Non Homework Handout: Re-Running Homework 8 of PSYC 943 as a Path Model

Data Analysis Description:

The data for this assignment were collected within the department of Cooking Education Sciences at Midwestern Red State University. The goal of the study was to ascertain the generalizability of a new method of instruction for breakfast construction. In particular, 100 participants chose to participate in a 4-week class focused on making better pancakes or better crepes. At the end of each class, all students were asked to make both dishes, in which the dish they had practiced came first, and the other was requested as a surprise. A panel of local celebrity judges then rated each dish on a 1 to 10 scale in which higher scores are better; the mean rating across judges for each dish served as the outcome. A covariate of the extent to which students had prior experience cooking pancakes or making crepes (whichever class they attended) was also collected on a 0 to 7 scale, in which 0=never, 1=once, ... 7=100 or more times, which should be represented with a single continuous slope for the linear effect of each additional level of experience.

Use the ratings data in your individual data file and SAS PROC MIXED on the stacked (long) data to answer the questions below. Estimate each model referenced below using maximum likelihood within SAS PROC MIXED (and KR denominator degrees of freedom). For this assignment it will be easier to NOT use the CLASS statement, to use the NOINT option and create your own intercept per DV, and to use ESTIMATE statements for requested effect comparisons, in which the condition before the vs. should get the negative value in the ESTIMATE statement comparison. Please use an unstructured covariance matrix to describe the two outcomes (ratings for pancakes or crepes) for each person. All values to be entered below are numeric and must be entered to the nearest **.01** to be correct.

Question 1: Begin with an empty multivariate model. Enter the -2LL **762.21**

Question 10: Add to the model the effect of instruction type (0=pancake, 1=crepe) on both outcomes. Enter the -2LL **660.22**

Question 21: Add to the model the effect of pre-instruction experience (uncentered) as a main effect and interaction with instruction type on both outcomes. Enter the -2LL **629.64**

Final Model Analysis Syntax:

```
PROC MIXED DATA=work.myHW08stacked NOCLPRINT ITDETAILS NOINFO METHOD=ML;
      CLASS DV;
      MODEL rating = pancake crepeclass*pancake pancake*exp
                     crepe   crepeclass*crepe   crepe*exp
                     crepeclass*pancake*exp
                     crepeclass*crepe*exp/ NOINT SOLUTION DDFM=KR;
      REPEATED DV / R RCORR TYPE=UN SUBJECT=PersonID;
RUN;
```

Descriptive Statistics:

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
Exp	exp: Experience with Food of Instruction	100	2.83	1.645655	0	7
rating_Pancake	rating_Pancake: Rating of Pancakes	100	6.753039	1.119979	3.8236922	10
rating_Crepe	rating_Crepe: Rating of Crepes	100	5.501174	2.429569	1	10

Final Model Output:

Estimated R Matrix for Subject 1

Row	Col1	Col2
1	0.9564	0.6969
2	0.6969	2.4529

Estimated R Correlation Matrix for Subject 1

Row	Col1	Col2
1	1.0000	0.4550
2	0.4550	1.0000

Covariance Parameter Estimates

Cov Parm	Subject	Estimate
UN(1,1)	PersonID	0.9564
UN(2,1)	PersonID	0.6969
UN(2,2)	PersonID	2.4529

Fit Statistics

-2 Log Likelihood	629.6
AIC (smaller is better)	651.6
AICC (smaller is better)	653.0
BIC (smaller is better)	680.3

Final Model Output Continued:

Solution for Fixed Effects					
Effect	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
pancake	7.1950	0.2938	100	24.49	<.0001
crepe	2.8118	0.4705	100	5.98	<.0001
pancake*CrepeClass	-1.7615	0.3952	100	-4.46	<.0001
crepe*CrepeClass	2.8637	0.6329	100	4.52	<.0001
pancake*Exp	-0.05913	0.09580	100	-0.62	0.5385
crepe*Exp	0.3285	0.1534	100	2.14	0.0347
pancake*CrepeCla*Exp	0.4197	0.1228	100	3.42	0.0009
crepe*CrepeClass*Exp	0.1541	0.1967	100	0.78	0.4351

