

## *Differential Diagnosis of Apraxia of Speech*

Diagnoses of apraxia of speech (AOS), aphasia with phonemic paraphasia (APP), minimal speech impairment (MIN), or borderline AOS (BORD) were determined based on consensus ratings of segmental errors and temporal prosody by three certified speech-language pathologists. The clinicians completed a rating form for each speaker while listening to multisyllabic words and sentences from the motor speech examination. Four parameters were rated separately for the multisyllable and sentence tasks, including two parameters for segmental errors (substitutions, distortions) and two for temporal prosody (slow rate, prolonged segments/pauses). A 5-point rating scale was used to index severity for each parameter: 0 = *once or never*, 1 = *occasionally present* (clearly less than half of items), 2 = *present in about half of items*, 3 = *often present* (clearly more than half of items), 4 = *always or almost always present*.

The list of items was played as many times as desired by the listeners, and initial ratings were made independently. After revealing the ratings, if all three were within one point, the final rating was taken as the value chosen by all three or two of the three listeners. If any rating had a discrepancy greater than one point, the speech sample was presented again and the raters discussed their impressions until consensus was achieved (Jacks, Haley, Scott, & Jones, 2012).

Based on the final consensus ratings, diagnoses were determined operationally, with a determination of AOS if both sound distortions and sound/pause prolongations were rated as 2 or above (*present in at least half of utterances*). A BORD diagnosis was determined if either distortions or prolongations were rated as 2 or above. A diagnosis of APP required a rating of phoneme-level (i.e., substitution) errors that was 2 or above and a rating of distortion errors or prolongations as 0 or 1. A diagnosis of MIN was found if all parameters were rated as occurring occasionally or once/never. When dysarthria was present in other speakers, the features of the diagnosed disorder (e.g., AOS, APP) were considered more salient than those due to dysarthria alone.

## *Dysarthria Ratings*

To determine the presence of dysarthria, ratings of vocal quality and nasal resonance were completed by two certified speech-language pathologists, using the consensus procedure as described above for AOS diagnosis. A 5-point rating scale (0 = *normal*, 1 = *questionably present*, 2 = *mild*, 3 = *moderate*, 4 = *severe*) was used for the vocal quality and nasal resonance dimensions from the Mayo Clinic rating system (Duffy, 2013).

## **References**

- Duffy, J. R. (2013). *Motor speech disorders: Substrates, differential diagnosis, and management* (3rd ed.). St. Louis, MO: Elsevier Mosby.
- Jacks, A., Haley, K. L., Scott, B. L., & Jones, H. (2012). Auditory-perceptual analysis of dysarthria in bilateral striatopallidodentate calcinosis (Fahr's disease). *Journal of Medical Speech-Language Pathology*, 20, 29–34.

**Supplemental Table 1.** Consensus ratings for segmental and prosodic parameters of speech production from the motor speech examination.

Part. ID	Speech Diag.	Multisyllabic Words				Sentence Production			
		Segmental		Prosodic		Segmental		Prosodic	
		Phonemic errors	Distortion errors	Slow Rate	Prolongations	Phonemic errors	Distortion errors	Slow Rate	Prolongations
P1	AOS	4	4	4	4	4	4	4	4
P2 <sup>a</sup>	AOS	2	2	4	2	1	3	4	2
P3	MIN	0	0	0	0	0	0	0	3
P4	AOS <sup>b</sup>	4	3	3	2	4	3	1	1
P5	BORD <sup>c</sup>	3	1	0	0	1	2	2	3
P6	AOS	3	3	0	1	3	4	4	4
P7	APP	0	0	0	0	2	2	0	0
P8	AOS	3	3	0	0	3	2	2	2
P9	DYS <sup>d</sup>	1	1	3	0	3	3	2	2
P10	BORD <sup>e</sup>	3	3	1	1	4	3	0	0

*Note.* Values reflect consensus ratings from three independent listeners, using the following scale: 0 = *once or never*, 1 = *occasionally present* (clearly less than half of items), 2 = *present in about half of items*, 3 = *often present* (clearly more than half of items), 4 = *always or almost always present*.

<sup>a</sup>P2 experienced a focal traumatic injury, whereas all others had survived stroke. <sup>b</sup>P4 had all signs of AOS in multisyllabic words (articulatory distortions, slow rate, and prolongations); however, in sentences slow rate and prolongations occurred rarely.

<sup>c</sup>Borderline AOS classification was identified in P5 due to articulatory distortions in approximately half of multisyllabic words and less than half of sentences, and abnormal prosody at the sentence level only. <sup>d</sup>P9 was a nonnative speaker of English, with voice characteristics consistent with a unilateral upper motor neuron dysarthria. <sup>e</sup>Borderline AOS classification was identified in P10

because of articulatory distortions, but she had no evidence of dysprosody.

**Supplemental Table 2.** Neurologically healthy control participants: Information and analyses.

Part. ID	Age <sup>a</sup>	Sex	Ethnicity/ Race	First Experimental Condition	Syllable Rate Level				Disfluency duration level			
					MAF effect	MAF release	AAF effect	AAF release	MAF effect	MAF release	AAF effect	AAF release
C1	62;8	M	AA	AAF	1.26	1.12	-4.37***	4.04***	0.03	-0.50	1.36	-0.03
C2	74;7	F	EA	AAF	-0.18	-1.33	-4.07***	2.88**	0.00	1.09	-0.95	0.95
C3	67;6	M	EA	AAF	-0.34	-0.65	-3.27**	3.21**	-1.40	—	—	1.40
C4	73;1	F	EA	MAF	-0.47	0.91	-4.69***	5.40***	-0.95	—	1.75	-1.75
C5	75;10	F	EA	AAF	-1.88	1.12	-4.99***	5.07***	—	—	0.95	-0.95
C6	72;3	M	EA	MAF	-0.95	1.16	-0.89	2.88**	—	—	—	—
C7	72;3	F	EA	MAF	1.45	-0.39	-0.83	3.18**	-0.95	0.95	-0.95	—
C8	68;3	M	EA	AAF	-1.23	2.06	-5.29***	4.86***	0.50	-1.40	0.00	0.00
C9	36;2	F	Latina	MAF	0.38	0.72	-4.04***	4.75***	—	—	—	—
C10	35;4	M	Asian	MAF	-2.38*	3.04**	-4.67***	-4.50***	0.95	-0.95	—	—

*Note.* AA = African American; EA = European American; MAF = masked auditory feedback; AAF = altered auditory feedback; M = male; F = female. The effect of MAF and AAF on changed level and variability of syllable rate and disfluency is represented by nonparametric analyses (Wilcoxon [Z score]). Effects represent comparison to the preceding baseline phase. Release from MAF and AAF indicates comparison of measures to the following baseline condition. Negative values indicate that level or variability was reduced in comparison to the prior phase. Dashes indicate that tests among conditions were not completed because an overall effect was not found for that participant using the Kruskal-Wallis test.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .