

## Digital Appendix

The following models were used to estimate parameters presented in Table 1.

### Single-Group B-GLIRT Interaction Model

```
Title: (B-GLIRT cross-link function interaction in Table 1)
DATA: FILE IS responses_and_times_wide_format.dat;
VARIABLE: NAMES ARE
  CBAR1-CBAR30,      ! CBA Responses Item 1-30
  CBAT2-CBAT15,      ! CBA Times Item 2-15,17-30
  CBAT16-CBAT30,
  PBAR1-PBAR30,      ! PBA Responses Item 1-30
  PBAT1-PBAT30       ! PBA Times Item 2-15,17-30
  PBAT16-PBAT30;
USEVARIABLES ARE
  CBAR1-CBAR30,      ! CBA Responses Item 1-30
  CBAT2-CBAT15,      ! CBA Times Item 2-15,17-30
  CBAT16-CBAT30;
CATEGORICAL ARE
  CBAR1-CBAR30, ! CBA Responses Item 1-30
MISSING = *;
ANALYSIS: type=RANDOM;
INTEGRATION IS MONTECARLO;
MODEL:
  cbaabil BY CBAR1-CBAR30*;
  cbaspeed BY CBAT2-CBAT30*;
  cbaabil BY CBAT2-CBAT30*(cd);
  cbaabil WITH cbaspeed @0;
  cbaabil@1;
  cbaspeed@1;
  cbaquad | cbaabil xwith cbaspeed;
  CBAT2 on cbaquad(cc);
  CBAT3 on cbaquad(cc);
  !...
  CBAT30 on cbaquad(cc);
OUTPUT: TECH1 TECH8; STANDARDIZED;
```

**Single-Group B-GLIRT Regression Model**

Title: (B-GLIRT cross-link function regression in Table 1)

DATA: FILE IS responses\_and\_times\_wide\_format.dat;

VARIABLE: NAMES ARE

CBAR1-CBAR30, ! CBA Responses Item 1-30  
 CBAT2-CBAT15, ! CBA Times Item 2-15,17-30  
 CBAT16-CBAT30,  
 PBAR1-PBAR30, ! PBA Responses Item 1-30  
 PBAT1-PBAT30 ! PBA Times Item 2-15,17-30  
 PBAT16-PBAT30;

USEVARIABLES ARE

CBAR1-CBAR30, ! CBA Responses Item 1-30  
 CBAT2-CBAT15, ! CBA Times Item 2-15,17-30  
 CBAT16-CBAT30;

CATEGORICAL ARE

CBAR1-CBAR30, ! CBA Responses Item 1-30

MISSING = \*;

ANALYSIS: type=RANDOM;

INTEGRATION IS MONTECARLO;

ALGORITHM = ODLL;

MODEL:

cbaabil BY CBAR1-CBAR30\* (ca11-cai30);  
 cbaspeed BY CBAT2-CBAT30\*;  
 cbaabil BY CBAT2-CBAT30\* (cload1-cload28);  
 cbaabil WITH cbaspeed@0;  
 [CBAR1\$1-CBAR30\$1] (cbi1-cbi30);  
 [CBAT2-CBAT30] (cicept1-cicept28);  
 cbaabil@1;  
 cbaspeed@1;

MODEL CONSTRAINT: NEW(rho);

DO(1,28) cload#=-rho\*cai#;

OUTPUT: TECH1 TECH8; STANDARDIZED;

**Single-Group B-GLIRT Hierarchical Model**

Title: (B-GLIRT cross-link function hierarchical in Table 1)

DATA: FILE IS responses\_and\_times\_wide\_format.dat;

VARIABLE: NAMES ARE

CBAR1-CBAR30, ! CBA Responses Item 1-30  
 CBAT2-CBAT15, ! CBA Times Item 2-15,17-30  
 CBAT16-CBAT30,  
 PBAR1-PBAR30, ! PBA Responses Item 1-30  
 PBAT1-PBAT30 ! PBA Times Item 2-15,17-30  
 PBAT16-PBAT30;

USEVARIABLES ARE

CBAR1-CBAR30, ! CBA Responses Item 1-30  
 CBAT2-CBAT15, ! CBA Times Item 2-15,17-30  
 CBAT16-CBAT30;

CATEGORICAL ARE

CBAR1-CBAR30, ! CBA Responses Item 1-30

MISSING = \*;

ANALYSIS: type=RANDOM;

INTEGRATION IS MONTECARLO;

ALGORITHM = ODLL;

MODEL:

cbaabil BY CBAR1-CBAR30\* (ca11-cai30);  
 cbaspeed BY CBAT2-CBAT30\* (cphi1-cphi28);  
 cbaabil BY CBAT2-CBAT30\* (cload1-cload28);  
 cbaabil WITH cbaspeed@0;  
 [CBAR1\$1-CBAR30\$1] (cbi1-cbi30);  
 [CBAT2-CBAT30] (ccept1-ccept28);  
 cbaabil@1;  
 cbaspeed\*(varT);

MODEL CONSTRAINT: NEW(rho);

varT = 1-rho\*rho;

DO(1,28) cload#=-rho\*cphi#;

OUTPUT: TECH1 TECH8; STANDARDIZED;