Overall Model in Equation Form:

$$Y_{ri} = \beta_P Pancake_i + \beta_C Crepe_i + \beta_{CC*P} CrepeClass_i * Pancake_i + \beta_{CC*C} CrepeClass_i * Crepe_i + \beta_{E*P} Exp_i * Pancake_i + \beta_{E*C} Exp_i * Crepe_i + \beta_{CC*E*P} CrepeClass_i * Pancake_i * Exp_i + \beta_{CC*E*C} CrepeClass_i * Crepe_i * Exp_i + e_{ri}$$

Where are the dependent variables? Hidden in the dummy codes for pancake and crepe training:

Pancake Rating Model in Equation Form (here $\boldsymbol{Pancake_i = 1}$ and $\boldsymbol{Crepe_i = 0}$):

$$Y_{ri}^{Pancake} = \beta_p + \beta_{CC*P}\, CrepeClass_i + \beta_{E*P} Exp_i + \beta_{CC*E*P} CrepeClass_i * Exp_i + e_{ri}^{Pancake}$$

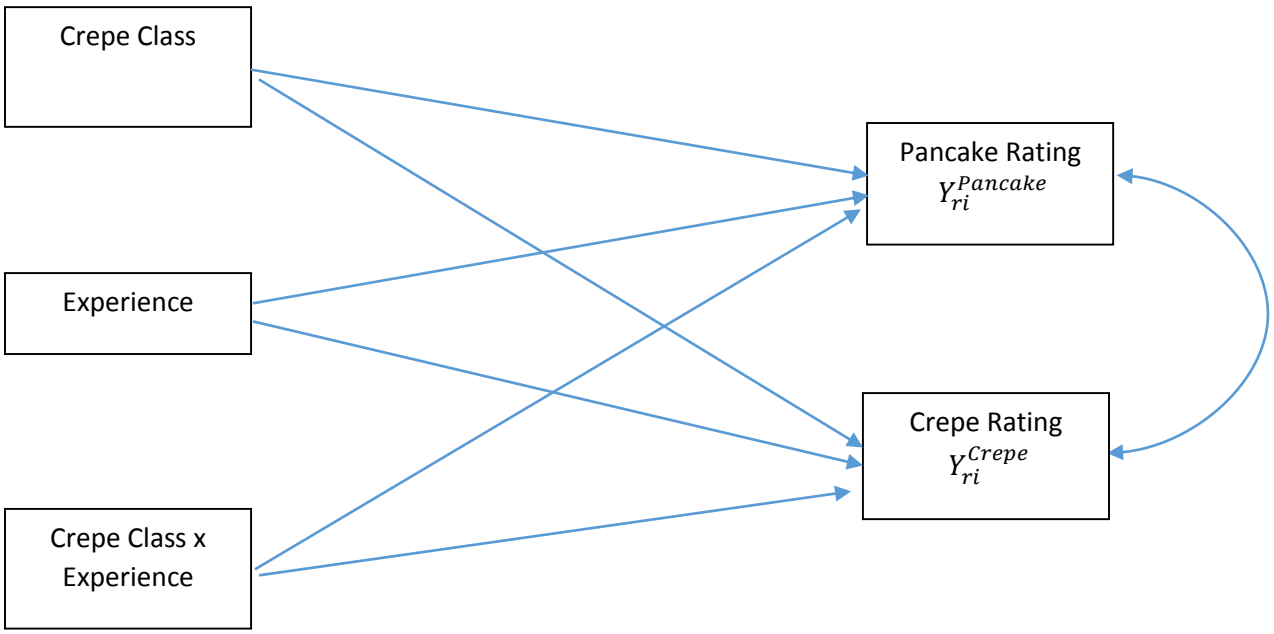
Crepe Rating Model in Equation Form (here $\boldsymbol{Pancake_i = 0}$ and $\boldsymbol{Crepe_i = 1}$):

$$Y_{ri}^{Crepe} = \beta_C + \beta_{CC*C} CrepeClass_i + \beta_{E*C} Exp_i + \beta_{CC*E*C} CrepeClass_i * Exp_i + e_{ri}^{Crepe}$$

