**Appendix A**

|  |  |
| --- | --- |
| Unique sentences used in the third ladder task. | |
| **Language Background** | **Sentence** |
| British | The clown had a funny face |
| French | They had some chocolate pudding |
| German | The dinner plate was hot |
| Hindi/Indian | The baby has blue eyes |
| Japanese | A child ripped open the bag |
| Korean | The baby slept all night |
| Mandarin | The oven was too hot |
| American English | The truck carries fresh fruit |
| American English | They walked across the grass |
| Scottish | They had a wonderful day |
| Spanish | He’s washing his face with soap |

**Appendix B**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Summary of objective pronunciation distance metrics. | | | | |
| **Sentence** | **Accent** | **DTW** | **LevD** | **Speaking Rate** |
| 1 | Midland (1) | 4.4510136 | 0 | 3.79 |
| 2 | Midland (1) | 4.3401 | 0 | 3.54 |
| 3 | Midland (1) | 4.36867677 | 0 | 3.65 |
| 1 | Midland (2) | 4.29428976 | 0 | 4.04 |
| 2 | Midland (2) | 4.34343333 | 0 | 3.45 |
| 3 | Midland (2) | 4.39141168 | 0 | 2.7 |
| 1 | British | 4.76103786 | 0.375 | 4.08 |
| 2 | British | 4.36595 | 0.15 | 2.91 |
| 3 | British | 4.73211818 | 0 | 3.18 |
| 1 | French | 4.71584883 | 0.3125 | 4.2 |
| 2 | French | 4.344225 | 0.51613531 | 2.68 |
| 3 | French | 4.61793627 | 0 | 5.4 |
| 1 | German | 4.34606922 | 0.25 | 3.11 |
| 2 | German | 4.55046142 | 0.1 | 2.55 |
| 3 | German | 4.53261304 | 0.1 | 2.81 |
| 1 | Indian/Hindi | 4.93326143 | 0.5 | 4.23 |
| 2 | Indian/Hindi | 4.69883908 | 0.4 | 3.93 |
| 3 | Indian/Hindi | 4.52219308 | 0 | 4.07 |
| 1 | Japanese | 4.95778904 | 0.7875 | 3.55 |
| 2 | Japanese | 4.67602997 | 0 | 3.13 |
| 3 | Japanese | 4.5268646 | 0.45833333 | 4.16 |
| 1 | Korean | 4.24237864 | 0.5625 | 3.09 |
| 2 | Korean | 4.34124748 | 0.36613531 | 3.31 |
| 3 | Korean | 4.55860998 | 0.61613531 | 2.79 |
| 1 | Mandarin | 4.48481905 | 0.64516914 | 3.53 |
| 2 | Mandarin | 4.4439184 | 0.58146187 | 2.91 |
| 3 | Mandarin | 4.88821901 | 0 | 3.8 |
| 1 | Spanish | 4.61935184 | 0.9375 | 5.22 |
| 2 | Spanish | 4.7043959 | 0.15 | 3.4 |
| 3 | Spanish | 4.45183302 | 0.25 | 3.12 |
| 1 | Scottish | 4.79443876 | 0.4375 | 2.12 |
| 2 | Scottish | 4.62799445 | 0.1 | 3.55 |
| 3 | Scottish | 4.46212129 | 0.1 | 3.75 |

**Appendix C**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Results from Perceptual Linear Mixed Effects Model | | | |  |
| ***Predictors*** | ***Est.*** | ***CI*** | ***t*** | ***p*** |
| (Intercept) | 1.5 | -0.00 – 3.00 | 1.96 | 0.05 |
