167 0.128 1.303 0.193 Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances National State National State National State National State | Between Effect | t 1.9 | 715 0 | .3688 | 105 | 5.35 | <.(| 0001 | SYMPTOM | 0.613 | 0.043 | 14.185 | 0.000 | | | | | | | |
| Between Level SYMPTOM ON FEMALE -0.536 0.219 -2.445 0.014 AGE 0.074 0.034 2.167 0.030 AGEFEM -0.098 0.038 -2.569 0.010 MOOD 2.341 0.558 4.199 0.000 Means MOOD 1.205 0.026 46.159 0.000 MPMTOY 0.167 0.128 1.303 0.193 Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances 0.000 0.000 0.000 0.000 0.000 | | | | | | | | | | | | | | | | | | | | |
| SYMPTOM ON FEMALE -0.536 0.219 -2.445 0.014 AGE 0.074 0.034 2.167 0.030 AGEFEM -0.098 0.038 -2.569 0.010 MOOD 2.341 0.558 4.199 0.000 Means MOOD 1.205 0.026 46.159 0.000 WPMTOY 0.167 0.128 1.303 0.193 Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances Variances 0.000 0.000 0.000 0.000 | | | | | | | | | Between Level | | | | | | | | | | | |
| MARLE 0.030 2.143 0.014 AGE 0.074 0.034 2.167 0.030 AGEFEM -0.098 0.038 -2.569 0.010 MOOD 2.341 0.558 4.199 0.000 Means MOOD 1.205 0.026 46.159 0.000 WPMTOY 0.167 0.128 1.303 0.193 Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances 0.0107 0.100 0.010 0.000 | | | | | | | | | SYMPTOM ON | -0 536 | 0 219 | -2 445 | 0 014 | | | | | | | |
| AGEFEM -0.098 0.038 -2.569 0.010 MOOD 2.341 0.558 4.199 0.000 Means MOOD 1.205 0.026 46.159 0.000 WPMTOY 0.167 0.128 1.303 0.193 Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances Variances 0.000 0.000 0.000 0.000 | | | | | | | | | AGE | 0.074 | 0.219 | 2.167 | 0.014 | | | | | | | |
| MOOD 2.341 0.558 4.199 0.000 Means MOOD 1.205 0.026 46.159 0.000 WPMTOY 0.167 0.128 1.303 0.193 Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances Variances 0.000 0.000 0.000 | | | | | | | | | AGEFEM | -0.098 | 0.038 | -2.569 | 0.010 | | | | | | | |
| Means 0.026 46.159 0.000 WPMTOY 0.167 0.128 1.303 0.193 Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances Variances 0.000 0.000 0.000 | | | | | | | | | MOOD | 2.341 | 0.558 | 4.199 | 0.000 | | | | | | | |
| MOOD 1.205 0.026 46.159 0.000 WPMTOY 0.167 0.128 1.303 0.193 Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances 0.000 0.000 0.000 0.000 0.000 | | | | | | | | | Moong | | | | | | | | | | | |
| WPMTOY 0.167 0.128 1.303 0.193 Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances | | | | | | | | | MOOD | 1,205 | 0.026 | 46.159 | 0.000 | | | | | | | |
| Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances | | | | | | | | | WPMTOY | 0.167 | 0.128 | 1.303 | 0.193 | | | | | | | |
| Intercepts SYMPTOM -1.307 0.666 -1.964 0.050 Variances | | | | | | | | | | | | | | | | | | | | |
| Variances | | | | | | | | | Intercepts | 1 207 | 0 666 | 1 0 6 4 | 0 050 | | | | | | | |
| Variances | | | | | | | | | SIMPIOM | -1.307 | 0.000 | -1.964 | 0.050 | | | | | | | |
| | | | | | | | | | Variances | | | | | | | | | | | |
| MOOD 0.052 0.010 5.175 0.000 | | | | | | | | | MOOD | 0.052 | 0.010 | 5.175 | 0.000 | | | | | | | |
| WPMTOY 0.000 0.000 999.000 999.000 | | | | | | | | | WPMTOY | 0.000 | 0.000 | 999.000 | 999.000 | | | | | | | |
| Residual Variances | | | | | | | | | Residual Variances | 3 | | | | | | | | | | |
| SYMPTOM 0.754 0.140 5.404 0.000 | | | | | | | | | SYMPTOM | 0.754 | 0.140 | 5.404 | 0.000 | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| New/Additional Parameters | | | | | | | | | New/Additional Para | ameters | 0 5 3 6 | 4 8 2 2 2 | 0 000 | | | | | | | |
| BPMOOD 2.508 0.530 4.730 0.000 | | | | | | | | | BEMOOD | 2.508 | 0.530 | 4./30 | 0.000 | | | | | | | |

Step 4: Fitting the Full Between-Person and Within-Person Stress (X) \rightarrow Mood (M) \rightarrow Symptoms (Y) Mediation Model

```
The full mediation model is not possible in SAS, but we can
                                                                        In Mplus, partitioning WP vs. contextual for stress by brute force,
compare effects predicting symptoms (X, M \rightarrow Y).
