Assignment 08

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I specified a multivariate latent growth model to examine the trajectories of insomnia severity and anxiety from baseline to post-test. More specifically, whether initial levels of anxiety were related to change in insomnia severity.

The model defined time-specific latent factors for insomnia and anxiety, each measured by seven items. The growth component for each construct was defined by an intercept factor (representing baseline levels, with loadings fixed at 1 for both time points on the respective latent factor) and a slope factor (representing the change from baseline to post-test, with loadings fixed at 0 for baseline and 1 for post-test). Given the ordered categorical nature of the items, I used the Diagonally Weighted Least Squares (DWLS) estimator.

The model demonstrated good overall fit to the data: $\chi^2(338) = 510.29$, $p < 0.001$; CFI = 0.965; TLI = 0.961; RMSEA = 0.051 (90% CI [0.042, 0.060]); SRMR = 0.080. Addressing the primary research question, the covariance between baseline anxiety levels and the subsequent change in insomnia severity was not statistically significant (β = -0.006, SE = 0.015, $p = 0.687$). This suggests that initial anxiety levels did not predict the magnitude of change in insomnia severity from baseline to post-test in this sample.

```
library(lavaan)
library(tidyr)
library(dplyr)
```

```
dat <- read.csv("../data/clean_data2.csv")

mydata <- dplyr::filter(dat, redcap_event_name %in% c(
    "elegibilidade_arm_1",
    "desfechos_arm_1", "followup_arm_1")
  ) |>
  dplyr::mutate(
    redcap_event_name = factor(dplyr::case_when(
      redcap_event_name == "elegibilidade_arm_1" ~ 1,
      redcap_event_name == "desfechos_arm_1" ~ 2,
      redcap_event_name == "followup_arm_1" ~ 3
    ))) |>
  dplyr::select(record_id, redcap_event_name,
                dplyr::starts_with("igi"),
                dplyr::starts_with("ehad"))


wide_data <- mydata |>
  tidyr::pivot_wider(
    id_cols = "record_id",
    names_from = "redcap_event_name",
    names_sep = ".",
    values_from = c(igi_1a:ehad_14)
  )
```

$$

Table 1: Parameter Estimates for the Two-Time-Point Latent Growth Model of Insomnia and Anxiety

Parameter Path	Estimate (B)	SE	z-value	p-value
χ^2 (df)	510.288 (338)			<.001
CFI	0.965			
TLI	0.961			
RMSEA [90% CI]	0.051	[0.042, 0.060]		
SRMR	0.080			
Measurement Model Loadings (Baseline, Time 1)				
Insomnia Severity T1 →				
igi_1a.1	1.000	–	–	–
igi_1b.1	1.006	0.112	8.973	<.001
igi_2.1	0.666	0.075	8.846	<.001
igi_3.1	1.188	0.126	9.398	<.001
igi_4.1	1.280	0.141	9.089	<.001
igi_5.1	1.082	0.118	9.162	<.001
igi_1c.1	0.589	0.093	6.316	<.001
Anxiety T1 →				
ehad_1.1	1.000	–	–	–
ehad_3.1	1.466	0.108	13.526	<.001
ehad_5.1	0.914	0.073	12.453	<.001
ehad_7.1	0.615	0.059	10.495	<.001
ehad_9.1	1.054	0.087	12.089	<.001
ehad_11.1	1.129	0.094	11.956	<.001
ehad_13.1	0.940	0.077	12.275	<.001
Growth Factor Means				
Insomnia Intercept (ItcI, Baseline)	0.000	0.021	0.000	1.000
Anxiety Intercept (ItcA, Baseline)	0.000	0.018	0.000	1.000
Insomnia Slope (SlopeI, Change T1-T2)	0.000	0.028	0.000	1.000
Anxiety Slope (SlopeA, Change T1-T2)	0.000	0.024	0.000	1.000
Growth Factor (Co)Variances				
Variances:				
Var(ItcI)	0.140	0.032	4.431	<.001
Var(ItcA)	0.166	0.019	8.588	<.001
Var(SlopeI)	0.086	0.022	3.962	<.001
Var(SlopeA)	0.018	0.013	1.346	0.178
Covariances (Selected):				
Cov(ItcI, ItcA)	0.106	0.013	8.205	<.001
Cov(ItcA, SlopeI)	-0.006	0.015	-0.403	0.687
Cov(ItcA, SlopeA)[c]	0.041	0.014	2.972	0.003
Cov(SlopeI, SlopeA)[c]	0.111	0.017	6.413	<.001
Residual Variances of Latent Factors (Time-Specific)[a]				
Insomnia (In)	0.113	0.016	7.055	<.001
Anxiety (An)	0.055	0.009	6.314	<.001

