Example 4: Examining BP and WP Effects of Negative Mood Predicting Next-Morning Glucose
(complete data, syntax, and output available for SAS, SPSS, and STATA electronically)

These data were simulated loosely based on real data reported in the citation below. The daily diary study followed persons with Type II diabetes for 21 consecutive days to examine within-person relationships between mood, stress, and morning glucose (an index of how well-controlled the diabetes is). Here we will examine between-person and within-person relationships between daily negative mood and glucose the next morning (which was log-transformed given skewness) and how these relationships are moderated by sex.

Skaff, M., Mullan J., Fisher, L., Almeida, D., **Hoffman, L.,** Masharani, U., & Mohr, D. (2009). Effects of mood on daily fasting glucose in Type 2 Diabetes. *Health Psychology, 28*(3), 265-272.

SAS Data Setup:

```
* SAS code to read data into work library and center predictors;
DATA work.example4; SET filepath.example4;
* Level-2 effect of Negative Mood (mean=0, SD=1);
  PMnm0 = PMnegmood - 0;  LABEL PMnm0= "PMnm0: Person Mean Negative Mood (0=0)";
* Level-1 effect to use with PERSON-MEAN-CENTERING;
  WPnm = negmood - PMnegmood; LABEL wpnm= "WPnm: Within-Person Negative Mood (0=PM)";
* Level-1 effect to use with GRAND-MEAN-CENTERING;
  TVnm0 = negmood - 0; LABEL TVnm0= "TVnm0: Time-Varying Negative Mood (0=0)";
RUN;
```

SPSS Data Setup:

```
* SPSS code to import data and center predictors.
GET FILE = "example/Example4.sav".
DATASET NAME example4 WINDOW=FRONT.
COMPUTE PMnm0 = PMnegmood - 0.
COMPUTE WPnm  = negmood - PMnegmood.
COMPUTE TVnm0 = negmood - 0.
VARIABLE LABELS
  PMnm0 "PMnm0: Person Mean Negative Mood (0=0)"
  WPnm  "WPnm: Within-Person Negative Mood (0=PM)"
  TVnm0 "TVnm0: Time-Varying Negative Mood (0=0)".
EXECUTE.
```

STATA Data Setup:

```
 * STATA code to center predictors
 * level-2 effect of negative mood
gen PMnm0 = PMnegmood - 0
label variable PMnm0 "PMnm0: Person Mean Negative Mood (0=0)"
 * level-1 effect to use with PERSON-MEAN-CENTERING
gen WPnm = negmood - PMnegmood
label variable WPnm "WPnm: Within-Person Negative Mood (0=PM)"
 * level-1 effect to use with GRAND-MEAN-CENTERING
gen TVnm0 = negmood - 0
label variable TVnm0 "TVnm0: Time-Varying Negative Mood (0=0)"
```

Model 1a. Empty Model for LN Morning Glucose (Daily Outcome)

```
TITLE "SAS Model 1a: Empty Model for Daily Glucose Outcome";
PROC MIXED DATA=work.example4 COVTEST NOCLPRINT NOITPRINT NAMELEN=100 IC METHOD=ML;
       CLASS ID day;
       MODEL lGlucAM = / SOLUTION DDFM=Satterthwaite;
       RANDOM INTERCEPT / VCORR SUBJECT=ID TYPE=UN;
       REPEATED day / SUBJECT=ID TYPE=VC; RUN;

TITLE "SPSS Model 1a: Empty Model for Daily Glucose Outcome".
MIXED lGlucAM BY ID day
       /METHOD = ML
       /PRINT  = SOLUTION TESTCOV
       /FIXED  =
       /RANDOM = INTERCEPT | SUBJECT(ID) COVTYPE(UN)
       /REPEATED = day | SUBJECT(ID) COVTYPE(ID).

* STATA Model 1a: Empty Model for Daily Glucose Outcome
xtmixed lglucAM  , || id: , variance ml covariance(un) residuals(independent,t(day)),
       estimates store empty      // save LL for LRT
```

$$\text{Level 1: } \text{Glucose}_{ti} = \beta_{0i} + e_{ti}$$
$$\text{Level 2: } \beta_{0i} = \gamma_{00} + U_{0i}$$

STATA output:

```
Mixed-effects ML regression                     Number of obs      =      4140
Group variable: id                              Number of groups   =       207
                                                Obs per group: min =        20
                                                               avg =      20.0
                                                               max =        20
                                                Wald chi2(0)       =         .
Log likelihood =  970.72808                     Prob > chi2        =         .
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |   4.942683   .0181322   272.59   0.000     4.907145    4.978221
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
id: Identity                 |
                  var(_cons) |   .0665423   .0066897      .0546417    .0810348
-----------------------------+------------------------------------------------
               var(Residual) |   .0302851   .0006829      .0289757    .0316537
------------------------------------------------------------------------------
LR test vs. linear regression: chibar2(01) =  4024.09 Prob >= chibar2 = 0.0000
                Covariance Parameter Estimates
```

Calculate the ICC for the glucose outcome:

$$\text{ICC} = \frac{.06654}{.06654 + .03029} = .69$$

This LR test tells us that the random intercept variance is significantly greater than 0, and thus so is the ICC.

Model 1b. Empty Model for Negative Mood (Daily Predictor)

```
TITLE "SAS Model 1b: Empty Model for Daily Negative Mood Predictor";
PROC MIXED DATA=work.example4 COVTEST NOCLPRINT NOITPRINT NAMELEN=100 IC METHOD=ML;
       CLASS ID day;
       MODEL negmood = / SOLUTION DDFM=Satterthwaite;
       RANDOM INTERCEPT / VCORR SUBJECT=ID TYPE=UN;
       REPEATED day / SUBJECT=ID TYPE=VC; RUN;

TITLE "SPSS Model 1b: Empty Model for Daily Negative Mood Predictor".
MIXED negmood BY ID day
       /METHOD = ML
       /PRINT  = SOLUTION TESTCOV
       /FIXED  =
       /RANDOM = INTERCEPT | SUBJECT(ID) COVTYPE(UN)
       /REPEATED = day | SUBJECT(ID) COVTYPE(ID).

* STATA Model 1b: Empty Model for Daily Negative Mood Predictors
xtmixed negmood  , || id: ,  ///
       variance ml covariance(un) residuals(independent,t(day))
```

$$\text{Level 1: } \text{Mood}_{ti} = \beta_{0i} + e_{ti}$$
$$\text{Level 2: } \beta_{0i} = \gamma_{00} + U_{0i}$$

STATA output:

```
                                                Wald chi2(0)       =         .
Log likelihood = -4815.1935                     Prob > chi2        =         .
------------------------------------------------------------------------------
     negmood |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |   .1597403   .0418067     3.82   0.000     .0778007      .24168
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
id: Identity                 |
                  var(_cons) |   .3355036   .0355674      .2725584    .4129855
-----------------------------+------------------------------------------------
               var(Residual) |    .525824   .0118575      .5030898    .5495855
------------------------------------------------------------------------------
LR test vs. linear regression: chibar2(01) =  1500.40 Prob >= chibar2 = 0.0000
```

Calculate the ICC for the mood predictor:

$$\text{ICC} = \frac{.3355}{.3355 + .5258} = .39$$

This LR test tells us that the random intercept variance is significantly greater than 0, and thus so is the ICC.

Model 2a. Fixed Effects of Negative Mood using Person-Mean-Centering (PMC)

Level 1: $\text{Glucose}_{ti} = \beta_{0i} + \beta_{1i}\left(\text{Mood}_{ti} - \overline{\text{Mood}}_i\right) + e_{ti}$

Level 2: Intercept: $\beta_{0i} = \gamma_{00} + \gamma_{01}\left(\overline{\text{Mood}}_i - 0\right) + U_{0i}$

Within-Person Mood: $\beta_{1i} = \gamma_{10}$

```
TITLE "SAS Model 2a: Fixed Effects of Negative Mood using PMC";
PROC MIXED DATA=work.example4 COVTEST NOCLPRINT NOITPRINT NAMELEN=100 IC METHOD=ML;
       CLASS ID day;
       MODEL lglucAM = WPnm PMnm0 / SOLUTION DDFM=Satterthwaite OUTPM=MoodPred;
       RANDOM INTERCEPT / SUBJECT=ID TYPE=UN;
       REPEATED day / SUBJECT=ID TYPE=VC;
       ESTIMATE "Within-Person Mood Effect"    WPnm  1;
       ESTIMATE "Between-Person Mood Effect"   PMnm0 1;
       ESTIMATE "Contextual Mood Effect"       PMnm0 1 WPnm -1;
RUN; PROC CORR NOSIMPLE DATA=MoodPred; VAR lglucAM pred; RUN;

TITLE "SPSS Model 2a: Fixed Effects of Negative Mood using PMC".
MIXED lglucAM BY ID day WITH WPnm PMnm0
       /METHOD = ML
       /PRINT  = SOLUTION TESTCOV
       /FIXED  = WPnm PMnm0
       /RANDOM = INTERCEPT | SUBJECT(ID) COVTYPE(UN)
       /REPEATED = day | SUBJECT(ID) COVTYPE(ID)
       /SAVE = FIXPRED (predmood)
       /TEST = "Within-Person Mood Effect"     WPnm  1
       /TEST = "Between-Person Mood Effect"    PMnm0 1
       /TEST = "Contextual Mood Effect"        PMnm0 1 WPnm -1.
CORRELATIONS lglucAM predmood.

* STATA Model 2a: Fixed Effects of Negative Mood using PMC
xtmixed lglucAM c.WPnm c.PMnm0, || id: ,       ///
       variance ml covariance(un) residuals(independent,t(day)),
       estat ic, n(207),
       predict predmood,          // save fixed-effect predicted outcomes
       estimates store FixWP,     // save LL for LRT
       lrtest FixWP empty,        // LRT against empty model
       lincom 1*c.WPnm                  // within-person mood effect
       lincom 1*c.PMnm0                 // between-person mood effect
       lincom 1*c.PMnm0 - 1*c.WPnm      // contextual mood effect
corr lglucAM predmood
```

STATA output:

```
                                                Wald chi2(2)       =     15.20
Log likelihood =    978.269                     Prob > chi2        =    0.0005
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       WPnm |   .0109743   .0038207     2.87   0.004     .0034859    .0184626
      PMnm0 |   .0803976    .030461     2.64   0.008     .0206952       .1401
      _cons |   4.930171   .0184512   267.20   0.000     4.894008    4.966335
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
id: Identity                 |
                  var(_cons) |   .0643486   .0064737      .0528329    .0783743 → intercept var down 3.29%
-----------------------------+------------------------------------------------
               var(Residual) |   .0302214   .0006815      .0289147     .031587 → residual var down 0.23%
------------------------------------------------------------------------------
LR test vs. linear regression: chibar2(01) =  3941.45 Prob >= chibar2 = 0.0000

.         estat ic, n(207),
-----------------------------------------------------------------------------
       Model |    Obs    ll(null)   ll(model)     df          AIC         BIC
-------------+---------------------------------------------------------------
           . |    207           .     978.269      5    -1946.538   -1929.874
-----------------------------------------------------------------------------
               Note:  N=207 used in calculating BIC

.         lrtest FixWP empty,             // LRT against empty model

Likelihood-ratio test                                 LR chi2(2)  =     15.08
(Assumption: empty nested in FixWP)                   Prob > chi2 =    0.0005

.         lincom 1*c.WPnm                          // within-person mood effect
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0109743   .0038207     2.87   0.004     .0034859    .0184626
------------------------------------------------------------------------------

.         lincom 1*c.PMnm0                         // between-person mood effect
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0803976    .030461     2.64   0.008     .0206952       .1401
------------------------------------------------------------------------------

.         lincom 1*c.PMnm0 - 1*c.WPnm               // contextual mood effect
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0694233   .0306963     2.26   0.024     .0092597     .129587
------------------------------------------------------------------------------

. corr lglucAM predmood
(obs=4140)
             |  lglucAM predmood
-------------+------------------
     lglucAM |   1.0000
    predmood |   0.1527   1.0000
```

Is this a better model than the empty model (1a)—is the total R^2 significant?
Yes, ML −2ΔLL(2) = 15, p =.004

Total R^2 from mood = .023

What does the level-1 effect (WPnm) represent in this model?
The level-1 effect is the within-person effect of negative mood. For every unit relative increase in your own negative mood that day, that next day's glucose goes up by .01097 (WP relation among daily levels).

What does the level-2 effect (PMnm0) represent in this model?
The level-2 effect is the between-person effect of negative mood. For every unit higher person mean negative mood, mean glucose is higher by .08040 (BP relation among mean levels).

What does the "contextual mood effect" represent?
It is the difference in the between-person and within-person effects: the between-person mood effect is significantly greater than the within-person mood effect by .0694 (so convergence was not obtained). So after controlling for current negative mood, there is an incremental effect of .0694 per unit higher person mean negative mood.

Model 2b. Random Effect of WP Negative Mood under PMC

$$\text{Level 1: Glucose}_{ti} = \beta_{0i} + \beta_{1i}\left(\text{Mood}_{ti} - \overline{\text{Mood}}_i\right) + e_{ti}$$
$$\text{Level 2: Intercept: } \beta_{0i} = \gamma_{00} + \gamma_{01}\left(\overline{\text{Mood}}_i - 0\right) + U_{0i}$$
$$\text{Within-Person Mood: } \beta_{1i} = \gamma_{10} + U_{1i}$$

```
TITLE "SAS Model 2b: Random Effect of WP Negative Mood using PMC";
PROC MIXED DATA=work.example4 COVTEST NOCLPRINT NOITPRINT NAMELEN=100 IC METHOD=ML;
       CLASS ID day;
       MODEL lglucAM = WPnm PMnm0 / SOLUTION DDFM=Satterthwaite;
       RANDOM INTERCEPT WPnm / SUBJECT=ID TYPE=UN;
       REPEATED day / SUBJECT=ID TYPE=VC;
       ESTIMATE "Within-Person Mood Effect"    WPnm  1;
       ESTIMATE "Between-Person Mood Effect"   PMnm0 1;
       ESTIMATE "Contextual Mood Effect"       PMnm0 1 WPnm -1;  RUN;

TITLE "SPSS Model 2b: Random Effect of WP Negative Mood using PMC".
MIXED lglucAM BY ID day WITH WPnm PMnm0
       /METHOD = ML
       /PRINT  = SOLUTION TESTCOV
       /FIXED  = WPnm PMnm0
       /RANDOM = INTERCEPT WPnm | SUBJECT(ID) COVTYPE(UN)
       /REPEATED = day | SUBJECT(ID) COVTYPE(ID)
       /TEST = "Within-Person Mood Effect"     WPnm  1
       /TEST = "Between-Person Mood Effect"    PMnm0 1
       /TEST = "Contextual Mood Effect" PMnm0 1 WPnm -1.

* STATA Model 2b: Random Effect of WP Negative Mood using PMC
xtmixed lglucAM c.WPnm c.PMnm0, || id: WPnm,   ///
       variance ml covariance(un)  residuals(independent,t(day)),
       estat ic, n(207),
       estimates store RandWP,
       lrtest RandWP FixWP,
       lincom 1*c.WPnm                  // within-person mood effect
       lincom 1*c.PMnm0                 // between-person mood effect
       lincom 1*c.PMnm0 - 1*c.WPnm      // contextual mood effect
```

