Online supplement to accompany Preacher, K. J., & Yaremych, H. E. (2023). Model selection in structural equation modeling. In Hoyle, R. H. (Ed.), *Handbook of structural equation modeling* (2nd ed.) (pp. 206-222). The Guilford Press.

## EMPIRICAL ILLUSTRATIONS

To illustrate some key concepts from the foregoing discussion, we rely on two examples from published research using SEM.

*Example 1: Yang (2016)*

First is an application of SEM model selection reported by Yang (2016). The author explored six competing models using data from $N = 341$ insurance company employees in Taiwan. Models were fit to 39 variables, but summary statistics for scale-level data were provided in the article in the form of means, standard deviations, and a 12 × 12 correlation matrix, which were sufficient to partially replicate the author's findings and provide an opportunity to illustrate and interpret several selection criteria.

In all 6 models, *transformational leadership* (TL, latent, six indicators) was the primary predictor and *job satisfaction* (SAT, latent, two indicators) was the primary outcome. The models differed principally in how the other two variables—*leadership trust* (TR, measured) and *change commitment* (COM, latent, three indicators)—were assigned the roles of covariate or mediator. No covariance parameters were permitted among exogenous predictors or among residuals. All six models are depicted in Figure A1, with only principal variables represented for brevity.

We fit all 6 models to the reconstructed covariance matrix using *lavaan* v. 0.6-8 (Rosseel, 2012) and M*plus* 8.6 (Muthén & Muthén, 1998-2017). Several selection criteria[1] from Table 1 are listed for the 6 models in Table A1. BMS is omitted because we had no prior information to incorporate. NML, SC, and FIA are omitted due to intractable multidimensional integration. In this example, the reported selection criteria all tell the same story: Models M5 and M6—which are statistically equivalent (Lee & Hershberger, 1990) and hence have the same values for $q$, $df$,

[1] Most criteria were provided by *lavaan* v. 0.6-8 (Rosseel, 2012). HBIC, IBIC, and SIC were obtained using *semTools* v. 0.5-5.905 (Jorgensen et al., 2021).

and ln*L*—are the preferred models. These are followed by M4, M2, M3, and M1, in that order (the same ranking reported by Yang [2016] for the full models). The SIC values differ for M5 and M6 even though, in theory, $\left|\hat{\boldsymbol{\Sigma}}(\theta)\right|$ should be identical across parameterizations. We attribute this difference to minute differences in the precision with which elements of $\hat{\boldsymbol{\Sigma}}(\theta)$ are estimated, which can have a noticeable impact on determinant computation. We recommend using as much precision as possible when computing criteria that include $\left|\hat{\boldsymbol{\Sigma}}(\theta)\right|$.

Adequate absolute fit was reported for all 6 models. Ultimately, Yang (2016) selected M5 over M6 because M5 had better theoretical support, underscoring the importance of substantive expertise in model selection. M*plus* and *lavaan* code, data, and output are provided below.

*Example 2: Tong, He, & Deacon (2017)*

Our second example is drawn from Tong, He and Deacon's (2017) study of prosody in Cantonese-English bilingual children. The authors compared three models for conjectured mechanisms by which Chinese lexical tone influences English word reading. Data were collected from 123 second-grade children. Tong et al. (2017) provided means, standard deviations, and a 10 × 10 correlation matrix of observed variables.

In all 3 of Tong et al.'s (2017) models, *tone sensitivity* (TS, latent, two indicators) was the primary predictor and *English word reading* (EWR, latent, two indicators) was the primary outcome. The models differed principally in how the other four variables—*Chinese segmental phonological awareness* (CSPA, latent, two indicators), *English segmental phonological awareness* (ESPA, latent, two indicators), *stress sensitivity* (SS, measured), and *nonverbal ability* (IQ, measured)—were assigned the roles of covariate or mediator. Covariance parameters were freely estimated among exogenous predictors. All three models are depicted in Figure A2, with

only principal variables represented for brevity.

We fit all 3 models to the reconstructed covariance matrix using *lavaan* v. 0.6-8 (Rosseel, 2012) and M*plus* 8.6 (Muthén & Muthén, 1998-2017). We obtained the same selection criteria as in the first example, which are listed for all 3 models in Table A2. Model rankings implied by ECVI, AIC, and BIC indicated that Model C was superior, followed by Model B, then Model A (C > B > A). These agree with the rankings reported by the authors, which were based on CFI, NNFI, RMSEA, AIC, and $AIC_c$. However, HBIC, IBIC, and SIC yielded the ranking A > B > C, reversing the order reported by Tong et al. (2017). Importantly, this example demonstrates that information criteria that consider structural complexity often yield rankings that are different from those that do not. In such situations, the role of substantive expertise and theory becomes even more important for model selection.

Adequate absolute fit was reported for all 3 models. Ultimately, Tong et al. (2017) selected Model C because of its marginally better AIC and $AIC_c$. M*plus* and *lavaan* code, data, and output are provided below.

## REFERENCES


Jorgensen, T. D., Pornprasertmanit, S., Schoemann, A. M., & Rosseel, Y. (2021). *semTools: Useful tools for structural equation modeling*. R package version 0.5-5.905. Retrieved from https://CRAN.R-project.org/package=semTools

Lee., S., & Hershberger, S. L. (1990). A simple rule for generating equivalent models in covariance structure modeling. *Multivariate Behavioral Research*, *25*, 313-334.

Muthén, L. K., & Muthén, B. O. (1998-2017). *Mplus user's guide* (8th ed.). Muthén & Muthén.

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, *48*, 1-36.

Tong, X., He, X., & Deacon, S. H. (2017). Tone matters for Cantonese-English bilingual children's English word reading development: A unified model of phonological transfer. *Memory & Cognition*, *45*, 320-333.

Yang, Y.-F. (2016). Examining competing models of transformational leadership, leadership trust, change commitment, and job satisfaction. *Psychological Reports*, *119*, 154-173.

*Table A1*. Information criteria for our partial replication of Yang's (2016) analyses.

| Criterion | M1 | M2 | M3 | M4 | M5 | M6 |
|---|---|---|---|---|---|---|
| ECVI | 0.802 | 0.676 | 0.715 | 0.580 | *0.562* | *0.562* |
| AIC | 5734.242 | 5691.150 | 5704.605 | 5658.660 | *5652.284* | *5652.284* |
| BIC | 5833.871 | 5794.611 | 5808.066 | 5765.953 | *5763.408* | *5763.408* |
| HBIC | 5786.086 | 5744.988 | 5758.443 | 5714.492 | *5710.110* | *5710.110* |
| IBIC | 5813.023 | 5771.233 | 5785.429 | 5740.908 | *5737.277* | *5735.407* |
| SIC | 5860.808 | 5820.856 | 5835.051 | 5792.368 | *5790.575* | *5788.705* |
| ln*L* | -2841.121 | -2818.575 | -2825.303 | -2801.330 | -2797.142 | -2797.142 |
| $\chi^2$ | 221.533 | 176.440 | 189.895 | 141.950 | 133.574 | 133.574 |
| *df* | 52 | 51 | 51 | 50 | 49 | 49 |
| *q* | 26 | 27 | 27 | 28 | 29 | 29 |

*Note*. M1-M6: Models 1-6 described by Yang (2016); ECVI: Expected Cross-Validation Index; AIC: (Akaike's) An Information Criterion; BIC: Bayesian Information criterion; HBIC: Haughton's BIC; IBIC: Information Matrix-Based BIC; SIC: Stochastic Information Complexity; ln*L* = log-likelihood; $\chi^2$ = chi-square statistic; *df* = degrees of freedom; *q* = number of free parameters. The lowest value(s) for each criterion are underlined and italicized for emphasis. All of these quantities are reported by *lavaan* except for HBIC, IBIC, and SIC, which are reported by *semTools* in conjunction with *lavaan*.

*Table A2*. Information criteria for our replication of Tong et al.'s (2017) analyses.

| Criterion | Model A | Model B | Model C |
|---|---|---|---|
| ECVI | 0.849 | 0.819 | *0.811* |
| AIC | 6720.591 | 6716.869 | *6715.948* |
| BIC | 6802.144 | 6789.986 | *6786.253* |
| HBIC | *6609.292* | 6617.084 | 6620.001 |
| IBIC | *6636.656* | 6645.528 | 6652.378 |
| SIC | *6689.954* | 6693.313 | 6698.325 |
| ln*L* | -3331.295 | -3332.434 | -3332.974 |
| $\chi^2$ | 46.426 | 48.704 | 49.783 |
| *df* | 26 | 29 | 30 |
| *q* | 29 | 26 | 25 |

*Note*. Models A-C: Models described by Tong et al. (2017); ECVI: Expected Cross-Validation Index; AIC: (Akaike's) An Information Criterion; BIC: Bayesian Information criterion; HBIC: Haughton's BIC; IBIC: Information Matrix-Based BIC; SIC: Stochastic Information Complexity; ln*L* = log-likelihood; $\chi^2$ = chi-square statistic; *df* = degrees of freedom; *q* = number of free parameters. The lowest value(s) for each criterion are underlined and italicized for emphasis. All of these quantities are reported by *lavaan* except for HBIC, IBIC, and SIC, which are reported by *semTools* in conjunction with *lavaan*.

