From Between-Person to Within-Person Models for Longitudinal Data

The models for this example come from Hoffman (in preparation) chapter 3. We will be examining the extent to which a learning achievement outcome) can be predicted from group (control as the reference vs. treatment) and time (pre-test as the reference vs. post-test) in a sample of 50 children.

SAS Syntax and Output for Data Manipulation:

```
* Location for files to be saved - CHANGE THIS TO YOUR DIRECTORY;
%LET example=F:\Example Data\Chapter 3 Data\Two-Occasion;
LIBNAME example "&example.";
* Open SAS stacked version of ANOVA data into work (temporary) library;
* Centering predictors for analysis;
DATA work.prepost_stacked; SET example.Example3;
       time1 = time - 1; * Time was coded 1,2;
       treat = group - 1; * Group was coded 1,2;
       LABEL time1 = "Time (0=pre-test, 1= post-test)"
              treat = "Treatment Group (0=control, 1=treatment)"; RUN;
TITLE "Cell means by group and time for y outcome";
PROC MEANS MEAN STDERR MIN MAX DATA=work.prepost_stacked; CLASS group time; VAR y; RUN;
TITLE "Marginal means by group for y outcome";
PROC MEANS MEAN STDERR MIN MAX DATA=work.prepost_stacked; CLASS group; VAR y; RUN;
TITLE "Marginal means by time for y outcome";
PROC MEANS MEAN STDERR MIN MAX DATA=work.prepost stacked; CLASS time; VAR y; RUN;
TITLE "Grand mean for y outcome";
PROC MEANS MEAN STDERR MIN MAX DATA=work.prepost_stacked; VAR y; RUN; TITLE;
Cell means by group and time for y outcome
Treatment Group
                     Time
  (1=control,
                 (1=pre-test
                                 N
 2=treatment)
                2=post-test)
                                0bs
                                              Mean
                                                         Std Error
                                                                          Minimum
                                                                                          Maximum
           1
                           1
                                 25
                                         49.0767977
                                                         1.1370576
                                                                        37.5335041
                                                                                       59.5504810
                           2
                                 25
                                         54.8991630
                                                         1.1256529
                                                                        44.5615778
                                                                                       67.1060321
           2
                           1
                                 25
                                         50.7587396
                                                         0.9070808
                                                                        40.5321932
                                                                                       62.1309134
                                 25
                                         58.6236314
                                                         0.9864754
                                                                        47.4303443
                                                                                       68.6163028
Marginal means by group for y outcome
Treatment Group
  (1=control,
 2=treatment)
                                                           Minimum
                               Mean
                                          Std Error
                                                                          Maximum
                         51.9879804
                                                                        67.1060321
           1
                 50
                                         0.8943692
                                                        37.5335041
           2
                 50
                         54.6911855
                                         0.8691455
                                                        40.5321932
                                                                        68.6163028
Marginal means by time for y outcome
 (1=pre-test
                 Ν
2=post-test)
               0bs
                              Mean
                                         Std Error
                                                          Minimum
                                                                          Maximum
          1
                50
                        49.9177687
                                         0.7297690
                                                       37.5335041
                                                                       62.1309134
          2
                50
                        56.7613972
                                         0.7870204
                                                       44.5615778
                                                                       68.6163028
Grand mean for v outcome
       Mean
                  Std Error
                                    Minimum
                                                   Maximum
  53.3395829
                  0.6351006
                                 37.5335041
                                                68.6163028
```

3.1: Between-Person Empty Model $y_{ti} = \beta_0 + e_{ti}$

Dimensions

Covariance Parameters 1
Columns in X 1
Columns in Z 0
Subjects 50
Max Obs Per Subject 2

This table tells you how many parameters are in your model for the means ("columns in x", the fixed effects, or 1 fixed intercept here) and in your model for the variances ("covariance parameters", or 1 residual variance here). It also tells you how many observations were read per subject, as defined by SUBJECT= on the REPEATED line.

Number of Observations
Number of Observations Read
Number of Observations Used
Number of Observations Not Used

100 100 0

Estimated R Matrix

for PersonID 1 Row Col1 Col2 1 40.3353

2 40.3353

Estimated R Correlation
Matrix for PersonID 1
Row Col1 Col2

1 1.0000

2 1.0000

Covariance Parameter Estimates

Cov Standard Z Parm Subject Estimate Error Value Pr > Z time PersonID 40.3353 5.7330 7.04 <.0001

This is the estimate of the residual variance σ_e^2 . It is labeled "time" because that is how the R matrix is structured via the REPEATED line.

