Between-Person and Within-Person Effects of Negative Mood Predicting Next-Morning Glucose
COMPLETED VERSION

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:

```
* Reading into work library and centering predictors;
DATA Example9b; SET example.Example9b;
      * Level-2 effect of Negative Mood (mean=0, SD=1);
        pmnm0 = pmnegmood - 0; LABEL pmnm0 = "PM Negative Mood (0=0)";
      * Level-1 effect to use with PERSON-MEAN-CENTERING;
        wpnm  = negmood - pmnegmood; LABEL wpnm = "WP Negative Mood (0=PM)";
      * Level-1 effect to use with GRAND-MEAN-CENTERING;
        tvnm0 = negmood - 0; LABEL tvnm0 = "TV Negative Mood (0=0)";
      * Gender already exists;
        LABEL sexMW = "Participant Sex(0=M, 1=W)";
RUN;
```

PART 1: VARIANCE DECOMPOSITION

1a) Empty Means, Random Intercept Model for Log-Transformed Next Morning Glucose (DV)

```
TITLE "Empty Means, Random Intercept Model for Glucose (TV Outcome)";
PROC MIXED DATA=Example9b COVTEST NOCLPRINT IC NAMELEN=100 METHOD=ML;
      CLASS ID Day;
      MODEL lGlucAM = / SOLUTION DDFM=Satterthwaite;
      RANDOM INTERCEPT / VCORR SUBJECT=ID TYPE=UN;
      REPEATED Day / SUBJECT=ID TYPE=VC;
      ODS OUTPUT CovParms=CovEmpty InfoCrit=FitEmpty; * Save covparms, fit;
RUN;
```

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

Covariance Parameter Estimates

Cov Parm	Subject	Estimate	Standard Error	Z Value	Pr > Z
UN(1,1)	ID	0.06654	0.006690	9.95	<.0001
day	ID	0.03029	0.000683	44.35	<.0001

ICC for Glucose:
.06654 / (.06654 + .03029) = .69

1b) Empty Means, Random Intercept Model for Negative Mood (TV Predictor)

```
TITLE "Empty Means, Random Intercept Model for Negative Mood (TV Predictor)";
PROC MIXED DATA=Example9b COVTEST NOCLPRINT IC NAMELEN=100 METHOD=ML;
      CLASS ID Day;
      MODEL negmood = / SOLUTION DDFM=Satterthwaite;
      RANDOM INTERCEPT / VCORR SUBJECT=ID TYPE=UN;
      REPEATED Day / SUBJECT=ID TYPE=VC; RUN;
```

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

Covariance Parameter Estimates

Cov Parm	Subject	Estimate	Standard Error	Z Value	Pr > Z
UN(1,1)	ID	0.3355	0.03557	9.43	<.0001
day	ID	0.5258	0.01186	44.35	<.0001

ICC for Negative Mood:
.3355 / (.3353 + .5258) = .39

PART 2: PERSON-MEAN-CENTERING OF NEGATIVE MOOD TO PREDICT GLUCOSE

2a) Predicting Glucose from Fixed Effects of Negative Mood using Person-Mean-Centering:

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 "Adding both fixed effects of negative mood under Person-MC";
PROC MIXED DATA=Example9b COVTEST NOCLPRINT IC NAMELEN=100 METHOD=ML;
      CLASS ID day;
      MODEL lGlucAM = WPnm PMnm0 / SOLUTION DDFM=Satterthwaite OUTPM=PredMood;
      RANDOM INTERCEPT / SUBJECT=ID TYPE=UN;
      REPEATED day / SUBJECT=ID TYPE=VC;
      ODS OUTPUT CovParms=CovMood InfoCrit=FitMood; * Save covparms, fit;
      ESTIMATE "Within-Person Effect"     WPnm 1;
      ESTIMATE "Between-Person Effect"    PMnm0 1;
      ESTIMATE "Contextual Effect"        WPnm -1 PMnm0 1;
RUN;
```

Covariance Parameter Estimates

Cov Parm	Subject	Estimate	Standard Error	Z Value	Pr Z
UN(1,1)	ID	0.06435	0.006474	9.94	<.0001
Day	ID	0.03022	0.000682	44.35	<.0001

Information Criteria

Neg2LogLike	Parms	AIC	AICC	HQIC	BIC	CAIC
-1956.5	5	-1946.5	-1946.5	-1939.8	-1929.9	-1924.9

Solution for Fixed Effects

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	4.9302	0.01845	207	267.20	<.0001
WPnm	0.01097	0.003821	3941	2.87	0.0041
PMnm0	0.08040	0.03046	207	2.64	0.0089

Estimates

Label	Estimate	Standard Error	DF	t Value	Pr > |t|
Within-Person Effect	0.01097	0.003821	3941	2.87	0.0041
Between-Person Effect	0.08040	0.03046	207	2.64	0.0089
Contextual Effect	0.06942	0.03070	213	2.26	0.0247

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 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 increase in your mean negative mood, mean glucose is higher by .01097 (BP relation among mean levels).

What does the "contextual effect" represent?
It is the test of the difference in the between-person and within-person effects: the between-person effect is significantly greater than the within-person effect by .07 (so convergence was not obtained).

Which variance did the level-1 effect of WPnm account for? *0.2% of the residual variance*

Which variance did the level-2 effect of PMnm0 account for? *3.3% of the random intercept variance*

