PSY 9556B (March 12) Multiple Groups in Longitudinal Analysis

CLSA Proposals

1. Retirement status, work ability, and depression
2. Changes in mobility over time and health outcomes
3. Healthy successful aging with diabetes
4. Healthy successful aging as a function of social functioning

Suggestions for full application:

- In the introduction describe prevalence rates, future rates, cost/implications
- Theoretical value also in developing knowledge of aging (most of you said this)
- Describe the longitudinal design in detail including cohort effects (e.g., mandatory retirement)
- Positive "spin" focusing on protective factors (e.g., social support, neighbourhood cohesion)
- In terms of implications, could describe potential future interventions (ways to improve physical mobility, social cohesion)
- Graph of trajectories by group (e.g., diabetes, non-diabetes)

PSY 9556B (March 12) Multiple Groups in Longitudinal Analysis

- Useful when number of groups is small (and interested in comparing groups)
- Measurement Invariance
- Sample size per group at least 50 (100 would be much more stable)
- Alternative – model group as categorical variable with dummy code
- Imputation of missing data within group (Little)
- Note defaults in Mplus:
  - Assumes measurement invariance across groups
  - And therefore constrains the following parameters to equality across groups:
    - Factor loadings
    - Intercepts (or thresholds for categorical items)
  - Structural and residual parameters are unconstrained
  - Factor mean fixed at zero in first group
  - No constraints across repeated measures (need to add your own constraints)

Multiple Groups in Longitudinal Analysis

- Appropriate Null Model (for CFI calculations) Little p. 215-216
  - No covariances
  - Means and variances equal across groups and time points
  - Not essential if you use Cheung's new invariance procedure

```
USEVARIABLES ARE week1a week2a week3a w1Beck w2Beck w3Beck;
grouping = gender (1=male 2=female);
analysis: model = nocovariances;
model:week1a-week3a (1);
w1Beck-w3Beck(2);
[week1a-week3a] (3);
[w1Beck-w3Beck] (4);
output: sampstat;
```

$$CFI = 1 - \frac{\max\left[\left(x_t^2 - df_t\right), 0\right]}{\max\left[\left(x_t^2 - df_t\right), \left(x_0^2 - df_0\right), 0\right]}$$

Note: in this example means and variances are constrained to equality across groups by default (in addition to my constraints across time points)

Multiple Groups in Longitudinal Analysis

- Can start with a configural invariance model across groups and time points
- Could alternatively do analyses separately by group if interested in longitudinal variance in each group
- For weak (loading) invariance, can start with omnibus test constraining loadings across groups and time-points
    - If concerned about potential lack of invariance across groups or time, start with either group or time constraint
- Same as above for invariance of the intercepts
- Tests of mean level differences in latent constructs
    - Think in terms of ANOVA designs with main effects, interactions
- Invariance (homogeneity) of the variance-covariance matrix
    - If no differences across groups, then could combine groups
    - If differences exist, continue investigation across groups
    - If differences in variances, consider using phantom constructs

Multiple Groups in Longitudinal Analysis: Three Types of Data Files in Mplus

1. All individual data stored in one data file: “Grouping option”

```
Title: longitudinal cfa example;
data: File is sem_mplus.dat;
    Format is 1F4, 1F1, 1F2, 23F8.2, 1F11.3, 72F8.2;
variable: names are studid gender age
bppa bpv bpa bph bptot
sq1 sq2 sq3 sq4 sq5 sq6 sq7 sq8 sq9 sq10 sq11 sq12 sq13 sq14 sq15
es es_pt es_fin grade
drink1 drink2 drink3 drink4 epis1 epis2 epis3 epis4
stress1 stress2 stress3 stress4 pleased1 pleased2 pleased3 pleased4
enjoyc1 enjoyc2 enjoyc3 enjoyc4 enjoyu1 enjoyu2 enjoyu3 enjoyu4
effort1 effort2 effort3 effort4 harm1 harm2 harm3 harm4 dep1 dep2 dep3 dep4
drink1b drink2b drink3b drink4b epis1b epis2b epis3b epis4b
stress1b stress2b stress3b stress4b please1b please2b please3b please4b
enjoyc1b enjoyc2b enjoyc3b enjoyc4b enjoyu1b enjoyu2b enjoyu3b enjoyu4b
effort1b effort2b effort3b effort4b harm1b harm2b harm3b harm4b
dep1b dep2b dep3b dep4b;
missing = blank;
usevariables are stress1b stress2b stress3b stress4b
drink1b drink2b drink3b drink4b;
grouping is gender (1=male 2=female);  !multi-group statement
model: stress by stress1b stress2b stress3b stress4b;
drink by drink1b drink2b drink3b drink4b;
model female: ! statements to indicate that parameters which are not constrained across groups
stress by stress2b stress3b stress4b; !to remove default loading equality constraints across groups
drink by drink2b drink3b drink4b; !do not include first indicator which was fixed
output: sampstat stdyx modindices;
```

