## Online Supplement

## Model Fit Statistics and Comparison of Nested Models with Equality Constraints

# Table S1

*Model Comparisons for Inflectional Morphology and Expressive Vocabulary*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Structure | Constraints | χ2 | *p*-value | df | CFI | RMSEA | 90% CI | SRMS | Nested model comparisons |
| CLPM | None | 22.256 | <.001 | 4 | .931 | .137 | .085–.195 | .046 | –– |
| CLPM | LE & CL | 28.460 | <.001 | 8 | .922 | .103 | .064–.145 | .068 | Δχ2 (4) = 8.023 *p* = .091 |
| CLPM2 | None | 0 | 0 | 0 | 1.00 | 0 | 0 | 0 | –– |
| CLPM2 | LE & CL | 8.865 a | .065 | 4 | .982 | .071 | .000–.135 | .041 | — |
| RI-CLPM | None | 0.054 | .816 | 1 | 1.00 | .000 | .000–.105 | .003 | –– |
| RI-CLPM | LE & CL | 19.583 | .001 | 5 | .945 | .110 | .061–.163 | .070 | Δχ2 (4) = 20.025 *p* <.001 |
| RI-CLPM | LE Voc & CL | 6.921 | .140 | 4 | .989 | .055 | .000–.122 | .027 | Δχ2 (3) = 7.494 *p* = .058 |
| *Note*. CLPM = cross-lagged paned model; CLPM2 = cross-lagged panel model lag-2 effects; RI-CLPM = random-intercept cross-lagged panel model; LE = equal lagged effects; CL = equal cross-lagged effects; LE Voc = equal lagged effects for vocabulary; Δχ2 = Satorra-Bentler scaled chi-square difference test of the null hypothesis of identical fit of the two nested models; a χ2 Equals the chi-square difference between the saturated unrestricted and the restricted model. |

# Table S2

*Model Comparisons for Inflectional Morphology and Receptive Vocabulary*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Structure | Constraints | χ2 | *p*-value | df | CFI | RMSEA | 90% CI | SRMS | Nested model comparisons |
| CLPM | None | 9.808 | .043 | 4 | .985 | .077 | .012–.140 | .029 | –– |
| CLPM | LE & CL | 25.143 | .001 | 8 | .954 | .094 | .054–.137 | .090 | Δχ2 (4) = 15.335 *p* = .004 |
| CLPM | LE Voc & CL | 17.244 | .016 | 7 | .973 | .078 | .031–125 | .080 | Δχ2 (3) = 7.436 *p* = .059 |
| CLPM2 | None | 0 | 0 | 0 | 1.00 | .0 | 0 | 0 | –– |
| CLPM2 | LE & CL | 7.597 a | .107 | 4 | .990 | .061 | .000–.127 | .034 | — |
| RI-CLPM | None | 0.306 | .580 | 1 | 1.00 | .000 | .000–.139 | .012 | –– |
| RI-CLPM | LE & CL | 13.297 | .021 | 5 | .978 | .083 | .030–.138 | .055 | Δχ2 (4) = 12.991 *p* = .011 |
| RI-CLPM | LE Voc & CL | 1.963 | .743 | 4 | 1.00 | .000 | .000–.069 | .024 | Δχ2 (3) = 1.657 *p* = .647 |
| *Note*. CLPM = cross-lagged paned model; CLPM2 = cross-lagged panel model lag-2 effects; RI-CLPM = random-intercept cross-lagged panel model; LE = equal lagged effects; CL = equal cross-lagged effects; LE Voc = equal lagged effects for vocabulary; Δχ2 chi-square difference test of the null hypothesis of identical fit of the two nested models; **a** χ2Equals the chi-square difference between the saturated unrestricted and the restricted model. |