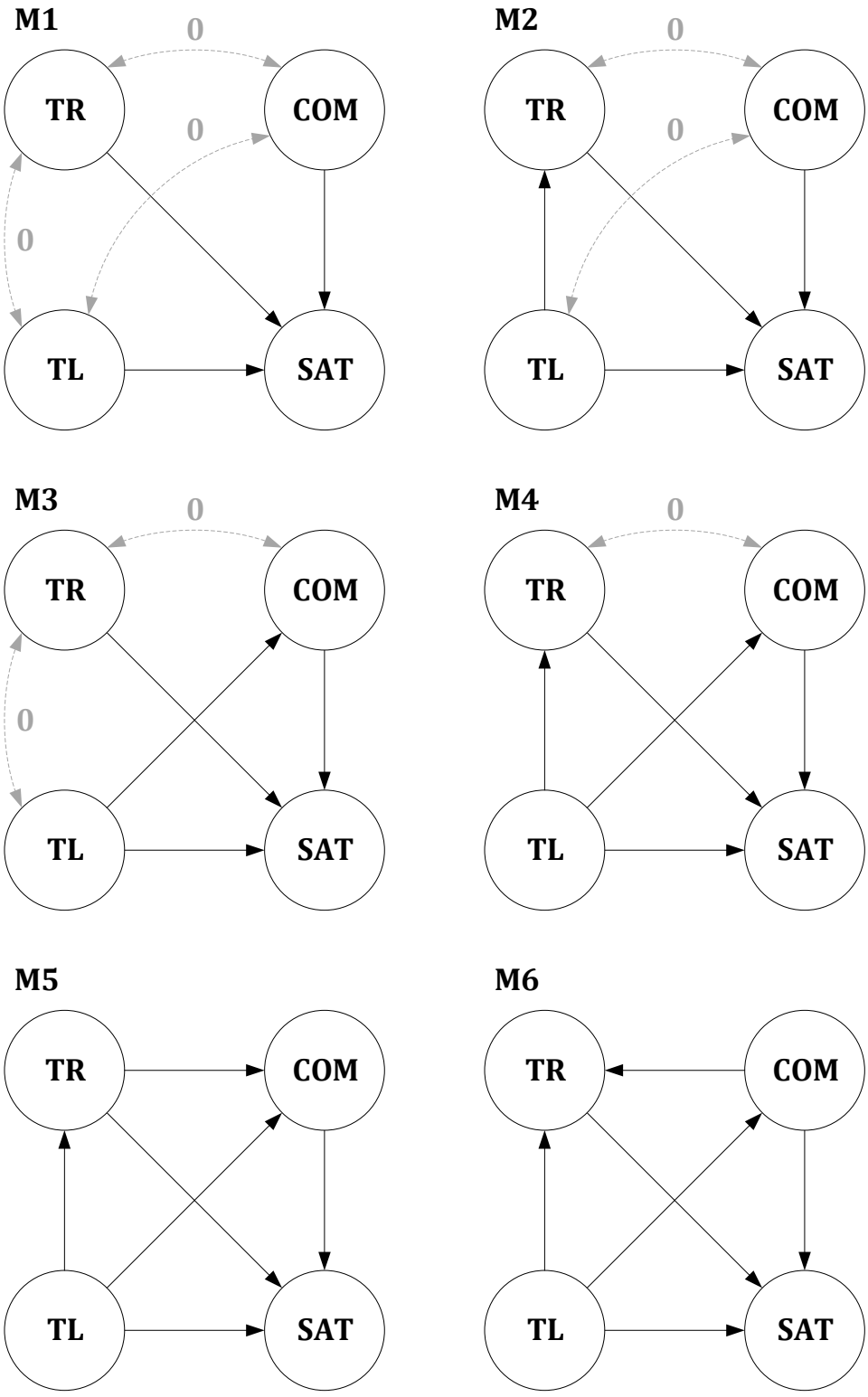


*Figure A1. Yang's (2016) six rival models.*

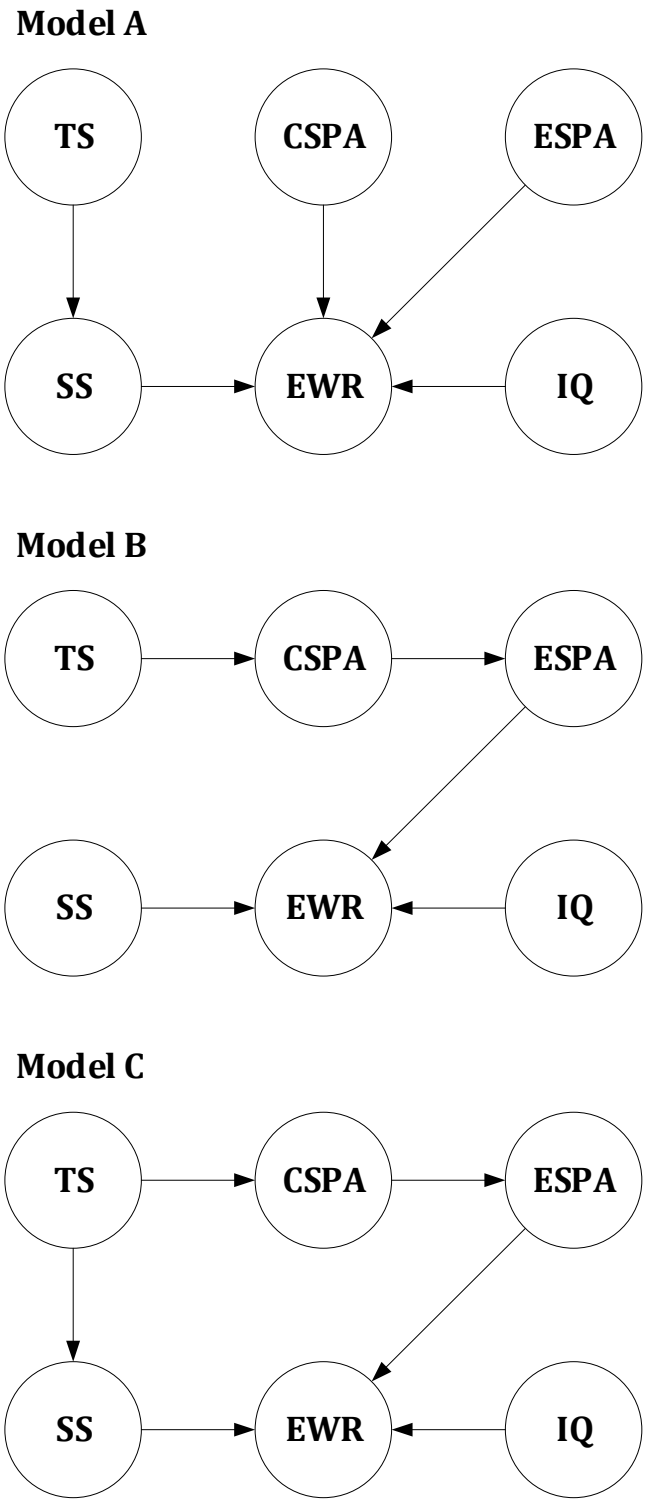


*Figure A2. Tong et al.'s (2017) three rival models. Although not depicted, all exogenous predictor covariances are estimated.*

**LAVAAN CODE FOR YANG'S (2016) MODELS AND OBTAINING SELECTION CRITERIA**

```
library(lavaan) #load and attach lavaan (must be installed)
library(semTools) #load and attach semTools (must be installed)

#yang data
p <- 12
yang.cor <- matrix(c(1,.51,.36,.40,.39,.33,.29,.23,.17,.17,.33,.29,
.51,1,.40,.38,.39,.31,.24,.12,.09,.13,.19,.20,
.36,.40,1,.56,.57,.47,.29,.23,.20,.24,.30,.27,
.40,.38,.56,1,.59,.50,.21,.19,.15,.08,.20,.22,
.39,.39,.57,.59,1,.58,.27,.31,.18,.20,.30,.30,
.33,.31,.47,.50,.58,1,.32,.29,.24,.27,.24,.21,
.29,.24,.29,.21,.27,.32,1,.26,.20,.23,.42,.40,
.23,.12,.23,.19,.31,.29,.26,1,.45,.39,.42,.31,
.17,.09,.20,.15,.18,.24,.20,.45,1,.61,.33,.35,
.17,.13,.24,.08,.20,.27,.23,.39,.61,1,.30,.32,
.33,.19,.30,.20,.30,.24,.42,.42,.33,.30,1,.42,
.29,.20,.27,.22,.30,.21,.40,.31,.35,.32,.42,1
),p,p)
yang.sds <- c(.53, .59, .57, .57, .60, .57, .52, .55, .57, .58, .53, .52)
yang.cov <- cor2cov(sds=yang.sds, R=yang.cor, names=paste0("v", seq(1,p)))

#syntax for Model 1
mod1 <- 'tl =~ v1 + v2 + v3 + v4 + v5 + v6
  com =~ v8 + v9 + v10
  sat =~ v11 + v12
  com ~~ com
  tl ~~ tl
  tl ~~ 0*com
  sat ~ tl + v7 + com
  sat ~~ sat
  v1 ~~ v1
  v2 ~~ v2
```

```
  v3 ~~ v3
  v4 ~~ v4
  v5 ~~ v5
  v6 ~~ v6
  v7 ~~ v7
  v8 ~~ v8
  v9 ~~ v9
  v10 ~~ v10
  v11 ~~ v11
  v12 ~~ v12'

mod1.fit <- sem(mod1, sample.cov=yang.cov, sample.nobs=341) #fit Model 1
summary(mod1.fit) #display Model 1 output
fitMeasures(mod1.fit) #report all lavaan fit measures
moreFitIndices(mod1.fit) #report additional semTools fit measures

#syntax for Model 2
mod2 <- 'tl =~ v1 + v2 + v3 + v4 + v5 + v6
  com =~ v8 + v9 + v10
  sat =~ v11 + v12
  v7 ~ tl
  sat ~ tl + v7 + com
  com ~~ com
  tl ~~ tl
  sat ~~ sat
  com ~~ 0*v7
  com ~~ 0*tl
  v1 ~~ v1
  v2 ~~ v2
  v3 ~~ v3
  v4 ~~ v4
  v5 ~~ v5
  v6 ~~ v6
  v7 ~~ v7
```

```
  v8 ~~ v8
  v9 ~~ v9
  v10 ~~ v10
  v11 ~~ v11
  v12 ~~ v12'

mod2.fit <- sem(mod2, sample.cov=yang.cov, sample.nobs=341) #fit Model 2
summary(mod2.fit) #display Model 2 output
fitMeasures(mod2.fit) #report all lavaan fit measures
moreFitIndices(mod2.fit) #report additional semTools fit measures

#syntax for Model 3
mod3 <- 'tl =~ v1 + v2 + v3 + v4 + v5 + v6
  com =~ v8 + v9 + v10
  sat =~ v11 + v12
  com ~ tl
  sat ~ tl + v7 + com
  com ~~ com
  tl ~~ tl
  sat ~~ sat
  com ~~ 0*v7
  tl ~~ 0*v7
  v1 ~~ v1
  v2 ~~ v2
  v3 ~~ v3
  v4 ~~ v4
  v5 ~~ v5
  v6 ~~ v6
  v7 ~~ v7
  v8 ~~ v8
  v9 ~~ v9
  v10 ~~ v10
  v11 ~~ v11
  v12 ~~ v12'
```

```
mod3.fit <- sem(mod3, sample.cov=yang.cov, sample.nobs=341) #fit Model 3
summary(mod3.fit) #display Model 3 output
fitMeasures(mod3.fit) #report all lavaan fit measures
moreFitIndices(mod3.fit) #report additional semTools fit measures

#syntax for Model 4
mod4 <- 'tl =~ v1 + v2 + v3 + v4 + v5 + v6
  com =~ v8 + v9 + v10
  sat =~ v11 + v12
  sat ~ tl + v7 + com
  v7 ~ tl
  com ~ tl
  com ~~ com
  tl ~~ tl
  sat ~~ sat
  com ~~ 0*v7
  v1 ~~ v1
  v2 ~~ v2
  v3 ~~ v3
  v4 ~~ v4
  v5 ~~ v5
  v6 ~~ v6
  v7 ~~ v7
  v8 ~~ v8
  v9 ~~ v9
  v10 ~~ v10
  v11 ~~ v11
  v12 ~~ v12'

mod4.fit <- sem(mod4, sample.cov=yang.cov, sample.nobs=341) #fit Model 4
summary(mod4.fit) #display Model 4 output
fitMeasures(mod4.fit) #report all lavaan fit measures
moreFitIndices(mod4.fit) #report additional semTools fit measures
```

```
#syntax for Model 5
mod5 <- 'tl =~ v1 + v2 + v3 + v4 + v5 + v6
  com =~ v8 + v9 + v10
  sat =~ v11 + v12
  sat ~ tl + v7 + com
  com ~ tl + v7
  v7 ~ tl
  tl ~~ tl
  com ~~ com
  sat ~~ sat
  v1 ~~ v1
  v2 ~~ v2
  v3 ~~ v3
  v4 ~~ v4
  v5 ~~ v5
  v6 ~~ v6
  v7 ~~ v7
  v8 ~~ v8
  v9 ~~ v9
  v10 ~~ v10
  v11 ~~ v11
  v12 ~~ v12'

mod5.fit <- sem(mod5, sample.cov=yang.cov, sample.nobs=341) #fit Model 5
summary(mod5.fit) #display Model 5 output
fitMeasures(mod5.fit) #report all lavaan fit measures
moreFitIndices(mod5.fit) #report additional semTools fit measures

#syntax for Model 6
mod6 <- 'tl =~ v1 + v2 + v3 + v4 + v5 + v6
  com =~ v8 + v9 + v10
  sat =~ v11 + v12
  sat ~ tl + v7 + com
```

```
  v7 ~ tl + com
  com ~ tl
  tl ~~ tl
  com ~~ com
  sat ~~ sat
  v1 ~~ v1
  v2 ~~ v2
  v3 ~~ v3
  v4 ~~ v4
  v5 ~~ v5
  v6 ~~ v6
  v7 ~~ v7
  v8 ~~ v8
  v9 ~~ v9
  v10 ~~ v10
  v11 ~~ v11
  v12 ~~ v12'

mod6.fit <- sem(mod6, sample.cov=yang.cov, sample.nobs=341) #fit Model 6
summary(mod6.fit) #display Model 6 output
fitMeasures(mod6.fit) #report all lavaan fit measures
moreFitIndices(mod6.fit) #report additional semTools fit measures
```

