

SUPPLEMENTAL MATERIAL FOR

Using the Mplus computer program
to estimate models for continuous and categorical data from twins

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Mplus input scripts and output files for examples described in Prescott, 2003

Example	Description	Figure	Input file	Output file
1	two-group twin model for a continuous variable		example1.inp	example1.out Appendix I
2 - delta	two-group twin model for a binary variable using delta parameterization		example2_delta.inp	example2.out Appendix II
2 - theta	two-group twin model for a binary variable using theta parameterization; first estimate thresholds using example2_step1, then estimate the model using example2_theta.inp with fixed threshold estimates		example2_step1.inp example2_theta.inp	example2_step1.out example2_theta.out
3	five-group twin model for a transformed continuous variable		example3.inp	example3.out Appendix IIIA
4	five-group twin model for a three-category outcome and a continuous covariate		example4.inp	example4.out Appendix IV
5	two-group bivariate twin model (one continuous and one binary variable)		example5.inp	example5.out Appendix V
6	two-group bivariate twin model with fixed unreliability in the continuous variable		example6.inp	example6.out Appendix VI

7	two-group bivariate twin model (two binary variables); first estimate thresholds using example7_step1, then estimate model with example7_step2		example7_step1.inp example7_step2.inp	example7_step1.out example7_step2.out Appendix VII
8	five-group twin model for a continuous variable. constrains male-female covariances to be non-negative		MF_sqrroot.inp Appendix VIII	MF_sqrroot.out

Data File:

example1.dat used as input for Examples 1, 2-delta and

Files are available at: <http://www.vipbg.vcu.edu/~cprescot/twinmplus>

Appendices

I-III appear in the paper
 IIIA, IV-VIII are included in this document

Appendix IIIA. Selected Mplus output from a twin model for a transformed continuous variable (Example 3)

```

...
COVARIANCE COVERAGE OF DATA
...
      PROPORTION OF DATA PRESENT FOR DZO

          Covariance Coverage
          ONSET1          ONSET2

ONSET1          0.962
ONSET2          0.879          0.916

SAMPLE STATISTICS
...
      ESTIMATED SAMPLE STATISTICS FOR DZO

          Means
          ONSET1          ONSET2

1          11.825          12.302

          Covariances
          ONSET1          ONSET2

ONSET1          1.051
ONSET2          0.235          0.967

          Correlations
          ONSET1          ONSET2

ONSET1          1.000
ONSET2          0.233          1.000
...
MODEL RESULTS

          Estimates      S.E.  Est./S.E.  Std  StdYX

Group DZO

O1  BY  ONSET1  1.089  0.018  60.321  1.010  1.000
O2  BY  ONSET2  1.000  0.000   0.000  0.928  1.000
A1  BY  O1      0.586  0.041  14.220  0.632  0.632
A2  BY  O2      0.586  0.041  14.220  0.632  0.632
C1  BY  O1     -0.264  0.071  -3.725  -0.284  -0.284
C2  BY  O2     -0.264  0.071  -3.725  -0.284  -0.284
E1  BY  O1      0.669  0.015  45.798  0.721  0.721
E2  BY  O2      0.669  0.015  45.798  0.721  0.721

O1  WITH A1      0.000  0.000   0.000  0.000  0.000
     WITH A2      0.000  0.000   0.000  0.000  0.000
     WITH C1      0.000  0.000   0.000  0.000  0.000
     WITH C2      0.000  0.000   0.000  0.000  0.000
     WITH E1      0.000  0.000   0.000  0.000  0.000
     WITH E2      0.000  0.000   0.000  0.000  0.000
     WITH O2      0.000  0.000   0.000  0.000  0.000

O2  WITH A1      0.000  0.000   0.000  0.000  0.000
     WITH A2      0.000  0.000   0.000  0.000  0.000
     WITH C1      0.000  0.000   0.000  0.000  0.000
     WITH C2      0.000  0.000   0.000  0.000  0.000
     WITH E1      0.000  0.000   0.000  0.000  0.000
     WITH E2      0.000  0.000   0.000  0.000  0.000

A1  WITH C1      0.000  0.000   0.000  0.000  0.000
     WITH C2      0.000  0.000   0.000  0.000  0.000
     WITH E1      0.000  0.000   0.000  0.000  0.000
     WITH E2      0.000  0.000   0.000  0.000  0.000
     WITH A2      0.500  0.000   0.000  0.500  0.500

A2  WITH C1      0.000  0.000   0.000  0.000  0.000
     WITH C2      0.000  0.000   0.000  0.000  0.000
     WITH E1      0.000  0.000   0.000  0.000  0.000
     WITH E2      0.000  0.000   0.000  0.000  0.000