Fit Statistics

-2 Res Log Likelihood 651.6
AIC (smaller is better) 653.6
AICC (smaller is better) 653.6
BIC (smaller is better) 655.5

Null Model Likelihood Ratio Test

DF Chi-Square Pr > ChiSq

0 0.00 1.0000

This "null model" LRT examines the need for any random effects variances and covariances. Because we don't have any (yet), df = 0.

Information Criteria

 Neg2LogLike
 Parms
 AIC
 AICC
 HQIC
 BIC
 CAIC

 651.6
 1
 653.6
 653.6
 654.3
 655.5
 656.5

In REML, model df = # for calculating AIC and BIC only includes parameters in the model for the variance.

Solution for Fixed Effects

Standard

Effect Estimate Error DF t Value Pr > |t| Intercept 53.3396 0.6351 49 83.99 <.0001

This is the estimate of the fixed intercept β_0 .

```
3.2: Within-Person Empty Model
                                          \mathbf{y_{ti}} = \mathbf{\beta_0} + \mathbf{U_{0i}} + \mathbf{e_{ti}}
TITLE "Eq 3.2: Empty Within-Person model via MIXED";
PROC MIXED DATA=work.prepost stacked NOITPRINT NOCLPRINT COVTEST METHOD=REML;
        CLASS PersonID time;
       MODEL y = / SOLUTION DDFM=BW;
        REPEATED time / R RCORR TYPE=CS SUBJECT=PersonID; RUN; TITLE;
            Dimensions
Covariance Parameters
                                    2
Columns in X
                                    1
Columns in Z
                                    0
                                          We still have 1 fixed effect, the fixed intercept, but now the model for
Subjects
                                   50
                                          the variances includes random intercept variance and residual variance.
Max Obs Per Subject
                                    2
          Number of Observations
                                           100
Number of Observations Read
Number of Observations Used
                                           100
Number of Observations Not Used
                                             0
     Estimated R Matrix
       for PersonID 1
 Row
            Col1
                         Co12
         40.4590
                      12.2526
   2
         12.2526
                      40.4590
   Estimated R Correlation
    Matrix for PersonID 1
 Row
            Col1
                         Col2
          1.0000
                       0.3028
   1
   2
          0.3028
                       1.0000
                   Covariance Parameter Estimates
                                        Standard
                                                          Ζ
Cov Parm
             Subject
                           Estimate
                                           Error
                                                      Value
                                                                    Pr Z
                                                                           CS = Random Intercept Variance \tau_{Uo}^2
CS
             PersonID
                            12.2526
                                          6.0256
                                                       2.03
                                                                  0.0420
Residual
                            28.2064
                                          5.6413
                                                       5.00
                                                                  <.0001
                                                                           Residual = Residual Variance \sigma_e^2
           Fit Statistics
-2 Res Log Likelihood
                                  646.8
AIC (smaller is better)
                                  650.8
AICC (smaller is better)
                                  650.9
BIC (smaller is better)
                                  654.6
                                          Now we have a random intercept
  Null Model Likelihood Ratio Test
                                          variance, so df=1. This is the model
    DF
          Chi-Square
                            Pr > ChiSq
                                          comparison of BP vs. WP. Who wins?
     1
                 4.77
                                0.0289
                              Information Criteria
                                                                                     Now the model for
Neg2LogLike
                Parms
                              AIC
                                         AICC
                                                    HQIC
                                                                 BIC
                                                                            CAIC
      646.8
                            650.8
                                        650.9
                                                    652.3
                                                               654.6
                                                                            656.6
                                                                                     the variance df=2.
                    Solution for Fixed Effects
                           Standard
                                                                         This is still the estimate of the fixed
Effect
             Estimate
                              Error
                                          DF
                                                t Value
                                                            Pr > |t|
                                                               <.0001
Intercept
               53.3396
                             0.7260
                                                  73.47
                                                                         intercept \beta_0, but note the SE differs.
```

Which is the better empty model, and how do you know?