# Table S3

*Model Comparisons for Derivational Morphology and Expressive Vocabulary*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Structure | Constraints | χ2 | *p*-value | df | CFI | RMSEA | 90% CI | SRMS | Nested model comparisons |
| CLPM | None | 23.689 | <.001 | 4 | .840 | .143 | .091–.201 | .051 | –– |
| CLPM | LE & CL | 21.156 | .007 | 8 | .893 | .082 | .040–.126 | .057 | Δχ2 (4) = 2.365 *p* = .669 |
| CLPM2 | None | 0 | 0 | 0 | 1.00 | .0 | 0 | 0 | –– |
| CLPM2 | LE & CL | 6.734 a | .151 | 4 | .978 | .053 | .000–.121 | .045 | — |
| RI-CLPM | None | 0.243 | .622 | 1 | 1.00 | .000 | .000–.134 | .007 | –– |
| RI-CLPM | LE & CL | 5.177 | .395 | 5 | .999 | .012 | .000–.091 | .032 | Δχ2 (4) = 4.785 *p* = .310 |
| *Note*. CLPM = cross-lagged paned model; CLPM2 = cross-lagged panel model lag-2 effects; RI-CLPM = random-intercept cross-lagged panel model; LE = equal lagged effects; CL = equal cross-lagged effects; Δχ2 Satorra-Bentler scaled chi-square difference test of the null hypothesis of identical fit of the two nested models; a χ2 Equals the chi-square difference between the saturated unrestricted and the restricted model.  |

# Table S4

*Model Comparisons for Derivational Morphology and Receptive Vocabulary*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Structure | Constraints | χ2 | *p*-value | df | CFI | RMSEA | 90% CI | SRMS | Nested model comparisons |
| CLPM | None | 15.813 | .003 | 4 | .946 | .110 | .057–.170 | .043 | –– |
| CLPM | LE & CL | 22.139 | .005 | 8 | .935 | .085 | .044–.129 | .072 | Δχ2 (4) = 6.326 *p* = .176 |
| CLPM2 | None | 0 | 0 | 0 | 1.00 | .0 | 0 | 0 | –– |
| CLPM2 | LE & CL | 8.733 a | .068 | 4 | .978 | .070 | .000–.134 | .049 | — |
| RI-CLPM | None | 0.131 | .717 | 1 | 1.00 | .000 | .000–.122 | .007 | –– |
| RI-CLPM | LE & CL | 5.300 | .380 | 5 | .999 | .016 | .000–.092 | .048 | Δχ2 (4) = 5.169 *p* = .270 |
| *Note*. CLPM = cross-lagged paned model; CLPM2 = cross-lagged panel model lag-2 effects; RI-CLPM = random-intercept cross-lagged panel model; LE = equal lagged effects; CL = equal cross-lagged effects; Δχ2 chi-square difference test of the null hypothesis of identical fit of the two nested models; a χ2 Equals the chi-square difference between the saturated unrestricted and the restricted model. |