```
* Calculate PseudoR2 relative to empty model;
%PseudoR2(NCov=2, CovFewer=CovEmpty, NameFewer=Empty, CovMore=CovMood, NameMore=Mood);
```

```
PsuedoR2 (% Reduction) for Empty vs. Mood
Name     CovParm    Subject    Estimate      StdErr    ZValue     ProbZ    PseudoR2
Empty    UN(1,1)      ID        0.06654    0.006690      9.95    <.0001      .
Empty    day          ID        0.03029    0.000683     44.35    <.0001      .
Mood     UN(1,1)      ID        0.06435    0.006474      9.94    <.0001    0.032967
Mood     day          ID        0.03022    0.000682     44.35    <.0001    0.002105
```

What is the total reduction in glucose variance so far? *2.3% of the overall variance*

```
PROC CORR DATA=PredMood; VAR lGlucAM pred; RUN;
Pearson Correlation Coefficients, N = 4140
       Prob > |r| under H0: Rho=0
                    lglucAM          Pred
lglucAM             1.00000       0.15269
                                   <.0001
```

Total variance accounted for in glucose by the effects of negative mood: $r = .15269$, $R^2 = .023$.

Is this total reduction in variance significant? *Yes, according to the df=2 LRT against the empty means model.*

```
* Calculate difference in model fit relative to empty model;
%FitTest(FitFewer=FitEmpty, NameFewer=Empty, FitMore=FitMood, NameMore=Mood);
Likelihood Ratio Test for Empty vs. Mood
        Neg2Log
Name     Like      Parms       AIC        BIC     DevDiff    DFdiff       Pvalue
Empty   -1941.5      3      -1935.5    -1925.5       .          .      .
Mood    -1956.5      5      -1946.5    -1929.9    15.0818       2      .000530910
```

2b) Testing a random effect of WP negative mood under Person-MC:

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: $\beta_{1i} = \gamma_{10} + U_{1i}$

```
TITLE "Add random effect of WP negative mood under Person-MC";
PROC MIXED DATA=Example9b COVTEST NOCLPRINT IC NAMELEN=100 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;
      ODS OUTPUT InfoCrit= FitRandMood;    * Save fit;
      ESTIMATE "Within-Person Effect"      WPnm 1;
      ESTIMATE "Between-Person Effect"     PMnm0 1;
      ESTIMATE "Contextual Effect"         WPnm -1 PMnm0 1;
RUN;
```

```
                Covariance Parameter Estimates
                                  Standard         Z
Cov Parm    Subject    Estimate       Error     Value        Pr Z
UN(1,1)     ID          0.06440    0.006479      9.94      <.0001
UN(2,1)     ID         -0.00020    0.001067     -0.19      0.8478
UN(2,2)     ID         0.000505    0.000335      1.51      0.0656
Day         ID          0.02995    0.000692     43.28      <.0001
```

```
                          Information Criteria
Neg2LogLike    Parms        AIC       AICC       HQIC        BIC       CAIC
    -1959.4        7    -1945.4    -1945.4    -1936.0    -1922.1    -1915.1

                  Solution for Fixed Effects
                        Standard
Effect       Estimate       Error      DF    t Value    Pr > |t|
Intercept      4.9302     0.01846     207     267.10      <.0001
WPnm          0.01104    0.004137     202       2.67      0.0083
PMnm0         0.08022     0.03047     207       2.63      0.0091

                               Estimates
                                   Standard
Label                     Estimate       Error       DF    t Value    Pr > |t|
Within-Person Effect       0.01104    0.004137      202       2.67      0.0083
Between-Person Effect      0.08022     0.03047      207       2.63      0.0091
Contextual Effect          0.06918     0.03075      215       2.25      0.0255
```

Note the change in DF and SE for the now-random WPnm effect.

Is this a better model than the fixed effects person-MC model (2a)? What does this result mean?
It means that so far, each person does not need his or her own effect of worse negative mood than usual.