```

Mplus models for twin data - A5

C1	WITH E1	0.000	0.000	0.000	0.000	0.000
	E2	0.000	0.000	0.000	0.000	0.000
	C2	1.000	0.000	0.000	1.000	1.000
C2	WITH E1	0.000	0.000	0.000	0.000	0.000
	E2	0.000	0.000	0.000	0.000	0.000
E1	WITH E2	0.000	0.000	0.000	0.000	0.000
Means						
A1		0.000	0.000	0.000	0.000	0.000
A2		0.000	0.000	0.000	0.000	0.000
C1		0.000	0.000	0.000	0.000	0.000
C2		0.000	0.000	0.000	0.000	0.000
E1		0.000	0.000	0.000	0.000	0.000
E2		0.000	0.000	0.000	0.000	0.000
Intercepts						
ONSET1		11.874	0.017	696.936	11.874	11.752
ONSET2		12.350	0.018	689.072	12.350	13.315
O1		0.000	0.000	0.000	0.000	0.000
O2		0.000	0.000	0.000	0.000	0.000
...						

Appendix IV. Selected output from a twin model for a 3-category variable in 5 zygosity groups (Example 4)

```

...
MODEL RESULTS

```

			Estimates	S.E.	Est./S.E.	Std	StdYX
Group DZO							
A1	BY	DX1	0.701	0.097	7.201	0.701	0.701
A2	BY	DX2	0.695	0.202	3.433	0.695	0.695
C1	BY	DX1	0.137	0.429	0.319	0.137	0.137
C2	BY	DX2	0.003	46.395	0.000	0.003	0.003
DX1	ON	DAGE	-0.019	0.026	-0.737	-0.019	-0.017
		DAGESQ	-0.133	0.026	-5.202	-0.133	-0.115
DX2	ON	DAGE	-0.149	0.035	-4.229	-0.149	-0.130
		DAGESQ	-0.088	0.038	-2.304	-0.088	-0.076
DAGE	WITH	A1	0.000	0.000	0.000	0.000	0.000
		A2	0.000	0.000	0.000	0.000	0.000
		C1	0.000	0.000	0.000	0.000	0.000
		C2	0.000	0.000	0.000	0.000	0.000
DAGESQ	WITH	A1	0.000	0.000	0.000	0.000	0.000
		A2	0.000	0.000	0.000	0.000	0.000
		C1	0.000	0.000	0.000	0.000	0.000
		C2	0.000	0.000	0.000	0.000	0.000
A1	WITH	C1	0.000	0.000	0.000	0.000	0.000
		C2	0.000	0.000	0.000	0.000	0.000
		A2	0.204	12.977	0.016	0.204	0.204
A2	WITH	C1	0.000	0.000	0.000	0.000	0.000
		C2	0.000	0.000	0.000	0.000	0.000
C1	WITH	C2	1.000	0.000	0.000	1.000	1.000
DAGE	WITH	DAGESQ	0.239	0.010	23.886	0.239	0.318
Means							
		DAGE	0.062	0.015	4.149	0.062	0.071
		DAGESQ	0.789	0.020	38.742	0.789	0.914
		A1	0.000	0.000	0.000	0.000	0.000
		A2	0.000	0.000	0.000	0.000	0.000
		C1	0.000	0.000	0.000	0.000	0.000
		C2	0.000	0.000	0.000	0.000	0.000
Thresholds							
		DX1\$1	0.223	0.029	7.708	0.223	0.223
		DX1\$2	0.591	0.030	19.651	0.591	0.591
		DX2\$1	0.929	0.042	22.196	0.929	0.929
		DX2\$2	1.213	0.045	26.813	1.213	1.213
Variances							
		DAGE	0.756	0.024	31.598	0.756	1.000
		DAGESQ	0.745	0.015	50.769	0.745	1.000
		A1	1.000	0.000	0.000	1.000	1.000
		A2	1.000	0.000	0.000	1.000	1.000
		C1	1.000	0.000	0.000	1.000	1.000
		C2	1.000	0.000	0.000	1.000	1.000
Scales							
		DX1	1.000	0.000	0.000	1.000	1.000
		DX2	1.000	0.000	0.000	1.000	1.000
...							
R-SQUARE							
Group DZO							
	Observed	Residual					
	Variable	Variance	R-Square				
	DX1	0.475	0.525				
	DX2	0.488	0.512				