| Age 12 | 0.28 | -1.85 – 2.40 | 0.25 | 0.8 |
| Age 6 | 0.53 | -1.60 – 2.65 | 0.48 | 0.628 |
| Sentence 2 | 0.28 | -1.25 – 1.80 | 0.35 | 0.723 |
| Sentence 3 | 0.38 | -1.13 – 1.88 | 0.49 | 0.625 |
| British | 5.75 | 4.00 – 7.50 | 6.45 | <0.001 |
| German | 4.35 | 2.60 – 6.10 | 4.88 | <0.001 |
| Scottish | 6.65 | 4.90 – 8.40 | 7.45 | <0.001 |
| French | 5.75 | 4.00 – 7.50 | 6.45 | <0.001 |
| Korean | 6.65 | 4.90 – 8.40 | 7.45 | <0.001 |
| Mandarin | 9.5 | 7.75 – 11.25 | 10.65 | <0.001 |
| Spanish | 13.4 | 11.65 – 15.15 | 15.02 | <0.001 |
| Biling. Hindi | 11.35 | 9.60 – 13.10 | 12.72 | <0.001 |
| Japanese | 12.9 | 11.15 – 14.65 | 14.46 | <0.001 |
| Age 12 by Sentence 2 | -0.6 | -2.75 – 1.55 | -0.55 | 0.584 |
| Age 6 by Sentence 2 | -0.05 | -2.20 – 2.10 | -0.05 | 0.964 |
| Age 12 by Sentence 3 | -0.4 | -2.53 – 1.73 | -0.37 | 0.712 |
| Age 6 by Sentence 3 | 0.62 | -1.50 – 2.75 | 0.58 | 0.565 |
| Age 12 by British | -0.53 | -3.00 – 1.95 | -0.42 | 0.677 |
| Age 6 by British | 0.33 | -2.15 – 2.80 | 0.26 | 0.797 |
| Age 12 by German | -0.93 | -3.40 – 1.55 | -0.73 | 0.464 |
| Age 6 by German | -1.47 | -3.95 – 1.00 | -1.17 | 0.243 |
| Age 12 by Scottish | -0.73 | -3.20 – 1.75 | -0.57 | 0.566 |
| Age 6 by Scottish | -0.82 | -3.30 – 1.65 | -0.65 | 0.513 |
| Age 12 by French | -0.73 | -3.20 – 1.75 | -0.57 | 0.566 |
| Age 6 by French | 0.28 | -2.20 – 2.75 | 0.22 | 0.827 |
| Age 12 by Korean | -0.53 | -3.00 – 1.95 | -0.42 | 0.677 |
| Age 6 by Korean | -1.32 | -3.80 – 1.15 | -1.05 | 0.294 |
| Age 12 by Mandarin | -2.18 | -4.65 – 0.30 | -1.72 | 0.085 |
| Age 6 by Mandarin | -0.82 | -3.30 – 1.65 | -0.65 | 0.513 |
| Age 12 by Spanish | -1.38 | -3.85 – 1.10 | -1.09 | 0.276 |
| Age 6 by Spanish | -2.07 | -4.55 – 0.40 | -1.64 | 0.1 |
| Age 12 by Biling. Hindi | -1.63 | -4.10 – 0.85 | -1.29 | 0.198 |
| Age 6 by Biling. Hindi | -0.27 | -2.75 – 2.20 | -0.22 | 0.827 |
| Age 12 by Japanese | -0.53 | -3.00 – 1.95 | -0.42 | 0.677 |
| Age 6 by Japanese | -0.82 | -3.30 – 1.65 | -0.65 | 0.513 |
| Sentence 2 by British | -5.12 | -7.60 – -2.65 | -4.06 | <0.001 |
| Sentence 3 by British | 1.23 | -1.25 – 3.70 | 0.97 | 0.332 |
| Sentence 2 by German | 0.88 | -1.60 – 3.35 | 0.69 | 0.488 |
| Sentence 3 by German | 0.08 | -2.40 – 2.55 | 0.06 | 0.953 |
| Sentence 2 by Scottish | -0.62 | -3.10 – 1.85 | -0.5 | 0.62 |
| Sentence 3 by Scottish | -4.67 | -7.15 – -2.20 | -3.71 | <0.001 |
| Sentence 2 by French | 1.98 | -0.50 – 4.45 | 1.57 | 0.118 |
| Sentence 3 by French | -1.52 | -4.00 – 0.95 | -1.21 | 0.227 |