```
* Calculate difference in model fit relative to fixed WPnm model;
%FitTest(FitFewer=FitMood, NameFewer=FixedWPnm, FitMore=FitRandMood,
NameMore=RandomWPnm);
```

```
Likelihood Ratio Test for FixedWPnm0 vs. RandomWPnm0
              Neg2Log
   Name        Like      Parms        AIC        BIC     DevDiff     DFdiff      Pvalue
FixedWPnm     -1956.5       5     -1946.5    -1929.9      .            .          .
RandomWPnm    -1959.4       7     -1945.4    -1922.1     2.90730       2       0.23372
```

2c) Adding moderation effects by sex (0=M, 1=W) for each mood effect under P-MC:

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

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

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

```
TITLE "Add 3 effects of sex (0=M, 1=F) under Person-MC negative mood";
PROC MIXED DATA=Example9b COVTEST NOCLPRINT IC NAMELEN=100 METHOD=ML;
      CLASS ID Day;
      MODEL lGlucAM = WPnm PMnm0 sexMW WPnm*sexMW PMnm0*sexMW
                        / SOLUTION DDFM=Satterthwaite OUTPM=PredSex;
      RANDOM INTERCEPT / SUBJECT=ID TYPE=UN;
      REPEATED Day / SUBJECT=ID TYPE=VC;
      ODS OUTPUT CovParms=CovSex InfoCrit=FitSex; * Save covparms, fit;
```

```
                Covariance Parameter Estimates
                                Standard         Z
Cov Parm     Subject    Estimate       Error     Value        Pr Z
UN(1,1)      ID          0.06074    0.006118      9.93      <.0001
Day          ID          0.03007    0.000678     44.35      <.0001

                          Information Criteria
Neg2LogLike    Parms        AIC       AICC       HQIC        BIC       CAIC
    -1988.1        8    -1972.1    -1972.0    -1961.3    -1945.4    -1937.4
```

Solution for Fixed Effects

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	4.9539	0.02734	207	181.21	<.0001
WPnm	0.03119	0.005937	3942	5.25	<.0001
PMnm0	0.1996	0.04849	207	4.12	<.0001
sexMW	-0.03619	0.03626	207	-1.00	0.3194
WPnm*sexMW	-0.03443	0.007743	3942	-4.45	<.0001
PMnm0*sexMW	-0.1849	0.06135	207	-3.01	0.0029

What does the intercept now represent in this model?
The intercept of 4.9539 is the expected glucose level for a man with a mean negative mood score of 0, on an average day (WPnm = 0, too).

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 day's glucose goes up by .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 mean negative mood, mean glucose is higher by .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 mean negative mood of 0 on day when they are at their mean. In those persons, women are -.03619 lower in mean glucose (n.s.).

What does the WPnm*Sex interaction represent in this model?
*The WP*Sex interaction represents how the WP effect of negative mood varies by sex. For men, the WP effect is .03119 (WPnm effect), and the WP effect is .03443 smaller in women (significant interaction).*

What does the PMnm0*Sex interaction represent in this model?
*The BP*Sex interaction represents how the BP effect of negative mood varies by sex. For men, the BP effect is .1996 (PMnm0 effect), and the BP effect is .1849 smaller in women (significant interaction).*

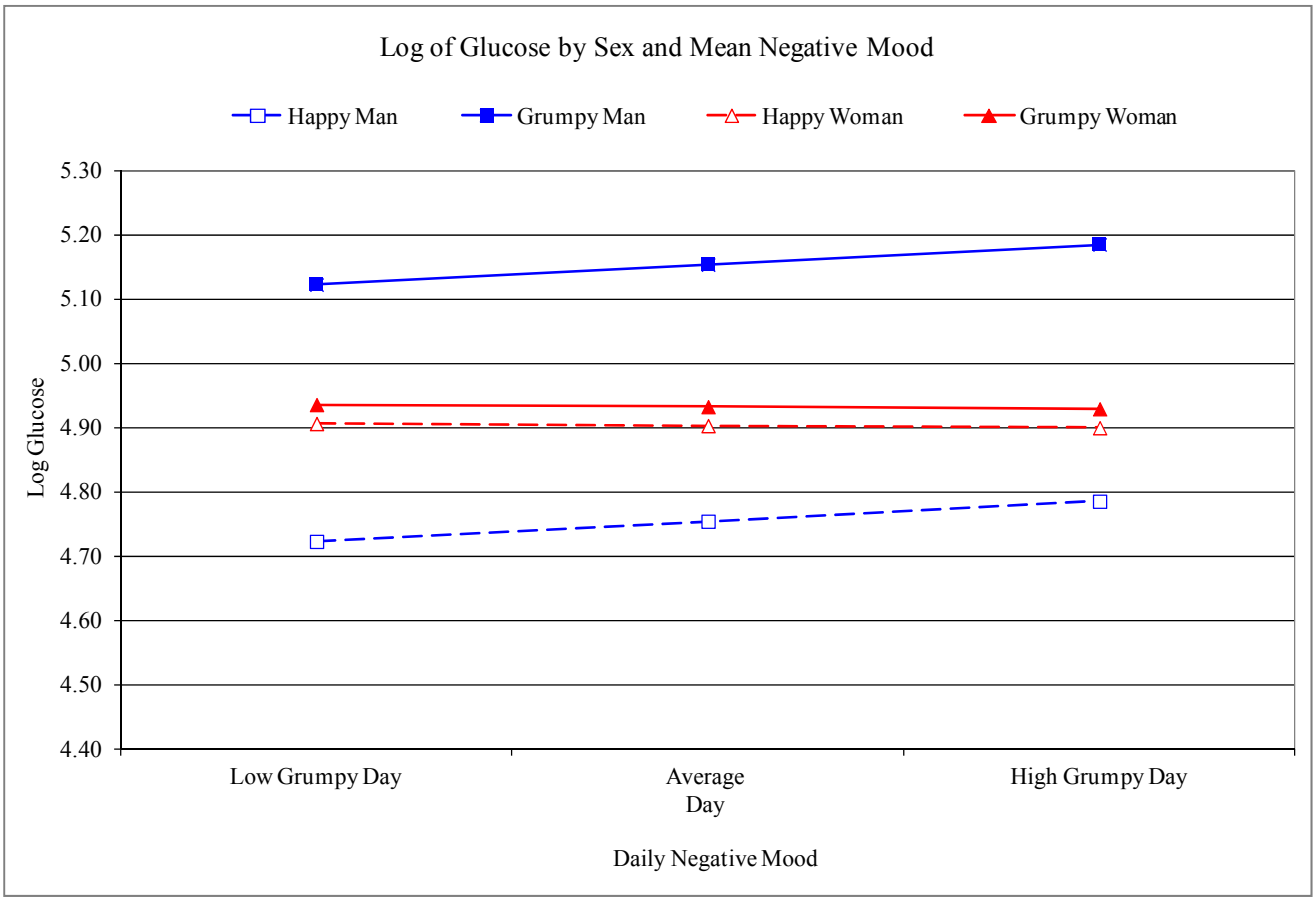
Which of these estimated effects were already given to us in the model?
Effects for men as reference group: Intercept, WP mood, BP mood
*Differences between men and women: Intercept difference (sex main effect), WP mood effect difference (sex*WP), BP mood effect difference (sex*BP)*

Which of these estimated effects were NOT already given to us in the model?
Effects for women as alternative group: Intercept, WP mood effect, BP mood effect.
No contextual effects are given directly from the Person-MC, too.