What is the ICC for these data and what does it mean?

3.7 (top): Between-Person Conditional Model

602.5

604.5

604.5

605.2

606.4

607.4

```
\mathbf{v}_{ti} = \beta_0 + \beta_1(\text{Time}_{ti}) + \beta_2(\text{Group}_i) + \beta_3(\text{Time}_{ti})(\text{Group}_i) + \mathbf{e}_{ti}
TITLE1 "Eq 3.7 (top): Between-Person Conditional (Predictor) Model via MIXED";
TITLE2 "Not using CLASS statement, manually dummy coding group and time";
PROC MIXED DATA=work.prepost_stacked NOITPRINT NOCLPRINT COVTEST METHOD=REML;
       CLASS PersonID time;
       MODEL y = time1 treat time1*treat / SOLUTION DDFM=BW;
       REPEATED time / R RCORR TYPE=VC SUBJECT=PersonID;
ESTIMATE "Mean: Control Group at Pre-Test"
                                                      intercept 1 time1 0 treat 0 time1*treat 0;
ESTIMATE "Mean: Control Group at Post-Test"
                                                      intercept 1 time1 1 treat 0 time1*treat 0;
ESTIMATE "Mean: Treatment Group at Pre-Test"
                                                      intercept 1 time1 0 treat 1 time1*treat 0;
ESTIMATE "Mean: Treatment Group at Post-Test"
                                                     intercept 1 time1 1 treat 1 time1*treat 1;
ESTIMATE "Time Effect for Control Group"
                                                      time1 1 time1*treat 0;
ESTIMATE "Time Effect for Treatment Group"
                                                      time1 1 time1*treat 1;
ESTIMATE "Group Effect at Pre-Test"
                                                      treat 1 time1*treat 0;
ESTIMATE "Group Effect at Post-Test"
                                                      treat 1 time1*treat 1;
RUN; TITLE1; TITLE2;
            Dimensions
Covariance Parameters
                                   1
                                         Now we have 4 parameters in the model for the means
Columns in X
                                   4
                                         and 1 parameter in the model for the variance (\sigma_{\rm e}^2).
                                   0
Columns in Z
Subjects
                                  50
                                   2
Max Obs Per Subject
          Number of Observations
Number of Observations Read
                                         100
Number of Observations Used
                                         100
Number of Observations Not Used
                                           0
     Estimated R Matrix
       for PersonID 1
 Row
            Col1
                        Co12
   1
         27.2245
   2
                     27.2245
   Estimated R Correlation
    Matrix for PersonID 1
 Row
            Col1
                        Co12
          1.0000
   2
                      1.0000
                                                                     This is the estimate of the residual
                Covariance Parameter Estimates
                                                                    variance \sigma_e^2. It is labeled "time"
                                                   Z
Cov
                                  Standard
Parm
         Subject
                     Estimate
                                     Error
                                               Value
                                                          Pr > Z
                                                                    because that is how the R matrix is
time
         PersonID
                      27.2245
                                    3.9295
                                                6.93
                                                          <.0001
                                                                     structured via the REPEATED line.
           Fit Statistics
-2 Res Log Likelihood
                                 602.5
AIC (smaller is better)
                                 604.5
AICC (smaller is better)
                                 604.5
BIC (smaller is better)
                                 606.4
                                         This "null model" LRT examines the need for
  Null Model Likelihood Ratio Test
                                         any random effects variances and covariances.
    DF
          Chi-Square
                          Pr > ChiSq
                                        Because we don't have any (yet), df = 0.
     0
                0.00
                              1.0000
                             Information Criteria
Neg2LogLike
               Parms
                            AIC
                                       AICC
                                                  HQIC
                                                              BIC
                                                                         CAIC
```

BP Solution for Fixed Effects

Standard

Effect	Estimate	Error	DF	t Value	Pr > t	
Intercept	49.0768	1.0435	48	47.03	<.0001	beta0
time1	5.8224	1.4758	48	3.95	0.0003	beta1
treat	1.6819	1.4758	48	1.14	0.2601	beta2
time1*treat	2.0425	2.0871	48	0.98	0.3327	beta3

Type 3 Tests of Fixed Effects

	Nulli	Dell		
Effect	DF	DF	F Value	Pr > F
time1	1	48	15.56	0.0003
treat	1	48	1.30	0.2601
time1*treat	1	48	0.96	0.3327