$$

```
## Multivariate Linear LGM

MLlgm <- '
insomnia_severity1 =~ igi_1a.1 + igi_1b.1 + igi_1c.1 + igi_2.1 + igi_3.1 + igi_4.1 + igi_5.1
insomnia_severity2 =~ igi_1a.2 + igi_1b.2 + igi_1c.2 + igi_2.2 + igi_3.2 + igi_4.2 + igi_5.2

anxiety1 =~ ehad_1.1 + ehad_3.1 + ehad_5.1 + ehad_7.1 + ehad_9.1 + ehad_11.1 + ehad_13.1
anxiety2 =~ ehad_1.2 + ehad_3.2 + ehad_5.2 + ehad_7.2 + ehad_9.2 + ehad_11.2 + ehad_13.2

#Level/Intercept (all constraint to 1)
ItcI =~ 1*insomnia_severity1 + 1*insomnia_severity2
ItcA =~ 1*anxiety1 + 1*anxiety2

# Slope
SlopeI =~ 0*insomnia_severity1 + 1*insomnia_severity2
SlopeA =~ 0*anxiety1 + 1*anxiety2

#Residuals (Equality constraints)
insomnia_severity1 ~~ In*insomnia_severity1
insomnia_severity2 ~~ In*insomnia_severity2


anxiety1 ~~ An*anxiety1
anxiety2 ~~ An*anxiety2


#Intercept & slope means
ItcI~1
ItcA~1
SlopeI~1
SlopeA~1

#Intercept & slope variances
ItcI ~~ ItcI
ItcI ~~ ItcA
ItcI ~~ SlopeI
ItcI ~~ SlopeA
ItcA ~~ ItcA
ItcA ~~ SlopeI
ItcA ~~ SlopeA
SlopeI ~~ SlopeI
SlopeI ~~ SlopeA
SlopeA ~~ SlopeA
'

#creating a new object 'MLlgm' & running a SEM model
fit_MLlgm <- lavaan(MLlgm, data=wide_data, estimator = "DWLS",
                    auto.var=TRUE, auto.fix.first=TRUE, auto.cov.lv.x=TRUE,
                    meanstructure = TRUE, int.ov.free = TRUE)

#getting summary of model estimates (fit & parameters)
summary(fit_MLlgm, fit.measures=TRUE)
```

```
## lavaan 0.6-19 ended normally after 62 iterations
##
##   Estimator                                         DWLS
##   Optimization method                           NLMINB
##   Number of model parameters                        98
##   Number of equality constraints                     2
##
##                                                   Used       Total
##   Number of observations                           199         227
##
## Model Test User Model:
##
##   Test statistic                               510.288
##   Degrees of freedom                               338
##   P-value (Chi-square)                           0.000
##
## Model Test Baseline Model:
##
##   Test statistic                              5309.189
##   Degrees of freedom                               378
##   P-value                                        0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.965
##   Tucker-Lewis Index (TLI)                       0.961
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.051
##   90 Percent confidence interval - lower         0.042
##   90 Percent confidence interval - upper         0.060
##   P-value H_0: RMSEA <= 0.050                    0.437
##   P-value H_0: RMSEA >= 0.080                    0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.080
##
## Parameter Estimates:
##
##   Standard errors                             Standard
##   Information                                 Expected
##   Information saturated (h1) model        Unstructured
##
## Latent Variables:
##                        Estimate  Std.Err  z-value  P(>|z|)
##   insomnia_severity1 =~
##     igi_1a.1              1.000
##     igi_1b.1              1.006    0.112    8.973    0.000
##     igi_1c.1              0.589    0.093    6.316    0.000
##     igi_2.1               0.666    0.075    8.846    0.000
##     igi_3.1               1.188    0.126    9.398    0.000
##     igi_4.1               1.280    0.141    9.089    0.000
```

```
##     igi_5.1               1.082    0.118    9.162    0.000
##   insomnia_severity2 =~
##     igi_1a.2              1.000
##     igi_1b.2              1.236    0.098   12.563    0.000
##     igi_1c.2              1.040    0.090   11.572    0.000
##     igi_2.2               1.231    0.097   12.710    0.000
##     igi_3.2               1.283    0.100   12.818    0.000
##     igi_4.2               1.065    0.087   12.262    0.000
##     igi_5.2               1.606    0.121   13.264    0.000
##   anxiety1 =~
##     ehad_1.1              1.000
##     ehad_3.1              1.466    0.108   13.526    0.000
##     ehad_5.1              0.914    0.073   12.453    0.000
##     ehad_7.1              0.615    0.059   10.495    0.000
##     ehad_9.1              1.054    0.087   12.089    0.000
##     ehad_11.1             1.129    0.094   11.956    0.000
##     ehad_13.1             0.940    0.077   12.275    0.000
##   anxiety2 =~
##     ehad_1.2              1.000
##     ehad_3.2              1.145    0.076   15.132    0.000
##     ehad_5.2              1.211    0.077   15.773    0.000
##     ehad_7.2              0.725    0.052   13.804    0.000
##     ehad_9.2              0.956    0.064   15.006    0.000
##     ehad_11.2             0.960    0.068   14.090    0.000
##     ehad_13.2             0.685    0.049   13.867    0.000
##   ItcI =~
##     insomni_svrty1        1.000
##     insomni_svrty2        1.000
##   ItcA =~
##     anxiety1              1.000
##     anxiety2              1.000
##   SlopeI =~
##     insomni_svrty1        0.000
##     insomni_svrty2        1.000
##   SlopeA =~
##     anxiety1              0.000
##     anxiety2              1.