**MPLUS CODE FOR RUNNING YANG'S (2016) MODELS AND OBTAINING THE ASYMPTOTIC COVARIANCE MATRIX OF PARAMETER ESTIMATES FOR MANUAL COMPUTATION OF LOG(DET(I))**

```
TITLE: Yang 2016;
DATA: FILE IS yang.nomeans.dat;
TYPE IS CORRELATION STDEVIATIONS;
NOBSERVATIONS IS 341;
VARIABLE: NAMES = agg hpe is am aav pis tr acc ccc ncc ijs ejs;
ANALYSIS: MODEL = NOMEANSTRUCTURE;
MODEL: tl BY agg hpe is am aav pis; com BY acc ccc ncc; sat BY ijs ejs;
```

```
!UNCOMMENT ONE LINE BELOW TO RUN DESIRED MODEL
!sat ON tl tr com; com tl tr WITH com@0 tl@0 tr@0; !MODEL 1
!tr ON tl; sat ON tl tr com; com WITH tr@0 tl@0;   !MODEL 2
!com ON tl; sat ON tl com tr; tr WITH com@0 tl@0;  !MODEL 3
!tr com sat ON tl; sat ON tr com;                 !MODEL 4
!tr com sat ON tl; com sat ON tr; sat ON com;     !MODEL 5
!com tr sat ON tl; tr sat ON com; sat on tr;      !MODEL 6

OUTPUT: TECH1 TECH3; !REQUEST ASYMPTOTIC COVARIANCE MATRIX
```

**YANG'S (2016) SUMMARY DATA (YANG.NOMEANS.DAT)**

```
.53 .59 .57 .57 .60 .57 .52 .55 .57 .58 .53 .52
  1
  .51 1
  .36 .40 1
  .40 .38 .56 1
  .39 .39 .57 .59 1
  .33 .31 .47 .50 .58 1
  .29 .24 .29 .21 .27 .32 1
  .23 .12 .23 .19 .31 .29 .26 1
  .17 .09 .20 .15 .18 .24 .20 .45 1
  .17 .13 .24 .08 .20 .27 .23 .39 .61 1
  .33 .19 .30 .20 .30 .24 .42 .42 .33 .30 1
  .29 .20 .27 .22 .30 .21 .40 .31 .35 .32 .42 1
```

**EXAMPLE MPLUS OUTPUT FOR YANG'S (2016) MODEL 1**

```
Mplus VERSION 8.6
MUTHEN & MUTHEN
08/28/2021   3:55 PM

INPUT INSTRUCTIONS
```

```
  TITLE: Yang 2016;
  DATA: FILE IS yang.nomeans.dat;
  TYPE IS CORRELATION STDEVIATIONS;
  NOBSERVATIONS IS 341;
  VARIABLE: NAMES = agg hpe is am aav pis tr acc ccc ncc ijs ejs;
  ANALYSIS: MODEL = NOMEANSTRUCTURE;
  MODEL: tl BY agg hpe is am aav pis; com BY acc ccc ncc; sat BY ijs ejs;

  !UNCOMMENT ONE LINE BELOW TO RUN DESIRED MODEL
  sat ON tl tr com; com tl tr WITH com@0 tl@0 tr@0; !MODEL 1
  !tr ON tl; sat ON tl tr com; com WITH tr@0 tl@0;   !MODEL 2
  !com ON tl; sat ON tl com tr; tr WITH com@0 tl@0;  !MODEL 3
  !tr com sat ON tl; sat ON tr com;                  !MODEL 4
  !tr com sat ON tl; com sat ON tr; sat ON com;      !MODEL 5
  !com tr sat ON tl; tr sat ON com; sat on tr;       !MODEL 6

  OUTPUT: TECH1 TECH3; !REQUEST ASYMPTOTIC COVARIANCE MATRIX
```

INPUT READING TERMINATED NORMALLY

Yang 2016;

SUMMARY OF ANALYSIS

| | |
|---|---|
| Number of groups | 1 |
| Number of observations | 341 |
| Number of dependent variables | 11 |
| Number of independent variables | 1 |
| Number of continuous latent variables | 3 |

Observed dependent variables

  Continuous
   AGG         HPE         IS          AM          AAV         PIS
   ACC         CCC         NCC         IJS         EJS

Observed independent variables
   TR

Continuous latent variables
   TL          COM         SAT

| | |
|---|---|
| Estimator | ML |
| Information matrix | EXPECTED |
| Maximum number of iterations | 1000 |
| Convergence criterion | 0.500D-04 |
| Maximum number of steepest descent iterations | 20 |

Input data file(s)
  yang.nomeans.dat

Input data format  FREE

THE MODEL ESTIMATION TERMINATED NORMALLY

MODEL FIT INFORMATION

Number of Free Parameters                       26

Loglikelihood

| | |
|---|---|
| H0 Value | -2841.121 |
| H1 Value | -2730.355 |

Information Criteria

| | |
|---|---|
| Akaike (AIC) | 5734.242 |
| Bayesian (BIC) | 5833.871 |
| Sample-Size Adjusted BIC (n* = (n + 2) / 24) | 5751.394 |

Chi-Square Test of Model Fit

| | |
|---|---|
| Value | 221.533 |
| Degrees of Freedom | 52 |
| P-Value | 0.0000 |

RMSEA (Root Mean Square Error Of Approximation)

| | | |
|---|---|---|
| Estimate | 0.098 | |
| 90 Percent C.I. | 0.085 | 0.111 |
| Probability RMSEA <= .05 | 0.000 | |

CFI/TLI

| | |
|---|---|
| CFI | 0.869 |
| TLI | 0.834 |

Chi-Square Test of Model Fit for the Baseline Model

| | |
|---|---|
| Value | 1361.018 |
| Degrees of Freedom | 66 |

P-Value 0.0000

SRMR (Standardized Root Mean Square Residual)

Value 0.154

MODEL RESULTS

| | | Estimate | S.E. | Est./S.E. | Two-Tailed P-Value |
|---|---|---|---|---|---|
| TL | BY | | | | |
| AGG | | 1.000 | 0.000 | 999.000 | 999.000 |
| HPE | | 1.102 | 0.143 | 7.692 | 0.000 |
| IS | | 1.424 | 0.155 | 9.215 | 0.000 |
| AM | | 1.470 | 0.157 | 9.371 | 0.000 |
| AAV | | 1.646 | 0.171 | 9.644 | 0.000 |
| PIS | | 1.317 | 0.149 | 8.821 | 0.000 |
| COM | BY | | | | |
| ACC | | 1.000 | 0.000 | 999.000 | 999.000 |
| CCC | | 1.530 | 0.174 | 8.770 | 0.000 |
| NCC | | 1.371 | 0.155 | 8.838 | 0.000 |
| SAT | BY | | | | |
| IJS | | 1.000 | 0.000 | 999.000 | 999.000 |
| EJS | | 0.954 | 0.131 | 7.296 | 0.000 |
| SAT | ON | | | | |
| TL | | 0.319 | 0.080 | 3.994 | 0.000 |
| COM | | 0.544 | 0.092 | 5.884 | 0.000 |

| | | | | |
|---|---|---|---|---|
| SAT ON | | | | |
| TR | 0.293 | 0.041 | 7.070 | 0.000 |
| COM WITH | | | | |
| TL | 0.000 | 0.000 | 999.000 | 999.000 |
| TR | 0.000 | 0.000 | 999.000 | 999.000 |
| TL WITH | | | | |
| TR | 0.000 | 0.000 | 999.000 | 999.000 |
| Variances | | | | |
| TR | 0.270 | 0.021 | 13.058 | 0.000 |
| TL | 0.083 | 0.016 | 5.061 | 0.000 |
| COM | 0.094 | 0.019 | 4.968 | 0.000 |
| Residual Variances | | | | |
| AGG | 0.197 | 0.016 | 12.085 | 0.000 |
| HPE | 0.246 | 0.020 | 12.111 | 0.000 |
| IS | 0.155 | 0.015 | 10.509 | 0.000 |
| AM | 0.144 | 0.014 | 10.116 | 0.000 |
| AAV | 0.133 | 0.015 | 9.085 | 0.000 |
| PIS | 0.179 | 0.016 | 11.185 | 0.000 |
| ACC | 0.207 | 0.018 | 11.411 | 0.000 |
| CCC | 0.104 | 0.020 | 5.233 | 0.000 |
| NCC | 0.158 | 0.019 | 8.262 | 0.000 |
| IJS | 0.159 | 0.017 | 9.163 | 0.000 |
| EJS | 0.160 | 0.017 | 9.609 | 0.000 |
| SAT | 0.034 | 0.013 | 2.681 | 0.007 |

QUALITY OF NUMERICAL RESULTS

Condition Number for the Information Matrix (ratio of smallest to largest eigenvalue) 0.617E-03

TECHNICAL 1 OUTPUT

PARAMETER SPECIFICATION

LAMBDA

| | TL | COM | SAT | TR |
|---|---|---|---|---|
| AGG | 0 | 0 | 0 | 0 |
| HPE | 1 | 0 | 0 | 0 |
| IS | 2 | 0 | 0 | 0 |
| AM | 3 | 0 | 0 | 0 |
| AAV | 4 | 0 | 0 | 0 |
| PIS | 5 | 0 | 0 | 0 |
| ACC | 0 | 0 | 0 | 0 |
| CCC | 0 | 6 | 0 | 0 |
| NCC | 0 | 7 | 0 | 0 |
| IJS | 0 | 0 | 0 | 0 |
| EJS | 0 | 0 | 8 | 0 |
| TR | 0 | 0 | 0 | 0 |

THETA

| | AGG | HPE | IS | AM | AAV |
|---|---|---|---|---|---|
| AGG | 9 | | | | |
| HPE | 0 | 10 | | | |
| IS | 0 | 0 | 11 | | |
| AM | 0 | 0 | 0 | 12 | |
| AAV | 0 | 0 | 0 | 0 | 13 |
| PIS | 0 | 0 | 0 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| ACC | 0 | 0 | 0 | 0 | 0 |
| CCC | 0 | 0 | 0 | 0 | 0 |
| NCC | 0 | 0 | 0 | 0 | 0 |
| IJS | 0 | 0 | 0 | 0 | 0 |
| EJS | 0 | 0 | 0 | 0 | 0 |
| TR | 0 | 0 | 0 | 0 | 0 |

THETA

| | PIS | ACC | CCC | NCC | IJS |
|---|---|---|---|---|---|
| PIS | 14 | | | | |
| ACC | 0 | 15 | | | |
| CCC | 0 | 0 | 16 | | |
| NCC | 0 | 0 | 0 | 17 | |
| IJS | 0 | 0 | 0 | 0 | 18 |
| EJS | 0 | 0 | 0 | 0 | 0 |
| TR | 0 | 0 | 0 | 0 | 0 |

THETA

| | EJS | TR |
|---|---|---|
| EJS | 19 | |
| TR | 0 | 0 |

BETA

| | TL | COM | SAT | TR |
|---|---|---|---|---|
| TL | 0 | 0 | 0 | 0 |
| COM | 0 | 0 | 0 | 0 |
| SAT | 20 | 21 | 0 | 22 |
| TR | 0 | 0 | 0 | 0 |

PSI

| | TL | COM | SAT | TR |
|---|---|---|---|---|
| TL | 23 | | | |
| COM | 0 | 24 | | |
| SAT | 0 | 0 | 25 | |
| TR | 0 | 0 | 0 | 26 |