Estimates

		Standard				
Label	Estimate	Error	DF	t Value	Pr > t	
Mean: Control Group at Pre-Test	49.0768	1.0435	48	47.03	<.0001	
Mean: Control Group at Post-Test	54.8992	1.0435	48	52.61	<.0001	
Mean: Treatment Group at Pre-Test	50.7587	1.0435	48	48.64	<.0001	
Mean: Treatment Group at Post-Test	58.6236	1.0435	48	56.18	<.0001	
Time Effect for Control Group	5.8224	1.4758	48	3.95	0.0003	beta1
Time Effect for Treatment Group	7.8649	1.4758	48	5.33	<.0001	beta1+beta3
Group Effect at Pre-Test	1.6819	1.4758	48	1.14	0.2601	beta2
Group Effect at Post-Test	3.7245	1.4758	48	2.52	0.0150	beta2+beta3

Ctandand

These results assume independent observations... what happens if that's not the case?

3.7 (bottom): Within-Person Conditional Model

Number of Observations Read

Number of Observations Used

Number of Observations Not Used

```
y_{ti} = \beta_0 + \beta_1(Time_{ti}) + \beta_2(Group_i) + \beta_3(Time_{ti})(Group_i) + U_{0i} + e_{ti}
 TITLE1 "Eq 3.7 (bottom): Within-Person Conditional (Predictor) Model via MIXED";
 TITLE2 "Not using CLASS statement, manually dummy coding group and time";
 PROC MIXED DATA=work.prepost_stacked NOITPRINT NOCLPRINT IC COVTEST METHOD=REML;
                        CLASS PersonID time;
                        MODEL y = time1 treat time1*treat / SOLUTION DDFM=BW;
                        REPEATED time / R RCORR TYPE=CS SUBJECT=PersonID;
ESTIMATE "Mean: Control Group at Pre-Test" intercept 1 time1 0 treat 0 time1*treat 0;
ESTIMATE "Mean: Control Group at Post-Test" intercept 1 time1 1 treat 0 time1*treat 0;
ESTIMATE "Mean: Treatment Group at Pre-Test" intercept 1 time1 0 treat 1 time1*treat 0;
ESTIMATE "Mean: Treatment Group at 1000 11 time1 time1*treat 0;
ESTIMATE "Time Effect for Control Group" time1 1 time1*treat 0;
ESTIMATE "Group Effect at Pre-Test" treat 1 time1*treat 0;
The state of 
 ESTIMATE "Mean: Treatment Group at Post-Test" intercept 1 time1 1 treat 1 time1*treat 1;
RUN; TITLE1; TITLE2;
                                     Dimensions
 Covariance Parameters
                                                                                                          2
                                                                                                                            We still have 4 parameters in the model for the
 Columns in X
                                                                                                          4
                                                                                                                            means, but now we have 2 parameters in the
                                                                                                          0
 Columns in Z
 Subjects
                                                                                                        50
                                                                                                                            model for the variance (\tau_{U_0}^2 and \sigma_e^2).
 Max Obs Per Subject
                                Number of Observations
```