```
ESTIMATE "Intercept: Men (Mood=0)"          intercept 1 sexMW 0;
ESTIMATE "Intercept: Women (Mood=0)"        intercept 1 sexMW 1;
ESTIMATE "Intercept: Women Diff (Mood=0)"   sexMW 1;

ESTIMATE "Within-Person Effect: Men"        WPnm 1 WPnm*sexMW 0;
ESTIMATE "Within-Person Effect: Women"      WPnm 1 WPnm*sexMW 1;
ESTIMATE "Within-Person Effect: Women Diff" WPnm*sexMW 1;

ESTIMATE "Between-Person Effect: Men"        PMnm0 1 PMnm0*sexMW 0;
ESTIMATE "Between-Person Effect: Women"      PMnm0 1 PMnm0*sexMW 1;
ESTIMATE "Between-Person Effect: Women Diff" PMnm0*sexMW 1;

ESTIMATE "Contextual Effect: Men"          WPnm -1 WPnm*sexMW  0 PMnm0 1 PMnm0*sexMW 0;
ESTIMATE "Contextual Effect: Women"        WPnm -1 WPnm*sexMW -1 PMnm0 1 PMnm0*sexMW 1;
ESTIMATE "Contextual Effect: Women Diff"   WPnm*sexMW -1 PMnm0*sexMW 1; RUN;
```

Estimates

Label	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept: Men (Mood=0)	4.9539	0.02734	207	181.21	<.0001
Intercept: Women (Mood=0)	4.9177	0.02382	207	206.42	<.0001
Intercept: Women Diff (Mood=0)	-0.03619	0.03626	207	-1.00	0.3194
Within-Person Effect: Men	0.03119	0.005937	3942	5.25	<.0001
Within-Person Effect: Women	-0.00325	0.004970	3942	-0.65	0.5138
Within-Person Effect: Women Diff	-0.03443	0.007743	3942	-4.45	<.0001
Between-Person Effect: Men	0.1996	0.04849	207	4.12	<.0001
Between-Person Effect: Women	0.01469	0.03759	207	0.39	0.6962
Between-Person Effect: Women Diff	-0.1849	0.06135	207	-3.01	0.0029
Contextual Effect: Men	0.1684	0.04886	214	3.45	0.0007
Contextual Effect: Women	0.01794	0.03790	214	0.47	0.6364
Contextual Effect: Women Diff	-0.1505	0.06184	214	-2.43	0.0158