STARTING VALUES

LAMBDA

| | TL | COM | SAT | TR |
|---|---|---|---|---|
| AGG | 1.000 | 0.000 | 0.000 | 0.000 |
| HPE | 1.000 | 0.000 | 0.000 | 0.000 |
| IS | 1.000 | 0.000 | 0.000 | 0.000 |
| AM | 1.000 | 0.000 | 0.000 | 0.000 |
| AAV | 1.000 | 0.000 | 0.000 | 0.000 |
| PIS | 1.000 | 0.000 | 0.000 | 0.000 |
| ACC | 0.000 | 1.000 | 0.000 | 0.000 |
| CCC | 0.000 | 1.000 | 0.000 | 0.000 |
| NCC | 0.000 | 1.000 | 0.000 | 0.000 |
| IJS | 0.000 | 0.000 | 1.000 | 0.000 |
| EJS | 0.000 | 0.000 | 1.000 | 0.000 |
| TR | 0.000 | 0.000 | 0.000 | 1.000 |

THETA

| | AGG | HPE | IS | AM | AAV |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| AGG | 0.140 | | | | |
| HPE | 0.000 | 0.174 | | | |
| IS | 0.000 | 0.000 | 0.162 | | |
| AM | 0.000 | 0.000 | 0.000 | 0.162 | |
| AAV | 0.000 | 0.000 | 0.000 | 0.000 | 0.180 |
| PIS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| ACC | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| CCC | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| NCC | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| IJS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| EJS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TR | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

THETA

| | PIS | ACC | CCC | NCC | IJS |
|---|---|---|---|---|---|
| PIS | 0.162 | | | | |
| ACC | 0.000 | 0.151 | | | |
| CCC | 0.000 | 0.000 | 0.162 | | |
| NCC | 0.000 | 0.000 | 0.000 | 0.168 | |
| IJS | 0.000 | 0.000 | 0.000 | 0.000 | 0.140 |
| EJS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TR | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

THETA

| | EJS | TR |
|---|---|---|
| EJS | 0.135 | |
| TR | 0.000 | 0.000 |

BETA

| | TL | COM | SAT | TR |
|---|---|---|---|---|
| TL | 0.000 | 0.000 | 0.000 | 0.000 |
| COM | 0.000 | 0.000 | 0.000 | 0.000 |
| SAT | 0.000 | 0.000 | 0.000 | 0.000 |
| TR | 0.000 | 0.000 | 0.000 | 0.000 |

PSI

| | TL | COM | SAT | TR |
|---|---|---|---|---|
| TL | 0.050 | | | |
| COM | 0.000 | 0.050 | | |
| SAT | 0.000 | 0.000 | 0.050 | |
| TR | 0.000 | 0.000 | 0.000 | 0.135 |

TECHNICAL 3 OUTPUT

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 0.205407D-01 | | | | |
| 2 | 0.130875D-01 | 0.238744D-01 | | | |
| 3 | 0.135161D-01 | 0.174386D-01 | 0.246235D-01 | | |
| 4 | 0.151272D-01 | 0.194953D-01 | 0.201179D-01 | 0.291199D-01 | |
| 5 | 0.121087D-01 | 0.156329D-01 | 0.161427D-01 | 0.180566D-01 | 0.223041D-01 |
| 6 | 0.278074D-19 | 0.718562D-19 | 0.510505D-19 | 0.636691D-19 | 0.592079D-19 |
| 7 | 0.174900D-19 | 0.496210D-19 | 0.359318D-19 | 0.473593D-19 | 0.418542D-19 |
| 8 | -0.791454D-18 | -0.103460D-17 | -0.116814D-17 | -0.113507D-17 | -0.784377D-18 |
| 9 | 0.259558D-03 | 0.339156D-03 | 0.351750D-03 | 0.400451D-03 | 0.311982D-03 |
| 10 | -0.322848D-03 | 0.469729D-05 | 0.665067D-05 | 0.156447D-04 | 0.215496D-05 |
| 11 | -0.104527D-06 | -0.351993D-03 | 0.153082D-04 | 0.360100D-04 | 0.496018D-05 |

| | | | | | |
|---|---|---|---|---|---|
| 12 | -0.122731D-06 | 0.126949D-04 | -0.364583D-03 | 0.422814D-04 | 0.582402D-05 |
| 13 | -0.211089D-06 | 0.218345D-04 | 0.309144D-04 | -0.472204D-03 | 0.100169D-04 |
| 14 | -0.772112D-07 | 0.798650D-05 | 0.113077D-04 | 0.265996D-04 | -0.331439D-03 |
| 15 | 0.185507D-21 | 0.127365D-20 | 0.533743D-21 | 0.106003D-20 | 0.974492D-21 |
| 16 | 0.536149D-21 | -0.213621D-21 | 0.929004D-21 | 0.357691D-21 | 0.345271D-21 |
| 17 | 0.273644D-21 | 0.617266D-21 | 0.335336D-21 | 0.561377D-21 | 0.406129D-21 |
| 18 | -0.122034D-19 | -0.182820D-19 | -0.201499D-19 | -0.208256D-19 | -0.765062D-20 |
| 19 | 0.167913D-19 | 0.237865D-19 | 0.276018D-19 | 0.241640D-19 | 0.157682D-19 |
| 20 | 0.293068D-02 | 0.378598D-02 | 0.391033D-02 | 0.437800D-02 | 0.350242D-02 |
| 21 | 0.161778D-18 | 0.234924D-18 | 0.257617D-18 | 0.252610D-18 | 0.169784D-18 |
| 22 | 0.737894D-20 | 0.191564D-19 | 0.243628D-19 | 0.177256D-19 | -0.185801D-19 |
| 23 | -0.153175D-02 | -0.198222D-02 | -0.204862D-02 | -0.229956D-02 | -0.183218D-02 |
| 24 | -0.954118D-21 | -0.601058D-20 | -0.326052D-20 | -0.455435D-20 | -0.446586D-20 |
| 25 | -0.333384D-08 | 0.344843D-06 | 0.488248D-06 | 0.114853D-05 | 0.158203D-06 |
| 26 | -0.268909D-35 | -0.379230D-35 | -0.428238D-35 | -0.424389D-35 | -0.214247D-35 |

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|
| 6 | 0.304241D-01 | | | | |
| 7 | 0.168767D-01 | 0.240701D-01 | | | |
| 8 | -0.244184D-18 | -0.127179D-18 | 0.170810D-01 | | |
| 9 | 0.132147D-20 | 0.985514D-21 | -0.166128D-19 | 0.265063D-03 | |
| 10 | -0.695511D-22 | -0.447114D-22 | -0.143077D-20 | -0.147203D-05 | 0.411882D-03 |
| 11 | -0.218589D-21 | -0.149038D-21 | -0.508717D-20 | -0.338823D-05 | -0.409899D-05 |
| 12 | -0.178846D-21 | -0.279446D-21 | 0.208256D-19 | -0.397832D-05 | -0.481286D-05 |
| 13 | 0.794870D-22 | -0.496794D-23 | 0.635896D-21 | -0.684244D-05 | -0.827780D-05 |
| 14 | 0.794870D-22 | 0.186919D-21 | -0.619998D-20 | -0.250280D-05 | -0.302781D-05 |
| 15 | 0.816885D-03 | 0.537598D-03 | -0.445127D-20 | 0.230543D-22 | -0.225110D-23 |
| 16 | -0.156916D-02 | 0.299713D-03 | -0.610460D-19 | 0.372595D-23 | -0.248397D-23 |
| 17 | 0.676917D-03 | -0.795012D-03 | -0.394255D-19 | 0.838339D-23 | 0.620992D-24 |
| 18 | -0.203487D-19 | -0.426050D-19 | 0.729235D-03 | -0.258333D-21 | -0.397435D-22 |
| 19 | -0.508717D-20 | 0.236871D-19 | -0.663032D-03 | 0.417307D-21 | 0.496794D-22 |

| | | | | | |
|---|---|---|---|---|---|
| 20 | 0.114461D-18 | 0.662921D-19 | -0.271541D-02 | 0.747844D-04 | -0.356018D-06 |
| 21 | 0.722219D-02 | 0.640291D-02 | -0.463080D-02 | 0.380047D-20 | 0.337820D-21 |
| 22 | -0.661332D-19 | -0.103015D-18 | -0.249269D-02 | -0.109295D-21 | 0.208653D-21 |
| 23 | -0.898699D-20 | -0.705385D-20 | 0.127736D-18 | -0.380248D-04 | 0.147203D-05 |
| 24 | -0.267808D-02 | -0.220592D-02 | 0.944305D-19 | -0.100445D-21 | 0.698616D-23 |
| 25 | 0.522046D-04 | -0.349630D-05 | -0.606716D-03 | -0.108066D-06 | -0.130736D-06 |
| 26 | 0.249604D-34 | 0.199725D-34 | 0.161386D-18 | -0.372046D-37 | -0.121877D-37 |

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|
| 11 | 0.217584D-03 | | | | |
| 12 | -0.110780D-04 | 0.201965D-03 | | | |
| 13 | -0.190534D-04 | -0.223717D-04 | 0.215123D-03 | | |
| 14 | -0.696926D-05 | -0.818301D-05 | -0.140742D-04 | 0.257045D-03 | |
| 15 | -0.791765D-23 | -0.527843D-23 | -0.496794D-23 | 0.217347D-23 | 0.330470D-03 |
| 16 | 0.181604D-69 | -0.397435D-22 | -0.496794D-22 | 0.124198D-22 | -0.526475D-04 |
| 17 | -0.434694D-23 | 0.161458D-22 | 0.124198D-23 | -0.117988D-22 | 0.796357D-05 |
| 18 | -0.317948D-21 | 0.834613D-21 | 0.238461D-21 | -0.337820D-21 | -0.103333D-20 |
| 19 | 0.158974D-21 | -0.616024D-21 | -0.357691D-21 | 0.248397D-21 | -0.115256D-20 |
| 20 | -0.819465D-06 | -0.962180D-06 | -0.165489D-05 | -0.605316D-06 | 0.182820D-20 |
| 21 | 0.834613D-21 | -0.590191D-20 | -0.123205D-20 | 0.188782D-20 | 0.219418D-03 |
| 22 | 0.794870D-21 | -0.270256D-20 | -0.238461D-21 | 0.933972D-21 | -0.274230D-20 |
| 23 | 0.338823D-05 | 0.397832D-05 | 0.684244D-05 | 0.250280D-05 | -0.169764D-21 |
| 24 | 0.211137D-22 | 0.318258D-22 | -0.683091D-23 | -0.214242D-22 | -0.780760D-04 |
| 25 | -0.300921D-06 | -0.353328D-06 | -0.607701D-06 | -0.222282D-06 | 0.614159D-06 |
| 26 | -0.449021D-37 | 0.184740D-36 | 0.153950D-37 | -0.577313D-37 | 0.697907D-36 |

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|
| 16 | 0.391820D-03 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 17 | -0.176390D-03 | 0.367362D-03 | | | |
| 18 | -0.890254D-20 | 0.127179D-20 | 0.301264D-03 | | |
| 19 | 0.763075D-20 | -0.357691D-20 | 0.979902D-05 | 0.275730D-03 | |
| 20 | 0.139897D-19 | 0.461024D-20 | -0.115928D-03 | 0.105404D-03 | 0.637423D-02 |
| 21 | -0.191686D-04 | 0.289948D-05 | -0.197701D-03 | 0.179753D-03 | 0.736170D-03 |
| 22 | 0.114461D-19 | 0.619998D-20 | -0.106420D-03 | 0.967586D-04 | 0.396270D-03 |
| 23 | -0.447114D-22 | -0.499898D-22 | 0.198717D-20 | -0.284166D-20 | -0.442721D-03 |
| 24 | 0.526475D-04 | -0.796357D-05 | 0.953844D-20 | -0.365640D-20 | -0.240448D-19 |
| 25 | -0.136034D-04 | 0.205768D-05 | -0.109713D-03 | -0.490797D-04 | 0.554653D-04 |
| 26 | -0.172424D-35 | -0.123160D-36 | 0.689000D-20 | -0.626449D-20 | -0.256559D-19 |