                                                                         but for mood within the MODEL:
                                                                        TITLE: Full mediation model of Stress --> Mood --> Symptoms;
In SAS, partitioning stress and mood into level-1 WP vs. level-2
                                                                        DATA: FILE = symptoms.csv; ! Can just list file if in same directory;
contextual effects by brute force (observed variables):
                                                                                FORMAT = free;
                                                                                                      ! FREE or FIXED format;
                                                                                TYPE = individual;
                                                                                                      ! Individual or matrix data as input;
                                                                         VARIABLE:
TITLE1 "GMC Mood and GMC Stressors Predicting Symptoms:
                                                                         ! List of ALL variables in stacked data file, in order;
        X + M --> Y'';
                                                                         ! Mplus does NOT know what they used to be called, though;
PROC MIXED DATA=example COVTEST NOCLPRINT NOITPRINT NOINFO IC
                                                                            NAMES ARE PersonID symptom female age mood WPmood PMmood TVstres
NAMELEN=50 METHOD=ML;
                                                                                      WPstres PMstres;
       CLASS ID;
                                                                         ! List of ALL variables used in model (DEFINED variables at end);
       MODEL symptom5 = female age80 female*age80
                                                                            USEVARIABLES ARE symptom female age mood TVstres PMstres agefem;
                                                                         ! Missing data codes (here, -999);
                         PMmood2 TVmood2 PMstress40 TVstress
                                                                            MISSING ARE ALL (-999);
               / SOLUTION DDFM=SATTERTHWAITE NOTEST:
                                                                         ! Identify person-level nesting;
       RANDOM INTERCEPT / TYPE=UN SUBJECT=ID;
                                                                            CLUSTER = PersonID;
       REPEATED / TYPE=VC SUBJECT=ID;
                                                                         ! Predictor variables with variation ONLY within-persons at level 1;
ESTIMATE "Between Stress Effect" TVstress 1 PMstress40 1;
                                                                            WITHIN = TVstres;
ESTIMATE "Between Mood Effect"
                                    TVmood2 1 PMmood2 1;
                                                                         ! Predictor variables with variation ONLY between-persons at level 2;
RUN:
                                                                            BETWEEN = age female agefem PMstres;
                                                                                                             ! Creating level-2 interaction;
                                                                        DEFINE:
                                                                                    agefem = age*female;
                                                                        ANALYSIS:
                                                                                    TYPE IS TWOLEVEL RANDOM: ! 2-level model with random slopes:
Mplus code, continued under %BETWEEN%:
                                                                                    ESTIMATOR IS ML;
                                                                                                             ! Can use MLR for non-normality;