```
* Calculate PseudoR2 relative to fixed-mood-only model;
%PseudoR2(NCov=2, CovFewer=CovMood, NameFewer=Mood, CovMore=CovSex, NameMore=Sex);
```

PsuedoR2 (% Reduction) for Mood vs. Sex

Name	CovParm	Subject	Estimate	StdErr	ZValue	ProbZ	PseudoR2
Mood	UN(1,1)	ID	0.06435	0.006474	9.94	<.0001	.
Mood	day	ID	0.03022	0.000682	44.35	<.0001	.
Sex	UN(1,1)	ID	0.06074	0.006118	9.93	<.0001	0.056080
Sex	day	ID	0.03007	0.000678	44.35	<.0001	0.005027

Which new effects accounted for residual variance? *Sex*WPnm*
Which new effects accounted for random intercept variance? *Sex, Sex*PMnm0*

What is the difference in the total reduction in glucose variance due to sex? *3.8% of the overall variance*

```
* Calculate Total R2 change relative to fixed-mood-only model;
%TotalR2(DV=lGlucAM, PredFewer=PredMood, NameFewer=Mood, PredMore=PredSex,
NameMore=Sex);
```

```
Total R2 (% Reduction) for Mood vs. Sex
          Pred                   Total
Name      Corr      TotalR2     R2Diff
Mood    0.15269    0.023315     .
Sex     0.24931    0.062155    0.038840
```

Is this total new reduction in variance significant? *Yes, according to the df=3 LRT against the mood-only model.*

```
* Calculate difference in model fit relative to fixed-mood-only model;
%FitTest(FitFewer=FitMood, NameFewer=Mood, FitMore=FitSex, NameMore=Sex);
```

```
Likelihood Ratio Test for Mood vs. Sex
        Neg2Log
Name     Like      Parms        AIC        BIC    DevDiff    DFdiff        Pvalue
Mood    -1956.5       5     -1946.5    -1929.9      .          .      .
Sex     -1988.1       8     -1972.1    -1945.4    31.5122      3      .000000663
```

Had we used the CLASS statement for sex, here's what that code would have been instead.
Note that two values need to give for sex now because it is represented as two distinct groups (not a slope).

```
TITLE "SAS Person-MC Mood and Sex (0=M, 1=W) USING CLASS STATEMENT";
PROC MIXED DATA=Example9b COVTEST NOCLPRINT IC NAMELEN=100 METHOD=ML;
      CLASS ID day sexMW;
      MODEL lGlucAM = WPnm PMnm0 sexMW WPnm*sexMW PMnm0*sexMW
            / SOLUTION DDFM=Satterthwaite;
      RANDOM INTERCEPT / SUBJECT=ID TYPE=UN;
      REPEATED day / SUBJECT=ID TYPE=VC;
      ODS OUTPUT CovParms=CovSex InfoCrit=FitSex; * Save covparms, fit;
      ESTIMATE "Intercept: Men"           intercept 1 sexMW 1 0;
      ESTIMATE "Intercept: Women"         intercept 1 sexMW 0 1;
      ESTIMATE "Intercept: Women Diff"    sexMW -1 1;

      ESTIMATE "Within-Person Effect: Men"            WPnm 1 WPnm*sexMW 1 0;
      ESTIMATE "Within-Person Effect: Women"          WPnm 1 WPnm*sexMW 0 1;
      ESTIMATE "Within-Person Effect: Women Diff" WPnm*sexMW -1 1;

      ESTIMATE "Between-Person Effect: Men"            PMnm0 1 PMnm0*sexMW 1 0;
      ESTIMATE "Between-Person Effect: Women"    PMnm0 1 PMnm0*sexMW 0 1;
      ESTIMATE "Between-Person Effect: Women Diff" PMnm0*sexMW -1 1;

      ESTIMATE "Context Effect: Men"   WPnm -1 WPnm*sexMW -1 0 PMnm0 1 PMnm0*sexMW 1 0;
      ESTIMATE "Context Effect: Women" WPnm -1 WPnm*sexMW 0 -1 PMnm0 1 PMnm0*sexMW 0 1;
      ESTIMATE "Context Effect: Women Diff" WPnm*sexMW 1 -1 PMnm0*sexMW -1 1;
RUN;
```

Person-mean-centering is one approach to including the effects of time-varying predictors.
Now let's examine the same series of models using the alternative approach—grand-mean-centering.

