**Supplemental Tables**

Table S1

Speaker demographics for the neurologically healthy control (HC) speaker group.

|  | **Group** | **Age** | **Intelligibility (%)***1* |
| --- | --- | --- | --- |
| **Female Speakers** | | | |
| HCF01 | HC | 66 | 90.74 |
| HCF02 | HC | 54 | 83.33 |
| HCF03 | HC | 68 | 82.15 |
| HCF04 | HC | 56 | 93.36 |
| HCF05 | HC | 68 | 83.71 |
| HCF06 | HC | 65 | 84.74 |
| HCF07 | HC | 49 | 86.74 |
| HCF08 | HC | 65 | 80.29 |
| HCF09 | HC | 72 | 91.77 |
| **M** | — | 62.56 | 86.31 |
| **SD** | — | 7.68 | 4.62 |
| **Male Speakers** | | | |
| HCM01 | HC | 55 | 86.59 |
| HCM02 | HC | 49 | 63.64*2* |
| HCM03 | HC | 51 | 81.91 |
| HCM04 | HC | 85 | 58.70*3* |
| HCM05 | HC | 47 | 79.14 |
| HCM06 | HC | 68 | 84.32 |
| HCM07 | HC | 70 | 91.40 |
| HCM08 | HC | 53 | 81.05 |
| HCM09 | HC | 74 | 76.75 |
| **M** | — | 61.33 | 78.17 |
| **SD** | — | 13.29 | 10.60 |
| *1* The reported intelligibility (%) scores are aggregated from the Visual Analog Scale (VAS) ratings made for conversational speech samples in the current study. | | | |
| *2* The HCM02 speaker, while healthy and intelligible, had a Spanish accent that likely influenced his intelligibility ratings. Further discussion about this speaker and the implications for his intelligibility ratings can be found in the limitations section. | | | |
| *3* The HCM04 speaker, presented with a perceptually rough voice quality consistent with healthy aging. This voice quality likely influenced his intelligibility ratings. | | | |

Table S2

Speaker demographics for the neurologically healthy control (HC) speaker group.

|  | **Group** | **Age** | **Time Since Diagnosis (Years)** | **Intelligibility (%)***1* | **Severity***2* |
| --- | --- | --- | --- | --- | --- |
| **Female Speakers** | | | | | |
| PDF01 | PD | 51 | 12 | 86.98 | Mild |
| PDF02 | PD | 73 | 2 | 88.02 | Mild |
| PDF03 | PD | 80 | 4 | 89.90 | Mild |
| PDF04 | PD | 61 | 12 | 68.75 | Severe |
| PDF05 | PD | 63 | 3 | 85.19 | Mild |
| PDF06 | PD | 69 | 3 | 82.55 | Moderate |
| **M** | — | 66.17 | 5.92 | 83.56 | — |
| **SD** | — | 10.13 | 4.78 | 7.68 | — |
| **Male Speakers** | | | | | |
| PDM01 | PD | 63 | 8 | 17.69 | Profound |
| PDM02 | PD | 77 | 9 | 37.17 | Profound |
| PDM03 | PD | 73 | 2 | 59.72 | Severe |
| PDM04 | PD | 67 | 6 | 62.36 | Severe |
| PDM05 | PD | 49 | 12 | 25.43 | Profound |
| PDM06 | PD | 67 | 1 | 63.87 | Severe |
| PDM07 | PD | 68 | 7 | 9.74 | Profound |
| PDM08 | PD | 60 | 15 | 44.09 | Profound |
| PDM09 | PD | 80 | 13 | 4.36 | Profound |
| PDM10 | PD | 50 | 7 | 91.62 | Mild |
| PDM11 | PD | 79 | 6 | 63.73 | Severe |
| PDM12 | PD | 65 | 6 | 81.84 | Moderate |
| PDM13 | PD | 82 | 10 | 72.47 | Moderate |
| PDM14 | PD | 78 | 3 | 53.43 | Severe |
| PDM15 | PD | 82 | 2 | 74.91 | Moderate |
| PDM16 | PD | 74 | 2 | 78.49 | Moderate |
| **M** | — | 69.62 | 6.80 | 52.56 | — |
| **SD** | — | 10.46 | 4.30 | 26.79 | — |
| *1* The reported intelligibility (%) scores are aggregated from the Visual Analog Scale (VAS) ratings made for conversational speech samples in the current study. | | | | | |
| *2* Severity labels were determined based on the intelligibility measures using the surrogate-severity measures outlined in Stipancic et al. (2022). Specifically, intelligibility values > 94% are `Normal`, 85% - 94% are `Mild`, 70% - 84% are `Moderate`, 45% - 69% are `Severe`, and < 45% are `Profound`. | | | | | |