Multiple Groups

2. Individual data stored in separate files: Multiple file statement

```
Title: longitudinal cfa example;
data: File (male) is sem_male.txt;
      File (female) is sem_female.txt;
    Format is 1F4, 1F1, 1F2, 23F8.2, 1F11.3, 72F8.2;
variable: names are studid gender age
bppa bpv bpa bph bptot
sq1 sq2 sq3 sq4 sq5 sq6 sq7 sq8 sq9 sq10 sq11 sq12 sq13 sq14 sq15
es es_pt es_fin grade
drink1 drink2 drink3 drink4 epis1 epis2 epis3 epis4
stress1 stress2 stress3 stress4 pleased1 pleased2 pleased3 pleased4
enjoyc1 enjoyc2 enjoyc3 enjoyc4 enjoyu1 enjoyu2 enjoyu3 enjoyu4
effort1 effort2 effort3 effort4 harm1 harm2 harm3 harm4 dep1 dep2 dep3 dep4
drink1b drink2b drink3b drink4b epis1b epis2b epis3b epis4b
stress1b stress2b stress3b stress4b please1b please2b please3b please4b
enjoyc1b enjoyc2b enjoyc3b enjoyc4b enjoyu1b enjoyu2b enjoyu3b enjoyu4b
effort1b effort2b effort3b effort4b harm1b harm2b harm3b harm4b
dep1b dep2b dep3b dep4b;
missing = blank;
usevariables are stress1b stress2b stress3b stress4b
drink1b drink2b drink3b drink4b;
!grouping is gender (1=male 2=female);  !don't need
model: stress by stress1b stress2b stress3b stress4b;
drink by drink1b drink2b drink3b drink4b;
model female: ! statements to indicate that parameters which are not constrained across groups
stress by stress2b stress3b stress4b; !to remove default loading equality constraints across groups
drink by drink2b drink3b drink4b; !do not include first indicator which was fixed
output: sampstat stdyx modindices;
```

Multiple Groups

3. Summary Data, One Data Set

```
Title: Example of a latent-growth-modeling study with summary data;
data:
file is groupdata.txt;
ngroups = 2;
nobservations = 180 200;
type=correlation means stdeviations;
variable:
names are x1 x2 x3 x4 x5;
usevariables are x1 x2 x3 x4 x5;
analysis:
estimator = ml; !note summary data such as correlation matrix cannot use mlr
model:
latent1 by x1 x2 x3 x4 x5;
output: sampstat residual stdyx tech4 modindices;
```

groupdata - Notepad

File Edit Format View Help

```
5.0 5.2 5.7 6.2 6.1
3.9 4.1 3.8 4.5 4.6
1.0
.70 1.0
.60 .70 1.0
.50 .60 .70 1.0
.40 .50 .60 .70 1.0
4.1 4.3 4.6 5.2 5.1
3.8 3.9 3.8 4.1 4.2
1.0
.68 1.0
.58 .69 1.0
.48 .61 .68 1.0
.41 .48 .59 .69 1.0
```

Time Series, P-technique, and Dynamic P-technique

- Time-series analysis - applications
- Factor Analysis – P-Technique
  - The correlation matrix – one per subject
  - Need several repeated measures (minimum~50)
  - Can do multi-group analysis using individual as the group
  - Ergodicity
  - Nomothetic and idiographic models
  - Applications
- Dynamic P-technique
  - Adding Lag1 and Lag2 variables (see Little, p. 234)
  - Applications