                                                                        MODEL:
                                                                                   !!!!! Stress --> Mood --> Symptoms Mediation Model;
                                                                         ! Level-1, time-level model;
mood
        ON PMstres (conXtoM); ! Context effect of stress on mood;
                                                                         %WITHIN%
symptom ON PMstres (conXtoY); ! Context effect of stress on symptoms;
                                                                                                         ! Residual level-1 mood variance:
symptom ON mood
                  (conMtoY); ! Context effect of mood on symptoms;
                                                                           mood:
                                                                                                         ! Residual level-1 symptoms variance;
                                                                           symptom;
!!! Getting BP effects and indirect effects at each level;
                                                                           WPXtoM | mood on TVstres;
                                                                                                         ! Level-1 effect of stress on mood;
                                                                           WPXtoY
                                                                                    symptom ON TVstres; ! Level-1 effect of stress on symptoms;
MODEL CONSTRAINT:
                                                                           WPMtoY | symptom ON mood;
                                                                                                         ! Level-1 effect of mood on symptoms;
NEW(BPXtoM BPXtoY BPMtoY WPind Conind BPind);
! BP effects;
                                                                         ! Level-2, person-level model;
 BPXtoM = WPXtoM + conXtoM;
                                   ! BP effect of stress on mood:
                                                                         %BETWEEN%
 BPXtoY = WPXtoY + conXtoY;
                                   ! BP effect of stress on symptoms;
                                                                           mood;
                                                                                                         ! Random mood intercept variance;
  BPMtoY = WPMtoY + conMtoY;
                                   ! BP effect of mood on symptoms;
                                                                           symptom;
                                                                                                         ! Random symptoms intercept variance;
! Indirect effects;
                                                                                                         ! Fixed intercept for mood;
                                                                           [mood];
 WPind = WPXtoM*WPMtoY;
                                   ! WP indirect effect;
                                   ! Context indirect effect;
                                                                           [symptom];
                                                                                                         ! Fixed intercept for symptoms;
 Conind = conXtoM*conMtoY;
                                                                           [WPXtoM]
                                                                                              (WPXtoM); ! WP effect of stress on mood;
 BPind = BPXtoM*BPMtoY;
                                   ! BP indirect effect;
                                                                           WPXtoM@0;
                                                                                                         ! No random effect of stress on mood;
                                                                           [WPXtoY]
                                                                                              (WPXtoY); ! WP effect of stress on symptoms;