**Table S3**

The target measures across the speaking conditions, presented for male, female, and all speakers.

|  | **Conversational** | | | | **Less Clear** | | | | **More Clear** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **HC** | | **PD** | | **HC** | | **PD** | | **HC** | | **PD** | |
| **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** |
| **All Speakers** | | | | | | | | | | | | |
| Intelligibility (VAS) | 82.31 | 26.98 | 61.06 | 38.45 | 70.88 | 33.86 | 54.49 | 39.33 | 87.68 | 22.59 | 66.25 | 37.48 |
| Articulatory Precision (VAS) | 76.09 | 27.10 | 53.34 | 35.58 | 57.70 | 33.02 | 42.92 | 35.34 | 84.19 | 23.14 | 60.40 | 35.89 |
| Acoustic VSA (kHz²) | 238.44 | 132.84 | 140.22 | 77.97 | 243.83 | 189.49 | 129.82 | 114.25 | 335.81 | 192.62 | 178.75 | 146.81 |
| Acoustic Distance (Hz) | 532.94 | 224.19 | 518.58 | 254.01 | 609.13 | 362.49 | 490.95 | 338.06 | 839.04 | 369.38 | 681.48 | 339.54 |
| F2 Slope (Hz/ms) | 4.11 | 1.71 | 3.48 | 1.91 | 4.16 | 2.07 | 3.35 | 1.90 | 3.31 | 1.15 | 2.91 | 1.16 |
| Kinematic VSA (mm²) | 50.96 | 22.96 | 55.75 | 32.07 | 46.55 | 23.79 | 44.07 | 25.99 | 67.18 | 36.84 | 65.04 | 36.87 |
| Kinematic Distance (mm) | 11.64 | 3.80 | 10.24 | 5.93 | 11.71 | 4.83 | 9.07 | 5.28 | 15.63 | 4.64 | 13.91 | 7.12 |
| Kinematic Speed (mm/s) | 97.90 | 42.59 | 77.57 | 54.11 | 100.24 | 56.05 | 69.96 | 47.97 | 74.37 | 36.10 | 64.82 | 37.55 |
| **Female Speakers** | | | | | | | | | | | | |
| Intelligibility (VAS) | 86.31 | 23.34 | 83.51 | 25.39 | 72.43 | 32.99 | 77.73 | 29.46 | 91.17 | 19.36 | 89.91 | 19.68 |
| Articulatory Precision (VAS) | 83.51 | 21.10 | 77.77 | 24.36 | 59.50 | 32.59 | 67.00 | 29.01 | 87.72 | 20.77 | 84.87 | 21.69 |
| Acoustic VSA (kHz²) | 350.01 | 91.60 | 220.67 | 73.73 | 384.85 | 170.77 | 222.94 | 172.19 | 483.87 | 165.42 | 332.19 | 192.78 |
| Acoustic Distance (Hz) | 649.28 | 241.91 | 732.90 | 211.90 | 804.25 | 378.90 | 846.39 | 360.57 | 1123.95 | 252.68 | 1031.16 | 259.59 |
| F2 Slope (Hz/ms) | 4.45 | 1.91 | 4.70 | 1.67 | 4.67 | 2.07 | 5.03 | 2.10 | 3.58 | 1.08 | 3.57 | 1.02 |
| Kinematic VSA (mm²) | 43.82 | 15.36 | 54.88 | 20.79 | 38.25 | 17.81 | 43.68 | 14.04 | 58.93 | 31.09 | 72.63 | 37.88 |
| Kinematic Distance (mm) | 11.45 | 4.21 | 13.09 | 3.64 | 12.01 | 4.32 | 12.70 | 3.78 | 15.90 | 4.96 | 17.90 | 3.51 |
| Kinematic Speed (mm/s) | 85.13 | 41.76 | 90.49 | 39.26 | 89.31 | 56.03 | 87.22 | 42.51 | 59.30 | 34.35 | 68.42 | 23.19 |
| **Male Speakers** | | | | | | | | | | | | |
| Intelligibility (VAS) | 78.24 | 29.71 | 52.54 | 39.14 | 69.29 | 34.69 | 45.67 | 39.02 | 84.13 | 24.98 | 57.27 | 38.71 |
| Articulatory Precision (VAS) | 68.85 | 30.19 | 44.32 | 34.83 | 55.94 | 33.37 | 34.03 | 33.27 | 80.74 | 24.78 | 51.36 | 35.88 |
| Acoustic VSA (kHz²) | 126.86 | 33.11 | 110.05 | 56.03 | 102.81 | 48.89 | 94.90 | 60.17 | 187.75 | 46.39 | 121.21 | 69.54 |
| Acoustic Distance (Hz) | 419.12 | 128.56 | 440.17 | 221.60 | 414.01 | 210.58 | 360.48 | 214.22 | 554.12 | 214.69 | 553.55 | 268.34 |
| F2 Slope (Hz/ms) | 3.78 | 1.43 | 3.03 | 1.80 | 3.65 | 1.96 | 2.73 | 1.39 | 3.05 | 1.17 | 2.67 | 1.11 |
| Kinematic VSA (mm²) | 58.11 | 27.74 | 56.09 | 36.26 | 54.84 | 27.03 | 44.23 | 29.91 | 75.44 | 42.00 | 62.01 | 37.35 |
| Kinematic Distance (mm) | 11.81 | 3.38 | 9.13 | 6.29 | 11.41 | 5.32 | 7.63 | 5.12 | 15.36 | 4.34 | 12.31 | 7.58 |
| Kinematic Speed (mm/s) | 110.39 | 40.01 | 72.54 | 58.35 | 111.17 | 54.50 | 63.11 | 48.56 | 89.79 | 31.28 | 63.38 | 41.99 |

