Appendix

1. Formulas for linear mixed-effects modelling

Dependent and fixed variables:

{F2 / vowelShifting } ~ region \* transcriptionType + yearOfBirth + gender +

followingEnvironment

Random effects, General North / South:

AE: (1 + yearOfBirth + followingEnvironment | speaker) +

(1 + region + transcriptionType + followingEnvironment |word)

AW: (1 + region + followingEnvironment | speaker) +

(1 + region + transcriptionType + followingEnvironment |word)

EY: (1 + region + transcriptionType + yearOfBirth + followingEnvironment | speaker) +

(1 + region + transcriptionType + followingEnvironment |word)

EH: (1 + region + transcriptionType + gender + followingEnvironment | speaker) +

(1 + region \* transcriptionType | word)

IY: (1 + transcriptionType + gender + followingEnvironment | speaker) +

(1 + region \* transcriptionType + followingEnvironment | word)

IH: (1 + transcriptionType + followingEnvironment | speaker) +

(1 + region + transcriptionType + followingEnvironment | word)

OW: (1 + transcriptionType + followingEnvironment | speaker) +

(1 + region + transcriptionType | word)

UW: (1 + followingEnvironment | speaker) +

(1 + region |word)

Random effects, General North / Inland North

AA: (1 + transcriptionType + gender + followingEnvironment | speaker) +

(1 + followingEnvironment |word)

AE: (1 + followingEnvironment | speaker) +

(1 + followingEnvironment |word)

AH: (1+ gender + followingEnvironment | speaker) +

(1 + region +followingEnvironment |word)

AO: (1 + followingEnvironment | speaker) +

(1 + region + followingEnvironment |word)

EH: (1 + region + gender + followingEnvironment | speaker) +

(1 + followingEnvironment |word)

1. Random Effect Structure for Southern Vowel Linear Mixed-Effects Models

|  |  |  |  |
| --- | --- | --- | --- |
| SVS Vowels | By word | By speaker | Residual |
| AE (n=5198) | InterceptRegionSouthTranscriptionGTFolEnv+VoicedObsFolEnv-VoicedObs | 0.010 ± 0.1010.004 ± 0.0650.0008 ± 0.0290.006 ± 0.0740.007 ± 0.085 | InterceptYearOfBirthFolEnv+VoicedObsFolEnv-VoicedObs | 0.006 ± 0.0780.0006 ± 0.0240.012 ± 0.1110.011 ± 0.105 | 0.0076 ± 0.087 |
| AW (n=3116) | InterceptRegionSouthTranscriptionGTFolEnv+VoicedObsFolEnv-VoicedObs | 0.003 ± 0.0510.0005 ± 0.0220.003 ± 0.0570.006 ± 0.0790.007 ± 0.083 | InterceptRegionSouthFolEnv+VoicedObsFolEnv-VoicedObs | 0.004 ± 0.0640.007 ± 0.0810.004 ± 0.0610.003 ± 0.058 | 0.008 ± 0.091 |
| EY (n=5730) | InterceptRegionSouthTranscriptionGTFolEnv+VoicedObsFolEnv-VoicedObs | 0.007 ± 0.0840.002 ± 0.0460.0005 ± 0.0230.007 ± 0.0850.004 ± 0.064 | InterceptRegionSouthTranscriptionGTYearOfBirthFolEnv+VoicedObsFolEnv-VoicedObs | 0.008 ± 0.0910.007 ± 0.0830.0005 ± 0.0230.0003 ± 0.0830.008 ± 0.0920.007 ± 0.086 | 0.009 ± 0.096 |
| EH (n=5930) | InterceptRegionSouth:TranscriptionGTRegionSouthTranscriptionGT | 0.009 ± 0.0950.003 ± 0.0550.011 ± 0.1050.001 ± 0.033 | Intercept:RegionSouthTranscriptionGTGendermaleFolEnv+VoicedObsFolEnv-VoicedObs | 0.006 ± 0.0750.005 ± 0.0690.0004 ± 0.0210.004 ± 0.0600.004 ± 0.0660.005 ± 0.072 | 0.011 ± 0.104 |
| IY (n=4442) | InterceptRegionSouth:TranscriptionGTRegionSouthTranscriptionGTFolEnv+VoicedObsFolEnv-VoicedObs | 0.015 ± 0.1240.005 ± 0.0720.009 ± 0.0950.0007 ± 0.0270.004 ± 0.0640.006 ± 0.077 | InterceptTranscriptionGTGendermaleFolEnv+VoicedObsFolEnv-VoicedObs | 0.008 ± 0.0900.0006 ± 0.0250.004 ± 0.0610.004 ± 0.0630.005 ± 0.070 | 0.008 ± 0.088 |
| IH (n=5961) | InterceptRegionSouthTranscriptionGTFolEnv+VoicedObsFolEnv-VoicedObs | 0.013 ± 0.1100.004 ± 0.0600.0004 ± 0.0200.028 ± 0.1680.002 ± 0.046 | Intercept:TranscriptionGTFolEnv+VoicedObsFolEnv-VoicedObs | 0.003 ± 0.0590.0001 ± 0.0120.004 ± 0.0660.004 ± 0.067 | 0.007 ± 0.085 |
| OW (n=4611) | InterceptRegionSouthTranscriptionGT | 0.005 ± 0.0710.0008 ± 0.0280.0001 ± 0.011 | Intercept:TranscriptionGTFolEnv+VoicedObsFolEnv-VoicedObs | 0.004 ± 0.0610.0004 ± 0.0210.002 ± 0.0470.002 ± 0.043 | 0.010 ± 0.098 |
| UW (n=2786) | InterceptRegionSouth | 0.009 ± 0.0970.002 ± 0.045 | InterceptFolEnv+VoicedObsFolEnv-VoicedObs | 0.007 ± 0.0830.003 ± 0.0590.005 ± 0.069 | 0.010 ± 0.098 |