```
      * Level-1 effect to use with GRAND-MEAN-CENTERING;
        tvnm0 = negmood - 0; LABEL tvnm0 = "TV Negative Mood (0=0)";
```

PART 3: GRAND-MEAN-CENTERING OF NEGATIVE MOOD TO PREDICT GLUCOSE

3a) Predicting Glucose from Time-Varying Negative Mood only (Grand-MC):

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

```
TITLE "Add fixed effect of level-1 negative mood only under Grand-MC";
PROC MIXED DATA=Example9b COVTEST NOCLPRINT IC NAMELEN=100 METHOD=ML;
      CLASS ID Day;
      MODEL lGlucAM = TVnm0 / SOLUTION DDFM=Satterthwaite;
      RANDOM INTERCEPT / SUBJECT=ID TYPE=UN;
      REPEATED Day / SUBJECT=ID TYPE=VC;
      ODS OUTPUT CovParms=CovSmush InfoCrit=FitSmush; * Save covparms, fit;
RUN;
```

```
                Covariance Parameter Estimates
                                  Standard         Z
Cov Parm    Subject    Estimate       Error     Value      Pr > Z
UN(1,1)     ID          0.06595    0.006634      9.94      <.0001
Day         ID          0.03022    0.000682     44.34      <.0001

                          Information Criteria
Neg2LogLike    Parms        AIC       AICC       HQIC        BIC       CAIC
    -1951.5        4    -1943.5    -1943.5    -1938.1    -1930.2    -1926.2

                  Solution for Fixed Effects
                        Standard
Effect       Estimate       Error      DF    t Value    Pr > |t|
Intercept      4.9408     0.01806     207     273.52      <.0001
TVnm0         0.01202    0.003792    4041       3.17      0.0015
```

What does the level-1 effect of TVnm0 represent in this model?
This is the combined ("smushed") BP and WP effect. For every 1-unit absolute increase in time-varying negative mood, there is a .01202 increase in glucose.

How much variance did the level-1 effect of TVnm0 account for?

```
* Calculate PseudoR2 relative to empty model;
%PseudoR2(NCov=2, CovFewer=CovEmpty, NameFewer=Empty, CovMore=CovSmush,
NameMore=Smush);
```

```
PsuedoR2 (% Reduction) for Empty vs. Smush
Name     CovParm    Subject    Estimate      StdErr    ZValue     ProbZ      PseudoR2
Empty    UN(1,1)      ID        0.06654    0.006690      9.95    <.0001    .
Empty    day          ID        0.03029    0.000683     44.35    <.0001    .
Smush    UN(1,1)      ID        0.06595    0.006634      9.94    <.0001    .008842272
Smush    day          ID        0.03022    0.000682     44.34    <.0001    .002088088
```

3b) Adding person mean negative mood at level 2 under Grand-MC (to un-smush the level-1 effect):

Level 1: $Glucose_{ti} = \beta_{0i} + \beta_{1i}(Mood_{ti} - 0) + e_{ti}$

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

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

```
TITLE "Add fixed effect of level-2 negative mood under Grand-MC";
PROC MIXED DATA=Example9b COVTEST NOCLPRINT IC NAMELEN=100 METHOD=ML;
      CLASS ID Day;
      MODEL lGlucAM = TVnm0 PMnm0 / SOLUTION DDFM=Satterthwaite OUTPM=TVMoodPred;
      RANDOM INTERCEPT / SUBJECT=ID TYPE=UN;
      REPEATED Day / SUBJECT=ID TYPE=VC;
      ODS OUTPUT CovParms=CovTVmood InfoCrit=FitTVmood; * Save covparms, fit;
      ESTIMATE "Within-Person Effect"     TVnm0 1;
      ESTIMATE "Between-Person Effect"    TVnm0 1 PMnm0 1;
      ESTIMATE "Contextual Effect"        PMnm0 1;
RUN;
```

Covariance Parameter Estimates

Cov Parm	Subject	Estimate	Standard Error	Z Value	Pr Z
UN(1,1)	ID	0.06435	0.006474	9.94	<.0001
Day	ID	0.03022	0.000682	44.35	<.0001

Information Criteria

Neg2LogLike	Parms	AIC	AICC	HQIC	BIC	CAIC
-1956.5	5	-1946.5	-1946.5	-1939.8	-1929.9	-1924.9

Solution for Fixed Effects

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	4.9302	0.01845	207	267.20	<.0001
TVnm0	0.01097	0.003821	3941	2.87	0.0041
PMnm0	0.06942	0.03070	213	2.26	0.0247

Estimates

Label	Estimate	Standard Error	DF	t Value	Pr > |t|
Within-Person Effect	0.01097	0.003821	3941	2.87	0.0041
Between-Person Effect	0.08040	0.03046	207	2.64	0.0089
Contextual Effect	0.06942	0.03070	213	2.26	0.0247

What does the level-1 effect (TVnm0) NOW represent in this model?
The level-1 effect is now the within-person effect of negative mood. For every unit relative increase in your own negative mood that day, that 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 now the person context effect of negative mood, or the test of the difference in the BP and WP effects. After controlling for absolute daily level of negative mood, for every unit increase in your own mean negative mood, overall glucose goes up by an additional .06942 ("extra" relation among average levels). Also, the BP effect is .06942 larger than the WP effect.

How much variance did the level-2 effect of PMnm0 account for? *2.4% more than the smushed effect*