Note: MODEL INDIRECT is the usual way of obtaining indirect effects in
                                                                           WPXtoY@0;
                                                                                                         ! No random stress effect on symptoms;
Mplus, but is not available for multilevel models. So we are using MODEL
                                                                           [WPMtoY]
                                                                                               (WPMtoY); ! WP effect of mood on symptoms;
                                                                           WPMtoY@0;
                                                                                                         ! No random effect of mood on symptoms;
CONSTRAINT to calculate the indirect effects ourselves to accomplish the
                                                                           mood ON female
                                                                                               (femtoM); ! BP effect of female on mood;
same thing. Further, although one can get bootstrapped p-values and
                                                                           mood ON age
                                                                                               (agetoM); ! BP effect of age on mood;
confidence intervals for single-level mediation models, they are not available
                                                                           mood ON agefem
                                                                                               (agefemM); ! BP effect of age*female on mood;
for multilevel mediation models. That means the p-values from the indirect
                                                                           symptom ON female (femtoY); ! BP effect of female on symptoms;
                                                                           symptom ON age
                                                                                               (agetoY); ! BP effect of age on symptoms;
effects may be a little suspect, and other methods of assessing significance
                                                                           symptom ON agefem (agefemY); ! BP effect of age*female on symptoms;
may be needed (see Kris Preacher's website for online tools to do so).
```

| SAS Result | s: This is j | ust X + M → | Y | | Mplus Results: This is a fuller model of $X \rightarrow M \rightarrow Y$ | | | | | | |
|--------------|--------------|---------------|------------|---------|--|---------|------------------------------|---------------------|---------|-----------|------------|
| | Covert | ianaa Danamat | on Estimot | taa | MODEL FIT INFORMATION | | | | | | |
| | Covari | Lance Paramet | er Estima | Les _ | | | Number of Free Parameters 18 | | | | |
| | | | Standard | Z | | | Loglikeliho | od | | 10 | |
| Cov Parm | Subject | Estimate | Error | Value | Pr > 1 | Z | H0 Value -/ | | | | |
| UN(1,1) | ID | 0.7138 | 0.1172 | 6.09 | <.000 | 1 | Information | Criteria | | | |
| Residual | ID | 0.6116 | 0.04310 | 14.19 | <.000 | 1 | A | kaike (AIC) | | 1764.530 | |
| | | | | | | | Ba | ayesian (BIC) | | 1840.714 | |
| | | Informat | ion Crite | ria | | | Sa | ample-Size Adjusted | l BIC | 1783.580 | |
| Nea2Loalike | Parms | ATC | ATCC | нотс | BIC | CATC | MODEL DECUL | (n* = (n + 2) / 24 | E) | | |
| 1200 0 | 10 | 1410 0 | 1412 2 | 1402 6 | 1420 4 | 1440 4 | MODEL RESUL. | 15 | | | Two-Tailed |
| 1392.0 | 10 | 1412.0 | 1413.3 | 1423.0 | 1439.4 | 1449.4 | | Estimate | S.E. | Est./S.E. | P-Value |
| | | | | | | | Within Level | 1 | 5.2. | 2001/0121 | 1 10200 |
| | Solu | ution for Fix | ed Effects | 5 | | | Residual Va | ariances | | | |
| | | Standard | | | | | SYMPTOM | 0.612 | 0.043 | 14.184 | 0.000 |
| Effect | Estimate | e Error | DF | t Value | Pr > | t | MOOD | 0.089 | 0.006 | 14.146 | 0.000 |
| Intercept | 2.7813 | 3 0.3520 | 109 | 7.90 | <.00 | 01 | | | | | |
| female | -0.5094 | 4 0.2053 | 105 | -2.48 | 0.01 | 47 | Between Leve | el | | | |