Appendix V. Selected output from a bivariate model for a continuous and a categorical variable (Example 5).

```

...
ESTIMATED SAMPLE STATISTICS FOR MZF
MEANS/INTERCEPTS/THRESHOLDS
      1      DX1$1      DX2$1      ONSET1      ONSET2
      -1.124      -1.044      17.239      17.436

CORRELATION MATRIX (WITH VARIANCES ON THE DIAGONAL)
      DX1      DX2      ONSET1      ONSET2
DX1
DX2      0.462
ONSET1      0.368      0.447      12.213
ONSET2      0.353      0.455      0.523      11.219

ESTIMATED SAMPLE STATISTICS FOR DZF
MEANS/INTERCEPTS/THRESHOLDS
      1      DX1$1      DX2$1      ONSET1      ONSET2
      -1.002      -0.882      17.241      17.375

CORRELATION MATRIX (WITH VARIANCES ON THE DIAGONAL)
      DX1      DX2      ONSET1      ONSET2
DX1
DX2      0.162
ONSET1      0.447      0.292      9.812
ONSET2      0.052      0.418      0.345      12.392

...
MODEL RESULTS
      Estimates      S.E.      Est./S.E.      Std      StdYX
Group MZF
AO1 BY ONSET1      2.165      0.259      8.365      2.165      0.639
      DX1      0.667      0.241      2.763      0.667      0.667
AO2 BY ONSET2      2.165      0.259      8.365      2.165      0.639
      DX2      0.667      0.241      2.763      0.667      0.667
CO1 BY ONSET1      1.202      0.417      2.885      1.202      0.355
      DX1      -0.064      0.392      -0.163      -0.064      -0.064
CO2 BY ONSET2      1.202      0.417      2.885      1.202      0.355
      DX2      -0.064      0.392      -0.163      -0.064      -0.064
EO1 BY ONSET1      2.314      0.045      51.614      2.314      0.683
      DX1      0.047      0.068      0.703      0.047      0.047
EO2 BY ONSET2      2.314      0.045      51.614      2.314      0.683
      DX2      0.047      0.068      0.703      0.047      0.047
ADX1 BY DX1      -0.005      41.446      0.000      -0.005      -0.005
ADX2 BY DX2      -0.005      41.446      0.000      -0.005      -0.005
CDX1 BY DX1      0.000      907.963      0.000      0.000      0.000
CDX2 BY DX2      0.000      907.963      0.000      0.000      0.000

...
Intercepts
ONSET1      17.324      0.117      148.240      17.324      5.111
ONSET2      17.324      0.117      148.240      17.324      5.111
Thresholds
DX1$1      -1.023      0.043      -23.808      -1.023      -1.023
DX2$1      -1.023      0.043      -23.808      -1.023      -1.023

...
Residual Variances
ONSET1      0.000      0.000      0.000      0.000      0.000
ONSET2      0.000      0.000      0.000      0.000      0.000
Scales
DX1      1.000      0.000      0.000      1.000      1.000
DX2      1.000      0.000      0.000      1.000      1.000

...
R-SQUARE
Group MZF
Observed Residual
Variable Variance R-Square
DX1      0.549      0.451
DX2      0.549      0.451
ONSET1      1.000
ONSET2      1.000