```
* Calculate PseudoR2 relative to smushed model;
%PseudoR2(NCov=2, CovFewer=CovSmush, NameFewer=Smush, CovMore=CovTVmood,
NameMore=TVmood);
```

PsuedoR2 (% Reduction) for Smush vs. TVmood

Name	CovParm	Subject	Estimate	StdErr	ZValue	ProbZ	PseudoR2
Smush	UN(1,1)	ID	0.06595	0.006634	9.94	<.0001	.
Smush	day	ID	0.03022	0.000682	44.34	<.0001	.
TVmood	UN(1,1)	ID	0.06435	0.006474	9.94	<.0001	0.024340
TVmood	day	ID	0.03022	0.000682	44.35	<.0001	0.000017

3c) Testing a random effect of TV negative mood under Grand-MC:

Level 1: $Glucose_{ti} = \beta_{0i} + \beta_{1i}\left(Mood_{ti} - 0\right) + e_{ti}$

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

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

```
TITLE "Add random effect of level-1 negative mood only under Grand-MC";
PROC MIXED DATA=Example9b COVTEST NOCLPRINT IC NAMELEN=100 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;
      ODS OUTPUT InfoCrit=FitTVRandMood; * Save fit;
      ESTIMATE "Within-Person Effect"     TVnm0 1;
      ESTIMATE "Between-Person Effect"    TVnm0 1 PMnm0 1;
      ESTIMATE "Contextual Effect"        PMnm0 1;
 RUN;
```

Covariance Parameter Estimates

Cov Parm	Subject	Estimate	Standard Error	Z Value	Pr Z
UN(1,1)	ID	0.06400	0.006464	9.90	<.0001
UN(2,1)	ID	-0.00033	0.001050	-0.31	0.7549
UN(2,2)	ID	0.000579	0.000339	1.71	0.0441
Day	ID	0.02992	0.000690	43.34	<.0001

Information Criteria

Neg2LogLike	Parms	AIC	AICC	HQIC	BIC	CAIC
-1960.4	7	-1946.4	-1946.4	-1937.0	-1923.1	-1916.1

Solution for Fixed Effects

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	4.9302	0.01843	206	267.45	<.0001
TVnm0	0.01102	0.004181	205	2.64	0.0090
PMnm0	0.07015	0.03066	214	2.29	0.0231

Estimates

Label	Estimate	Standard Error	DF	t Value	Pr > |t|
Within-Person Effect	0.01102	0.004181	205	2.64	0.0090
Between-Person Effect	0.08117	0.03047	209	2.66	0.0083
Contextual Effect	0.07015	0.03066	214	2.29	0.0231

Is this a better model than the fixed effects grand-MC model (3b)? What does this result mean?
It means that so far, each person does not need his or her own effect of worse negative mood (than usual).

```
* Calculate difference in model fit relative to fixed-mood-only model;
%FitTest(FitFewer=FitTVMood, NameFewer=FixedMood, FitMore=FitTVRandMood,
NameMore=RandomMood);
```

```
Likelihood Ratio Test for FixedMood vs. RandomMood
             Neg2Log
   Name       Like      Parms       AIC        BIC     DevDiff    DFdiff     Pvalue
FixedMood    -1956.5      5      -1946.5    -1929.9      .          .         .
RandomMood   -1960.4      7      -1946.4    -1923.1    3.85979      2       0.14516
```

Note that the PMC and GMC models no longer yield equivalent results if the level-1 effect is random.

3d) Adding main effect of sex and interactions with negative mood under Grand-MC:

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

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

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

```
TITLE "Add sex, sex*TVnm0, and sex*PMnm0 under Grand-MC";
PROC MIXED DATA=Example9b COVTEST NOCLPRINT IC NAMELEN=100 METHOD=ML;
      CLASS ID Day;
      MODEL lGlucAM = TVnm0 PMnm0 sexMW TVnm0*sexMW PMnm0*sexMW
                       / SOLUTION DDFM=Satterthwaite OUTPM=PredSex;
      RANDOM INTERCEPT / SUBJECT=ID TYPE=UN;
      REPEATED Day / SUBJECT=ID TYPE=VC;
      ODS OUTPUT CovParms=CovSex InfoCrit=FitSex; * Save covparms, fit;
```

```
          Covariance Parameter Estimates
                                 Standard         Z
Cov Parm     Subject    Estimate      Error     Value      Pr > Z
UN(1,1)      ID         0.06074    0.006118      9.93      <.0001
Day          ID         0.03007    0.000678     44.35      <.0001

                         Information Criteria
Neg2LogLike    Parms        AIC       AICC       HQIC        BIC       CAIC
    -1988.1        8    -1972.1    -1972.0    -1961.3    -1945.4    -1937.4

