formant transitions reflect small movements of individual articulators. Reduced lip and jaw movements have been reported for speakers with Parkinson's disease and amyotrophic lateral sclerosis. However, comparable reports for tongue movement are not available. In this study, x-ray microbeam data were used to compare the acoustic and articulatory phonetic working spaces of neurologically normal and dysarthric speakers. Measurements of formant frequencies, and sagittal-plane locations of tongue fleshpoints, were made for the English vowels /i ae a u/ at the temporal midpoint of the vowel nucleus in three different words for each of ten normal and seven dysarthric speakers. Speakers' articulatory phonetic working spaces were defined as areas enclosed by tongue fleshpoint locations. Data obtained from this study provide an enhanced appreciation of the articulatory bases of acoustic features of dysarthric speech. [Work supported by 1-R01-DC03723.]

2aSC11. Observing the link between speech production and speech perception from disordered speech. Emily Q. Wang (Dept. of Commun. Disord. and Sci., Rush Univ., 1653 W. Congress Pkwy., Ste. 203 SENN, Chicago, IL 60612), Yi Xu (Northwestern Univ., Evanston, IL 60208), Katie Kompoliti, and Christopher G. Goetz (Rush Univ., Chicago, IL 60612)

It was recently reported that individuals with idiopathic Parkinsons Disease (PD) and hypokinetic dysarthria were able to signal sentence focus using acoustic parameters such as $f0$, intensity, and vowel duration that normal speakers use. However, it was also found that PD speakers did not show all the $f0$ patterns that normal speakers use. For example, although the $f0$ range of the word under focus was expanded, the $f0$ range of the postfocus word was not always suppressed. In this paper, the $f0$ patterns produced by ten speakers with idiopathic PD (Hoehn and Yahr stage 3 and 4, off) and mild, or mild-moderate, or moderate hypokinetic dysarthrias will be examined. These patterns will also be correlated to their perception by normal speakers. The following issues will be addressed: (1) Can listeners correctly perceive focus produced by the PD speakers when the $f0$ patterns are similar to those used by normal speakers? (2) Can listeners correctly perceive focus when there are missing cues in the $f0$ patterns (e.g., lack of post-focus suppression)? (3) Can misperception result from the speakers attempt to compensate for their articulatory limitations due to the disease process? Implications of the findings will be discussed in terms of speech motor control.

2aSC12. On the correlation between articulatory and acoustic data. Jintao Jiang, Abeer Alwan (Elec. Eng. Dept., Univ. of California, Los Angeles, Los Angeles, CA 90095), Patricia Keating (Univ. of California, Los Angeles, Los Angeles, CA, 90095), Lynne E. Bernstein, and Edward Auer (House Ear Inst., Los Angeles, CA 90057)

In J. Acoust. Soc. Am. **107**, 2904 (2000), we investigated the correlations between external facial movements, tongue movements, and speech acoustics using a database of consonant–vowel syllables spoken by one female and two male talkers. The intelligibility of the talkers, based on visual information, was judged by hearing-impaired individuals. In this study, we extend the analysis to two sentences and a fourth talker (female); each sentence was repeated five times. Two of the talkers (one male and one female) had high-intelligibility ratings while the other two had low ratings. A Qualisys (optical motion capture system) and an EMA system were used to characterize orofacial and tongue movements, respectively. The articulatory and acoustic data streams were recorded simultaneously and aligned. Acoustic features were represented by line spectral pairs. A multilinear regression technique was applied to quantify the correlation between the data. A universal estimator was obtained with training data, using a jack-knife approach, and then applied to the test data. Correlations results were speaker dependent, and, on average, the highest correlations were between the optical and EMA data. Detailed results, including a comparison between the results for CVs and sentences, and implications will be discussed. [Work supported in part by NSF KDI award 9996088.]

2aSC13. Tongue surface dynamics during speech and swallowing. Jordan R. Green, Steven L. Pittelko, and Yutsai Wang (Dept. of Commun. Disord., Univ. of Wisconsin–Madison, 1975 Willow Dr., Madison, WI 53706)

This investigation characterizes tongue surface dynamics that underlie phonemic variation and that distinguish speech from swallowing. Vertical displacements of pellets affixed to the tongue were extracted from the x-ray microbeam database [Westbury, J. X-ray Microbeam Speech Production Database Users Handbook, Version 1 (1994)], which contains articulatory kinematic data from 57 typical speakers. Participants recited 21 vowel–consonant–vowel (VCV) combinations, read the Grandfather Passage, and swallowed 10 cc of water. Consonantal context was manipulated in the VCV utterances as a means to describe the range of tongue dynamics produced during speech. For each task, tongue dynamics was quantified by performing zero-lag cross correlations on selected pellet pairs. A coupling index was then computed by scaling the derived coefficients by a multiplier that reflected the amplitude of each displacement signal. A wide range of movement coupling among tongue pellets was observed across tasks. Phonemic differentiation in vertical tongue dynamics was observed as coupling varied predictably across marker pairs with place of articulation. Moreover, tongue displacements for speech and swallowing clustered into distinct groups based on their coupling profiles. The strengths and weaknesses of the coupling index for characterizing tongue surface dynamics across multiple speakers are considered.

2aSC14. Vocal-tract model experiment for illustrating vowel production. Soo-Ki Hong and S. W. Yoon (Acoust. Res. Lab., Dept. of Phys., Sung Kyun Kwan Univ., Suwon 440-746, Republic of Korea)

Everyone can articulate the same words even though each individual has unique vocal organ. Findings of common features in the same vowels articulated by everyone are very useful for speech recognition and reproduction. In this study a vocal tract is modeled with a cylindrical silicone tube to understand the mechanisms of vowel production. The constrictions on the tube are varied with locations, lengths, and degrees. The resonance frequency shifts of vocal-tract depend on the length ratio and the cross-section area ratio of the constriction in the tube. The resonance frequencies show good correlation with the formants measured in speech. [One of the authors (SWY) was supported by the BK21 project.]

2aSC15. Simulations of voice onset–offset hysteresis in /aha/ utterances. Jorge C. Lucero (Dept. of Mathematics, Univ. of Brasilia, Brasilia DF 70910-900, Brazil, lucero@mat.unb.br) and Laura L. Koenig (New York Univ.)

The subcritical Hopf bifurcation model for voice onset–offset hysteresis [J. C. Lucero, J. Acoust. Soc. Am. **105**, 423–431 (1999)] is investigated considering the glottal area as control parameter. A two-mass model of the vocal folds coupled to a two-tube approximation for the vocal tract is used for producing oral airflow simulations. The glottal rest area is varied in an abduction–adduction pattern to reproduce smoothed oral airflow records measured during /aha/ production [L. L. Koenig and R. S. McGowan, J. Acoust. Soc. Am. **100**, 2689(A) (1996)]. The resultant simulations show good agreement with the unsmoothed measured records, with a clear hysteresis effect: vocal-fold oscillation stops during glottal abduction at a higher value of the glottal area than the value at which it starts during the adduction. The dependence of the onset–offset hysteresis and voice parameters on vocal-fold stiffness (Q factor), subglottal pressure, and male–female laryngeal configurations is analyzed and illustrated with bifurcation diagrams. [Work supported by CNPq, Brazil, and NIH.]