**Multi-Group Version of the B-GLIRT Interaction Model used to Investigate Measurement Invariance between Boys and Girls / Mode (Baseline)**

```

Title: Model C1 in Table 2 / Model P1 in Table 4
DATA: FILE IS responses_and_times_wide_format.dat;
VARIABLE: NAMES ARE
  CBAR1-CBAR30, ! CBA Responses Item 1-30
  CBAT2-CBAT15, ! CBA Times Item 2-15,17-30
  CBAT16-CBAT30,
  PBAR1-PBAR30, ! PBA Responses Item 1-30
  PBAT1-PBAT30 ! PBA Times Item 2-15,17-30
  PBAT16-PBAT30,
  SEX;
CLASSES = gender (2);
KNOWNCLASS = gender (SEX=0 SEX=1);
USEVARIABLES ARE
  CBAR1-CBAR30, ! CBA Responses Item 1-30
  CBAT2-CBAT15, ! CBA Times Item 2-15,17-30
  CBAT16-CBAT30;
CATEGORICAL ARE
  CBAR1-CBAR30, ! CBA Responses Item 1-30
MISSING = *;
ANALYSIS: type=RANDOM;
ALGORITHM=INTEGRATION;
TYPE = MIXTURE;
ITERATIONS = 2500
MITERATIONS = 1000
MODEL:
MODEL: %overall%
  abil BY CBAR1-CBAR30* (malpha1-malpha30);
  speed BY CBAT2-CBAT30* (mph11-mphi28);
  abil BY CBAT2-CBAT30* (mcd);
  abil WITH speed@0;
  abil@1;
  speed@1;
  [abil@0];
  [speed@0];
  [CBAR1$1-CBAR30$1] (mbil-mbi30);
  [CBAT2-CBAT30] (micept1-micept28);
  quad | abil xwith speed;
  CBAT2 on quad(mcc);
  CBAT3 on quad(mcc);
  !...
  CBAT30 on quad(mcc);
  CBAT2(msig1);
  CBAT3(msig2);
  !...
  CBAT30(msig28);

```

```
%gender#2%
abil BY CBAR1-CBAR30* (falpa1-falpa30);
speed BY CBAT2-CBAT30* (fphi1-fphi28);
abil BY CBAT2-CBAT30* (fcd);
abil WITH speed@0;
abil@1;
speed@1;
[abil@0];
[speed@0];
[CBAR1$1-CBAR30$1] (fbi1-fbi30);
[CBAT2-CBAT30] (fcept1-fcept28);
CBAT2 (fsig1);
CBAT3 (fsig3);
!...
CBAT30 (fsig28);
CBAT2 on quad(fcc);
CBAT3 on quad(fcc);
!...
CBAT30 on quad(fcc);
OUTPUT: TECH1 TECH8; STANDARDIZED;
```

**Multi-Group Version of the B-GLIRT Interaction Model used to Investigate Mode Effects**

```

Title: Model M1 in Table 5
DATA: FILE IS responses_and_times_wide_format.dat;
VARIABLE: NAMES ARE
  CBAR1-CBAR30, ! CBA Responses Item 1-30
  CBAT2-CBAT15, ! CBA Times Item 2-15,17-30
  CBAT16-CBAT30,
  PBAR1-PBAR30, ! PBA Responses Item 1-30
  PBAT1-PBAT30 ! PBA Times Item 2-15,17-30
  PBAT16-PBAT30,
  SEX;
USEVARIABLES ARE
  CBAR1-CBAR30, ! CBA Responses Item 1-30
  CBAT2-CBAT15, ! CBA Times Item 2-15,17-30
  CBAT16-CBAT30;
  PBAR1-PBAR30, ! CBA Responses Item 1-30
  PBAT2-PBAT15, ! CBA Times Item 2-15,17-30
  PBAT16-PBAT30;
CATEGORICAL ARE
! (... see 'USEVARIABLES ARE')
MISSING = *;
ANALYSIS: type=RANDOM;
PROCESSORS = 12 ;
INTEGRATION IS MONTECARLO;
MODEL:
  abil BY CBAR1-CBAR30* (ca11-cai30);
  cbaspeed BY CBAT2-CBAT30* (cphil-cphi28);
  abil BY CBAT2-CBAT30* (ccd);
  abil WITH cbaspeed@0;
  [CBAR1$1-CBAR30$1] (cbi1-cbi30);
  [CBAT2-CBAT30] (ccept1-ccept28);
  CBAT2 (csig1);
  ...
  CBAT30 (csig28);
  abil@1;
  cbaspeed@1;
  cbaquad | abil xwith cbaspeed;
  CBAT2 on cbaquad(ccc);
  ...
  CBAT30 on cbaquad(ccc);
  abil BY PBAR1-PBAR30* (pai1-pai30);
  pbaspeed BY PBAT2-PBAT30* (pphil-pphi28);
  abil BY PBAT2-PBAT30* (pcd);
  abil WITH pbaspeed@0;
  [PBAR1$1-PBAR30$1] (pbi1-pbi30);
  [PBAT2-PBAT30] (pcept1-pcept28);

```

```
PBAT2 (psig1);  
...  
PBAT30 (psig28);  
abil@1;  
pbaspeed@1;  
pbaquad | abil xwith pbaspeed;  
PBAT2 on pbaquad(pcc);  
...  
PBAT30 on pbaquad(pcc);  
mode BY CBAR1-CBAR30@1;  
abil WITH mode*;  
[mode@0];  
mode WITH pbaspeed@0;  
mode WITH cbaspeed@0;  
cbaspeed WITH pbaspeed*;  
OUTPUT: TECH1 TECH8; STANDARDIZED;
```