100

100

for Pe		Col2 σ_e^2 - 7794 2245 τ	$+ \tau_{u_0}^2 \qquad \tau_{u_0}^2$	$\begin{bmatrix} z_{\mathbf{u}_0}^2 \end{bmatrix}$				
	R Correlati or PersonID							
Row C	Col1	Co12 \[\begin{array}{c} 1 \end{array}	ICC]					
		8367 IC	C 1					
2 0.8	3367 1.	.0000 LTC						
	Covari	lance Paramet	er Estimates Standard	Z				
Cov Parm	Subject	Estimate	Error	Value	Pr Z		andom Intonocut V	7 a mi a m a a — 2
CS	PersonID	22.7794	5.1236	4.45	<.0001	I	Indom Intercept V	_
Residual		4.4451	0.9073	4.90	<.0001	Residua	l = Residual Varia	ance σ_e^2
Fi -2 Res Log Li AIC (smaller AICC (smaller BIC (smaller	is better) `is better)	544. 548.	7 8					
Null Model	Likelihood	Ratio Test	Now we ha	ave a rando	m interce	pt variance,	so df=1. This is	
	-Square	Pr > ChiSq		comparison	of condi	tional BP vs.	WP. Who wins?	
1	57.81	<.0001						
		Intormat	ion Criteria					
Nea2LoaLike	Parms	ATC:	ATCC	HOTC	RTC	CATC		
Neg2LogLike 544.7	Parms 2	AIC 548.7	AICC 548.8	HQIC 550.2	BIC 552.5	CAIC 554.5		
	2	548.7 Solution for	548.8	550.2		554.5	ch results differ fi	rom
544.7	2 WP S	548.7 Solution for Standard	548.8 Fixed Effect	550.2 s	552.5	554.5 Whi	ch results differ fi 3P model, and wh	
544.7 Effect	2	548.7 Solution for	548.8 Fixed Effect	550.2 s		Which the I		
544.7	2 WP S Estimate	548.7 Solution for Standard Error	548.8 Fixed Effect DF t	550.2 s Value F	552.5 Pr > t	554.5 Which the Industrial beta0		
544.7 Effect Intercept time1 treat	2 WP S Estimate 49.0768 5.8224 1.6819	548.7 Solution for Standard Error 1.0435 0.5963 1.4758	548.8 Fixed Effect DF t 48 48 48	550.2 s Value F 47.03 9.76 1.14	552.5 Pr > t <.0001 <.0001 0.2601	Whithe I beta0 beta1 beta2		
544.7 Effect Intercept time1	2 WP S Estimate 49.0768 5.8224	548.7 Solution for Standard Error 1.0435 0.5963	548.8 Fixed Effect DF t 48 48	550.2 s Value F 47.03 9.76	552.5 Pr > t <.0001 <.0001	Whithe I beta0 beta1 beta2		
Effect Intercept time1 treat time1*treat	2 WP S Estimate 49.0768 5.8224 1.6819 2.0425	548.7 Solution for Standard Error 1.0435 0.5963 1.4758 0.8433	548.8 Fixed Effect DF t 48 48 48 48	550.2 s Value F 47.03 9.76 1.14	552.5 Pr > t <.0001 <.0001 0.2601	Whithe I beta0 beta1 beta2		
Effect Intercept time1 treat time1*treat	2 WP S Estimate 49.0768 5.8224 1.6819 2.0425	548.7 Solution for Standard Error 1.0435 0.5963 1.4758 0.8433	548.8 Fixed Effect DF t 48 48 48 48	550.2 S Value F 47.03 9.76 1.14 2.42	552.5 Pr > t <.0001 <.0001 0.2601	Whithe I beta0 beta1 beta2		
Effect Intercept time1 treat time1*treat Type	2 WP S Estimate 49.0768 5.8224 1.6819 2.0425 2.0425 3 Tests of Num DF 1	548.7 Solution for Standard Error 1.0435 0.5963 1.4758 0.8433 Frixed Effect Den DF F Val 48 95.	548.8 Fixed Effect DF t 48 48 48 48 ts ue Pr > F 33 <.0001	550.2 S Value 47.03 9.76 1.14 2.42	552.5 Pr > t <.0001 <.0001 0.2601	Whithe I beta0 beta1 beta2		