## CLPM and CLPM2 after Controlling for Working Memory, Nonverbal Reasoning, and Phonological Awareness

# Table S5

*Cross-Lagged Panel Model (CLPM) with Covariate Control–Standardized Parameter Coefficients*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Model  | Inflectional Morphology-Expressive Vocabulary |  | Inflectional Morphology-Receptive Vocabulary |  | Derivational Morphology-Expressive Vocabulary |  | Derivational Morphology-Receptive Vocabulary |
|  |  |  |  |  |  |  |  |
| Lagged effects | T1→T2 | T2→T3 | — |  | T1→T2 | T2→T3 | — |  | T1→T2 | T2→T3 | — |  | T1→T2 | T2→T3 | — |
| MA | .64\*\*\* | .73\*\*\* | — |  | .53\*\*\*† | .75\*\*\*† | — |  | .51\*\*\* | .46\*\*\* | — |  | .53\*\*\* | .48\*\*\* | — |
| V | .32\*\* | .29\*\* | — |  | .43\*\*\* | .43\*\*\* | — |  | .36\*\* | .33\*\*\* | — |  | .44\*\*\* | .42\*\*\* | — |
| Cross-lagged effects | T1→T2 | T2→T3 | — |  | T1→T2 | T2→T3 | — |  | T1→T2 | T2→T3 | — |  | T1→T2 | T2→T3 | — |
| MA → V | .25\*\*\* | .27\*\*\* | — |  | .15\* | .14\* | — |  | .12 | .12 | — |  | .09 | .08 | — |
| V → MA | .04 | .04 | — |  | .09\* | .09\* | — |  | .09 | .07 | — |  | .00 | .00 | — |
| Same-wave correlations | T1 | T2 | T3 |  | T1 | T2 | T3 |  | T1 | T2 | T3 |  | T1 | T2 | T3 |
| MA ↔ V | .20\*\* | .29\*\*\* | .02 |  | .35\*\*\* | .05 | .07 |  | .11 | .20\* | .21 |  | .33\*\*\* | .31\*\* | .02 |
| *Note.* MA = morphological awareness; V = vocabulary; T1 = preschool; T2 = Grade 1; T3 = Grade 2; T1—T3 controlled for preschool WM, NVIQ and PA; \*\*\*= *p* < .001; \*\*= *p* < .010; \*= *p* < .05; all lagged and cross-lagged effects were restricted to be equal over time, except when stated otherwise; † freely estimated effect without equality constraints. |

# Table S6

*Cross-Lagged Panel Model with Second-Order Effects (CLPM2) and Covariate Control–Standardized Parameter Coefficients*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Model  | Inflectional Morphology-Expressive Vocabulary |  | Inflectional Morphology-Receptive Vocabulary |  | Derivational Morphology-Expressive Vocabulary |  | Derivational Morphology-Receptive Vocabulary |
|  |  |  |  |  |  |  |  |
| Lagged effects | T1→T2 | T2→T3 | T1→T3 |  | T1→T2 | T2→T3 | T1→T3 |  | T1→T2 | T2→T3 | T1→T3 |  | T1→T2 | T2→T3 | T1→T3 |
| MA | .61\*\*\* | .67\*\*\* | .13† |  | .60\*\*\*  | .65\*\*\* | .14† |  | .47\*\*\*  | .42\*\*\* | .09† |  | .49\*\*\*  | .43\*\*\* | .10† |
| V | .26\*  | .23\*\* | .30\*\*\*† |  | .41\*\*\*  | .38\*\*\* | .16† |  | .31\*\*  | .27\*\*\* | .29\*\*\*† |  | .41\*\*\*  | .37\*\*\* | .19\*† |
| Cross-lagged effects | T1→T2 | T2→T3 | T1→T3 |  | T1→T2 | T2→T3 | T1→T3 |  | T1→T2 | T2→T3 | T1→T3 |  | T1→T2 | T2→T3 | T1→T3 |
| MA → V | .27\*\*\*  | .28\*\* | −.05† |  | .11  | .10 | .10† |  | .09  | .09 | .03† |  | .05  | .05 | .06† |
| V → MA | .02  | .02 | .01† |  | .08 | .08 | –.02† |  | .07 | .05 | .05† |  | .00 | .00 | –.03† |
| Same-wave correlations | T1 | T2 | T3 |  | T1 | T2 | T3 |  | T1 | T2 | T3 |  | T1 | T2 | T3 |
| MA ↔ V | .20\*\*  | .29\*\*\* | −.01 |  | .35\*\*\*  | .07 | .08 |  | .11  | .21\*\* | .21 |  | .33\*\* | .32\*\*\* | .03 |
| *Note.* MA = morphological awareness; V = vocabulary; T1 = preschool; T2 = Grade 1; T1—T3 controlled for preschool WM, NVIQ and PA;\*\*\*= *p* < .001; \*\*= *p* < .010; \*= *p* < .05; all lagged and cross-lagged effects were restricted to be equal over time, except when stated otherwise; † freely estimated effect without equality constraints. |