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|
| 21 | 0.854089D-02 | | | | |
| 22 | 0.675789D-03 | 0.171404D-02 | | | |
| 23 | -0.304236D-19 | -0.134134D-20 | 0.271059D-03 | | |
| 24 | -0.880999D-03 | 0.675639D-21 | 0.741464D-21 | 0.359236D-03 | |
| 25 | 0.558713D-04 | 0.885403D-04 | 0.108066D-06 | -0.614159D-06 | 0.156265D-03 |
| 26 | -0.437530D-19 | -0.235516D-19 | 0.409251D-36 | -0.244524D-35 | -0.573241D-20 |

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 26 |
|---|---|
| 26 | 0.426322D-03 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 1.000 | | | | |
| 2 | 0.591 | 1.000 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 3 | 0.601 | 0.719 | 1.000 | | |
| 4 | 0.619 | 0.739 | 0.751 | 1.000 | |
| 5 | 0.566 | 0.677 | 0.689 | 0.709 | 1.000 |
| 6 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 7 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 9 | 0.111 | 0.135 | 0.138 | 0.144 | 0.128 |
| 10 | -0.111 | 0.001 | 0.002 | 0.005 | 0.001 |
| 11 | 0.000 | -0.154 | 0.007 | 0.014 | 0.002 |
| 12 | 0.000 | 0.006 | -0.163 | 0.017 | 0.003 |
| 13 | 0.000 | 0.010 | 0.013 | -0.189 | 0.005 |
| 14 | 0.000 | 0.003 | 0.004 | 0.010 | -0.138 |
| 15 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 16 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 19 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 20 | 0.256 | 0.307 | 0.312 | 0.321 | 0.294 |
| 21 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | -0.649 | -0.779 | -0.793 | -0.818 | -0.745 |
| 24 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 |
| 26 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|
| 6 | 1.000 | | | | |
| 7 | 0.624 | 1.000 | | | |
| 8 | 0.000 | 0.000 | 1.000 | | |
| 9 | 0.000 | 0.000 | 0.000 | 1.000 | |
| 10 | 0.000 | 0.000 | 0.000 | -0.004 | 1.000 |

| | | | | | |
|---|---|---|---|---|---|
| 11 | 0.000 | 0.000 | 0.000 | -0.014 | -0.014 |
| 12 | 0.000 | 0.000 | 0.000 | -0.017 | -0.017 |
| 13 | 0.000 | 0.000 | 0.000 | -0.029 | -0.028 |
| 14 | 0.000 | 0.000 | 0.000 | -0.010 | -0.009 |
| 15 | 0.258 | 0.191 | 0.000 | 0.000 | 0.000 |
| 16 | -0.454 | 0.098 | 0.000 | 0.000 | 0.000 |
| 17 | 0.202 | -0.267 | 0.000 | 0.000 | 0.000 |
| 18 | 0.000 | 0.000 | 0.321 | 0.000 | 0.000 |
| 19 | 0.000 | 0.000 | -0.306 | 0.000 | 0.000 |
| 20 | 0.000 | 0.000 | -0.260 | 0.058 | 0.000 |
| 21 | 0.448 | 0.447 | -0.383 | 0.000 | 0.000 |
| 22 | 0.000 | 0.000 | -0.461 | 0.000 | 0.000 |
| 23 | 0.000 | 0.000 | 0.000 | -0.142 | 0.004 |
| 24 | -0.810 | -0.750 | 0.000 | 0.000 | 0.000 |
| 25 | 0.024 | -0.002 | -0.371 | -0.001 | -0.001 |
| 26 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|
| 11 | 1.000 | | | | |
| 12 | -0.053 | 1.000 | | | |
| 13 | -0.088 | -0.107 | 1.000 | | |
| 14 | -0.029 | -0.036 | -0.060 | 1.000 | |
| 15 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| 16 | 0.000 | 0.000 | 0.000 | 0.000 | -0.146 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 | 0.023 |
| 18 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 19 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 20 | -0.001 | -0.001 | -0.001 | 0.000 | 0.000 |
| 21 | 0.000 | 0.000 | 0.000 | 0.000 | 0.131 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.014 | 0.017 | 0.028 | 0.009 | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 24 | 0.000 | 0.000 | 0.000 | 0.000 | -0.227 |
| 25 | -0.002 | -0.002 | -0.003 | -0.001 | 0.003 |
| 26 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|
| 16 | 1.000 | | | | |
| 17 | -0.465 | 1.000 | | | |
| 18 | 0.000 | 0.000 | 1.000 | | |
| 19 | 0.000 | 0.000 | 0.034 | 1.000 | |
| 20 | 0.000 | 0.000 | -0.084 | 0.080 | 1.000 |
| 21 | -0.010 | 0.002 | -0.123 | 0.117 | 0.100 |
| 22 | 0.000 | 0.000 | -0.148 | 0.141 | 0.120 |
| 23 | 0.000 | 0.000 | 0.000 | 0.000 | -0.337 |
| 24 | 0.140 | -0.022 | 0.000 | 0.000 | 0.000 |
| 25 | -0.055 | 0.009 | -0.506 | -0.236 | 0.056 |
| 26 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|
| 21 | 1.000 | | | | |
| 22 | 0.177 | 1.000 | | | |
| 23 | 0.000 | 0.000 | 1.000 | | |
| 24 | -0.503 | 0.000 | 0.000 | 1.000 | |
| 25 | 0.048 | 0.171 | 0.001 | -0.003 | 1.000 |
| 26 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 26 |
|---|---|

```
     26         1.000
```

DIAGRAM INFORMATION

  Use View Diagram under the Diagram menu in the Mplus Editor to view the diagram.
  If running Mplus from the Mplus Diagrammer, the diagram opens automatically.

  Diagram output
    d:\documents\hoyle book\examples\yang\yang.nomeans.dgm

     Beginning Time:  15:55:48
        Ending Time:  15:55:48
       Elapsed Time:  00:00:00

MUTHEN & MUTHEN
3463 Stoner Ave.
Los Angeles, CA  90066

Tel: (310) 391-9971
Fax: (310) 391-8971
Web: www.StatModel.com
Support: Support@StatModel.com

**LAVAAN CODE FOR TONG ET AL.'S (2017) MODELS AND OBTAINING SELECTION CRITERIA**

```
library(lavaan) #load and attach lavaan (must be installed)
library(semTools) #load and attach semTools (must be installed)

#tong data
p <- 10
tong.cor <- matrix(c(1,.17,.36,.22,.25,.06,.14,.31,.24,.20,
                     .17,1,.20,.29,.17,.22,.28,.19,.33,.34,
                     .36,.20,1,.26,.39,.12,.28,.209,.33,.23,
                     .22,.29,.26,1,.35,.15,.20,.08,.35,.36,
                     .25,.17,.39,.35,1,.13,.42,.36,.45,.34,
                     .06,.22,.12,.15,.13,1,.27,.08,.57,.53,
                     .14,.28,.28,.20,.42,.27,1,.45,.45,.48,
                     .31,.19,.209,.08,.36,.08,.45,1,.38,.41,
                     .24,.33,.33,.35,.45,.57,.45,.38,1,.86,
                     .20,.34,.23,.36,.34,.53,.48,.41,.86,1
),p,p)
tong.sds <- c(8.57,4.61,2.26,3.76,6.45,2.83,2.50,2.71,4.09,12.53)
colnames(tong.cor) <- rownames(tong.cor) <-
c("block","toneid","tonedi","syll","phoneme","mss","elision","blending","wordid","ewrt")
tong.cov <- cor2cov(tong.cor,tong.sds)
colnames(tong.cov) <- rownames(tong.cov) <-
c("block","toneid","tonedi","syll","phoneme","mss","elision","blending","wordid","ewrt")

#syntax for Model A
moda <- 'ts =~ toneid + tonedi
  csegpa =~ syll + phoneme
  ss =~ mss
  esegpa =~ elision + blending
  ewr =~ wordid + ewrt
  iq =~ block
  ts ~~ ts
  csegpa ~~ csegpa
```

```
  ss ~~ ss
  esegpa ~~ esegpa
  ewr ~~ ewr
  iq ~~ iq
  block ~~ 0*block
  toneid ~~ toneid
  tonedi ~~ tonedi
  syll ~~ syll
  phoneme ~~ phoneme
  mss ~~ 0*mss
  wordid ~~ wordid
  ewrt ~~ ewrt
  ss ~ ts
  ewr ~ ss + csegpa + esegpa + iq'

moda.fit <- sem(moda, sample.cov=tong.cov, sample.nobs=123) #fit Model A
summary(moda.fit) #display Model A output
fitMeasures(moda.fit) #report all lavaan fit measures
moreFitIndices(moda.fit) #report additional semTools fit measures

#syntax for Model B
modb <- 'ts =~ toneid + tonedi
  csegpa =~ syll + phoneme
  ss =~ mss
  esegpa =~ elision + blending
  ewr =~ wordid + ewrt
  iq =~ block
  ts ~~ ts
  csegpa ~~ csegpa
  ss ~~ ss
  esegpa ~~ esegpa
  ewr ~~ ewr
  iq ~~ iq
  block ~~ 0*block
```

```
  toneid ~~ toneid
  tonedi ~~ tonedi
  syll ~~ syll
  phoneme ~~ phoneme
  mss ~~ 0*mss
  wordid ~~ wordid
  ewrt ~~ ewrt
  csegpa ~ ts
  esegpa ~ csegpa
  ewr ~ ss + esegpa + iq'

modb.fit <- sem(modb, sample.cov=tong.cov, sample.nobs=123) #fit Model B
summary(modb.fit) #display Model B output
fitMeasures(modb.fit) #report all lavaan fit measures
moreFitIndices(modb.fit) #report additional semTools fit measures

#syntax for Model C
modc <- 'ts =~ toneid + tonedi
  csegpa =~ syll + phoneme
  ss =~ mss
  esegpa =~ elision + blending
  ewr =~ wordid + ewrt
  iq =~ block
  ts ~~ ts
  csegpa ~~ csegpa
  ss ~~ ss
  esegpa ~~ esegpa
  ewr ~~ ewr
  iq ~~ iq
  block ~~ 0*block
  toneid ~~ toneid
  tonedi ~~ tonedi
  syll ~~ syll
  phoneme ~~ phoneme
```

```
  mss ~~ 0*mss
  wordid ~~ wordid
  ewrt ~~ ewrt
  csegpa ~ ts
  ss ~ ts
  esegpa ~ csegpa
  ewr ~ ss + esegpa + iq'

modc.fit <- sem(modc, sample.cov=tong.cov, sample.nobs=123) #fit Model C
summary(modc.fit) #display Model C output
fitMeasures(modc.fit) #report all lavaan fit measures
moreFitIndices(modc.fit) #report additional semTools fit measures
```