| age80 | 0.07313 | 3 0.03194 | 108 | 2.29 | 0.02 | 40 | MOOD | ON 0.000 | 0 0 5 4 | 0 1 5 0 | 0 074 |
| female*ade80 | -0 09388 | B 0.03577 | 107 | -2 62 | 0.00 | 99 | FEMALE | 0.009 | 0.054 | 1 628 | 0.874 |
| DMmood2 | 1 2426 | | 107 | 2.02 | 0.00 | 00 | AGEFEM | -0.006 | 0.009 | -0.633 | 0.526 |
| | 1.3430 | 0.3970 | 133 | 3.30 | 0.00 | 09 | PMSTRES | 0.124 | 0.079 | 1.564 | 0.118 |
| TVmood2 | 0.1339 | 9 0.1305 | 404 | 1.03 | 0.30 | 56 | SYMPTOM | ON | | | |
| PMstress40 | 0.9443 | 3 0.3032 | 128 | 3.11 | 0.00 | 23 | FEMALE | -0.531 | 0.209 | -2.540 | 0.011 |
| TVstress | 0.08555 | 5 0.09690 | 403 | 0.88 | 0.37 | 79 | AGE | 0.070 | 0.033 | 2.113 | 0.035 |
| | | | | | | | AGEFEM | -0.095 | 0.037 | -2.588 | 0.010 |
| | | Est | imates | | | | PMSTRES | 1.092 | 0.304 | 3.591 | 0.000 |
| | | | Standard | | | | MOOD | 1.853 | 0.606 | 3.059 | 0.002 |
| Label | | Estimate | Error | DF | t Value | Pr > t | WPXTOM | 0 162 | 0 036 | 4 486 | 0 000 |
| Between Stre | ss Effect | 1 0298 | 0 2875 | 104 | 3 58 | 0 0005 | WPXTOY | 0.085 | 0.097 | 0.872 | 0.383 |
| Between Mood | Effoot | 1 4774 | 0.20/0 | 105 | 3.05 | 0.0001 | WPMTOY | 0.141 | 0.131 | 1.078 | 0.281 |
| Detween wood | LITECT | 1.4//4 | 0.0740 | 105 | 0.95 | 0.0001 | Intercepts | | | | |
| | | | | | | | SYMPTOM | -0.650 | 0.672 | -0.967 | 0.334 |
| | | | | | | | MOOD | 1.120 | 0.049 | 22.769 | 0.000 |
| | | | | | | | Variances | | | | |
| | | | | | | | WPXTOM | 0.000 | 0.000 | 999.000 | 999.000 |
| | | | | | | | WPAIOY | 0.000 | 0.000 | 999.000 | 999.000 |
| | | | | | | | Residual Va | ariances | 0.000 | 555.000 | 555.000 |
| | | | | | | | SYMPTOM | 0.679 | 0.122 | 5.546 | 0.000 |
| | | | | | | | MOOD | 0.040 | 0.008 | 4.802 | 0.000 |
| | | | | | | | | | | | |
| | | | | | | | New/Additio | onal Parameters | | | |
| | | | | | | | BPXTOM | 0.286 | 0.070 | 4.066 | 0.000 |
| | | | | | | | BPXTOY | 1.176 | 0.289 | 4.069 | 0.000 |
| | | | | | | | REMI.OX | 1.994 | 0.576 | 3.460 | 0.001 |
| | | | | | | | CONTRD | 0.023 | 0.022 | 1 305 | 0.294 |
| | | | | | | | BPIND | 0.570 | 0.217 | 2.631 | 0.009 |
| | | | | | | | 21 11.0 | 0.070 | 0.21/ | 2.001 | 0.000 |
| | | | | | | | | | | | |

Hoffman Psyc 945 Example 5e Step 5: Fitting the Full BP and WP Stress (X) \rightarrow Mood (M) \rightarrow Symptoms (Y) Mediation Model with Mood*Sex Interactions \rightarrow Symptoms

| The full mediation model is not possible in SAS, but we can | In Mplus, partitioning WP vs. contextual for stress by brute force, | | | | | | |
|--|--|--|--|--|--|--|--|
| compare effects predicting symptoms (X, M \rightarrow Y). | but for mood within the MODEL: | | | | | | |
| | | | | | | | |
| In SAS, partitioning stress and mood into level-1 WP vs. level-2 contextual effects by brute force (observed variables): | TITLE: Full model of Stress> Mood> Symptoms with Mood by Sex;DATA:FILE = symptoms.csv;! Can just list file if in same directory;FORMAT = free;! FREE or FIXED format;TYPE = individual;! Individual or matrix data as input; | | | | | | |
| TITLE1 "Add Sex Interactions of GMC Mood"; | VARTABLE: | | | | | | |
| PROC MIXED DATA=example COVTEST NOCLPRINT NOITPRINT NOINFO | ! List of ALL variables in stacked data file, in order; | | | | | | |
| IC NAMELEN=50 METHOD=ML; | ! Mplus does NOT know what they used to be called, though; | | | | | | |
| CLASS ID; MODEL symptomE = female age80 femaletage80 | NAMES ARE PersonID symptom female age mood WPmood PMmood TVstres | | | | | | |
| MODEL Symptoms = remare ageou remare ageou | WPstres PMstres; | | | | | | |
| formal of DMmood 2 formal of TWmood 2 | ! LIST OF ALL VARIABLES USED IN MODEL (DEFINED VARIABLES AT END); | | | | | | |
| / SOLUTION DDEM-SATTEDTHWAITE NOTEST. | ! Missing data codes (here, -999): | | | | | | |
| DANDOM INTERCEPT / TYPE-IN SUBJECT-ID. | MISSING ARE ALL (-999); | | | | | | |
| PEPEATED / TYPE-UC SUBJECT-ID. | ! Identify person-level nesting; | | | | | | |
| ESTIMATE "BD Female*Mood" female*DMmood2 1 female*TVmood2 1. | CLUSTER = PersonID; | | | | | | |
| RIN. | ! Predictor variables with variation ONLY within-persons at level 1; | | | | | | |
| | WITHIN = TVstres; | | | | | | |