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   ItcI ~~
##     ItcA              0.106    0.013    8.205    0.000
##     SlopeI            0.036    0.024    1.550    0.121
##     SlopeA           -0.014    0.013   -1.083    0.279
##   ItcA ~~
##     SlopeI           -0.006    0.015   -0.403    0.687
##     SlopeA            0.041    0.014    2.972    0.003
##   SlopeI ~~
##     SlopeA            0.111    0.017    6.413    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##     ItcI              0.000    0.021    0.000    1.000
##     ItcA              0.000    0.018    0.000    1.000
```

```
##     SlopeI            0.000    0.028    0.000    1.000
##     SlopeA            0.000    0.024    0.000    1.000
##    .igi_1a.1          2.593    0.077   33.746    0.000
##    .igi_1b.1          2.704    0.058   46.322    0.000
##    .igi_1c.1          2.663    0.073   36.553    0.000
##    .igi_2.1           3.553    0.046   76.852    0.000
##    .igi_3.1           2.965    0.056   52.817    0.000
##    .igi_4.1           1.879    0.066   28.284    0.000
##    .igi_5.1           3.025    0.060   50.498    0.000
##    .igi_1a.2          1.533    0.077   19.932    0.000
##    .igi_1b.2          1.789    0.073   24.451    0.000
##    .igi_1c.2          1.663    0.078   21.393    0.000
##    .igi_2.2           2.362    0.073   32.438    0.000
##    .igi_3.2           2.030    0.071   28.478    0.000
##    .igi_4.2           1.236    0.071   17.302    0.000
##    .igi_5.2           1.769    0.073   24.199    0.000
##    .ehad_1.1          1.970    0.051   38.589    0.000
##    .ehad_3.1          1.568    0.058   27.198    0.000
##    .ehad_5.1          2.146    0.052   40.874    0.000
##    .ehad_7.1          1.678    0.047   35.689    0.000
##    .ehad_9.1          1.025    0.054   18.890    0.000
##    .ehad_11.1         1.271    0.063   20.088    0.000
##    .ehad_13.1         0.698    0.050   14.040    0.000
##    .ehad_1.2          1.563    0.050   31.506    0.000
##    .ehad_3.2          1.231    0.059   20.727    0.000
##    .ehad_5.2          1.704    0.056   30.445    0.000
##    .ehad_7.2          1.352    0.051   26.437    0.000
##    .ehad_9.2          0.824    0.052   15.706    0.000
##    .ehad_11.2         0.879    0.060   14.584    0.000
##    .ehad_13.2         0.452    0.046    9.877    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .insmn_sv1 (In)    0.113    0.016    7.055    0.000
##    .insmn_sv2 (In)    0.113    0.016    7.055    0.000
##    .anxiety1  (An)    0.055    0.009    6.314    0.000
##    .anxiety2  (An)    0.055    0.009    6.314    0.000
##     ItcI              0.140    0.032    4.431    0.000
##     ItcA              0.166    0.019    8.588    0.000
##     SlopeI            0.086    0.022    3.962    0.000
##     SlopeA            0.018    0.013    1.346    0.178
##    .igi_1a.1          1.151    0.133    8.670    0.000
##    .igi_1b.1          0.509    0.071    7.186    0.000
##    .igi_1c.1          1.026    0.101   10.131    0.000
##    .igi_2.1           0.318    0.096    3.307    0.001
##    .igi_3.1           0.384    0.085    4.502    0.000
##    .igi_4.1           0.753    0.118    6.386    0.000
##    .igi_5.1           0.537    0.088    6.106    0.000
##    .igi_1a.2          0.889    0.115    7.706    0.000
##    .igi_1b.2          0.608    0.116    5.227    0.000
##    .igi_1c.2          0.900    0.123    7.346    0.000
##    .igi_2.2           0.597    0.109    5.497    0.000
##    .igi_3.2           0.502    0.117    4.294    0.000
##    .igi_4.2           0.653    0.103    6.357    0.000
```

```
##    .igi_5.2          0.389    0.139    2.800    0.005
##    .ehad_1.1         0.353    0.046    7.642    0.000
##    .ehad_3.1         0.477    0.084    5.658    0.000
##    .ehad_5.1         0.415    0.058    7.180    0.000
##    .ehad_7.1         0.368    0.052    7.042    0.000
##    .ehad_9.1         0.425    0.074    5.738    0.000
##    .ehad_11.1        0.694    0.079    8.838    0.000
##    .ehad_13.1        0.339    0.063    5.386    0.000
##    .ehad_1.2         0.230    0.055    4.171    0.000
##    .ehad_3.2         0.486    0.076    6.403    0.000
##    .ehad_5.2         0.346    0.072    4.837    0.000
##    .ehad_7.2         0.384    0.052    7.445    0.000
##    .ehad_9.2         0.328    0.071    4.605    0.000
##    .ehad_11.2        0.559    0.087    6.435    0.000
##    .ehad_13.2        0.280    0.059    4.723    0.000
```