STATA output:

```
                                              Wald chi2(2)       =     14.03
Log likelihood =  979.72265                   Prob > chi2        =    0.0009
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       WPnm |   .0110375   .0041371     2.67   0.008     .0029288    .0191462
      PMnm0 |   .0802152    .030471     2.63   0.008     .0204931    .1399372
      _cons |   4.930206   .0184585   267.10   0.000     4.894028    4.966384
------------------------------------------------------------------------------
```

```
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.      [95% Conf. Interval]
-----------------------------+------------------------------------------------
id: Unstructured             |
                   var(WPnm) |   .0005056   .0003348      .0001381    .0018515 random WPnm slope variance
                  var(_cons) |   .0644045   .0064789      .0528795    .0784413 random intercept variance
             cov(WPnm,_cons) |  -.0002049    .001067     -.0022962    .0018865 int-WPnm slope covariance
-----------------------------+------------------------------------------------
               var(Residual) |    .029953    .000692      .0286269    .0313406
------------------------------------------------------------------------------
LR test vs. linear regression:       chi2(3) =  3944.36   Prob > chi2 = 0.0000
Note: LR test is conservative and provided only for reference.
.         estat ic, n(207),
-----------------------------------------------------------------------------
       Model |    Obs    ll(null)   ll(model)     df          AIC         BIC
-------------+---------------------------------------------------------------
           . |    207           .    979.7227      7    -1945.445   -1922.116
-----------------------------------------------------------------------------
               Note:  N=207 used in calculating BIC

.         estimates store RandWP,          // save LL for LRT
.         lrtest RandWP FixWP,             // LRT against fixed effect

Likelihood-ratio test                                 LR chi2(2)  =      2.91
(Assumption: FixWP nested in RandWP)                  Prob > chi2 =    0.2337

Note: The reported degrees of freedom assumes the null hypothesis is not on the boundary of the parameter
space.  If this is not true, then the reported test is conservative.
```

Is this a better model than the fixed effects model (2a)? How do we know?
No, ML −2ΔLL(2) = 2.91, p =.235
Each person does not need his or her own effect of worse negative mood than usual.

Model 2c. Adding Moderation Effects by Sex (0=M, 1=F) for Each Mood Effect under PMC

$$\text{Level 1: Glucose}_{ti} = \beta_{0i} + \beta_{1i}\left(\text{Mood}_{ti} - \overline{\text{Mood}}_i\right) + e_{ti}$$

$$\text{Level 2: Intercept: } \beta_{0i} = \gamma_{00} + \gamma_{01}\left(\overline{\text{Mood}}_i - 0\right) + \gamma_{02}\left(\text{Woman}_i\right) + \gamma_{03}\left(\overline{\text{Mood}}_i - 0\right)\left(\text{Woman}_i\right) + U_{0i}$$

$$\text{Within-Person Mood: } \beta_{1i} = \gamma_{10} + \gamma_{12}\left(\text{Woman}_i\right)$$

```
TITLE "SAS Model 2c: Fixed Effects of Sex (0=M, 1=F) by PMC Negative Mood";
PROC MIXED DATA=work.example4 COVTEST NOCLPRINT NOITPRINT NAMELEN=100 IC METHOD=ML;
       CLASS ID day;
       MODEL lglucAM = WPnm PMnm0 sexmf WPnm*sexmf PMnm0*sexmf
             / SOLUTION DDFM=Satterthwaite OUTPM=SexPred;
       RANDOM INTERCEPT / SUBJECT=ID TYPE=UN;
       REPEATED day / SUBJECT=ID TYPE=VC;
ESTIMATE "Intercept: Men (Mood=0)"                  intercept 1 sexmf 0;
ESTIMATE "Intercept: Women (Mood=0)"                intercept 1 sexmf 1;
ESTIMATE "Intercept: Women Diff (Mood=0)"           sexmf 1;
ESTIMATE "Within-Person Mood Effect: Men"           WPnm 1 WPnm*sexmf 0;
ESTIMATE "Within-Person Mood Effect: Women"         WPnm 1 WPnm*sexmf 1;
ESTIMATE "Within-Person Mood Effect: Women Diff"    WPnm*sexmf 1;
ESTIMATE "Between-Person Mood Effect: Men"          PMnm0 1 PMnm0*sexmf 0;
ESTIMATE "Between-Person Mood Effect: Women"        PMnm0 1 PMnm0*sexmf 1;
ESTIMATE "Between-Person Mood Effect: Women Diff"   PMnm0*sexmf 1;
ESTIMATE "Contextual Mood Effect: Men"              PMnm0 1 PMnm0*sexMF 0 WPnm -1 WPnm*sexMF  0;
ESTIMATE "Contextual Mood Effect: Women"            PMnm0 1 PMnm0*sexMF 1 WPnm -1 WPnm*sexMF -1;
ESTIMATE "Contextual Mood Effect: Women Diff"       PMnm0*sexMF 1 WPnm*sexMF -1;
RUN; PROC CORR NOSIMPLE DATA=SexPred; VAR lglucAM pred; RUN;

TITLE "SPSS Model 2c: Fixed Effects of Sex (0=M, 1=F) by PMC Negative Mood".
MIXED lglucAM BY ID day WITH WPnm PMnm0 sexmf
       /METHOD = ML
       /PRINT  = SOLUTION TESTCOV
       /FIXED  = WPnm PMnm0 sexmf WPnm*sexmf PMnm0*sexmf
       /RANDOM = INTERCEPT | SUBJECT(ID) COVTYPE(UN)
```

```
      /REPEATED = day | SUBJECT(ID) COVTYPE(ID)
      /SAVE = FIXPRED (predsex)
/TEST = "Intercept: Men (Mood=0)"                    intercept 1 sexmf 0
/TEST = "Intercept: Women (Mood=0)"                  intercept 1 sexmf 1
/TEST = "Intercept: Women Diff (Mood=0)"             sexmf 1
/TEST = "Within-Person Mood Effect: Men"             WPnm 1 WPnm*sexmf 0
/TEST = "Within-Person Mood Effect: Women"           WPnm 1 WPnm*sexmf 1
/TEST = "Within-Person Mood Effect: Women Diff"      WPnm*sexmf 1
/TEST = "Between-Person Mood Effect: Men"            PMnm0 1 PMnm0*sexmf 0
/TEST = "Between-Person Mood Effect: Women"          PMnm0 1 PMnm0*sexmf 1
/TEST = "Between-Person Mood Effect: Women Diff"     PMnm0*sexmf 1
/TEST = "Contextual Mood Effect: Men"                PMnm0 1 PMnm0*sexMF 0 WPnm -1 WPnm*sexMF  0
/TEST = "Contextual Mood Effect: Women"              PMnm0 1 PMnm0*sexMF 1 WPnm -1 WPnm*sexMF -1
/TEST = "Contextual Mood Effect: Women Diff"        PMnm0*sexMF 1 WPnm*sexMF -1.
CORRELATIONS lglucAM predsex.

* STATA Model 2c: SPSS Model 2c: Fixed Effects of Sex (0=M, 1=F) by PMC Negative Mood
xtmixed lglucAM c.WPnm c.PMnm0 c.sexmf c.WPnm#c.sexmf c.PMnm0#c.sexmf, ///
      || id: ,  variance ml covariance(un) residuals(independent,t(day)),
      estat ic, n(207),
      estimates store Sexeffects,       // save LL for LRT
      lrtest Sexeffects FixWP,          // LRT against main effects model
      predict predsex,           // save fixed-effect predicted outcomes
lincom 1*_cons + 0*c.sexmf              // intercept: men (mood=0)
lincom 1*_cons + 1*c.sexmf              // intercept: women (mood=0)
lincom 1*c.sexmf                        // intercept: women diff (mood=0)
lincom 1*c.WPnm + 0*c.WPnm#c.sexmf                    // within-person mood effect: men
lincom 1*c.WPnm + 1*c.WPnm#c.sexmf                    // within-person mood effect: women
lincom 1*c.WPnm#c.sexmf                               // within-person mood effect: women diff
lincom 1*c.PMnm0 + 0*c.PMnm0#c.sexmf                  // between-person mood effect: men
lincom 1*c.PMnm0 + 1*c.PMnm0#c.sexmf                  // between-person mood effect: women
lincom 1*c.PMnm0#c.sexmf                              // between-person mood effect: women diff
lincom 1*c.PMnm0 + 0*PMnm0#c.sexmf - 1*c.WPnm + 0*c.WPnm#c.sexmf   // contextual mood: men
lincom 1*c.PMnm0 + 1*pmnm0#c.sexmf - 1*c.WPnm - 1*c.WPnm#c.sexmf   // contextual mood: women
lincom 1*c.PMnm0#c.sexmf -1*WPnm#c.sexmf                           // contextual mood: women diff
margins, at(c.WPnm=(-1 0 1) c.PMnm0=(-1 1) c.sexmf=(0 1)) vsquish   // create predicted values
marginsplot, noci name(predicted_mood, replace) xdimension(WPnm)    // plot predicted, no CI
corr lglucAM predsex
```