| | <pre>! Predictor Variables with Variation ONLY between-persons at level 2; BETWEEN - age female agefem DMstres;</pre> | | | | | | |
| Mplus code, continued under %BETWEEN%: | DEIMEEN - age lemale agelem fmbtleb, | | | | | | |
| mandiat ON family (family) I DD affacts of family an mandiat | DEFINE: agefem = age*female; ! Creating level-2 interaction; | | | | | | |
| moodint ON remale (femtom); ! BP effect of remale on moodint; | | | | | | | |
| moodint ON agefem (agefemM): ! BP effect of age*female on moodint: | ANALYSIS: TYPE IS TWOLEVEL RANDOM; ! 2-level model with random slopes; | | | | | | |
| symptom ON female (femtoY); ! BP effect of female on symptoms; | ESTIMATOR IS ML; ! Can use MLR for non-normality; | | | | | | |
| <pre>symptom ON age (agetoY); ! BP effect of age on symptoms;</pre> | ALGORITHM=INTEGRATION; ! Numeric integration for latent interactions | | | | | | |
| <pre>symptom ON agefem (agefemY); ! BP effect of age*female on symptoms;</pre> | MODEL. | | | | | | |
| <pre>moodint ON PMstres (conXtoM); ! Context effect of stress on moodint;</pre> | <pre>!!!!! Stress> Mood> Symptoms Mediation Model;</pre> | | | | | | |
| symptom ON PMstres (conXtoY); ! Context effect of stress on symptoms; | ! Level-1, time-level model; | | | | | | |
| WPMtoY ON female (WPfemmo): Level-1 mood by sex on symptoms: | %WITHIN% | | | | | | |
| wincor on remare (wiremand), . Hever I mood by bea on bymptoms, | <pre>mood; ! Residual level-1 mood variance;</pre> | | | | | | |
| ! Latent interaction of sex*context mood; | symptom; ! Residual level-1 symptoms variance; | | | | | | |
| femmood2 female XWITH moodint; | WPXtoM mood on Tvstres; ! Level-1 effect of stress on mood; | | | | | | |
| | WPMtoY symptom ON mood: Level-1 effect of mood on symptoms: | | | | | | |
| ! L2 effect of latent sex*mood on symptoms; | | | | | | | |
| symptom ON femmood2 (Confemmo); | ! Level-2, person-level model; | | | | | | |
| III Getting BP interaction: | %BETWEEN% | | | | | | |
| MODEL CONSTRAINT: | <pre>moodint BY mood@1; ! Create latent variable for mood random int;</pre> | | | | | | |
| NEW(BPfemmo); | moodeu; ! Random mood intercept variance shut off; | | | | | | |
| BPfemmo = WPfemmo + confemmo; ! BP effect of female*mood on symptoms; | symptom; : Random symptoms intercept variance; | | | | | | |
| | [symptom]; ! Fixed intercept for modulit, not model; | | | | | | |
| | [WPXtoM] (WPXtoM); ! WP effect of stress on mood; | | | | | | |
| | WPXtoM@0; ! No random effect of stress on mood; | | | | | | |
| | [WPXtoY] (WPXtoY); ! WP effect of stress on symptoms; | | | | | | |
| | WPXtoY@0; ! No random effect of stress on symptoms; | | | | | | |
| | [WPMtoY] (WPMtoY); ! WP effect of mood on symptoms; | | | | | | |
| | wrmtoiwo; : No random errect or mood on symptoms; | | | | | | |

| SAS Result | ¢. | | | | Mplus Results: | | | | | | | | |
|---------------|------------|-------------|--------------------|------------------------------|--|--------------|--------------|---------|-----------------|---------|-----------|------------|--|
| ente nooun | 0. | | | | THE MODEL ESTIMATION TERMINATED NORMALLY | | | | | | | | |
| | Covari | ance Parame | ter Estimat | - es | MODEL FIT INFORMATION | | | | | | | | |
| | oorar 1 | Standard | 7 | Number of Free Parameters 20 | | | | | | | | | |
| Oax Dam | Stanuaru Z | | | | | Loglikelihoo | bd | | | | | | |
| Cov Parm | Subject | Estimate | Error | value | Pr | > Z | HC |) Value | e | | -862.851 | | |
| UN(1,1) | ID | 0.6973 | 0.1147 | 6.08 | <. | 0001 | Information | Crite | ria | | | | |
| Residual | ID | 0.6098 | 0.04295 | 14.20 | <. | 0001 | Ak | kaike i | (AIC) | | 1765.703 | | |
| | | | | | | | Ba | ayesiar | n (BIC) | | 1850.351 | | |
| | | Informa | tion Criter | ria | | | Sa | (n* - | Size Adjusted E | SIC | 1/86.869 | | |
| Neg2LogLike | Parms | AIC | ATCC | HOIC | В | TC CATC | | (11^ = | (11 + 2) / 24) | | | | |
| 1380 5 | 12 | 1/13 5 | 1/1/ 2 | 1426 4 | 1445 | A 1457 A | MODEL RESULT | 15 | | | | Two-Tailed | |
| 1009.0 | 12 | 1410.5 | 1414.2 | 1420.4 | 1445 | .4 1457.4 | | | Estimate | S.E. | Est./S.E. | P-Value | |
| | 0.1 | | tion of the second | | | | Within Level | L | | | | | |