Full Longitudinal Mediation: Example with Manifest Variables

```
USEVARIABLES ARE week1a week6a week11a week16a week21a week26a
w1work w6work w11work w16work w21work w26work
w1final w6final w11final w16final w21final w26final;
ANALYSIS:
bootstrap = 1000;
MODEL:
!autoregressive paths
week6a on week1a;
week11a on week6a;
week16a on week11a;
week21a on week16a;
week26a on week21a;
w6work on w1work;
w11work on w6work;
w16work on w11work;
w21work on w16work;
w26work on w21work;
w6final on w1final;
w11final on w6final;
w16final on w11final;
w21final on w16final;
w26final on w21final;
!residual paths
week6a with w6work w6final;
w6work with w6final;
week11a with w11work w11final;
w11work with w11final;
week16a with w16work w16final;
w16work with w16final;
week21a with w21work w21final;
w21work with w21final;
week26a with w26work w26final;
w26work with w26final;
!correlations observed exogenous
week1a with w1work w1final;
w1work with w1final;
!cross-lagged mediation paths
w6work on week1a;!first complete mediation path
w11final on w6work;
w11work on week6a;!second complete mediation path
w16final on w11work;
w16work on week11a;!third complete mediation path
w21final on w16work;
w21work on week16a;!fourth complete mediation path
w26final on w21work;
w6final on w1work;!incomplete path
w26work on week21a;!incomplete path
!modifications
week16a on week1a;
w16final on w6final;
MODEL INDIRECT:
w11final IND week1a;
w16final IND week6a;
w21final IND week11a;
w26final IND week16a;
w26final IND week1a;!total indirect effect from beginning to end
OUTPUT: sampstat stdyx modindices tech4 cinterval(bcbootstrap);
```

Longitudinal Mediation Example continued

MODEL FIT INFORMATION

Number of Free Parameters 81

Loglikelihood

H0 Value	-14364.010
H1 Value	-14108.598

Information Criteria

Akaike (AIC)	28890.019
Bayesian (BIC)	29215.919
Sample-Size Adjusted BIC (n* = (n + 2) / 24)	28958.888

Chi-Square Test of Model Fit

Value	510.824
Degrees of Freedom	108
P-Value	0.0000

RMSEA (Root Mean Square Error Of Approximation)

Estimate	0.095	
90 Percent C.I.	0.087	0.103
Probability RMSEA <= .05	0.000	

CFI/TLI

CFI	0.886
TLI	0.842

Chi-Square Test of Model Fit for the Baseline Model

Value	3685.663
Degrees of Freedom	150
P-Value	0.0000

SRMR (Standardized Root Mean Square Residual)

Value	0.118

Longitudinal Mediation Example continued

STANDARDIZED MODEL RESULTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
WEEK6A ON				
WEEK1A	0.481	0.043	11.283	0.000
WEEK11A ON				
WEEK6A	0.532	0.041	12.906	0.000
WEEK16A ON				
WEEK11A	0.173	0.050	3.447	0.001
WEEK1A	0.558	0.039	14.291	0.000
WEEK21A ON				
WEEK16A	0.372	0.047	7.932	0.000
WEEK26A ON				
WEEK21A	0.597	0.040	14.993	0.000
W6WORK ON				
W1WORK	0.379	0.048	7.943	0.000
WEEK1A	-0.103	0.050	-2.074	0.038
W11WORK ON				
W6WORK	0.146	0.057	2.542	0.011
WEEK6A	0.048	0.057	0.845	0.398
W16WORK ON				
W11WORK	0.210	0.053	3.928	0.000
WEEK11A	-0.128	0.055	-2.344	0.019
W21WORK ON				
W16WORK	0.442	0.047	9.381	0.000
WEEK16A	0.052	0.052	1.008	0.313
W26WORK ON				
W21WORK	0.363	0.052	7.004	0.000
WEEK21A	-0.165	0.058	-2.864	0.004
W6FINAL ON				
W1FINAL	0.739	0.024	30.743	0.000
W1WORK	0.007	0.036	0.183	0.855
W11FINAL ON				
W6FINAL	0.880	0.013	69.890	0.000
W6WORK	0.028	0.027	1.037	0.300
W16FINAL ON				
W11FINAL	0.578	0.048	11.932	0.000
W11WORK	0.004	0.025	0.154	0.878
W6FINAL	0.357	0.049	7.213	0.000
W21FINAL ON				
W16FINAL	0.912	0.009	96.968	0.000
W16WORK	0.014	0.024	0.584	0.559
W26FINAL ON				
W21FINAL	0.939	0.007	133.325	0.000
W21WORK	-0.014	0.022	-0.653	0.514

