# Supplementary Materials

Table S1: *Descriptive statistics for learners from 5 selected L1s and for all learners together (standard deviations in parentheses for all variables except Sex).*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Arabic (N=7510) | German (N=7245) | Serbian (N=2301) | Somali (N=411) | Turkish (N=2869) | Total (N=58299) |
| Speaking | 498.44 (33.03) | 549.48 (33.88) | 513.14 (30.39) | 481.18 (31.88) | 498.62 (39.53) | 517.56 (36.15) |
| Writing | 496.36 (41.07) | 556.88 (39.62) | 517.00 (37.91) | 482.35 (42.56) | 494.66 (47.05) | 520.86 (45.50) |
| Reading | 489.77 (24.78) | 561.67 (41.33) | 519.71 (32.28) | 487.36 (23.37) | 497.48 (30.51) | 520.77 (42.34) |
| Listening | 487.63 (25.91) | 545.29 (44.04) | 508.43 (32.21) | 484.22 (27.22) | 488.06 (29.59) | 510.62 (38.75) |
| Sex (Female) | 2860 (38.1%) | 5793 (80.0%) | 1469 (63.8%) | 82 (20.0%) | 1301 (45.3%) | 39561 (67.9%) |
| Age at arrival | 26.78 (5.95) | 25.57 (7.01) | 28.40 (6.73) | 26.32 (6.50) | 24.57 (5.07) | 27.13 (6.30) |
| Length of residence | 4.36 (4.09) | 1.69 (2.85) | 4.06 (3.05) | 5.59 (3.85) | 5.46 (5.51) | 3.90 (3.91) |
| Educational quality | -28.90 (21.55) | 21.97 (5.36) | 4.32 (6.50) | -68.44 (8.26) | -3.89 (23.30) | 0.53 (27.50) |
| Daily education | -0.02 (1.09) | -0.29 (1.07) | 0.12 (0.75) | -0.35 (1.00) | -0.17 (0.97) | 0.00 (1.00) |
| Lexical Distance | 1.00  | -1.88  | -0.03  | 1.00  | 1.00  | -0.02 (1.00) |
| Morphological Distance | 0.29  | -1.16  | 0.29  | -0.10  | 0.04  | -0.08 (0.82) |
| Phonological Distance | 1.15  | -1.48  | -0.60  | 1.15  | -1.13  | -0.02 (0.99) |

Table S2: *Parameter estimates for the speaking, writing, reading, and listening proficiency models (standard errors in parentheses), [standard deviations in brackets].*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Speaking | Writing | Reading | Listening |
| Intercept | 515.80\*\*\*(1.82) | 511.80\*\*\*(2.76) | 513.70\*\*\*(2.70) | 513.80\*\*\*(2.69) |
| *In model 1:* |  |  |  |  |
| Female | 6.48\*\*\*(.30) | 7.92\*\*\*(.39) | –.40(.33) | –.40(.33) |
| Age of arrival (AoA)  | –1.09\*\*\*(.04) | –.59\*\*\*(.05) | –.51\*\*\*(.05) | –.52\*\*\*(.04) |
| (AoA)2 | –.01\*(.00) | –.27\*\*\*(.01) | –.05\*\*\*(.01) | –.05\*\*\*(.00) |
| (AoA)3 | .00(.00) | .00(.00) | .01\*\*(.00) | .01\*\*(.00) |
| Education | 2.76\*\*\*(.15) | 5.23\*\*\*(.19) | 5.76\*\*\*(.17) | 5.80\*\*\*(.17) |
| Gross enrolment  | .17\*\*\*(.02) | –.18\*\*\*(.02) | .06\*\*(.02) | .07\*\*\*(.02) |
| Female x Gross enrolment | –.06\*\*\*(.01) | .02(.01) | –.04\*\*\*(.01) | –-.04\*\*\*(.01) |
| Education x Gross enrolment | .02\*\*\*(.00) | .01(.01) | .07\*\*\*(.01) | .07\*\*\*(.01) |
|  |
| *In model 2:* |  |  |  |  |
| Length of residence (LoR) | .59\*\*\*(.09) | –1.33\*\*\*(.12) | .29\*\*\*(.08) | –.10(.06) |
| (LoR)2 | –.00(.00) | .05\*\*\*(.01) | .02\*\*\*(.00) | .01\*\*\*(.00) |
|  AoA x LoR | –.08\*\*\*(.01) | –.04\*\*\*(.01) | –.04\*\*\*(.00) | –.04\*\*\*(.01) |
| *In model 3:* |  |  |  |  |
| Lexical distance (LEX) | –7.19\*\*\*(1.46) | –10.88\*\*\*(2.04) | –10.25\*\*\*(2.24) | –10.34\*\*\*(2.24) |
| LEX2 | –.79(1.20) | –2.12(1.68) | 1.63(1.83) | 1.68(1.52) |
| Morphological distance (MOR) | –6.28\*\*\*(1.54) | –4.44\*(2.16) | –3.35(2.30) | –3.39(2.30) |
| MOR2 | 1.14\*\*\*(.32) | 1.11\*(.45) | .84(.48) | .87(.48) |
| Phonological distance (PHON) | –2.41\*(1.06) | –2.64(1.47) | –2.90(1.63) | –2.89(1.64) |
| PHON2 | 1.62(1.02) | 4.47\*\*(1.44) | 1.68(1.52) | 1.66(1.52) |
| *In model 5:* |  |  |  |  |
| LEX x AoA  | –.04(.05) | –.14\*(.06) | –.02(.05) | .01(.05) |
| LEX2 x AoA | .11\*\*\*(.03) | .06(.04) | .11\*\*(.03) | .10\*\*(.03) |
| MOR x AoA | –.06(.05) | –.09(.07) | –.20\*\*\*(.06) | –.21\*\*\*(.06) |
| MOR2 x AoA | .04\*\*(.01) | .05\*\*(.02) | .04\*\*(.01) | .05\*\*(.01) |
| PHON x AoA | –.09\*\*(.03) | –.03(.04) | –.03(.03) | –.04(.03) |
| PHON2 x AoA | .15\*\*\*(.04) | .12\*\*(.05) | .11\*\*(.04) | .12\*\*(.04) |
| *Variance components* |  |  |  |  |
| Residual | 874[29.57] | 1,429[37.80] | 1,050[32.35] | 1,016[31.87] |
| Variance L1 | 20.88[4.57] | 39.27[6.27] | 56.98[7.55] | 36.17[6.01] |
| Variance L2 | 16.62[4.08] | 39.71[6.30] | 32.64[5.71] | 24.62[4.96] |
| Variance L1 x L2 | 6.45[2.54] | 22.04[4.69] | 18.50[4.30] | 10.03[3.17] |
| LoR (Random slope on L1L2) | .50[.71] | 1.01[1.01] | .28[.41] | .24[.49] |
| Variance Country | 65.79[8.11] | 248.73[15.77] | 155.22[12.46] | 44.28[9.69] |
| REML (*df* = 31)  | 539,371 | 567,069 | 549,742 | 547,710 |