Where, together, the residuals are assumed to follow a bivariate normal distribution:

$$\begin{bmatrix} e_{ri}^{Pancake} \\ e_{ri}^{Crepe} \end{bmatrix} \sim N_2(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \mathbf{R} = \begin{bmatrix} \sigma^2_{e:Pancake} & \sigma_{e:Pancake,Crepe} \\ \sigma_{e:Pancake,Crepe} & \sigma^2_{e:Crepe} \end{bmatrix}$$

Final Model as a Path Diagram:



Mplus Syntax:

```
TITLE:
    HW8 (2011 PSYC 943) IN MPLUS

DATA:
    FILE = HW08_33232691.csv;

VARIABLE:
    NAMES = PersonID Class Crepe Pancake Exp Rating_P Rating_C;
    IDVariable = PersonID;
    USEVARIABLE = Rating_P Rating_C Crepe Exp crepeexp;

DEFINE:
    crepeexp = crepe*exp;

ANALYSIS:
    ESTIMATOR = MLR;

MODEL:
    rating_p ON Crepe exp crepeexp;
    rating_c ON Crepe exp crepeexp;

OUTPUT:
    SAMPSTAT STANDARDIZED RESIDUAL;
```

Mplus Descriptive Statistics (Compare with SAS to ensure data are imported correctly):

```
     SAMPLE STATISTICS
           Means
              CLASS         CREPE         PANCAKE       EXP           RATING_P
              ________      ________      ________      ________      ________
     1          1.530         0.530         0.470         2.830         6.753

           Means
              RATING_C
              ________
     1          5.501


           Covariances
              CLASS         CREPE         PANCAKE       EXP           RATING_P
              ________      ________      ________      ________      ________
CLASS            0.249
CREPE            0.249         0.249
PANCAKE         -0.249        -0.249         0.249
EXP              0.070         0.070        -0.070         2.681
RATING_P        -0.133        -0.133         0.133         0.485         1.242
RATING_C         0.850         0.850        -0.850         1.363         0.504


           Covariances
              RATING_C
              ________
RATING_C         5.844


           Correlations
              CLASS         CREPE         PANCAKE       EXP           RATING_P
              ________      ________      ________      ________      ________
CLASS            1.000
CREPE            1.000         1.000
PANCAKE         -1.000        -1.000         1.000
EXP              0.086         0.086        -0.086         1.000
RATING_P        -0.240        -0.240         0.240         0.266         1.000
RATING_C         0.705         0.705        -0.705         0.344         0.187


           Correlations
              RATING_C
              ________
RATING_C         1.000
```

Mplus Output:

```
THE MODEL ESTIMATION TERMINATED NORMALLY



MODEL FIT INFORMATION

Number of Free Parameters                       11

Loglikelihood

          H0 Value                          -314.822
          H0 Scaling Correction Factor         0.9990
            for MLR
          H1 Value                          -314.822
          H1 Scaling Correction Factor         0.9990
            for MLR

Information Criteria

          Akaike (AIC)                       651.644
          Bayesian (BIC)                     680.300
          Sample-Size Adjusted BIC           645.560
            (n* = (n + 2) / 24)

Chi-Square Test of Model Fit

          Value                              0.000*
          Degrees of Freedom                     0
          P-Value                           0.0000
          Scaling Correction Factor          1.0000
            for MLR

*   The chi-square value for MLM, MLMV, MLR, ULSMV, WLSM and WLSMV cannot be used
    for chi-square difference testing in the regular way.  MLM, MLR and WLSM
    chi-square difference testing is described on the Mplus website.  MLMV, WLSMV,
    and ULSMV difference testing is done using the DIFFTEST option.

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                           0.000
          90 Percent C.I.                    0.000  0.000
          Probability RMSEA <= .05           0.000

CFI/TLI

          CFI                                1.000
          TLI                                1.000

Chi-Square Test of Model Fit for the Baseline Model

          Value                            126.048
          Degrees of Freedom                     7
          P-Value                           0.0000

SRMR (Standardized Root Mean Square Residual)

          Value                              0.000
```