Effect Intercept time1 treat time1*treat Type Effect time1 treat	2 WP S Estimate 49.0768 5.8224 1.6819 2.0425 9 3 Tests of Num DF 1 1	548.7 Solution for Standard Error 1.0435 0.5963 1.4758 0.8433 Fixed Effect Den DF F Val 48 95.48 1.	548.8 Fixed Effect DF t 48 48 48 48 ts ue Pr > F 33 < .0001 30 0.2601	550.2 S Value F 47.03 9.76 1.14 2.42	552.5 Pr > t <.0001 <.0001 0.2601	Whithe I beta0 beta1 beta2		
Effect Intercept time1 treat time1*treat Type	2 WP S Estimate 49.0768 5.8224 1.6819 2.0425 2.0425 3 Tests of Num DF 1	548.7 Solution for Standard Error 1.0435 0.5963 1.4758 0.8433 Fixed Effect Den DF F Val 48 95.48 1.	548.8 Fixed Effect DF t 48 48 48 48 ts ue Pr > F 33 <.0001	550.2 S Value F 47.03 9.76 1.14 2.42	552.5 Pr > t <.0001 <.0001 0.2601	Whithe I beta0 beta1 beta2		
Effect Intercept time1 treat time1*treat Type Effect time1 treat	2 WP S Estimate 49.0768 5.8224 1.6819 2.0425 9 3 Tests of Num DF 1 1	548.7 Solution for Standard Error 1.0435 0.5963 1.4758 0.8433 Fixed Effect Den DF F Val 48 95.48 1.	548.8 Fixed Effect DF t 48 48 48 48 ts ue Pr > F 33 < .0001 30 0.2601	550.2 S Value F 47.03 9.76 1.14 2.42	552.5 Pr > t <.0001 <.0001 0.2601	Whithe I beta0 beta1 beta2		
Effect Intercept time1 treat time1*treat Type Effect time1 treat time1*treat	2 WP S Estimate 49.0768 5.8224 1.6819 2.0425 3 Tests of Num DF 1 1 1	548.7 Solution for Standard Error 1.0435 0.5963 1.4758 0.8433 Frixed Effect Den DF F Val 48 95.48 1.48 5.	548.8 Fixed Effect DF t 48 48 48 48 ts ue Pr > F 33 < .0001 30 0.2601 87 0.0193 Estimate Estimate	\$\text{Value F} \\ 47.03 \\ 9.76 \\ 1.14 \\ 2.42 \\ \$\text{S} \\ \$\text{Standard} \\ \text{Error} \\ \text{Error}	552.5 Pr > t <.0001 <.0001 0.2601 0.0193	Whithe Experience of the Foundation of the Experience of the Exper	BP model, and wh	
Effect Intercept time1 treat time1*treat Type Effect time1 treat time1*treat Label Mean: Control	2 WP S Estimate 49.0768 5.8224 1.6819 2.0425 3 Tests of Num DF 1 1 1	548.7 Solution for Standard Error 1.0435 0.5963 1.4758 0.8433 Fixed Effect Den DF F Val 48 95.48 1.48 5.	548.8 Fixed Effect DF t 48 48 48 48 48 ts ue Pr > F 33 < .0001 30 0.2601 87 0.0193 Estimate 49.0768	\$\text{Value F} 47.03 \\ 9.76 \\ 1.14 \\ 2.42 \end{align*} \$s \$\text{Standard} \text{Error} \\ 1.0435	552.5 Pr > t <.0001 <.0001 0.2601 0.0193	beta0 beta1 beta2 beta3 t Value 47.03	Pr > t <.0001	
Effect Intercept time1 treat time1*treat Type Effect time1 treat time1*treat Label Mean: Control Mean: Control	2 WP S Estimate 49.0768 5.8224 1.6819 2.0425 3 Tests of Num DF 1 1 1 1 CGroup at F Group at F	548.7 Solution for Standard Error 1.0435 0.5963 1.4758 0.8433 Fixed Effect Den DF F Val 48 95.48 1.48 5.	548.8 Fixed Effect DF t 48 48 48 48 48 ts ue Pr > F 33 < .0001 30 0.2601 87 0.0193 Estimate 49.0768 54.8992	\$\text{Value} F \\ 47.03	DF 48 48	t Value 47.03 52.61	Pr > t	