\*: *p* < .05; \*\*: *p* < .01; \*\*\*: *p* < .001

Table S3: *Model comparison for the speaking (S), writing (W), reading (R), and listening (L) models.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Model | *df* | *AIC* | *BIC* | *deviance* | *–ΔChi2* | *Δdf* |
| S0 | 6 | 543157 | 543211 | 543145 |  |  |
| S1 | 14 | 541069 | 541195 | 541041 | 2103 | 8 |
| S2 | 17 | 540189 | 540341 | 540155 | 886 | 3 |
| S3 | 23 | 540133 | 540338 | 540087 | 69 | 6 |
| S4 | 29 | 539736 | 539995 | 539678 | 409 | 6 |
| S5 | 31 | 539333 | 539610 | 539271 | 407 | 2 |
| W0 | 6 | 569488 | 569542 | 569476 |  |  |
| W1 | 14 | 569277 | 569358 | 569259 | 217 | 8 |
| W2 | 17 | 567822 | 567973 | 567788 | 1471 | 3 |
| W3 | 23 | 567778 | 567984 | 567732 | 55 | 6 |
| W4 | 29 | 567527 | 567786 | 567469 | 264 | 6 |
| W5 | 31 | 567044 | 567321 | 566982 | 486 | 2 |
| R0 | 6 | 551922 | 551976 | 551910 |  |  |
| R1 | 14 | 550145 | 550270 | 550117 | 1793 | 8 |
| R2 | 17 | 550038 | 550190 | 550004 | 112 | 3 |
| R3 | 23 | 550000 | 550206 | 549954 | 50 | 6 |
| R4 | 29 | 549777 | 550036 | 549719 | 235 | 6 |
| R5 | 31 | 549713 | 499990 | 549651 | 68 | 2 |
| L0 | 6 | 549900 | 549954 | 549888 |  |  |
| L1 | 14 | 548729 | 548854 | 548701 | 1187 | 8 |
| L2 | 17 | 548209 | 548361 | 548175 | 526 | 3 |
| L3 | 23 | 548171 | 548377 | 548125 | 50 | 6 |
| L4 | 29 | 547773 | 548032 | 547715 | 410 | 6 |
| L5 | 31 | 547676 | 547953 | 547614 | 101 | 2 |

*Note. All model comparisons in the table are significant at the p < .0001 level.*

Table S4: *Marginal and Conditional R2 for the speaking, writing, reading, and listening models.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model  | SpeakingMarginal *R2*(Conditional *R2*) | WritingMarginal *R2*(Conditional *R2*) | ReadingMarginal *R2*(Conditional *R2*) | ListeningMarginal *R2*(Conditional *R2*) |
| 0 | .00 (.24) | .00 (.22) | .00 (.29) | .00 (.21) |
| 1 | .04 (.24) | .00 (.23) | .03 (.29) | .04 (.20) |
| 2 | .07 (.25) | .03 (.25) | .03 (.29) | .06 (.22) |
| 3 | .24 (.32) | .12 (.27) | .19 (.35) | .23 (.31) |
| 4 | .24 (.32) | .12 (.27) | .20 (.35) | .23 (.31) |
| 5  | .23 (.32) | .11 (.29) | .19 (.35) | .23 (.31) |



Figure S1. *Age of arrival distribution for learners by their language background; IE = Indo-European. The figure shows only learners older than 45 to focus on the ages where fewer scores are available (only a small percentage of all learners).*

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Figure S2: *Q-Q plots of residual scores for the speaking, writing, listening and reading models 5.*