Table S4

The Model Building Process for Predicting Intelligibility Using the Point-Based Spatial Measures

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Model 1** | | **Final Model** | |
| *Predictors* | *Estimates* | *p* | *Estimates* | *p* |
| (Intercept) | 49.32 | **<0.001** | 48.39 | **<0.001** |
| aVSA | 0.10 | **<0.001** | 0.13 | **<0.001** |
| Sex [F] | 17.41 | **0.018** | 27.69 | **<0.001** |
| kVSA | 0.07 | 0.199 |  |  |
| aVSA × Sex [F] | -0.08 | **0.004** | -0.10 | **<0.001** |
| Sex [F] × kVSA | 0.14 | 0.107 |  |  |
| **Random Effects** | | | | |
| σ2 | 44.78 | | 49.86 | |
| τ00 | 186.37 SpeakerID | | 202.90 SpeakerID | |
| ICC | 0.81 | | 0.80 | |
| N | 40 SpeakerID | | 40 SpeakerID | |
| Observations | 117 | | 120 | |
| Marginal R2 / Conditional R2 | 0.353 / 0.875 | | 0.371 / 0.876 | |

*Note.* Bold values indicate significance at .

Table S5

The Model Building Process for Predicting Intelligibility Using the Transition-Based Spatial Measures

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Model 1** | | **Final Model** | |
| *Predictors* | *Estimates* | *p* | *Estimates* | *p* |
| (Intercept) | 53.41 | **<0.001** | 54.56 | **<0.001** |
| acoDistance | 0.01 | 0.212 |  |  |
| Sex [F] | 16.63 | **0.001** | 14.15 | **0.001** |
| kinDistance | 1.04 | **<0.001** | 1.15 | **<0.001** |
| acoDistance × Sex [F] | -0.01 | 0.273 |  |  |
| Sex [F] × kinDistance | 0.03 | 0.908 |  |  |
| **Random Effects** | | | | |
| σ2 | 90.19 | | 90.14 | |
| τ00 | 156.32 SpeakerID | | 159.35 SpeakerID | |
| ICC | 0.63 | | 0.64 | |
| N | 39 SpeakerID | | 39 SpeakerID | |
| Observations | 581 | | 581 | |
| Marginal R2 / Conditional R2 | 0.318 / 0.750 | | 0.314 / 0.752 | |

*Note.* Bold values indicate significance at .

Table S6

The Model Building Process for Predicting Intelligibility Using the Spatiotemporal Measures

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Model 1** | | **Model 2** | | **Final Model** | |
| *Predictors* | *Estimates* | *p* | *Estimates* | *p* | *Estimates* | *p* |
| (Intercept) | 64.12 | **<0.001** | 68.42 | **<0.001** | 65.98 | **<0.001** |
| F2 Slope | 0.64 | 0.300 | -0.60 | 0.210 |  |  |
| Sex [F] | 29.24 | **<0.001** | 17.75 | **<0.001** | 18.67 | **<0.001** |
| kinSpeed | 19.38 | 0.331 | 12.98 | 0.458 |  |  |
| F2 Slope × Sex [F] | -2.25 | **0.021** |  |  |  |  |
| Sex [F] × kinSpeed | -41.96 | 0.288 |  |  |  |  |
| **Random Effects** | | | | | | |
| σ2 | 106.59 | | 110.28 | | 110.53 | |
| τ00 | 174.70 SpeakerID | | 177.57 SpeakerID | | 218.84 SpeakerID | |
| ICC | 0.62 | | 0.62 | | 0.66 | |
| N | 39 SpeakerID | | 39 SpeakerID | | 40 SpeakerID | |
| Observations | 581 | | 581 | | 600 | |
| Marginal R2 / Conditional R2 | 0.212 / 0.701 | | 0.194 / 0.691 | | 0.199 / 0.731 | |

*Note.* Bold values indicate significance at .