**MPLUS CODE FOR RUNNING TONG ET AL.'S (2017) MODELS AND OBTAINING THE ASYMPTOTIC COVARIANCE MATRIX OF PARAMETER ESTIMATES FOR MANUAL COMPUTATION OF LOG(DET(I))**

```
TITLE: Tong 2017;
DATA: FILE IS tong.nomeans.dat;
TYPE IS CORRELATION STDEVIATIONS;
NOBSERVATIONS IS 123;
VARIABLE: NAMES = block toneid tonedi syll phoneme mss elision blending wordid ewrt;
ANALYSIS: MODEL = NOMEANSTRUCTURE;
MODEL: ts BY toneid tonedi; cs BY syll phoneme; ss BY mss@1; mss@0;
es BY elision blending; ewr BY wordid ewrt; iq BY block@1; block@0;

!UNCOMMENT ONE LINE BELOW TO RUN DESIRED MODEL
!ss ON ts; ewr ON ss cs es iq; ts cs es iq WITH ts cs es iq;  !MODEL A
!cs ON ts; es ON cs; ewr ON ss es iq; ts ss iq WITH ts ss iq; !MODEL B
!cs ss ON ts; es ON cs; ewr ON ss es iq; ts WITH iq;          !MODEL C

OUTPUT: TECH1 TECH3; !REQUEST ASYMPTOTIC COVARIANCE MATRIX
```

**TONG ET AL.'S (2017) SUMMARY DATA (TONG.NOMEANS.DAT)**

```
8.57 4.61 2.26 3.76 6.45 2.83 2.50 2.71 4.09 12.53
1
.17 1
.36 .20 1
.22 .29 .26 1
.25 .17 .39 .35 1
.06 .22 .12 .15 .13 1
.14 .28 .28 .20 .42 .27 1
.31 .19 .209 .08 .36 .08 .45 1
.24 .33 .33 .35 .45 .57 .45 .38 1
.20 .34 .23 .36 .34 .53 .48 .41 .86 1
```

**EXAMPLE MPLUS OUTPUT FOR TONG ET AL.'S (2017) MODEL A**

```
Mplus VERSION 8.6
MUTHEN & MUTHEN
08/28/2021   3:56 PM

INPUT INSTRUCTIONS

  TITLE: Tong 2017;
  DATA: FILE IS tong.nomeans.dat;
  TYPE IS CORRELATION STDEVIATIONS;
  NOBSERVATIONS IS 123;
  VARIABLE: NAMES = block toneid tonedi syll phoneme mss elision blending wordid ewrt;
  ANALYSIS: MODEL = NOMEANSTRUCTURE;
  MODEL: ts BY toneid tonedi; cs BY syll phoneme; ss BY mss@1; mss@0;
  es BY elision blending; ewr BY wordid ewrt; iq BY block@1; block@0;

  !UNCOMMENT ONE LINE BELOW TO RUN DESIRED MODEL
  ss ON ts; ewr ON ss cs es iq; ts cs es iq WITH ts cs es iq;  !MODEL A
  !cs ON ts; es ON cs; ewr ON ss es iq; ts ss iq WITH ts ss iq; !MODEL B
  !cs ss ON ts; es ON cs; ewr ON ss es iq; ts WITH iq;          !MODEL C
```

```
  OUTPUT: TECH1 TECH3; !REQUEST ASYMPTOTIC COVARIANCE MATRIX


INPUT READING TERMINATED NORMALLY



Tong 2017;

SUMMARY OF ANALYSIS

Number of groups                                                 1
Number of observations                                         123

Number of dependent variables                                   10
Number of independent variables                                  0
Number of continuous latent variables                            6

Observed dependent variables

  Continuous
   BLOCK       TONEID      TONEDI      SYLL        PHONEME     MSS
   ELISION     BLENDING    WORDID      EWRT

Continuous latent variables
   TS          CS          SS          ES          EWR         IQ


Estimator                                                       ML
Information matrix                                      EXPECTED
Maximum number of iterations                                1000
Convergence criterion                                  0.500D-04
Maximum number of steepest descent iterations                 20
```

Input data file(s)
  tong.nomeans.dat

Input data format  FREE

THE MODEL ESTIMATION TERMINATED NORMALLY

MODEL FIT INFORMATION

| | |
|---|---|
| Number of Free Parameters | 29 |

Loglikelihood

| | |
|---|---|
| H0 Value | -3331.295 |
| H1 Value | -3308.082 |

Information Criteria

| | |
|---|---|
| Akaike (AIC) | 6720.591 |
| Bayesian (BIC) | 6802.144 |
| Sample-Size Adjusted BIC<br>(n* = (n + 2) / 24) | 6710.448 |

Chi-Square Test of Model Fit

| | |
|---|---|
| Value | 46.426 |
| Degrees of Freedom | 26 |
| P-Value | 0.0082 |

RMSEA (Root Mean Square Error Of Approximation)

| | | |
|---|---|---|
| Estimate | 0.080 | |
| 90 Percent C.I. | 0.040 | 0.117 |
| Probability RMSEA <= .05 | 0.096 | |

CFI/TLI

| | |
|---|---|
| CFI | 0.949 |
| TLI | 0.912 |

Chi-Square Test of Model Fit for the Baseline Model

| | |
|---|---|
| Value | 448.737 |
| Degrees of Freedom | 45 |
| P-Value | 0.0000 |

SRMR (Standardized Root Mean Square Residual)

| | |
|---|---|
| Value | 0.058 |

MODEL RESULTS

| | | Estimate | S.E. | Est./S.E. | Two-Tailed P-Value |
|---|---|---|---|---|---|
| TS | BY | | | | |
| | TONEID | 1.000 | 0.000 | 999.000 | 999.000 |
| | TONEDI | 0.694 | 0.200 | 3.474 | 0.001 |
| CS | BY | | | | |
| | SYLL | 1.000 | 0.000 | 999.000 | 999.000 |

| | | | | |
|---|---|---|---|---|
| PHONEME | 2.387 | 0.544 | 4.388 | 0.000 |
| SS BY | | | | |
| MSS | 1.000 | 0.000 | 999.000 | 999.000 |
| ES BY | | | | |
| ELISION | 1.000 | 0.000 | 999.000 | 999.000 |
| BLENDING | 1.002 | 0.197 | 5.091 | 0.000 |
| EWR BY | | | | |
| WORDID | 1.000 | 0.000 | 999.000 | 999.000 |
| EWRT | 2.853 | 0.193 | 14.756 | 0.000 |
| IQ BY | | | | |
| BLOCK | 1.000 | 0.000 | 999.000 | 999.000 |
| SS ON | | | | |
| TS | 0.391 | 0.183 | 2.136 | 0.033 |
| EWR ON | | | | |
| SS | 0.611 | 0.092 | 6.624 | 0.000 |
| CS | 0.740 | 0.415 | 1.785 | 0.074 |
| ES | 0.659 | 0.421 | 1.565 | 0.118 |
| IQ | -0.005 | 0.034 | -0.158 | 0.874 |
| TS WITH | | | | |
| CS | 3.153 | 1.084 | 2.908 | 0.004 |
| ES | 2.391 | 0.802 | 2.979 | 0.003 |
| IQ | 8.509 | 2.907 | 2.927 | 0.003 |
| CS WITH | | | | |
| ES | 2.391 | 0.706 | 3.386 | 0.001 |
| IQ | 6.079 | 2.253 | 2.698 | 0.007 |

| | | | | |
|---|---|---|---|---|
| ES WITH | | | | |
| IQ | 4.755 | 1.791 | 2.654 | 0.008 |
| Variances | | | | |
| TS | 3.356 | 1.783 | 1.882 | 0.060 |
| CS | 3.566 | 1.405 | 2.539 | 0.011 |
| ES | 3.022 | 0.860 | 3.513 | 0.000 |
| IQ | 72.847 | 9.289 | 7.842 | 0.000 |
| Residual Variances | | | | |
| BLOCK | 0.000 | 0.000 | 999.000 | 999.000 |
| TONEID | 17.723 | 2.484 | 7.134 | 0.000 |
| TONEDI | 3.450 | 0.642 | 5.371 | 0.000 |
| SYLL | 10.456 | 1.527 | 6.848 | 0.000 |
| PHONEME | 20.951 | 4.760 | 4.402 | 0.000 |
| MSS | 0.000 | 0.000 | 999.000 | 999.000 |
| ELISION | 3.177 | 0.666 | 4.771 | 0.000 |
| BLENDING | 4.253 | 0.758 | 5.607 | 0.000 |
| WORDID | 1.272 | 0.700 | 1.818 | 0.069 |
| EWRT | 30.987 | 6.807 | 4.552 | 0.000 |
| SS | 7.431 | 0.975 | 7.625 | 0.000 |
| EWR | 4.769 | 1.098 | 4.345 | 0.000 |

QUALITY OF NUMERICAL RESULTS

Condition Number for the Information Matrix 0.352E-03
(ratio of smallest to largest eigenvalue)

TECHNICAL 1 OUTPUT

PARAMETER SPECIFICATION

LAMBDA

| | TS | CS | SS | ES | EWR |
|---|---|---|---|---|---|
| BLOCK | 0 | 0 | 0 | 0 | 0 |
| TONEID | 0 | 0 | 0 | 0 | 0 |
| TONEDI | 1 | 0 | 0 | 0 | 0 |
| SYLL | 0 | 0 | 0 | 0 | 0 |
| PHONEME | 0 | 2 | 0 | 0 | 0 |
| MSS | 0 | 0 | 0 | 0 | 0 |
| ELISION | 0 | 0 | 0 | 0 | 0 |
| BLENDING | 0 | 0 | 0 | 3 | 0 |
| WORDID | 0 | 0 | 0 | 0 | 0 |
| EWRT | 0 | 0 | 0 | 0 | 4 |

LAMBDA

| | IQ |
|---|---|
| BLOCK | 0 |
| TONEID | 0 |
| TONEDI | 0 |
| SYLL | 0 |
| PHONEME | 0 |
| MSS | 0 |
| ELISION | 0 |
| BLENDING | 0 |
| WORDID | 0 |
| EWRT | 0 |

THETA

| BLOCK | TONEID | TONEDI | SYLL | PHONEME |
|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| BLOCK | 0 | | | | |
| TONEID | 0 | 5 | | | |
| TONEDI | 0 | 0 | 6 | | |
| SYLL | 0 | 0 | 0 | 7 | |
| PHONEME | 0 | 0 | 0 | 0 | 8 |
| MSS | 0 | 0 | 0 | 0 | 0 |
| ELISION | 0 | 0 | 0 | 0 | 0 |
| BLENDING | 0 | 0 | 0 | 0 | 0 |
| WORDID | 0 | 0 | 0 | 0 | 0 |
| EWRT | 0 | 0 | 0 | 0 | 0 |

THETA

| | MSS | ELISION | BLENDING | WORDID | EWRT |
|---|---|---|---|---|---|
| MSS | 0 | | | | |
| ELISION | 0 | 9 | | | |
| BLENDING | 0 | 0 | 10 | | |
| WORDID | 0 | 0 | 0 | 11 | |
| EWRT | 0 | 0 | 0 | 0 | 12 |

BETA

| | TS | CS | SS | ES | EWR |
|---|---|---|---|---|---|
| TS | 0 | 0 | 0 | 0 | 0 |
| CS | 0 | 0 | 0 | 0 | 0 |
| SS | 13 | 0 | 0 | 0 | 0 |
| ES | 0 | 0 | 0 | 0 | 0 |
| EWR | 0 | 14 | 15 | 16 | 0 |
| IQ | 0 | 0 | 0 | 0 | 0 |

BETA

| | IQ |
|---|---|
| TS | 0 |
| CS | 0 |
| SS | 0 |
| ES | 0 |
| EWR | 17 |
| IQ | 0 |

PSI

| | TS | CS | SS | ES | EWR |
|---|---|---|---|---|---|
| TS | 18 | | | | |
| CS | 19 | 20 | | | |
| SS | 0 | 0 | 21 | | |
| ES | 22 | 23 | 0 | 24 | |
| EWR | 0 | 0 | 0 | 0 | 25 |
| IQ | 26 | 27 | 0 | 28 | 0 |

PSI

| | IQ |
|---|---|
| IQ | 29 |

STARTING VALUES

LAMBDA

| | TS | CS | SS | ES | EWR |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| BLOCK | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TONEID | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TONEDI | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| SYLL | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| PHONEME | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| MSS | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 |
| ELISION | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| BLENDING | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| WORDID | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| EWRT | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |

LAMBDA

| | IQ |
|---|---|
| BLOCK | 1.000 |
| TONEID | 0.000 |
| TONEDI | 0.000 |
| SYLL | 0.000 |
| PHONEME | 0.000 |
| MSS | 0.000 |
| ELISION | 0.000 |
| BLENDING | 0.000 |
| WORDID | 0.000 |
| EWRT | 0.000 |

THETA

| | BLOCK | TONEID | TONEDI | SYLL | PHONEME |
|---|---|---|---|---|---|
| BLOCK | 0.000 | | | | |
| TONEID | 0.000 | 10.626 | | | |
| TONEDI | 0.000 | 0.000 | 2.554 | | |
| SYLL | 0.000 | 0.000 | 0.000 | 7.069 | |

| | | | | | |
|---|---|---|---|---|---|
| PHONEME | 0.000 | 0.000 | 0.000 | 0.000 | 20.801 |
| MSS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| ELISION | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| BLENDING | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| WORDID | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| EWRT | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

THETA

| | MSS | ELISION | BLENDING | WORDID | EWRT |
|---|---|---|---|---|---|
| MSS | 0.000 | | | | |
| ELISION | 0.000 | 3.125 | | | |
| BLENDING | 0.000 | 0.000 | 3.672 | | |
| WORDID | 0.000 | 0.000 | 0.000 | 8.364 | |
| EWRT | 0.000 | 0.000 | 0.000 | 0.000 | 78.500 |

BETA

| | TS | CS | SS | ES | EWR |
|---|---|---|---|---|---|
| TS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| CS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| SS | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| ES | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| EWR | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| IQ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

BETA

| | IQ |
|---|---|
| TS | 0.000 |
| CS | 0.000 |

| | |
|---|---|
| SS | 0.000 |
| ES | 0.000 |
| EWR | 0.000 |
| IQ | 0.000 |

PSI

| | TS | CS | SS | ES | EWR |
|---|---|---|---|---|---|
| TS | 0.050 | | | | |
| CS | 0.000 | 0.050 | | | |
| SS | 0.000 | 0.000 | 0.050 | | |
| ES | 0.000 | 0.000 | 0.000 | 0.050 | |
| EWR | 0.000 | 0.000 | 0.000 | 0.000 | 0.050 |
| IQ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

PSI

| | IQ |
|---|---|
| IQ | 0.050 |

TECHNICAL 3 OUTPUT

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 0.399003D-01 | | | | |
| 2 | 0.305287D-04 | 0.295828D+00 | | | |
| 3 | -0.663941D-06 | 0.725630D-04 | 0.386998D-01 | | |
| 4 | -0.171141D-17 | -0.386974D-19 | -0.678228D-19 | 0.373938D-01 | |
| 5 | 0.586929D-01 | -0.124888D-02 | 0.271607D-04 | 0.465624D-17 | 0.617123D+01 |

| | | | | | |
|---|---|---|---|---|---|
| 6 | -0.223244D-01 | -0.743670D-03 | 0.161734D-04 | 0.478768D-17 | 0.238861D+00 |
| 7 | -0.695802D-04 | 0.180423D+00 | -0.165384D-03 | 0.868879D-18 | 0.284641D-02 |
| 8 | -0.915990D-03 | -0.884190D+00 | -0.217719D-02 | 0.799758D-16 | 0.374716D-01 |
| 9 | -0.110020D-04 | 0.120242D-02 | 0.563670D-01 | -0.544580D-17 | 0.450072D-03 |
| 10 | -0.701695D-05 | 0.766892D-03 | -0.565863D-01 | -0.270761D-17 | 0.287051D-03 |
| 11 | -0.454215D-17 | -0.343748D-16 | 0.151067D-17 | 0.801182D-01 | 0.155540D-16 |
| 12 | 0.386926D-16 | 0.259786D-15 | 0.121980D-16 | -0.652329D+00 | -0.121299D-15 |
| 13 | 0.155362D-01 | -0.475549D-03 | 0.103423D-04 | -0.809014D-17 | 0.429424D-01 |
| 14 | -0.139457D-03 | 0.395851D-01 | -0.266441D-02 | -0.243080D-02 | 0.570496D-02 |
| 15 | 0.185039D-03 | 0.138479D-02 | -0.301164D-04 | -0.200513D-02 | -0.756962D-02 |
| 16 | 0.477910D-04 | 0.216467D-01 | 0.148327D-01 | -0.216476D-02 | -0.195505D-02 |
| 17 | 0.638438D-06 | 0.887491D-03 | -0.306707D-04 | 0.177490D-04 | -0.261174D-04 |
| 18 | -0.258690D+00 | 0.124888D-02 | -0.271607D-04 | -0.956132D-17 | -0.106358D+01 |
| 19 | -0.128835D+00 | -0.282393D+00 | -0.217587D-03 | 0.186759D-16 | -0.201130D+00 |
| 20 | 0.695802D-04 | -0.586182D+00 | 0.165384D-03 | 0.263617D-16 | -0.284641D-02 |
| 21 | -0.122023D-02 | 0.105703D-02 | -0.229884D-04 | -0.473651D-16 | 0.499176D-01 |
| 22 | -0.976496D-01 | 0.397889D-02 | -0.396594D-01 | -0.733144D-17 | -0.153847D+00 |
| 23 | -0.505670D-05 | -0.221153D+00 | -0.395865D-01 | 0.149191D-16 | 0.206861D-03 |
| 24 | 0.110020D-04 | -0.120242D-02 | -0.108105D+00 | 0.100209D-17 | -0.450072D-03 |
| 25 | 0.202857D-03 | 0.232618D-01 | -0.303072D-02 | -0.712927D-01 | -0.829853D-02 |
| 26 | -0.347424D+00 | 0.741784D-03 | -0.161324D-04 | -0.536792D-17 | -0.552584D+00 |
| 27 | -0.575206D-04 | -0.557383D+00 | -0.136719D-03 | 0.192776D-16 | 0.235307D-02 |
| 28 | 0.135025D-05 | -0.147571D-03 | -0.787036D-01 | -0.163557D-16 | -0.552366D-04 |
| 29 | 0.308731D-15 | 0.415892D-15 | -0.205478D-16 | -0.353595D-16 | 0.177999D-15 |

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|
| 6 | 0.412544D+00 | | | | |
| 7 | 0.169495D-02 | 0.233139D+01 | | | |
| 8 | 0.223132D-01 | 0.819490D-01 | 0.226557D+02 | | |
| 9 | 0.268005D-03 | -0.274053D-02 | -0.360777D-01 | 0.443342D+00 | |
| 10 | 0.170931D-03 | -0.174788D-02 | -0.230100D-01 | -0.611370D-01 | 0.575310D+00 |

| | | | | | |
|---|---|---|---|---|---|
| 11 | 0.141544D-16 | -0.167239D-16 | 0.538252D-15 | 0.657020D-18 | 0.643424D-17 |
| 12 | -0.114867D-15 | 0.110208D-15 | -0.492568D-14 | 0.138254D-15 | -0.298921D-17 |
| 13 | 0.258928D-02 | 0.108386D-02 | 0.142685D-01 | 0.171379D-03 | 0.109304D-03 |
| 14 | 0.339714D-02 | 0.105936D+00 | 0.646522D+00 | -0.441512D-01 | -0.281592D-01 |
| 15 | -0.450749D-02 | -0.315616D-02 | -0.415494D-01 | -0.499051D-03 | -0.318290D-03 |
| 16 | -0.116417D-02 | -0.493365D-01 | -0.649491D+00 | 0.808259D-01 | 0.254521D-01 |
| 17 | -0.155521D-04 | -0.202274D-02 | -0.266284D-01 | -0.508236D-03 | -0.324147D-03 |
| 18 | -0.238861D+00 | -0.284641D-02 | -0.374716D-01 | -0.450072D-03 | -0.287051D-03 |
| 19 | 0.655601D-01 | -0.191713D+00 | 0.661851D+00 | -0.360558D-02 | -0.229960D-02 |
| 20 | -0.169495D-02 | -0.553635D+00 | -0.819490D-01 | 0.274053D-02 | 0.174788D-02 |
| 21 | 0.297245D-01 | -0.240915D-02 | -0.317153D-01 | -0.380934D-03 | -0.242956D-03 |
| 22 | 0.489039D-01 | -0.906859D-02 | -0.119384D+00 | -0.590969D-01 | 0.569289D-01 |
| 23 | 0.123180D-03 | -0.129332D+00 | 0.712869D+00 | -0.578645D-01 | 0.577188D-01 |
| 24 | -0.268005D-03 | 0.274053D-02 | 0.360777D-01 | -0.279232D+00 | 0.611370D-01 |
| 25 | -0.494153D-02 | -0.530176D-01 | -0.697951D+00 | -0.502213D-01 | -0.320306D-01 |
| 26 | 0.171064D+00 | -0.169065D-02 | -0.222566D-01 | -0.267325D-03 | -0.170497D-03 |
| 27 | 0.140119D-02 | -0.339943D+00 | 0.166595D+01 | -0.226554D-02 | -0.144494D-02 |
| 28 | -0.328918D-04 | 0.336340D-03 | 0.442775D-02 | -0.114633D+00 | 0.115079D+00 |
| 29 | 0.723537D-15 | 0.376662D-15 | -0.103724D-14 | 0.000000D+00 | -0.410956D-16 |

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|
| 11 | 0.489722D+00 | | | | |
| 12 | -0.313219D+01 | 0.463344D+02 | | | |
| 13 | -0.157299D-16 | 0.126322D-15 | 0.335102D-01 | | |
| 14 | -0.520811D-02 | 0.424049D-01 | 0.217234D-02 | 0.171984D+00 | |
| 15 | -0.429610D-02 | 0.349792D-01 | -0.288237D-02 | -0.619546D-02 | 0.850090D-02 |
| 16 | -0.463812D-02 | 0.377640D-01 | -0.744445D-03 | -0.143880D+00 | 0.228388D-02 |
| 17 | 0.380282D-04 | -0.309629D-03 | -0.994501D-05 | -0.394004D-02 | 0.280079D-04 |
| 18 | -0.169368D-16 | 0.171138D-15 | -0.155626D+00 | -0.570496D-02 | 0.756962D-02 |
| 19 | 0.892246D-16 | -0.685267D-15 | -0.697793D-01 | -0.694962D-01 | -0.237222D-02 |
| 20 | 0.852398D-16 | -0.518899D-15 | -0.108386D-02 | -0.231825D+00 | 0.315616D-02 |

| | | | | | |
|---|---|---|---|---|---|
| 21 | -0.106662D-15 | 0.875710D-15 | -0.169023D-01 | -0.482859D-02 | 0.640680D-02 |
| 22 | -0.605877D-17 | 0.569994D-16 | -0.534209D-01 | -0.157904D-01 | -0.301644D-03 |
| 23 | 0.400778D-16 | -0.380243D-15 | 0.787687D-04 | -0.340234D-01 | -0.229372D-03 |
| 24 | -0.189597D-16 | -0.288529D-16 | -0.171379D-03 | 0.441512D-01 | 0.499051D-03 |
| 25 | -0.318047D+00 | 0.194862D+01 | -0.315992D-02 | -0.711656D-01 | 0.130245D-01 |
| 26 | -0.367058D-18 | 0.719479D-16 | -0.192044D+00 | -0.338852D-02 | 0.449605D-02 |
| 27 | 0.110029D-15 | -0.856097D-15 | 0.896005D-03 | -0.745842D-01 | -0.260914D-02 |
| 28 | -0.316618D-16 | 0.238106D-15 | -0.210330D-04 | 0.541860D-02 | 0.612476D-04 |
| 29 | -0.782899D-16 | 0.647250D-15 | -0.449935D-16 | 0.616434D-16 | 0.105548D-16 |