STATA output:

```
                                                Wald chi2(5)       =     47.55
Log likelihood =  994.02512                     Prob > chi2        =    0.0000
------------------------------------------------------------------------------
       lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------+--------------------------------------------------------------
          WPnm |   .0311885   .0059366     5.25   0.000     .0195529    .0428241
         PMnm0 |   .1996279   .0484871     4.12   0.000      .104595    .2946608
         sexmf |  -.0361935   .0362613    -1.00   0.318    -.1072643    .0348772
 c.WPnm#c.sexmf |  -.0344341   .0077425    -4.45   0.000    -.0496092    -.019259
c.PMnm0#c.sexmf |   -.184933   .0613487    -3.01   0.003    -.3051743   -.0646918
         _cons |   4.953854   .0273373   181.21   0.000     4.900274    5.007434
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
id: Identity                 |
                  var(_cons) |   .0607399   .0061183      .0498578    .0739972 → intercept var down by 5.61%
-----------------------------+------------------------------------------------
               var(Residual) |   .0300694   .0006781      .0287694    .0314282 → residual var down by 0.50%
------------------------------------------------------------------------------
LR test vs. linear regression: chibar2(01) =  3804.78 Prob >= chibar2 = 0.0000
.         estat ic, n(207),
------------------------------------------------------------------------------
       Model |    Obs    ll(null)   ll(model)     df          AIC         BIC
-------------+----------------------------------------------------------------
           . |    207           .    994.0251      8     -1972.05   -1945.388
```

```
.         estimates store Sexeffects,       // save LL for LRT
.         lrtest Sexeffects FixWP,          // LRT against main effects model

Likelihood-ratio test                                 LR chi2(3)  =     31.51
(Assumption: FixWP nested in Sexeffects)              Prob > chi2 =    0.0000
```

Is this a better model than the fixed main effects model (2b)?
Yes, ML −2ΔLL(3) = 31, p <.001

What does the intercept now represent in this model?
The intercept of 4.9539 is the expected glucose for a man with a PMnm = 0 and WPnm = 0.

What does the level-1 effect (WPnm) represent in this model?
The level-1 effect is the simple within-person effect of negative mood specifically for a man. For every unit relative increase in your own negative mood that day, that next day's glucose goes up by 0.03119 (significant).

What does the level-2 effect (PMnm0) represent in this model?
The level-2 effect is the simple between-person effect of negative mood specifically for a man. For every unit increase in your person mean negative mood, mean glucose is higher by 0.1996 (significant).

What does the main effect of sex represent in this model?
The simple effect of sex is the difference between men and women for someone with a person mean negative mood of 0 on day when they are at their mean. In those persons, women are −0.03619 lower in mean glucose (n.s.).

What does the WPnm*Sex interaction represent in this model?
*The WP*Sex interaction tells us that the WP mood effect is 0.03443 smaller in women (significant interaction).*

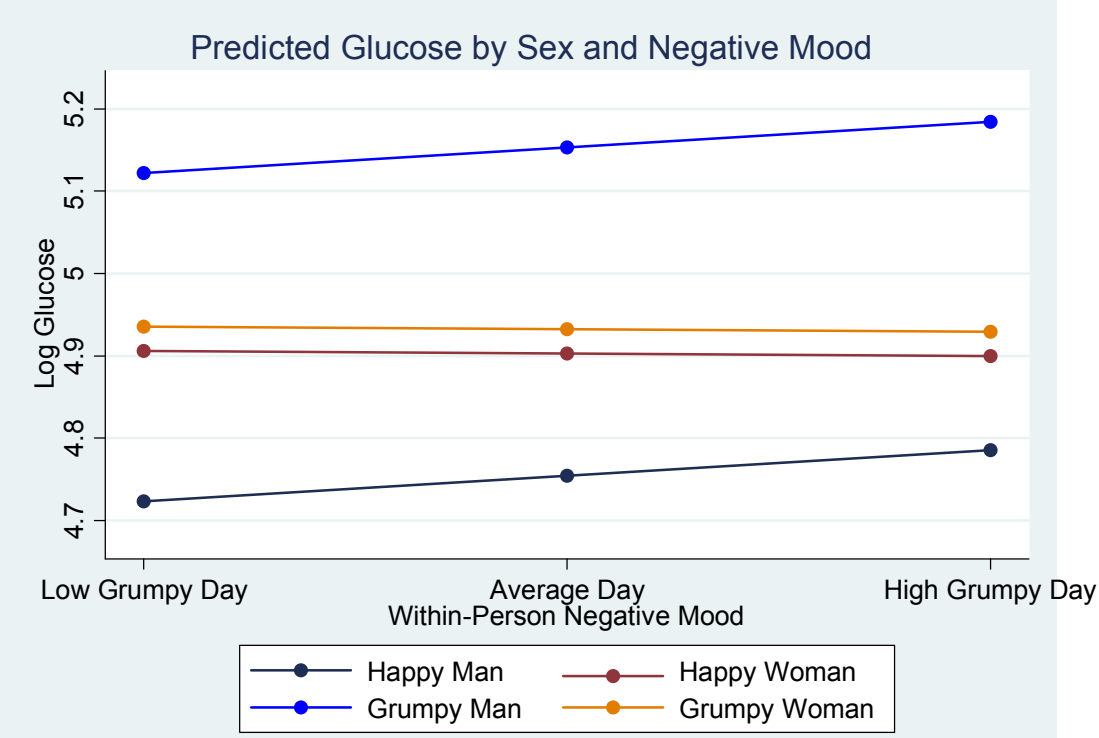
What does the PMnm0*Sex interaction represent in this model?
*The BP*Sex interaction tells us BP mood effect is 0.1849 smaller in women (significant interaction).*