Effect Intercept time1 treat time1*treat Type Effect time1 treat time1*treat Label Mean: Control Mean: Control Mean: Treatmen	WP S Estimate 49.0768 5.8224 1.6819 2.0425 3 Tests of Num DF 1 1 1 CGroup at F Group at F ent Group at F	548.7 Solution for Standard Error 1.0435 0.5963 1.4758 0.8433 Frixed Effect Den DF F Val 48 95.48 1.48 5.	548.8 Fixed Effect DF t 48 48 48 48 48 ts ue Pr > F 33 < .0001 30 0.2601 87 0.0193 Estimate 49.0768	\$\text{Value F} 47.03 \\ 9.76 \\ 1.14 \\ 2.42 \end{align*} \$s \$\text{Standard} \text{Error} \\ 1.0435	552.5 Pr > t <.0001 <.0001 0.2601 0.0193	beta0 beta1 beta2 beta3 t Value 47.03	Pr > t <.0001	
Effect Intercept time1 treat time1*treat Type Effect time1 treat time1*treat Label Mean: Control Mean: Control	WP S Estimate 49.0768 5.8224 1.6819 2.0425 3 Tests of Num DF 1 1 1 CGroup at F Group at F ent Group at F ent Group at	548.7 Solution for Standard Error 1.0435 0.5963 1.4758 0.8433 Frixed Effect Den DF F Val 48 95.48 1.48 5.	548.8 Fixed Effect DF t 48 48 48 48 48 ts ue Pr > F 33 < .0001 30 0.2601 87 0.0193 Estimate 49.0768 54.8992 50.7587	S Value F 47.03 9.76 1.14 2.42 S Standard Error 1.0435 1.0435 1.0435	DF 48 48 48	t Value 47.03 52.61 48.64	Pr > t <.0001 <.0001 <.0001	ay?
Effect Intercept time1 treat time1*treat Type Effect time1 treat time1*treat Label Mean: Control Mean: Treatme Mean: Treatme Time Effect f Time Effect f	Estimate 49.0768 5.8224 1.6819 2.0425 3 Tests of Num DF 1 1 1 1 Group at F Group at F ent Group at F	Solution for Standard Error 1.0435 0.5963 1.4758 0.8433 Fixed Effect Den DF F Val 48 95. 48 1. 48 5. Pre-Test Post-Test Post-Test Group The Group	548.8 Fixed Effect DF t 48 48 48 48 48 ts ue Pr > F 33 < .0001 30 0.2601 87 0.0193 Estimate 49.0768 54.8992 50.7587 58.6236 5.8224 7.8649	S Value F 47.03 9.76 1.14 2.42 S S Standard Error 1.0435 1.0435 0.5963 0.5963	552.5 Pr > t <.0001 <.0001 0.2601 0.0193 DF 48 48 48 48 48	t Value 47.03 52.61 48.64 56.18 9.76 13.19	Pr > t	ny? 1 1+beta3
Effect Intercept time1 treat time1*treat Type Effect time1 treat time1*treat Label Mean: Control Mean: Control Mean: Treatme Mean: Treatme Time Effect f	WP S Estimate 49.0768 5.8224 1.6819 2.0425 3 Tests of Num DF 1 1 1 1 CGroup at F Group at F Group at F ent Group at For Control For Treatmer at Pre-Test	Solution for Standard Error 1.0435 0.5963 1.4758 0.8433 Fixed Effect Den DF F Val 48 95. 48 1. 48 5. Pre-Test Post-Test Fre-Test Group of Group	548.8 Fixed Effect DF t 48 48 48 48 48 ts ue Pr > F 33 < .0001 30 0.2601 87 0.0193 Estimate 49.0768 54.8992 50.7587 58.6236 5.8224	S Value F 47.03 9.76 1.14 2.42 S Standard Error 1.0435 1.0435 1.0435 0.5963	552.5 Pr > t <.0001 <.0001 0.2601 0.0193 DF 48 48 48 48	t Value 47.03 52.61 48.64 56.18 9.76	Pr > t	1 1+beta3 2