```

Appendix VI. Selected Mplus output from a bivariate mediation model with unreliability (Example 6)

```

...
MODEL RESULTS

```

			Estimates	S.E.	Est./S.E.	Std	StdYX
Group MZF							
AO1	BY	ONSET1	2.249	0.258	8.722	2.249	0.666
AO2	BY	ONSET2	2.249	0.258	8.722	2.249	0.666
CO1	BY	ONSET1	1.141	0.455	2.510	1.141	0.338
CO2	BY	ONSET2	1.141	0.455	2.510	1.141	0.338
EO1	BY	ONSET1	0.732	0.147	4.989	0.732	0.217
EO2	BY	ONSET2	0.732	0.147	4.989	0.732	0.217
ADX1	BY	DX1	0.568	0.265	2.141	0.568	0.568
ADX2	BY	DX2	0.568	0.265	2.141	0.568	0.568
CDX1	BY	DX1	0.000	*****	0.000	0.000	0.000
CDX2	BY	DX2	0.000	*****	0.000	0.000	0.000
DX1	ON	ONSET1	0.138	0.008	17.752	0.138	0.464
DX2	ON	ONSET2	0.138	0.008	17.752	0.138	0.464
...							
Residual Variances							
		ONSET1	4.502	0.000	0.000	4.502	0.395
		ONSET2	4.502	0.000	0.000	4.502	0.395
...							
R-SQUARE							
Group MZF							
	Observed	Residual					
	Variable	Variance	R-Square				
	DX1	0.461	0.539				
	DX2	0.461	0.539				
	ONSET1		0.605				
	ONSET2		0.605				

Appendix VII. Selected Mplus output from a model for two binary variables using the THETA parameterization (Example 7)

```

...
ESTIMATED SAMPLE STATISTICS FOR MZM
  SAMPLE THRESHOLDS
    DX1$1      DX2$1      ONSET1$1      ONSET2$1
    0.386      0.431      0.303      0.258

  SAMPLE TETRACHORIC CORRELATIONS
    DX1      DX2      ONSET1      ONSET2
DX1
DX2      0.549
ONSET1      0.351      0.336
ONSET2      0.339      0.348      0.597

ESTIMATED SAMPLE STATISTICS FOR DZM
  SAMPLE THRESHOLDS
    DX1$1      DX2$1      ONSET1$1      ONSET2$1
    0.322      0.305      0.194      0.222

  SAMPLE TETRACHORIC CORRELATIONS
    DX1      DX2      ONSET1      ONSET2
DX1
DX2      0.317
ONSET1      0.401      0.087
ONSET2      0.244      0.354      0.405
...
MODEL RESULTS
      Estimates      S.E.      Est./S.E.      Std      StdYX
Group MZM
AO1      BY
  ONSET1      0.619      0.129      4.800      0.619      0.619
  DX1      0.546      0.199      2.743      0.546      0.546
AO2      BY
  ONSET2      0.619      0.129      4.800      0.619      0.619
  DX2      0.546      0.199      2.743      0.546      0.546
CO1      BY
  ONSET1      0.463      0.136      3.394      0.463      0.462
  DX1      -0.001      0.219      -0.005      -0.001      -0.001
CO2      BY
  ONSET2      0.463      0.136      3.394      0.463      0.462
  DX2      -0.001      0.219      -0.005      -0.001      -0.001
EO1      BY
  ONSET1      0.636      0.075      8.532      0.636      0.635
  DX1      0.039      0.057      0.692      0.039      0.039
EO2      BY
  ONSET2      0.636      0.075      8.532      0.636      0.635
  DX2      0.039      0.057      0.692      0.039      0.039