Which effects are not directly given by the model?
The effects for women and all of the contextual effects, as shown below.

```
.         lincom 1*c.WPnm + 1*c.WPnm#c.sexmf                    // within-person mood effect: women
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0032456   .0049702    -0.65   0.514    -.0129871    .0064959
------------------------------------------------------------------------------
.         lincom 1*c.PMnm0 + 1*c.PMnm0#c.sexmf                  // between-person mood effect: women
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0146949   .0375854     0.39   0.696    -.0589712     .088361
------------------------------------------------------------------------------
.         lincom 1*c.PMnm0 + 0*c.PMnm0#c.sexmf - 1*c.WPnm + 0*c.WPnm#c.sexmf   // contextual mood: men
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .1684394   .0488639     3.45   0.001     .0726679    .2642109
------------------------------------------------------------------------------
.         lincom 1*c.PMnm0 + 1*c.PMnm0#c.sexmf - 1*c.WPnm - 1*c.WPnm#c.sexmf   // contextual mood: women
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0179405   .0378969     0.47   0.636    -.0563361    .0922171
------------------------------------------------------------------------------
.         lincom 1*c.PMnm0#c.sexmf -1*c.WPnm#c.sexmf                    // contextual mood: women diff
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.1504989   .0618374    -2.43   0.015    -.2716979      -.0293
------------------------------------------------------------------------------
.         margins, at(c.WPnm=(-1 0 1) c.PMnm0=(-1 1) c.sexmf=(0 1)) vsquish   // create predicted values
```

```
Adjusted predictions                            Number of obs   =       4140
Expression   : Linear prediction, fixed portion, predict()
1._at  : WPnm    =   -1
         PMnm0   =   -1
         sexmf   =    0
2._at  : WPnm    =   -1
         PMnm0   =   -1
         sexmf   =    1
3._at  : WPnm    =   -1
         PMnm0   =    1
         sexmf   =    0
4._at  : WPnm    =   -1
         PMnm0   =    1
         sexmf   =    1
5._at  : WPnm    =    0
         PMnm0   =   -1
         sexmf   =    0
6._at  : WPnm    =    0
         PMnm0   =   -1
         sexmf   =    1
7._at  : WPnm    =    0
         PMnm0   =    1
         sexmf   =    0
8._at  : WPnm    =    0
         PMnm0   =    1
         sexmf   =    1
9._at  : WPnm    =    1
         PMnm0   =   -1
         sexmf   =    0
10._at : WPnm    =    1
         PMnm0   =   -1
         sexmf   =    1
11._at : WPnm    =    1
         PMnm0   =    1
         sexmf   =    0
12._at : WPnm    =    1
         PMnm0   =    1
         sexmf   =    1
------------------------------------------------------------------------------
             |            Delta-method
             |     Margin   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         _at |
          1  |   4.723038   .0600243    78.69   0.000     4.605392    4.840683
          2  |   4.906211   .0505436    97.07   0.000     4.807148    5.005275
          3  |   5.122294   .0516162    99.24   0.000     5.021128     5.22346
          4  |   4.935601   .0381615   129.33   0.000     4.860806    5.010396
          5  |   4.754226    .059742    79.58   0.000     4.637134    4.871319
          6  |   4.902966   .0502812    97.51   0.000     4.804416    5.001515
          7  |   5.153482   .0512596   100.54   0.000     5.053015    5.253949
          8  |   4.932356   .0378448   130.33   0.000     4.858181     5.00653
          9  |   4.785415   .0600482    79.69   0.000     4.667723    4.903107
         10  |    4.89972   .0505089    97.01   0.000     4.800725    4.998716
         11  |   5.184671   .0515882   100.50   0.000      5.08356    5.285782
         12  |    4.92911   .0381781   129.11   0.000     4.854282    5.003938
------------------------------------------------------------------------------
. corr lglucAM predsex
(obs=4140)
             |  lglucAM  predsex
-------------+------------------
     lglucAM |   1.0000
     predsex |   0.2493   1.0000
```

Figure 1



Total R^2 from mood+sex = .062, for a net increase of .039 from sex effects

Model 3. Predicting Glucose from Time-Varying Negative Mood only (GMC):

$$\text{Level 1: } Glucose_{ti} = \beta_{0i} + \beta_{1i}(Mood_{ti} - 0) + e_{ti}$$
$$\text{Level 2: Intercept: } \beta_{0i} = \gamma_{00} + U_{0i}$$
$$\text{Time-Varying Mood: } \beta_{1i} = \gamma_{10}$$

```
TITLE "SAS Model 3: Fixed Effect of TV Negative Mood only using GMC";
PROC MIXED DATA=work.example4 COVTEST NOCLPRINT NOITPRINT NAMELEN=100 IC METHOD=ML;
       CLASS ID day;
       MODEL lglucAM = TVnm0 / SOLUTION DDFM=Satterthwaite;
       RANDOM INTERCEPT / SUBJECT=ID TYPE=UN;
       REPEATED day / SUBJECT=ID TYPE=VC; RUN;

TITLE "SPSS Model 3: Fixed Effect of TV Negative Mood only using GMC".
MIXED lglucAM BY ID day WITH TVnm0
       /METHOD = ML
       /PRINT  = SOLUTION TESTCOV
       /FIXED  = TVnm0
       /RANDOM = INTERCEPT | SUBJECT(ID) COVTYPE(UN)
       /REPEATED = day | SUBJECT(ID) COVTYPE(ID).

* STATA Model 3: Fixed Effect of TV Negative Mood only using GMC
xtmixed lglucAM c.TVnm0, || id: , variance ml covariance(un) residuals(independent,t(day)),
       estat ic, n(207)
```

STATA output:

```
                                                Wald chi2(1)       =     10.04
Log likelihood =  975.74178                     Prob > chi2        =    0.0015
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       TVnm0 |   .0120181   .0037921     3.17   0.002     .0045856    .0194505
       _cons |   4.940763   .0180634   273.52   0.000      4.90536    4.976167
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
id: Identity                 |
                  var(_cons) |    .065954   .0066337      .0541534    .0803259 → intercept var down by 0.89%
-----------------------------+------------------------------------------------
               var(Residual) |   .0302219   .0006815      .0289152    .0315876 → residual var down by 0.23%
------------------------------------------------------------------------------
LR test vs. linear regression: chibar2(01) =  3982.05 Prob >= chibar2 = 0.0000

.         estat ic, n(207)
-----------------------------------------------------------------------------
       Model |    Obs    ll(null)   ll(model)     df          AIC         BIC
-------------+---------------------------------------------------------------
           . |    207           .    975.7418      4    -1943.484   -1930.153
-----------------------------------------------------------------------------
               Note:  N=207 used in calculating BIC
```

What does the effect of TVnm0 represent in this model?
It is the smushed (conflated, convergence) effect of mood.