| | 501 | ution for F | 1xed ETTECT | IS | | | Residual Va | ariance | es | | | | |
| | | | | | | | SYMPTOM | | 0.610 | 0.043 | 14.194 | 0.000 | |
| | | Stand | ard | | | | MOOD | | 0.089 | 0.006 | 14.121 | 0.000 | |
| Effect | Estima | te Er | ror DF | t Value | e P | r > t | | _ | | | | | |
| | | | | | | | Between Leve | el , | | | | | |
| Intercept | 3.67 | 89 0.7 | 037 109 | 5.23 | 3 | <.0001 | MOODINT BY | Ĺ | 1 000 | 0 000 | 000 000 | 000 000 | |
| female | -1 58 | 36 0 7 | 555 107 | 7 -2 10 |) | 0 0384 | MOOD | ON | 1.000 | 0.000 | 999.000 | 999.000 | |
| 20080 | 0.053 | 43 0.03 | 411 106 | 1 5 | 7 | 0 1202 | FEMALE | 011 | 0.007 | 0.054 | 0.129 | 0.897 | |
| ayeou | 0.055 | 43 0.03 | | 1.5 | | 0.1202 | AGE | | 0.014 | 0.008 | 1.697 | 0.090 | |
| Temale*age80 | -0.072 | 59 0.03 | 803 106 | -1.9 | | 0.0590 | AGEFEM | | -0.006 | 0.009 | -0.689 | 0.491 | |
| PMmood2 | 2.72 | 77 0.8 | 927 126 | 5 3.06 | 5 | 0.0027 | PMSTRES | | 0.141 | 0.079 | 1.787 | 0.074 | |
| TVmood2 | -0.11 | 23 0.2 | 713 407 | -0.41 | 1 | 0.6792 | WPMTOY | ON | | | | | |
| PMstress40 | 0.91 | 94 0.3 | 010 129 | 9 3.05 | 5 | 0.0027 | FEMALE | | 0.200 | 0.197 | 1.013 | 0.311 | |
| TVstress | 0.084 | 14 0.09 | 678 404 | 1 0.87 | 7 | 0.3852 | SYMPTOM | ON | | | | | |
| female*PMmoo | d2 -1.68 | 29 0.9 | 650 129 | 9 -1.74 | 1 | 0.0836 | MOODINT | - - | 3.809 | 1.463 | 2.604 | 0.009 | |
| female*TVmoo | 12 0.32 | 06 0.3 | 066 406 | 5 1.05 | 5 | 0.2963 | F EMMOOD2 | | -2.238 | 1.499 | -1.493 | 0.135 | |
| Tomaro Trinoo | | 00 010 | | | | 012000 | FEMALE | ON | 1 759 | 1 688 | 1 042 | 0 297 | |
| | | - | atimataa | | | | AGE | | 0.044 | 0.041 | 1.073 | 0.283 | |
| | | E | stimates | | | | AGEFEM | | -0.067 | 0.044 | -1.520 | 0.128 | |
| | | | Standard | | _ | | PMSTRES | | 1.001 | 0.310 | 3.233 | 0.001 | |
| Label | | Estimate | Error | DF t\ | /alue | Pr > t | Means | | | | | | |
| Between Fema | le by Mood | -1.3622 | 0.9204 | 107 - 1 | 1.48 | 0.1418 | WPXTOM | | 0.155 | 0.036 | 4.297 | 0.000 | |
| | | | | | | | WPXTOY | | 0.084 | 0.097 | 0.870 | 0.384 | |
| | | | | | | | Intercepts | | 0 670 | 1 (1 1 | 1 600 | 0 100 | |
| | | | | | | | SYMPTOM | | -2.6/2 | 1.641 | -1.629 | 0.103 | |
| | | | | | | | MOODINT | | 1 123 | 0.000 | 22 896 | 0 000 | |
| | | | | | | | WPMTOY | | -0.016 | 0.201 | -0.079 | 0.937 | |
| | | | | | | | Variances | | | | | | |
| | | | | | | | WPXTOM | | 0.000 | 0.000 | 999.000 | 999.000 | |
| | | | | | | | WPXTOY | | 0.000 | 0.000 | 999.000 | 999.000 | |
| | | | | | | | Residual Va | ariance | es | | | | |
| | | | | | | | SYMPTOM | | 0.631 | 0.123 | 5.119 | 0.000 | |
| | | | | | | | MOOD | | 0.000 | 0.000 | 999.000 | 999.000 | |
| | | | | | | | MOODINT | | 0.039 | 0.008 | 4.773 | 0.000 | |
| | | | | | | | WPMTOY | | 0.000 | 0.000 | 999.000 | 999.000 | |
| | | | | | | | New/Adultic | Juar Pa | -2 038 | 1 476 | -1 391 | 0 167 | |
| | | | | | | | DI I BRINO | | 2.050 | 1.1/0 | 1.501 | 0.107 | |

Example Results Section for Steps 1 to 4:

The relationships among time-varying stressors (i.e., whether or not a stressor was reported on a given day), negative mood (constructed as the mean of five items), and physical symptoms (constructed as the sum of five reported symptoms) were examined using multilevel structural equation modeling within Mplus v. 7.11 (Muthén & Muthén, 1998-2012) under maximum likelihood (ML). We obtained an identical pattern of results using a robust ML estimator to account for potential non-normality and so the original ML results are reported below. Two observed variables was used to partition the effect of dichotomous daily stressors into its contextual (level-2; incremental between-person) and within-person (level-1) effects, in which the level-2 predictor was created as the person mean of stressors centered at 40% of days (PMstress_i – .40) and the level-1 predictor was daily stressor variable. This same type of variance partitioning was model-based instead for the continuous level-1 outcomes of negative mood and physical symptoms, such that random intercept variances were estimated for each at level 2, and residual variances were estimated for each at level 1. The