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|
| 16 | 0.177497D+00 | | | | |
| 17 | 0.102732D-02 | 0.117000D-02 | | | |
| 18 | 0.195505D-02 | 0.261174D-04 | 0.318085D+01 | | |
| 19 | -0.106000D-01 | -0.726388D-03 | 0.128188D+01 | 0.117572D+01 | |
| 20 | 0.493365D-01 | 0.202274D-02 | 0.164513D+00 | 0.910668D+00 | 0.197319D+01 |
| 21 | 0.165472D-02 | 0.221053D-04 | -0.499176D-01 | 0.134385D-01 | 0.240915D-02 |
| 22 | -0.882177D-02 | 0.116122D-03 | 0.973276D+00 | 0.531532D+00 | 0.131649D+00 |
| 23 | -0.601215D-01 | -0.718880D-04 | 0.122369D+00 | 0.398537D+00 | 0.674469D+00 |
| 24 | -0.114889D+00 | 0.508236D-03 | 0.933872D-01 | 0.965465D-01 | 0.902042D-01 |
| 25 | 0.455971D-02 | 0.623230D-02 | 0.829853D-02 | 0.220756D-01 | 0.530176D-01 |
| 26 | 0.116122D-02 | 0.155127D-04 | 0.346903D+01 | 0.177447D+01 | 0.313342D+00 |
| 27 | -0.407855D-01 | -0.180532D-01 | 0.433908D+00 | 0.112286D+01 | 0.172591D+01 |
| 28 | -0.301651D-01 | -0.967333D-02 | 0.330829D+00 | 0.283984D+00 | 0.235968D+00 |
| 29 | 0.513695D-16 | 0.359586D-16 | 0.117727D+01 | 0.841001D+00 | 0.600784D+00 |

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|
| 21 | 0.949805D+00 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 22 | 0.113317D-01 | 0.643882D+00 | | | |
| 23 | -0.175084D-03 | 0.210309D+00 | 0.498478D+00 | | |
| 24 | 0.380934D-03 | 0.300082D+00 | 0.298859D+00 | 0.739994D+00 | |
| 25 | 0.702374D-02 | 0.300309D-01 | 0.128275D-01 | 0.502213D-01 | 0.120469D+01 |
| 26 | 0.445824D-01 | 0.135569D+01 | 0.239920D+00 | 0.185111D+00 | 0.492900D-02 |
| 27 | -0.199160D-02 | 0.279793D+00 | 0.777907D+00 | 0.187117D+00 | -0.438286D-01 |
| 28 | 0.467513D-04 | 0.507780D+00 | 0.412034D+00 | 0.593930D+00 | 0.616357D-02 |
| 29 | 0.501856D-16 | 0.657880D+00 | 0.469968D+00 | 0.367637D+00 | 0.565064D-16 |

ESTIMATED COVARIANCE MATRIX FOR PARAMETER ESTIMATES

| | 26 | 27 | 28 | 29 |
|---|---|---|---|---|
| 26 | 0.845284D+01 | | | |
| 27 | 0.228657D+01 | 0.507443D+01 | | |
| 28 | 0.174489D+01 | 0.165124D+01 | 0.320934D+01 | |
| 29 | 0.100788D+02 | 0.719999D+01 | 0.563225D+01 | 0.862870D+02 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 1.000 | | | | |
| 2 | 0.000 | 1.000 | | | |
| 3 | 0.000 | 0.001 | 1.000 | | |
| 4 | 0.000 | 0.000 | 0.000 | 1.000 | |
| 5 | 0.118 | -0.001 | 0.000 | 0.000 | 1.000 |
| 6 | -0.174 | -0.002 | 0.000 | 0.000 | 0.150 |
| 7 | 0.000 | 0.217 | -0.001 | 0.000 | 0.001 |
| 8 | -0.001 | -0.342 | -0.002 | 0.000 | 0.003 |
| 9 | 0.000 | 0.003 | 0.430 | 0.000 | 0.000 |
| 10 | 0.000 | 0.002 | -0.379 | 0.000 | 0.000 |
| 11 | 0.000 | 0.000 | 0.000 | 0.592 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 | -0.496 | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| 13 | 0.425 | -0.005 | 0.000 | 0.000 | 0.094 |
| 14 | -0.002 | 0.175 | -0.033 | -0.030 | 0.006 |
| 15 | 0.010 | 0.028 | -0.002 | -0.112 | -0.033 |
| 16 | 0.001 | 0.094 | 0.179 | -0.027 | -0.002 |
| 17 | 0.000 | 0.048 | -0.005 | 0.003 | 0.000 |
| 18 | -0.726 | 0.001 | 0.000 | 0.000 | -0.240 |
| 19 | -0.595 | -0.479 | -0.001 | 0.000 | -0.075 |
| 20 | 0.000 | -0.767 | 0.001 | 0.000 | -0.001 |
| 21 | -0.006 | 0.002 | 0.000 | 0.000 | 0.021 |
| 22 | -0.609 | 0.009 | -0.251 | 0.000 | -0.077 |
| 23 | 0.000 | -0.576 | -0.285 | 0.000 | 0.000 |
| 24 | 0.000 | -0.003 | -0.639 | 0.000 | 0.000 |
| 25 | 0.001 | 0.039 | -0.014 | -0.336 | -0.003 |
| 26 | -0.598 | 0.000 | 0.000 | 0.000 | -0.077 |
| 27 | 0.000 | -0.455 | 0.000 | 0.000 | 0.000 |
| 28 | 0.000 | 0.000 | -0.223 | 0.000 | 0.000 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|
| 6 | 1.000 | | | | |
| 7 | 0.002 | 1.000 | | | |
| 8 | 0.007 | 0.011 | 1.000 | | |
| 9 | 0.001 | -0.003 | -0.011 | 1.000 | |
| 10 | 0.000 | -0.002 | -0.006 | -0.121 | 1.000 |
| 11 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.022 | 0.004 | 0.016 | 0.001 | 0.001 |
| 14 | 0.013 | 0.167 | 0.328 | -0.160 | -0.090 |
| 15 | -0.076 | -0.022 | -0.095 | -0.008 | -0.005 |
| 16 | -0.004 | -0.077 | -0.324 | 0.288 | 0.080 |
| 17 | -0.001 | -0.039 | -0.164 | -0.022 | -0.012 |

| | | | | | |
|---|---|---|---|---|---|
| 18 | -0.209 | -0.001 | -0.004 | 0.000 | 0.000 |
| 19 | 0.094 | -0.116 | 0.128 | -0.005 | -0.003 |
| 20 | -0.002 | -0.258 | -0.012 | 0.003 | 0.002 |
| 21 | 0.047 | -0.002 | -0.007 | -0.001 | 0.000 |
| 22 | 0.095 | -0.007 | -0.031 | -0.111 | 0.094 |
| 23 | 0.000 | -0.120 | 0.212 | -0.123 | 0.108 |
| 24 | 0.000 | 0.002 | 0.009 | -0.488 | 0.094 |
| 25 | -0.007 | -0.032 | -0.134 | -0.069 | -0.038 |
| 26 | 0.092 | 0.000 | -0.002 | 0.000 | 0.000 |
| 27 | 0.001 | -0.099 | 0.155 | -0.002 | -0.001 |
| 28 | 0.000 | 0.000 | 0.001 | -0.096 | 0.085 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|
| 11 | 1.000 | | | | |
| 12 | -0.658 | 1.000 | | | |
| 13 | 0.000 | 0.000 | 1.000 | | |
| 14 | -0.018 | 0.015 | 0.029 | 1.000 | |
| 15 | -0.067 | 0.056 | -0.171 | -0.162 | 1.000 |
| 16 | -0.016 | 0.013 | -0.010 | -0.823 | 0.059 |
| 17 | 0.002 | -0.001 | -0.002 | -0.278 | 0.009 |
| 18 | 0.000 | 0.000 | -0.477 | -0.008 | 0.046 |
| 19 | 0.000 | 0.000 | -0.352 | -0.155 | -0.024 |
| 20 | 0.000 | 0.000 | -0.004 | -0.398 | 0.024 |
| 21 | 0.000 | 0.000 | -0.095 | -0.012 | 0.071 |
| 22 | 0.000 | 0.000 | -0.364 | -0.047 | -0.004 |
| 23 | 0.000 | 0.000 | 0.001 | -0.116 | -0.004 |
| 24 | 0.000 | 0.000 | -0.001 | 0.124 | 0.006 |
| 25 | -0.414 | 0.261 | -0.016 | -0.156 | 0.129 |
| 26 | 0.000 | 0.000 | -0.361 | -0.003 | 0.017 |
| 27 | 0.000 | 0.000 | 0.002 | -0.080 | -0.013 |

| | | | | | |
|---|---|---|---|---|---|
| 28 | 0.000 | 0.000 | 0.000 | 0.007 | 0.000 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|
| 16 | 1.000 | | | | |
| 17 | 0.071 | 1.000 | | | |
| 18 | 0.003 | 0.000 | 1.000 | | |
| 19 | -0.023 | -0.020 | 0.663 | 1.000 | |
| 20 | 0.083 | 0.042 | 0.066 | 0.598 | 1.000 |
| 21 | 0.004 | 0.001 | -0.029 | 0.013 | 0.002 |
| 22 | -0.026 | 0.004 | 0.680 | 0.611 | 0.117 |
| 23 | -0.202 | -0.003 | 0.097 | 0.521 | 0.680 |
| 24 | -0.317 | 0.017 | 0.061 | 0.104 | 0.075 |
| 25 | 0.010 | 0.166 | 0.004 | 0.019 | 0.034 |
| 26 | 0.001 | 0.000 | 0.669 | 0.563 | 0.077 |
| 27 | -0.043 | -0.234 | 0.108 | 0.460 | 0.545 |
| 28 | -0.040 | -0.158 | 0.104 | 0.146 | 0.094 |
| 29 | 0.000 | 0.000 | 0.071 | 0.083 | 0.046 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|
| 21 | 1.000 | | | | |
| 22 | 0.014 | 1.000 | | | |
| 23 | 0.000 | 0.371 | 1.000 | | |
| 24 | 0.000 | 0.435 | 0.492 | 1.000 | |
| 25 | 0.007 | 0.034 | 0.017 | 0.053 | 1.000 |
| 26 | 0.016 | 0.581 | 0.117 | 0.074 | 0.002 |
| 27 | -0.001 | 0.155 | 0.489 | 0.097 | -0.018 |
| 28 | 0.000 | 0.353 | 0.326 | 0.385 | 0.003 |

| | | | | | |
|---|---|---|---|---|---|
| 29 | 0.000 | 0.088 | 0.072 | 0.046 | 0.000 |

ESTIMATED CORRELATION MATRIX FOR PARAMETER ESTIMATES

| | 26 | 27 | 28 | 29 |
|---|---|---|---|---|
| 26 | 1.000 | | | |
| 27 | 0.349 | 1.000 | | |
| 28 | 0.335 | 0.409 | 1.000 | |
| 29 | 0.373 | 0.344 | 0.338 | 1.000 |

DIAGRAM INFORMATION

Use View Diagram under the Diagram menu in the Mplus Editor to view the diagram.
If running Mplus from the Mplus Diagrammer, the diagram opens automatically.

Diagram output
d:\documents\hoyle book\examples\tong\tong.nomeans.dgm

Beginning Time: 15:56:07
Ending Time: 15:56:07
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MUTHEN & MUTHEN
3463 Stoner Ave.
Los Angeles, CA 90066

Tel: (310) 391-9971
Fax: (310) 391-8971
Web: www.StatModel.com
Support: Support@StatModel.com