                   Solution for Fixed Effects
                            Standard
Effect         Estimate       Error      DF    t Value    Pr > |t|
Intercept       4.9539     0.02734     207     181.21      <.0001
TVnm0          0.03119    0.005937    3942       5.25      <.0001
PMnm0           0.1684     0.04886     214       3.45      0.0007
sexMW          -0.03619     0.03626     207      -1.00      0.3194
TVnm0*sexMW    -0.03443    0.007743    3942      -4.45      <.0001
PMnm0*sexMW     -0.1505     0.06184     214      -2.43      0.0158
```

```
ESTIMATE "Intercept: Men"                   intercept 1 sexMW 0;
ESTIMATE "Intercept: Women"                 intercept 1 sexMW 1;
ESTIMATE "Intercept: Women Diff"            sexMW 1;

ESTIMATE "Within-Person Effect: Men"        TVnm0 1 TVnm0*sexMW 0;
ESTIMATE "Within-Person Effect: Women"      TVnm0 1 TVnm0*sexMW 1;
ESTIMATE "Within-Person Effect: Women Diff" TVnm0*sexMW 1;

ESTIMATE "Between-Person Effect: Men"       TVnm0 1 TVnm0*sexMW 0 PMnm0 1PMnm0*sexMW 0;
ESTIMATE "Between-Person Effect: Women"     TVnm0 1 TVnm0*sexMW 1 PMnm0 1PMnm0*sexMW 1;
ESTIMATE "Between-Person Effect: Women Diff" TVnm0*sexMW 1 PMnm0*sexMW 1;

ESTIMATE "Contextual Effect: Men"           PMnm0 1 PMnm0*sexMW 0;
ESTIMATE "Contextual Effect: Women"         PMnm0 1 PMnm0*sexMW 1;
ESTIMATE "Contextual Effect: Women Diff"    PMnm0*sexMW 1;  RUN;
```

Estimates

Label	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept: Men	4.9539	0.02734	207	181.21	<.0001
Intercept: Women	4.9177	0.02382	207	206.42	<.0001
Intercept: Women Diff	-0.03619	0.03626	207	-1.00	0.3194
Within-Person Effect: Men	0.03119	0.005937	3942	5.25	<.0001
Within-Person Effect: Women	-0.00325	0.004970	3942	-0.65	0.5138
Within-Person Effect: Women Diff	-0.03443	0.007743	3942	-4.45	<.0001
Between-Person Effect: Men	0.1996	0.04849	207	4.12	<.0001
Between-Person Effect: Women	0.01469	0.03759	207	0.39	0.6962
Between-Person Effect: Women Diff	-0.1849	0.06135	207	-3.01	0.0029
Contextual Effect: Men	0.1684	0.04886	214	3.45	0.0007
Contextual Effect: Women	0.01794	0.03790	214	0.47	0.6364
Contextual Effect: Women Diff	-0.1505	0.06184	214	-2.43	0.0158

```
* Calculate PseudoR2 relative to fixed-mood-only model;
%PseudoR2(NCov=2, CovFewer=CovTVMood, NameFewer=Mood, CovMore=CovSex, NameMore=Sex);
```

PsuedoR2 (% Reduction) for Mood vs. Sex

Name	CovParm	Subject	Estimate	StdErr	ZValue	ProbZ	PseudoR2
Mood	UN(1,1)	ID	0.06435	0.006474	9.94	<.0001	.
Mood	day	ID	0.03022	0.000682	44.35	<.0001	.
Sex	UN(1,1)	ID	0.06074	0.006118	9.93	<.0001	0.056080
Sex	day	ID	0.03007	0.000678	44.35	<.0001	0.005027

Which new effects accounted for residual variance? *Sex*TVnm0*
Which new effects accounted for random intercept variance? *Sex, Sex*PMnm0, Sex*TVnm0*

What is the difference in the total reduction in glucose variance due to sex? *3.8% of the overall variance*

```
* Calculate Total R2 change relative to fixed-mood-only model;
%TotalR2(DV=lGlucAM, PredFewer=PredTVMood, NameFewer=Mood, PredMore=PredSex,
NameMore=Sex);
```

Total R2 (% Reduction) for Mood vs. Sex

Name	Pred Corr	TotalR2	Total R2Diff
Mood	0.15269	0.023315	.
Sex	0.24931	0.062155	0.038840

Is this total new reduction in variance significant? *Yes, according to the df=3 LRT against the mood-only model.*

```
* Calculate difference in model fit relative to fixed-mood-only model;
%FitTest(FitFewer=FitTVMood, NameFewer=Mood, FitMore=FitSex, NameMore=Sex);
```

Likelihood Ratio Test for Mood vs. Sex

Name	Neg2Log Like	Parms	AIC	BIC	DevDiff	DFdiff	Pvalue
Mood	-1956.5	5	-1946.5	-1929.9	.	.	.
Sex	-1988.1	8	-1972.1	-1945.4	31.5122	3	.000000663

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)