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
RATING_P ON				
CREPE	-1.762	0.386	-4.559	0.000
EXP	-0.059	0.082	-0.725	0.469
CREPEEXP	0.420	0.125	3.366	0.001
RATING_C ON				
CREPE	2.864	0.668	4.288	0.000
EXP	0.328	0.185	1.779	0.075
CREPEEXP	0.154	0.210	0.733	0.463
RATING_C WITH				
RATING_P	0.697	0.158	4.397	0.000
Intercepts				
RATING_P	7.195	0.243	29.606	0.000
RATING_C	2.812	0.561	5.011	0.000
Residual Variances				
RATING_P	0.956	0.130	7.383	0.000
RATING_C	2.453	0.323	7.587	0.000

STANDARDIZED MODEL RESULTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
RATING_P ON				
CREPE	-0.789	0.156	-5.070	0.000
EXP	-0.087	0.120	-0.725	0.468
CREPEEXP	0.735	0.207	3.553	0.000
RATING_C ON				
CREPE	0.591	0.126	4.675	0.000
EXP	0.222	0.124	1.799	0.072
CREPEEXP	0.124	0.171	0.728	0.466
RATING_C WITH				
RATING_P	0.455	0.077	5.921	0.000
Intercepts				
RATING_P	6.457	0.450	14.348	0.000
RATING_C	1.163	0.263	4.425	0.000
Residual Variances				
RATING_P	0.770	0.087	8.889	0.000
RATING_C	0.420	0.063	6.696	0.000