Longitudinal Mediation Example continued

WEEK6A WITH				
W6WORK	-0.053	0.054	-0.989	0.323
W6FINAL	0.062	0.055	1.138	0.255
W6WORK WITH				
W6FINAL	-0.048	0.053	-0.893	0.372
WEEK11A WITH				
W11WORK	0.048	0.057	0.838	0.402
W11FINAL	0.004	0.059	0.071	0.944
W11WORK WITH				
W11FINAL	-0.019	0.060	-0.309	0.757
WEEK16A WITH				
W16WORK	-0.130	0.054	-2.418	0.016
W16FINAL	-0.163	0.058	-2.817	0.005
W16WORK WITH				
W16FINAL	0.175	0.056	3.136	0.002
WEEK21A WITH				
W21WORK	-0.087	0.055	-1.584	0.113
W21FINAL	-0.025	0.055	-0.453	0.651
W21WORK WITH				
W21FINAL	0.122	0.056	2.185	0.029

WEEK26A WITH				
W26WORK	-0.095	0.059	-1.609	0.108
W26FINAL	0.044	0.060	0.726	0.468
W26WORK WITH				
W26FINAL	0.167	0.059	2.815	0.005
WEEK1A WITH				
W1WORK	-0.220	0.049	-4.488	0.000
W1FINAL	-0.059	0.051	-1.169	0.243
W1WORK WITH				
W1FINAL	0.137	0.050	2.715	0.007
Means				
WEEK1A	0.701	0.056	12.578	0.000
W1WORK	2.584	0.106	24.370	0.000
W1FINAL	5.230	0.196	26.742	0.000

Longitudinal Mediation Example continued

CONFIDENCE INTERVALS OF STANDARDIZED TOTAL, TOTAL INDIRECT, SPECIFIC INDIRECT, AND DIRECT EFFECTS

STDYX Standardization

	Lower .5%	Lower 2.5%	Lower 5%	Estimate	Upper 5%	Upper 2.5%	Upper .5%
Effects from WEEK1A to W11FINAL							
Total	-0.013	-0.010	-0.009	-0.003	0.003	0.005	0.007
Total indirect	-0.013	-0.010	-0.009	-0.003	0.003	0.005	0.007
Specific indirect							
W11FINAL							
W6WORK							
WEEK1A	-0.013	-0.010	-0.009	-0.003	0.003	0.005	0.007
Effects from WEEK6A to W16FINAL							
Total	-0.004	-0.003	-0.002	0.000	0.003	0.003	0.004
Total indirect	-0.004	-0.003	-0.002	0.000	0.003	0.003	0.004
Specific indirect							
W16FINAL							
W11WORK							
WEEK6A	-0.004	-0.003	-0.002	0.000	0.003	0.003	0.004

Longitudinal Mediation Example continued

STDYX Standardization

	Lower .5%	Lower 2.5%	Lower 5%	Estimate	Upper 5%	Upper 2.5%	Upper .5%
Effects from WEEK11A to W21FINAL							
Total	-0.011	-0.009	-0.008	-0.002	0.004	0.005	0.008
Total indirect	-0.011	-0.009	-0.008	-0.002	0.004	0.005	0.008
Specific indirect							
W21FINAL W16WORK WEEK11A	-0.011	-0.009	-0.008	-0.002	0.004	0.005	0.008
Effects from WEEK16A to W26FINAL							
Total	-0.005	-0.004	-0.004	-0.001	0.002	0.003	0.004
Total indirect	-0.005	-0.004	-0.004	-0.001	0.002	0.003	0.004
Specific indirect							
W26FINAL W21WORK WEEK16A	-0.005	-0.004	-0.004	-0.001	0.002	0.003	0.004
Effects from WEEK1A to W26FINAL							
Total	-0.009	-0.007	-0.006	-0.002	0.002	0.003	0.005
Total indirect	-0.009	-0.007	-0.006	-0.002	0.002	0.003	0.005