MODEL CONSTRAINT command was used to obtain model-implied between-person effects and indirect effects. Age, sex, and their interaction (with 80-year-old men as the reference group) were included as predictors in the level-2 model for both negative mood and physical symptoms. In addition, likelihood ratio revealed no significant random within-person direct effects in any of the models (all $-2\Delta LL(-2) < 5.99$, p > .05), and so all within-person effects of stressors on physical symptoms, we began by estimating a series of models to examine each of the relevant direct effects in isolation before evaluating their unique effects.

First, a multilevel model of stressors predicting negative mood (X \rightarrow M) revealed a significant positive within-person effect, such that negative mood was higher on days in which a stressor was experienced (after controlling for proportion of stressor days). Although there was also a significant between-person effect, such that negative mood was higher on average for persons who experienced more stressor days than others, this effect became nonsignificant after controlling for daily stressors (e.g., a nonsignificant contextual effect). Second, a separate multilevel model of stressors predicting physical symptoms (X \rightarrow Y) revealed a significant positive contextual and between-person effects but no significant within-person effect. Thus, physical symptoms were higher on average for persons who experienced more stressor days than others (even after controlling for daily stressors), but physical symptoms on a given day were not related to whether a stressor was experienced that day. Third, a separate multilevel model of negative mood predicting physical symptoms (M \rightarrow Y) revealed significant contextual and between-person effects but no significant within-person effect. Thus, physical symptoms (M \rightarrow Y) revealed significant contextual and between-person effects but no significant within-person effect. Thus, physical symptoms were higher on average for persons who reported higher negative mood than others (even after controlling for daily negative mood), but physical symptoms on a given day were not related to whether a negative mood was higher than usual that day. Thus, to summarize, significant direct effects were found between persons (at level 2) for all three paths, (although the X \rightarrow M path for the contextual effect was no longer significant after controlling for daily stressors), but significant direct effects were found within persons (at level 1) only for X \rightarrow M.

Finally, the extent to which daily negative mood mediated the relationship between daily stressors and daily physical symptoms at each level was examined in a multilevel mediation model with all three variables. Results are shown in Table 1. At level 2, the between-person effect of stressors on physical symptoms was significantly reduced after controlling for the between-person effect of negative mood, as indicated by a significant between-person indirect effect of stressors on physical symptoms through negative mood; however, both between-person effects of stressors and negative mood on symptoms (and their contextual effects) were still uniquely significant. Thus, reporting more stressor days than others is related to reporting more physical symptoms than others (even after controlling for daily stressors), but this link does not result solely from a concomitant difference in negative mood. The contextual indirect effect was not significant, indicating that some of this mediation is reduced after controlling for daily stressors and daily negative mood. At level 1, the within-person effect of stressors on physical symptoms was not significantly reduced (and still not significant) after controlling for negative mood, as indicated by a nonsignificant within-person indirect effect of stressors on physical symptoms through negative mood. Thus, after controlling for people's general tendencies to do so, reporting a stressor does not predict reporting more physical symptoms that day, although it does predict greater negative mood than usual that day.