```

Appendix VII, continued

ADX1	BY					
DX1		0.405	0.284	1.425	0.405	0.405
ADX2	BY					
DX2		0.405	0.284	1.425	0.405	0.405
CDX1	BY					
DX1		0.293	0.216	1.358	0.293	0.293
CDX2	BY					
DX2		0.293	0.216	1.358	0.293	0.293
EDX1	BY					
DX1		0.671	0.057	11.689	0.671	0.671
EDX2	BY					
DX2		0.671	0.057	11.689	0.671	0.671
...						
Thresholds						
DX1\$1		0.367	0.000	0.000	0.367	0.367
DX2\$1		0.367	0.000	0.000	0.367	0.367
ONSET1\$1		0.249	0.000	0.000	0.249	0.249
ONSET2\$1		0.249	0.000	0.000	0.249	0.249
...						
R-SQUARE						
Group MZM						
Observed	Scale					
Variable	Factors	R-Square				
DX1	1.000	1.000				
DX2	1.000	1.000				
ONSET1	0.999	1.000				
ONSET2	0.999	1.000				

Appendix VIII. Mplus input script to constrain non-negative male-female covariances (Figure 8)

```

TITLE: 5-group model for age at drinking onset
      A & C loadings parameterized as square roots to keep non-negative
DATA:   FILE = onset99.dat;
        FORMAT = Free;
VARIABLE: NAMES = famno mpair zyg age dx1 abst1 onset1 dx2 abst2 onset2;
          USEVARIABLES = onset1 onset2;
          GROUP = zyg(1=MZF 2=DZF 3=MZM 4=DZM 5=DZO);
          MISSING = onset1-onset2(98,99);
ANALYSIS: TYPE=MGROUP MEANSTRUCTURE MISSING H1;
MODEL:
  [onset1 onset2] (11);      ! means
  onset1@0 onset2@0;        ! residual variances on onset

! FIRST LEVEL OF LATENT VARIABLES
  AD1 BY onset1*.6 (41); AD2 BY onset2*.6 (41);
  CD1 BY onset1*.6 (42); CD2 BY onset2*.6 (42);
  [AD1-CD2@0];
  AD1-CD2@0;
  AD1-AD2 WITH CD1-CD2 @0;
  AD1 WITH AD2@0; CD1 WITH CD2@0;

!SECOND LEVEL OF LATENT VARIABLES
  A1 BY AD1*.6 (41); A2 BY AD2*.6 (41);
  C1 BY CD1*.6 (42); C2 BY CD2*.6 (42);
  E1 BY onset1*.8 (43); E2 BY onset2*.8 (43) ;
  [A1-E2@0];
  A1-E2@1;
  A1-A2 with C1-E2@0;
  C1-C2 with E1-E2@0;
  A1 with A2@1;
  C1 with C2@1;
  E1 with E2@0;

MODEL DZF:
  A1 with A2@0.5;

MODEL MZM:
  [onset1 onset2] (111); !means
  AD1 BY onset1*.6 (141); AD2 BY onset2*.6 (141);
  A1 BY AD1*.6 (141); A2 BY AD2*.6 (141);
  CD1 BY onset1*.6 (142); CD2 BY onset2*.6 (142);
  C1 BY CD1*.6 (142); C2 BY CD2*.6 (142);
  E1 BY onset1*.8 (143); E2 BY onset2*.8 (143) ;

MODEL DZM:
  [onset1 onset2] (111);
  AD1 BY onset1*.6 (141); AD2 BY onset2*.6 (141);
  A1 BY AD1*.6 (141); A2 BY AD2*.6 (141);
  CD1 BY onset1*.6 (142); CD2 BY onset2*.6 (142);
  C1 BY CD1*.6 (142); C2 BY CD2*.6 (142);
  E1 BY onset1*.8 (143); E2 BY onset2*.8 (143) ;
  A1 with A2@0.5;

MODEL DZO:
  [onset1] (111);
  AD1 BY onset1*.6 (141);
  A1 BY AD1*.6 (141);
  CD1 BY onset1*.6 (142);
  C1 BY CD1*.6 (142);
  E1 BY onset1*.8 (143);
  A1 with A2@0.5;

OUTPUT: SAMP STAND RES TECH1;

```