1. Random Effect Structure for Inland North Vowel Linear Mixed-Effects Models

|  |  |  |  |
| --- | --- | --- | --- |
| NCS Vowels | By word | By speaker | Residual |
| AA (n=1901) | InterceptFolEnv+VoicedObsFolEnv-VoicedObs | 0.013 ± 0.1130.025 ± 0.1600.028 ± 0.169 | InterceptRegionSouthTranscriptionGTGendermaleFolEnv+VoicedObsFolEnv-VoicedObs | 0.003 ± 0.0520.004 ± 0.0610.001 ± 0.0340.004 ± 0.0600.006 ± 0.0750.002 ± 0.048 | 0.005 ± 0.073 |
| AE (n=3433) | InterceptFolEnv+VoicedObsFolEnv-VoicedObs | 0.009 ± 0.0940.004 ± 0.0640.003 ± 0.057 | InterceptFolEnv+VoicedObsFolEnv-VoicedObs | 0.007 ± 0.0840.015 ± 0.1220.011 ± 0.105 | 0.009 ± 0.092 |
| AH (n=3388) | InterceptTranscriptionGT | 0.009 ± 0.0960.0008 ± 0.029 | Intercept:GendermaleFolEnv+VoicedObsFolEnv-VoicedObs | 0.002 ± 0.0390.005 ± 0.0690.002 ± 0.0400.003 ± 0.058 | 0.009 ± 0.097 |
| AO (n=1049) | Intercept:RegionSouthFolEnv+VoicedObsFolEnv-VoicedObs | 0.012 ± 0.1070.004 ± 0.0610.031 ± 0.1770.039 ± 0.197 | Intercept:FolEnv+VoicedObsFolEnv-VoicedObs | 0.010 ± 0.1020.014 ± 0.1170.016 ± 0.126 | 0.006 ± 0.076 |
| EH (n=4016) | Intercept:FolEnv+VoicedObsFolEnv-VoicedObs | 0.008 ± 0.0890.018 ± 0.1360.006 ± 0.076 | Intercept:RegionSouthGendermaleFolEnv+VoicedObsFolEnv-VoicedObs | 0.007 ± 0.0820.003 ± 0.0560.005 ± 0.0720.004 ± 0.0660.005 ± 0.069 | 0.011 ± 0.106 |