Model 3a. Fixed Effects of Negative Mood using Grand-Mean-Centering (GMC)

Level 1: $\text{Glucose}_{ti} = \beta_{0i} + \beta_{1i}\left(\text{Mood}_{ti} - 0\right) + e_{ti}$

Level 2: Intercept: $\beta_{0i} = \gamma_{00} + \gamma_{01}\left(\overline{\text{Mood}}_{i} - 0\right) + U_{0i}$

Time-Varying Mood: $\beta_{1i} = \gamma_{10}$

```
TITLE "SAS Model 3a: Fixed Effects of Negative Mood using GMC";
PROC MIXED DATA=work.example4 COVTEST NOCLPRINT NOITPRINT NAMELEN=100 IC METHOD=ML;
       CLASS ID day;
       MODEL lglucAM = TVnm0 PMnm0 / SOLUTION DDFM=Satterthwaite;
       RANDOM INTERCEPT / SUBJECT=ID TYPE=UN;
       REPEATED day / SUBJECT=ID TYPE=VC;
       ESTIMATE "Within-Person Mood Effect"    TVnm0 1;
       ESTIMATE "Between-Person Mood Effect"   TVnm0 1 PMnm0 1;
       ESTIMATE "Contextual Mood Effect"       PMnm0 1;  RUN;

TITLE "SPSS Model 3a: Fixed Effects of Negative Mood using GMC".
MIXED lglucAM BY ID day WITH TVnm0 PMnm0
       /METHOD = ML
       /PRINT  = SOLUTION TESTCOV
       /FIXED  = TVnm0 PMnm0
       /RANDOM = INTERCEPT | SUBJECT(ID) COVTYPE(UN)
       /REPEATED = day | SUBJECT(ID) COVTYPE(ID)
       /TEST = "Within-Person Mood Effect"     TVnm0 1
       /TEST = "Between-Person Mood Effect"    TVnm0 1 PMnm0 1
       /TEST = "Contextual Mood Effect"        PMnm0 1.

* STATA Model 3a: Fixed Effects of Negative Mood using GMC
xtmixed lglucAM c.TVnm0 c.PMnm0, || id: ,      ///
       variance ml covariance(un) residuals(independent,t(day)),
       estat ic, n(207),
       estimates store FixTV,            // save LL for LRT
       lincom 1*c.TVnm0                  // within-person mood effect
       lincom 1*c.TVnm0 + 1*c.PMnm0      // between-person mood effect
       lincom 1*c.PMnm0                  // contextual mood effect
```

STATA output:

```
                                                Wald chi2(2)       =     15.20
Log likelihood =    978.269                     Prob > chi2        =    0.0005
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       TVnm0 |   .0109743   .0038207     2.87   0.004     .0034859    .0184626
       PMnm0 |   .0694233   .0306963     2.26   0.024     .0092597     .129587
       _cons |   4.930171   .0184512   267.20   0.000     4.894008    4.966335
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
id: Identity                 |
                  var(_cons) |   .0643486   .0064737      .0528329    .0783743 → intercept var down by 2.4%
-----------------------------+------------------------------------------------
               var(Residual) |   .0302214   .0006815      .0289147     .031587
------------------------------------------------------------------------------
LR test vs. linear regression: chibar2(01) =  3941.45 Prob >= chibar2 = 0.0000

.         estat ic, n(207),
-----------------------------------------------------------------------------
       Model |    Obs    ll(null)   ll(model)     df          AIC         BIC
-------------+---------------------------------------------------------------
           . |    207           .     978.269      5    -1946.538   -1929.874
-----------------------------------------------------------------------------
               Note:  N=207 used in calculating BIC
```

Note that the fit is the same as model 2a (and thus the R^2 values are, too)

```
.         lincom 1*c.TVnm0                        // within-person mood effect
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0109743   .0038207     2.87   0.004     .0034859    .0184626
------------------------------------------------------------------------------
.         lincom 1*c.TVnm0 + 1*c.PMnm0           // between-person mood effect
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0803976    .030461     2.64   0.008     .0206952       .1401
------------------------------------------------------------------------------
.         lincom 1*c.PMnm0                           // contextual mood effect
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0694233   .0306963     2.26   0.024     .0092597     .129587
------------------------------------------------------------------------------
```

What does the level-2 effect (PMnm0) represent in this model?
It is the difference in the between-person and within-person effects (the contextual effect): the between-person mood effect is significantly greater than the within-person mood effect by .0694 (so convergence was not obtained).
In other words, after controlling for current negative mood, there is an incremental effect of .0694 per unit higher person mean negative mood.

Model 3b. Random Effect of TV Negative Mood under GMC

$$\text{Level 1: } \text{Glucose}_{ti} = \beta_{0i} + \beta_{1i}\left(\text{Mood}_{ti} - 0\right) + e_{ti}$$
$$\text{Level 2: Intercept: } \beta_{0i} = \gamma_{00} + \gamma_{01}\left(\overline{\text{Mood}}_{i} - 0\right) + U_{0i}$$
$$\text{Time-Varying Mood: } \beta_{1i} = \gamma_{10} + U_{1i}$$

```
TITLE "SAS Model 3b: Random Effect of TV Negative Mood using GMC";
PROC MIXED DATA=work.example4 COVTEST NOCLPRINT NOITPRINT NAMELEN=100 IC METHOD=ML;
       CLASS ID day;
       MODEL lglucAM = TVnm0 PMnm0 / SOLUTION DDFM=Satterthwaite;
       RANDOM INTERCEPT TVnm0 / SUBJECT=ID TYPE=UN;
       REPEATED day / SUBJECT=ID TYPE=VC;
       ESTIMATE "Within-Person Mood Effect"    TVnm0 1;
       ESTIMATE "Between-Person Mood Effect"   TVnm0 1 PMnm0 1;
       ESTIMATE "Contextual Mood Effect"       PMnm0 1;  RUN;

TITLE "SPSS Model 3b: Random Effect of TV Negative Mood using GMC".
MIXED lglucAM BY ID day WITH TVnm0 PMnm0
       /METHOD = ML
       /PRINT  = SOLUTION TESTCOV
       /FIXED  = TVnm0 PMnm0
       /RANDOM = INTERCEPT TVnm0 | SUBJECT(ID) COVTYPE(UN)
       /REPEATED = day | SUBJECT(ID) COVTYPE(ID)
       /TEST = "Within-Person Mood Effect"     TVnm0 1
       /TEST = "Between-Person Mood Effect"    TVnm0 1 PMnm0 1
       /TEST = "Contextual Mood Effect"        PMnm0 1.

* STATA Model 3b: Random Effect of WP Negative Mood using GMC
xtmixed lglucAM c.TVnm0 c.PMnm0, || id: TVnm0,        ///
       variance ml covariance(un) residuals(independent,t(day)),
       estat ic, n(207),
       estimates store RandTV,           // save LL for LRT
       lrtest RandTV FixTV,              // LRT against fixed effect
       lincom 1*c.TVnm0                  // within-person mood effect
       lincom 1*c.TVnm0 + 1*c.PMnm0      // between-person mood effect
       lincom 1*c.PMnm0                  // contextual mood effect
```