| Sentence 2 by Korean | 3.88 | 1.40 – 6.35 | 3.07 | 0.002 |
| Sentence 3 by Korean | 2.58 | 0.10 – 5.05 | 2.04 | 0.041 |
| Sentence 2 by Mandarin | 0.38 | -2.10 – 2.85 | 0.3 | 0.766 |
| Sentence 3 by Mandarin | -1.52 | -4.00 – 0.95 | -1.21 | 0.227 |
| Sentence 2 by Spanish | -7.27 | -9.75 – -4.80 | -5.77 | <0.001 |
| Sentence 3 by Spanish | -5.42 | -7.90 – -2.95 | -4.3 | <0.001 |
| Sentence 2 by Biling. Hindi | -0.42 | -2.90 – 2.05 | -0.34 | 0.736 |
| Sentence 3 by Biling. Hindi | -0.92 | -3.40 – 1.55 | -0.73 | 0.464 |
| Sentence 2 by Japanese | -1.07 | -3.55 – 1.40 | -0.85 | 0.394 |
| Sentence 3 by Japanese | 0.03 | -2.45 – 2.50 | 0.02 | 0.984 |
| Age 12 by Sentence 2 by British | 0.85 | -2.65 – 4.35 | 0.48 | 0.634 |
| Age 6 by Sentence 2 by British | -1.5 | -5.00 – 2.00 | -0.84 | 0.401 |
| Age 12 by Sentence 3 by British | -2.1 | -5.60 – 1.40 | -1.18 | 0.239 |
| Age 6 by Sentence 3 by British | -3.28 | -6.77 – 0.22 | -1.84 | 0.067 |
| Age 12 by Sentence 2 by German | 1.35 | -2.15 – 4.85 | 0.76 | 0.449 |
| Age 6 by Sentence 2 by German | 3.6 | 0.10 – 7.10 | 2.02 | 0.044 |
| Age 12 by Sentence 3 by German | 0.4 | -3.10 – 3.90 | 0.22 | 0.823 |
| Age 6 by Sentence 3 by German | 2.12 | -1.37 – 5.62 | 1.19 | 0.234 |
| Age 12 by Sentence 2 by Scottish | 0.35 | -3.15 – 3.85 | 0.2 | 0.845 |
| Age 6 by Sentence 2 by Scottish | 0.9 | -2.60 – 4.40 | 0.5 | 0.614 |
| Age 12 by Sentence 3 by Scottish | 0.8 | -2.70 – 4.30 | 0.45 | 0.654 |
| Age 6 by Sentence 3 by Scottish | -1.33 | -4.82 – 2.17 | -0.74 | 0.458 |
| Age 12 by Sentence 2 by French | 0.45 | -3.05 – 3.95 | 0.25 | 0.801 |
| Age 6 by Sentence 2 by French | 0.1 | -3.40 – 3.60 | 0.06 | 0.955 |
| Age 12 by Sentence 3 by French | 2.2 | -1.30 – 5.70 | 1.23 | 0.218 |
| Age 6 by Sentence 3 by French | -0.78 | -4.27 – 2.72 | -0.43 | 0.664 |
| Age 12 by Sentence 2 by Korean | -0.8 | -4.30 – 2.70 | -0.45 | 0.654 |
| Age 6 by Sentence 2 by Korean | -0.75 | -4.25 – 2.75 | -0.42 | 0.674 |
| Age 12 by Sentence 3 by Korean | 0.6 | -2.90 – 4.10 | 0.34 | 0.737 |
| Age 6 by Sentence 3 by Korean | -2.53 | -6.02 – 0.97 | -1.42 | 0.157 |
| Age 12 by Sentence 2 by Mandarin | 1.8 | -1.70 – 5.30 | 1.01 | 0.313 |
| Age 6 by Sentence 2 by Mandarin | 0.6 | -2.90 – 4.10 | 0.34 | 0.737 |
| Age 12 by Sentence 3 by Mandarin | 3.95 | 0.45 – 7.45 | 2.21 | 0.027 |
| Age 6 by Sentence 3 by Mandarin | -0.43 | -3.92 – 3.07 | -0.24 | 0.812 |
| Age 12 by Sentence 2 by Spanish | 2.45 | -1.05 – 5.95 | 1.37 | 0.17 |