STDY Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
RATING_P ON				

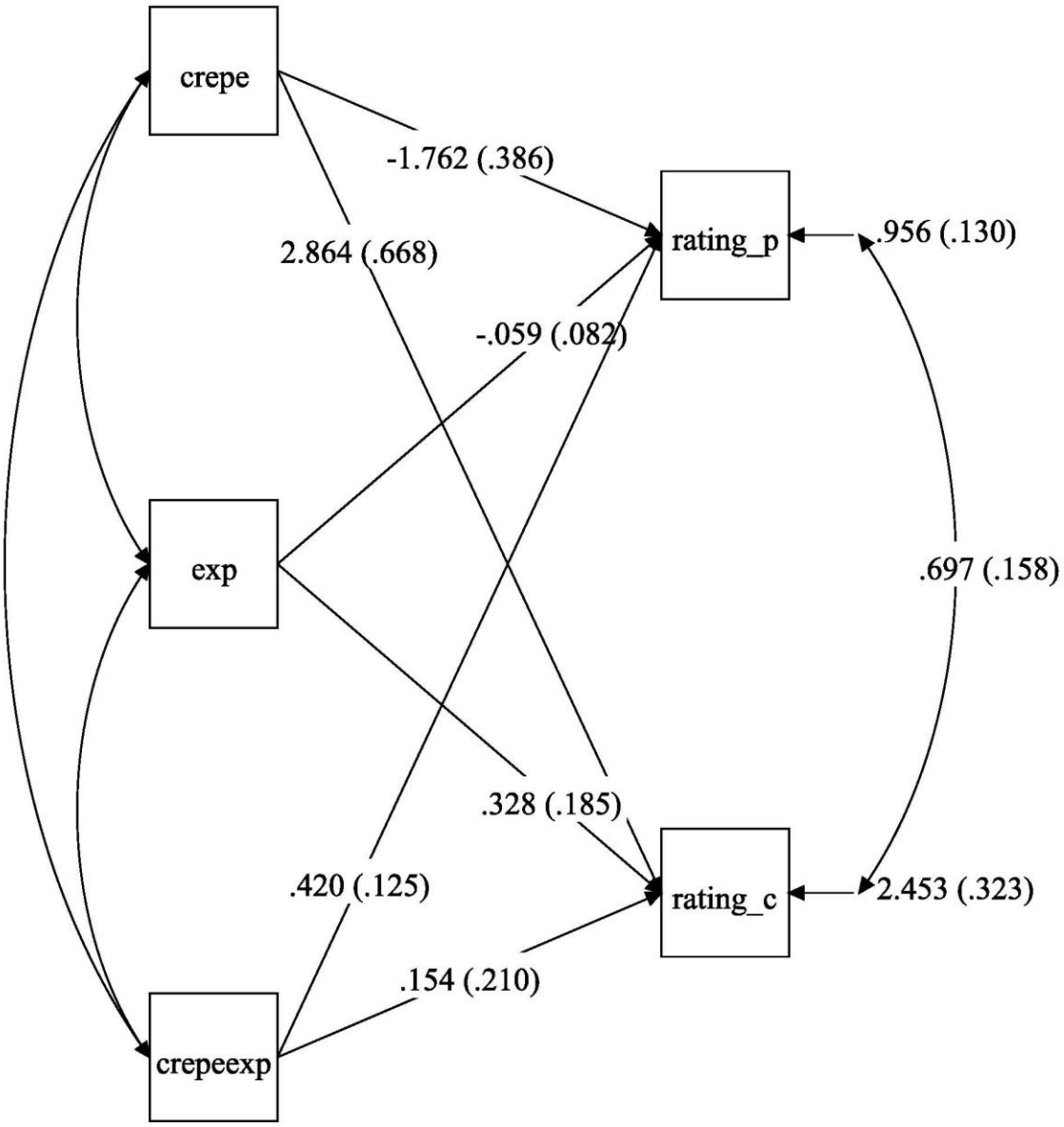
CREPE	-1.581	0.311	-5.079	0.000
EXP	-0.053	0.073	-0.726	0.468
CREPEEXP	0.377	0.103	3.640	0.000
RATING_C ON				
CREPE	1.185	0.253	4.676	0.000
EXP	0.136	0.075	1.807	0.071
CREPEEXP	0.064	0.087	0.729	0.466
RATING_C WITH				
RATING_P	0.455	0.077	5.921	0.000
Intercepts				
RATING_P	6.457	0.450	14.348	0.000
RATING_C	1.163	0.263	4.425	0.000
Residual Variances				
RATING_P	0.770	0.087	8.889	0.000
RATING_C	0.420	0.063	6.696	0.000

STD Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
RATING_P ON				
CREPE	-1.762	0.386	-4.559	0.000
EXP	-0.059	0.082	-0.725	0.469
CREPEEXP	0.420	0.125	3.366	0.001
RATING_C ON				
CREPE	2.864	0.668	4.288	0.000
EXP	0.328	0.185	1.779	0.075
CREPEEXP	0.154	0.210	0.733	0.463
RATING_C WITH				
RATING_P	0.697	0.158	4.397	0.000
Intercepts				
RATING_P	7.195	0.243	29.606	0.000
RATING_C	2.812	0.561	5.011	0.000
Residual Variances				
RATING_P	0.956	0.130	7.383	0.000
RATING_C	2.453	0.323	7.587	0.000

R-SQUARE

Observed Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
RATING_P	0.230	0.087	2.653	0.008
RATING_C	0.580	0.063	9.257	0.000


crepe
exp
crepeexp
rating_p
rating_c
-1.762 (.386)
2.864 (.668)
-.059 (.082)
.328 (.185)
.420 (.125)
.154 (.210)
.956 (.130)
.697 (.158)
2.453 (.323)