STATA output:

```
                                                Wald chi2(2)       =     13.72
Log likelihood =   980.1989                     Prob > chi2        =    0.0010
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       TVnm0 |   .0110189   .0041807     2.64   0.008     .0028248     .019213
       PMnm0 |   .0701465   .0306592     2.29   0.022     .0100555    .1302374
       _cons |   4.930203   .0184342   267.45   0.000     4.894073    4.966333
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
id: Unstructured             |
                  var(TVnm0) |   .0005787   .0003394      .0001833    .0018268 TV mood slope variance
                  var(_cons) |   .0639986   .0064641      .0525044    .0780092 intercept variance
            cov(TVnm0,_cons) |  -.0003279   .0010502     -.0023863    .0017305 int-mood slope covariance
-----------------------------+------------------------------------------------
               var(Residual) |   .0299214   .0006904      .0285984    .0313056
------------------------------------------------------------------------------
LR test vs. linear regression:       chi2(3) =  3945.31   Prob > chi2 = 0.0000
Note: LR test is conservative and provided only for reference.
.         estat ic, n(207),
-----------------------------------------------------------------------------
       Model |    Obs    ll(null)   ll(model)     df          AIC         BIC
-------------+---------------------------------------------------------------
           . |    207           .    980.1989      7    -1946.398   -1923.069
-----------------------------------------------------------------------------
               Note:  N=207 used in calculating BIC

.         estimates store RandTV,          // save LL for LRT
.         lrtest RandTV FixTV,             // LRT against fixed effect
Likelihood-ratio test                                 LR chi2(2)  =      3.86
(Assumption: FixTV nested in RandTV)                  Prob > chi2 =    0.1452
Note: The reported degrees of freedom assumes the null hypothesis is not on the boundary of the parameter
space.  If this is not true, then the reported test is conservative.
```

Is this a better model than the fixed effects model (3a)? How do we know?
No, ML −2ΔLL(2) = 3.86, p =.145
Each person does not need his or her own effect of worse negative mood than usual.

Model 3c. Adding Moderation Effects by Sex (0=M, 1=F) for Each Mood Effect under GMC

Level 1: $\text{Glucose}_{ti} = \beta_{0i} + \beta_{1i}(\text{Mood}_{ti} - 0) + e_{ti}$

Level 2: Intercept: $\beta_{0i} = \gamma_{00} + \gamma_{01}(\overline{\text{Mood}}_i - 0) + \gamma_{02}(\text{Woman}_i) + \gamma_{03}(\overline{\text{Mood}}_i - 0)(\text{Woman}_i) + U_{0i}$

Time-Varying Mood: $\beta_{1i} = \gamma_{10} + \gamma_{12}(\text{Woman}_i)$

```
TITLE "SAS Model 3c: Fixed Effects of Sex (0=M, 1=F) by GMC Negative Mood";
PROC MIXED DATA=work.example4 COVTEST NOCLPRINT NOITPRINT NAMELEN=100 IC METHOD=ML;
      CLASS ID day;
      MODEL lglucAM = TVnm0 PMnm0 sexmf TVnm0*sexmf PMnm0*sexmf
            / SOLUTION DDFM=Satterthwaite;
      RANDOM INTERCEPT / SUBJECT=ID TYPE=UN;
      REPEATED day / SUBJECT=ID TYPE=VC;
ESTIMATE "Intercept: Men (Mood=0)"            intercept 1 sexmf 0;
ESTIMATE "Intercept: Women (Mood=0)"          intercept 1 sexmf 1;
ESTIMATE "Intercept: Women Diff (Mood=0)"     sexmf 1;
ESTIMATE "Within-Person Effect: Men"          TVnm0 1 TVnm0*sexmf 0;
ESTIMATE "Within-Person Effect: Women"        TVnm0 1 TVnm0*sexmf 1;
ESTIMATE "Within-Person Effect: Women Diff"   TVnm0*sexmf 1;
ESTIMATE "Between-Person Effect: Men"         TVnm0 1 TVnm0*sexmf 0 PMnm0 1PMnm0*sexmf 0;
ESTIMATE "Between-Person Effect: Women"       TVnm0 1 TVnm0*sexmf 1 PMnm0 1PMnm0*sexmf 1;
ESTIMATE "Between-Person Effect: Women Diff"  TVnm0*sexmf 1 PMnm0*sexmf 1;
ESTIMATE "Contextual Effect: Men"             PMnm0 1 PMnm0*sexmf 0;
ESTIMATE "Contextual Effect: Women"           PMnm0 1 PMnm0*sexmf 1;
ESTIMATE "Contextual Effect: Women Diff"      PMnm0*sexmf 1;  RUN;
```

```
TITLE "SPSS Model 3c: Fixed Effects of Sex (0=M, 1=F) by GMC Negative Mood".
MIXED lglucAM BY ID day WITH TVnm0 PMnm0 sexmf
       /METHOD = ML
       /PRINT  = SOLUTION TESTCOV
       /FIXED  = TVnm0 PMnm0 sexmf TVnm0*sexmf PMnm0*sexmf
       /RANDOM = INTERCEPT | SUBJECT(ID) COVTYPE(UN)
       /REPEATED = day | SUBJECT(ID) COVTYPE(ID)
/TEST = "Intercept: Men (Mood=0)"                    intercept 1 sexmf 0
/TEST = "Intercept: Women (Mood=0)"                  intercept 1 sexmf 1
/TEST = "Intercept: Women Diff (Mood=0)"             sexmf 1
/TEST = "Within-Person Mood Effect: Men"             TVnm0 1 TVnm0*sexmf 0
/TEST = "Within-Person Mood Effect: Women"           TVnm0 1 TVnm0*sexmf 1
/TEST = "Within-Person Mood Effect: Women Diff"      TVnm0*sexmf 1
/TEST = "Between-Person Mood Effect: Men"            TVnm0 1 TVnm0*sexmf 0 PMnm0 1 PMnm0*sexmf 0
/TEST = "Between-Person Mood Effect: Women"          TVnm0 1 TVnm0*sexmf 1 PMnm0 1 PMnm0*sexmf 1
/TEST = "Between-Person Mood Effect: Women Diff"     TVnm0*sexmf 1 PMnm0*sexmf 1
/TEST = "Contextual Mood Effect: Men"                PMnm0 1 PMnm0*sexMF 0
/TEST = "Contextual Mood Effect: Women"              PMnm0 1 PMnm0*sexMF 1
/TEST = "Contextual Mood Effect: Women Diff"         PMnm0*sexMF 1.

* STATA Model 3c: SPSS Model 2c: Fixed Effects of Sex (0=M, 1=F) by GMC Negative Mood
xtmixed lglucAM c.TVnm0 c.PMnm0 c.sexmf c.TVnm0#c.sexmf c.PMnm0#c.sexmf, ///
       || id: ,  variance ml covariance(un) residuals(independent,t(day)),
       estat ic, n(207),
lincom 1*_cons + 0*c.sexmf                                          // intercept: men (mood=0)
lincom 1*_cons + 1*c.sexmf                                          // intercept: women (mood=0)
lincom 1*c.sexmf                                                    // intercept: women diff (mood=0)
lincom 1*c.TVnm0 + 0*c.TVnm0#c.sexmf                                      // within-person mood effect: men
lincom 1*c.TVnm0 + 1*c.TVnm0#c.sexmf                                      // within-person mood effect: women
lincom 1*c.TVnm0#c.sexmf                                            // within-person mood effect: women diff
lincom 1*c.TVnm0 + 0*c.TVnm0#c.sexmf + 1*c.PMnm0 + 0*c.PMnm0#c.sexmf // between-person: men
lincom 1*c.TVnm0 + 1*c.TVnm0#c.sexmf + 1*c.PMnm0 + 1*c.PMnm0#c.sexmf // between-person: women
lincom 1*c.TVnm0#c.sexmf + 1*c.PMnm0#c.sexmf                                 // between-person: women diff
lincom 1*c.PMnm0 + 0*c.PMnm0#c.sexmf                                // contextual mood effect: men
lincom 1*c.PMnm0 + 1*c.PMnm0#c.sexmf                                // contextual mood effect: women
lincom 1*c.PMnm0#c.sexmf                                            // contextual mood effect: women diff
```