| Age 6 by Sentence 2 by Spanish | 4.6 | 1.10 – 8.10 | 2.58 | 0.01 |
| Age 12 by Sentence 3 by Spanish | 0.5 | -3.00 – 4.00 | 0.28 | 0.779 |
| Age 6 by Sentence 3 by Spanish | 0.07 | -3.42 – 3.57 | 0.04 | 0.966 |
| Age 12 by Sentence 2 by Biling. Hindi | 0.4 | -3.10 – 3.90 | 0.22 | 0.823 |
| Age 6 by Sentence 2 by Biling. Hindi | 0.6 | -2.90 – 4.10 | 0.34 | 0.737 |
| Age 12 by Sentence 3 by Biling. Hindi | 1.3 | -2.20 – 4.80 | 0.73 | 0.466 |
| Age 6 by Sentence 3 by Biling. Hindi | -2.88 | -6.37 – 0.62 | -1.61 | 0.107 |
| Age 12 by Sentence 2 by Japanese | -0.6 | -4.10 – 2.90 | -0.34 | 0.737 |
| Age 6 by Sentence 2 by Japanese | -0.15 | -3.65 – 3.35 | -0.08 | 0.933 |
| Age 12 by Sentence 3 by Japanese | 0.3 | -3.20 – 3.80 | 0.17 | 0.866 |
| Age 6 by Sentence 3 by Japanese | -1.53 | -5.02 – 1.97 | -0.85 | 0.393 |

Model syntax: Ranking ~ Age\*Sentence\*Accent + (1+Sentence|Participant)

**Appendix D**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Results from Pronunciation Distance Linear Mixed Effects Model | | | |  |
| ***Predictors*** | ***Estimates*** | ***CI*** | ***t*** | ***p*** |
| (Intercept) | -9.72 | -18.79 – -0.65 | -2.1 | 0.036 |
| Levenshtein Distance | 5.44 | 3.47 – 7.40 | 5.43 | <0.001 |
| Age 12 | -1.27 | -10.41 – 7.88 | -0.27 | 0.786 |
| Age 6 | -3.72 | -12.87 – 5.42 | -0.8 | 0.425 |
| DTW | 2.93 | 0.96 – 4.90 | 2.92 | 0.004 |
| Speech Rate | 0.73 | 0.19 – 1.27 | 2.65 | 0.008 |
| Sentence 2 | -2.02 | -13.83 – 9.80 | -0.33 | 0.738 |
| Sentence 3 | -21.67 | -35.78 – -7.55 | -3.01 | 0.003 |
| Levenshtein Distance by Age 12 | -1.03 | -2.98 – 0.92 | -1.03 | 0.302 |
| Levenshtein Distance by Age 6 | -1.59 | -3.54 – 0.36 | -1.6 | 0.111 |
| Age 12 by DTW | 0.08 | -1.98 – 2.13 | 0.07 | 0.942 |
| Age 6 by DTW | 1.08 | -0.98 – 3.14 | 1.03 | 0.303 |
| Age 12 by Speech Rate | 0.21 | -0.34 – 0.76 | 0.75 | 0.453 |
| Age 6 by Speech Rate | -0.22 | -0.77 – 0.33 | -0.79 | 0.429 |
| Levenshtein Distance by Sentence 2 | 3.29 | 1.27 – 5.32 | 3.19 | 0.001 |
| Levenshtein Distance by Sentence 3 | -1.55 | -3.35 – 0.25 | -1.69 | 0.091 |
| DTW by Sentence 2 | 1.64 | -1.12 – 4.41 | 1.17 | 0.243 |
| DTW by Sentence 3 | 5.58 | 2.43 – 8.73 | 3.48 | 0.001 |
| Speech Rate by Sentence 2 | -1.41 | -2.37 – -0.45 | -2.88 | 0.004 |
| Speech Rate by Sentence 3 | -0.68 | -1.32 – -0.04 | -2.08 | 0.038 |

Model syntax: Ranking ~ Levenshtein Distance\*Age + DTW\*Age + SpeechRate\*Age + Levenshtein Distance\*Sentence + DTW\*Sentence + SpeechRate\*Sentence + (1|Accent) + (1+Levenshtein Distance|Participant)