Table S7

The Model Building Process for Predicting Articulatory Precision Using the Point-Based Spatial Measures

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Model 1** | | **Final Model** | |
| *Predictors* | *Estimates* | *p* | *Estimates* | *p* |
| (Intercept) | 28.40 | **<0.001** | 28.64 | **<0.001** |
| aVSA | 0.17 | **<0.001** | 0.20 | **<0.001** |
| Sex [F] | 23.88 | **0.011** | 38.27 | **<0.001** |
| kVSA | 0.10 | 0.165 |  |  |
| aVSA × Sex [F] | -0.14 | **<0.001** | -0.17 | **<0.001** |
| Sex [F] × kVSA | 0.20 | 0.083 |  |  |
| **Random Effects** | | | | |
| σ2 | 92.92 | | 102.40 | |
| τ00 | 222.33 SpeakerID | | 220.73 SpeakerID | |
| ICC | 0.71 | | 0.68 | |
| N | 40 SpeakerID | | 40 SpeakerID | |
| Observations | 117 | | 120 | |
| Marginal R2 / Conditional R2 | 0.426 / 0.831 | | 0.443 / 0.824 | |

*Note.* Bold values indicate significance at .

Table S8

The Model Building Process for Predicting Articulatory Precision Using the Transition-Based Spatial Measures

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Model 1** | | **Final Model** | |
| *Predictors* | *Estimates* | *p* | *Estimates* | *p* |
| (Intercept) | 37.09 | **<0.001** | 39.49 | **<0.001** |
| acoDistance | 0.00 | 0.590 |  |  |
| Sex [F] | 24.29 | **<0.001** | 17.38 | **0.001** |
| kinDistance | 1.65 | **<0.001** | 1.54 | **<0.001** |
| acoDistance × Sex [F] | -0.00 | 0.561 |  |  |
| Sex [F] × kinDistance | -0.38 | 0.283 |  |  |
| **Random Effects** | | | | |
| σ2 | 126.64 | | 128.02 | |
| τ00 | 239.88 SpeakerID | | 248.29 SpeakerID | |
| ICC | 0.65 | | 0.66 | |
| N | 39 SpeakerID | | 39 SpeakerID | |
| Observations | 581 | | 581 | |
| Marginal R2 / Conditional R2 | 0.349 / 0.775 | | 0.333 / 0.773 | |

*Note.* Bold values indicate significance at .

Table S9

The Model Building Process for Predicting Articulatory Precision Using the Spatiotemporal Measures

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Model 1** | | **Model 2** | | **Final Model** | |
| *Predictors* | *Estimates* | *p* | *Estimates* | *p* | *Estimates* | *p* |
| (Intercept) | 57.43 | **<0.001** | 61.05 | **<0.001** | 59.23 | **<0.001** |
| F2 Slope | -0.46 | 0.530 | -1.27 | **0.022** | -1.32 | **0.003** |
| Sex [F] | 33.36 | **<0.001** | 23.30 | **<0.001** | 24.85 | **<0.001** |
| kinSpeed | 0.01 | 0.751 | -0.01 | 0.777 |  |  |
| F2 Slope × Sex [F] | -1.20 | 0.298 |  |  |  |  |
| Sex [F] × kinSpeed | -0.07 | 0.112 |  |  |  |  |
| **Random Effects** | | | | | | |
| σ2 | 147.72 | | 150.23 | | 149.78 | |
| τ00 | 299.91 SpeakerID | | 293.07 SpeakerID | | 331.36 SpeakerID | |
| ICC | 0.67 | | 0.66 | | 0.69 | |
| N | 39 SpeakerID | | 39 SpeakerID | | 40 SpeakerID | |
| Observations | 581 | | 581 | | 600 | |
| Marginal R2 / Conditional R2 | 0.217 / 0.742 | | 0.210 / 0.732 | | 0.214 / 0.755 | |

*Note.* Bold values indicate significance at .