What other terms that could possibly be included are missing? Are they really missing?

What if we had used the CLASS statement instead for our conditional within-person model?

```
TITLE1 "Eq 3.7 (bottom): Within-Person Conditional (Predictor) Model via MIXED";
TITLE2 "NOW using CLASS statement";
PROC MIXED DATA=work.prepost_stacked NOITPRINT NOCLPRINT IC COVTEST METHOD=REML;
        CLASS PersonID time time1 treat;
        MODEL y = time1 treat time1*treat / SOLUTION DDFM=BW;
        REPEATED time / R RCORR TYPE=CS SUBJECT=PersonID;
        LSMEANS time1 treat time1*treat / DIFF=ALL;
RUN; TITLE1; TITLE2;
                                       Solution for Fixed Effects
                Time
                                 Treatment
                (0=pre-test,
                                 Group
                1=
                                 (0=control,
                                                                 Standard
Effect
                post-test)
                                 1=treatment)
                                                    Estimate
                                                                    Error
                                                                                DF
                                                                                       t Value
                                                                                                   Pr > |t|
Intercept
                                                     58.6236
                                                                   1.0435
                                                                                48
                                                                                         56.18
                                                                                                     <.0001
time1
                Λ
                                                     -7.8649
                                                                   0.5963
                                                                                48
                                                                                        -13.19
                                                                                                     <.0001
time1
                1
                                                           0
treat
                                 0
                                                     -3.7245
                                                                   1.4758
                                                                                48
                                                                                         -2.52
                                                                                                     0.0150
treat
                                 1
                                                           0
time1*treat
                                 0
                                                      2.0425
                                                                   0.8433
                                                                                48
                                                                                          2.42
                                                                                                     0.0193
                n
time1*treat
                0
                                 1
                                                           0
time1*treat
                                 0
                                                           0
time1*treat
                                                           0
         Type 3 Tests of Fixed Effects
                 Num
                          Den
                                                            Note that the p-values from the solution for fixed
Effect
                  DF
                           DF
                                 F Value
                                             Pr > F
                                                            effects (simple effects) and Type 3 tests of fixed
time1
                   1
                           48
                                  263.41
                                             <.0001
                                                            effects (marginal effects) do not match because
treat
                   1
                           48
                                    3.65
                                             0.0619
                                                            they mean different things (see slide 16).
time1*treat
                           48
                                     5.87
                                             0.0193
                                           Least Squares Means
                Time
                                 Treatment
                (0=pre-test,
                                 Group
                                 (0=control.
                                                                 Standard
                                 1=treatment)
Effect
                post-test)
                                                    Estimate
                                                                    Frror
                                                                                DF
                                                                                      t Value
                                                                                                   Pr > |t|
time1
                0
                                                     49.9178
                                                                   0.7379
                                                                                48
                                                                                         67.65
                                                                                                     <.0001
time1
                                                     56.7614
                                                                   0.7379
                                                                                48
                                                                                         76.92
                                                                                                     <.0001
treat
                                 0
                                                     51.9880
                                                                   1.0000
                                                                                48
                                                                                         51.99
                                                                                                     <.0001
treat
                                 1
                                                     54.6912
                                                                   1.0000
                                                                                48
                                                                                         54.69
                                                                                                     <.0001
time1*treat
                0
                                 0
                                                     49.0768
                                                                   1.0435
                                                                                48
                                                                                         47.03
                                                                                                     <.0001
time1*treat
                0
                                 1
                                                     50.7587
                                                                   1.0435
                                                                                48
                                                                                         48.64
                                                                                                     <.0001
time1*treat
                                 0
                                                     54.8992
                                                                   1.0435
                                                                                48
                                                                                         52.61
                                                                                                     <.0001
                1
time1*treat
                                                     58.6236
                                                                   1.0435
                                                                                48
                                                                                         56.18
                                                                                                     <.0001
                                      Differences of Least Squares Means
            Time
                         Treatment
                                        Time
                                                     Treatment
            (0=pre-test,
                         Group
                                        (0=pre-test,
                                                     Group
            1=
                         (0=control,
                                        1=
                                                     (0=control,
                                                                             Standard
                                                                                           t Value
Effect
            post-test)
                         1=treatment)
                                        post-test)
                                                     1=treatment)
                                                                   Estimate
                                                                               Error
                                                                                        DF
                                                                                                    Pr > |t|
time1
            0
                                                                    -6.8436
                                                                               0.4217
                                                                                        48
                                                                                             -16.23
                                                                                                      <.0001
                                        1
                         0
                                                                    -2.7032
                                                                               1.4143
                                                                                                      0.0619
                                                                                        48
                                                                                              -1.91
time1*treat
           0
                         0
                                        0
                                                     1
                                                                    -1.6819
                                                                               1.4758
                                                                                        48
                                                                                              -1.14
                                                                                                      0.2601
                         0
                                                                               0.5963
                                                                                              -9.76
                                                                                                      < .0001
            0
                                        1
                                                     O
                                                                    -5.8224
                                                                                        48
time1*treat
time1*treat
            0
                         0
                                        1
                                                                    -9.5468
                                                                               1.4758
                                                                                        48
                                                                                              -6.47
                                                                                                       <.0001
                                                     1
```

time1*treat

time1*treat

time1*treat 1

0

0

1

1

1

1

0

1

-4.1404

-7.8649

-3.7245

1.4758

0.5963

1.4758

48

48

48

-2.81

-2.52

-13.19

0.0072

< .0001

0.0150