STATA output (and non-directly provided estimates for simple effects):

```
                                                Wald chi2(5)       =     47.55
Log likelihood =  994.02512                     Prob > chi2        =    0.0000
------------------------------------------------------------------------------
       lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------+--------------------------------------------------------------
         TVnm0 |   .0311885   .0059366     5.25   0.000     .0195529    .0428241
         PMnm0 |   .1684394   .0488639     3.45   0.001     .0726679    .2642109
         sexmf |  -.0361935   .0362613    -1.00   0.318    -.1072643    .0348772
c.TVnm0#c.sexmf |  -.0344341   .0077425    -4.45   0.000    -.0496092    -.019259
c.PMnm0#c.sexmf |  -.1504989   .0618374    -2.43   0.015    -.2716979      -.0293
         _cons |   4.953854   .0273373   181.21   0.000     4.900274    5.007434
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
id: Identity                 |
                  var(_cons) |   .0607399   .0061183      .0498578    .0739972
-----------------------------+------------------------------------------------
               var(Residual) |   .0300694   .0006781      .0287694    .0314282
------------------------------------------------------------------------------
LR test vs. linear regression: chibar2(01) =  3804.78 Prob >= chibar2 = 0.0000

.         estat ic, n(207),
-----------------------------------------------------------------------------
       Model |    Obs    ll(null)   ll(model)     df          AIC         BIC
-------------+---------------------------------------------------------------
           . |    207           .    994.0251      8     -1972.05   -1945.388
-----------------------------------------------------------------------------
```

```
.         lincom 1*c.TVnm0 + 1*c.TVnm0#c.sexmf                    // within-person mood effect: women
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0032456   .0049702    -0.65   0.514    -.0129871    .0064959
------------------------------------------------------------------------------

. lincom 1*c.TVnm0 + 0*c.TVnm0#c.sexmf + 1*c.PMnm0 + 0*c.PMnm0#c.sexmf    // between-person mood effect: men
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .1996279   .0484871     4.12   0.000      .104595    .2946608
------------------------------------------------------------------------------

. lincom 1*c.TVnm0 + 1*c.TVnm0#c.sexmf + 1*c.PMnm0 + 1*c.PMnm0#c.sexmf   // between-person mood effect: women
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0146949   .0375854     0.39   0.696    -.0589712     .088361
------------------------------------------------------------------------------

.         lincom 1*c.TVnm0#c.sexmf + 1*c.PMnm0#c.sexmf             // between-person mood effect: women diff
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   -.184933   .0613487    -3.01   0.003    -.3051743   -.0646918
------------------------------------------------------------------------------

.         lincom 1*c.PMnm0 + 1*c.PMnm0#c.sexmf                        // contextual mood effect: women
------------------------------------------------------------------------------
     lglucAM |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0179405   .0378969     0.47   0.636    -.0563361    .0922171
------------------------------------------------------------------------------
```

Sample Results Section (note the order of the models is different than what is in the handout):

The effects of negative mood and sex on next day's morning glucose level were examined in 207 persons with type-2 diabetes over a 20-day period. Glucose was natural log transformed (after adding 1 to each score) to improve normality. Intraclass correlations as calculated from an empty means,, random intercept only model were .69 for glucose and .39 for negative mood, such that 69% and 39% of the variance in each variable was between persons, respectively. Preliminary analyses suggested that a random intercept only model for the variances of glucose over time had acceptable fit, and thus all conditional (predictor) models were examined using that structure as a baseline.

The time-varying (level-1) predictor for negative mood (left uncentered, given that 0 represented average level of the measure) was first entered into the model. A significant positive effect was obtained, such that higher daily levels of negative mood were related to higher daily levels of glucose. However, the inclusion of a single parameter for the effect of negative mood presumes that its between-person and within-person effects would be equivalent. This convergence hypothesis was tested explicitly by including person mean negative mood (also left uncentered, given that 0 represented average level of the original measure) as a level-2 predictor. The effect of person mean negative mood was significant, indicating that after controlling for absolute level of daily negative mood, persons with higher mean negative mood had higher mean glucose. Given that the significance of the level-2 effect also indicates that the between-person and within-person effects of negative mood were not equivalent, the model was re-specified to facilitate interpretation of these separate effects using group-mean-centering (i.e., person-mean-centering in longitudinal data). Specifically, a new level-1 predictor variable was created by subtracting each person's mean from daily negative mood, while the level-2 effect continued to be represented by the person mean. In this specification using person-mean-centering, the level-2 mean of negative mood represents the between-person effect directly and the level-1 within-person deviation of negative mood represents the within-person effect directly. Both the between- and within-person effects of negative mood were significantly positive. A random level-1 effect of negative mood was tested within both models, and was not found to be significant in either, $-2\Delta LL\ (\sim 2) < 5.14$, $p > .05$, indicating no significant individual differences in the within-person effect of negative mood.

Three effects of sex were then entered into the person-mean-centered model, including a main effect of sex and interactions with the between- and within-person effects of negative mood. The main effect of sex was non-significant, indicating no sex differences in mean glucose among persons with average levels of mean negative mood on average days (i.e., when average persons were at their mean). Given that both interactions were significant, however, results for both men and women will be presented as derived from ESTIMATE statements for the effects estimated specifically for each group within the overall model. Parameters for this final model are given in Table 1.

As shown, the intercept of 4.95 represents the expected morning LN glucose for a man with an average level of mean negative mood on an average day (i.e., both mean and person-mean-centered negative mood at 0). Men showed significant between- and within-person effects of negative mood, such that for every unit higher in mean negative mood, mean glucose was expected to be 0.20 higher (i.e., the between-person effect), and for every unit higher in negative mood on a given day relative to his own mean, glucose that next morning was expected to be 0.03 higher as well (i.e., the within-person effect). Thus, in men, being higher overall in negative mood and higher than usual in negative mood were each related to higher levels of glucose, and these effects were significantly different in magnitude (contextual effect = 0.17, SE =0 .05, $p < .001$). Said differently the contextual effect also indicates a significant contribution of person mean negative mood after controlling for daily negative mood.

As shown in Figure 1, however, these patterns were not found in women, as indicated by the significant interactions with sex. Specifically, the between-person and within-person effects of negative mood in women were 0.015 (SE = 0.038) and −0.003 (SE = 0.005), respectively. Neither effect was significant nor did they differ significantly in magnitude (contextual effect = 0.018, SE = .038). Both effects of negative mood were significantly smaller than in men (interaction terms of sex with between-person and within-person negative mood of −0.185 and −0.034, respectively). Finally, the contextual effect of negative mood, or the difference between the between-person and within-person effects of negative mood, was significantly larger for men (0.151, SE = 0.062, $p = .016$).

(Table 1 would have all parameter estimates from final model, see chapter 8 for examples)
(Figure 1 would show the within-person effect of negative mood for men and women with low or high mean negative mood – see plot for an example)