structures relative to the glottal walls, indicating the presence of quadrupole- or dipole-type sound sources, due to ordered flow structures.

4pSC22. Identification of final fall in subglottal pressure contours of speech utterances. Helen M. Hanson, Janet Slifka, Stefanie Shattuck-Hufnagel (Speech Commun. Group, MIT RLE, 36-511, 77 Massachusetts Ave., Cambridge, MA 02139, helen.hanson@alum.mit.edu), and James B. Kobler (Ctr. for Laryngeal Surgery and Voice Rehabilitation, Massachusetts General Hospital, Boston, MA 02114)

Subglottal pressure (P_s) contours for speech are described as having three phases: initial rise, constant or declining working phase, and final fall. The current work is part of a project to relate characteristics of the P_s contour to prosodic events. To that end, one must identify the three phases in a P_s contour. In past work, it was found that the initial phase is relatively easy to identify, but the transition from the working phase to final fall is less clear [J. Slifka (2000)]. Confounding issues could include segmental impedance, pitch accents, and phrase and boundary tones, all of which can have local effects on P_s. In this work, it is attempted to control tones and segments at the ends of utterances in order to better identify final fall. Lung pressure is estimated from esophageal pressure (corrected for lung volume). Pilot data from one subject indicate that the beginning of final fall is easier to identify when the phrase and boundary tones are low than when they are high. Results will be presented for additional subjects and it will be attempted to relate them to the distribution of pitch accents. [NIH grant DC04331.]

4pSC23. The articulatory and acoustical characteristics of the "apical vowels" in Beijing Mandarin. Wai-Sum Lee (Dept. of Linguist., Univ. of Hong Kong, Pokfulam Rd., Hong Kong, Hong Kong, wsleeba@hku.hk)

The study investigates the articulatory and acoustical characteristics of the two so-called "apical vowels" in Beijing Mandarin, which have been referred to as "apical anterior vowel" and "apical posterior vowel" by the linguists in China. The "apical posterior vowel" has also been described as a retroflex. The results of an EMA (electromagnetic articulograph) analysis show that both vowels are apical, with the tip of tongue approaching the alveolar region for the "anterior vowel" and the postalveolar region for the "posterior vowel." The "posterior vowel" is pharyngealized, as the body of tongue in particular the posterodorsal portion is pulled backward toward the pharynx. Acoustical data obtained using the CSL4400 speech analysis software show that the two "apical vowels" have similar $F1$ value. The $F2$ value is slightly larger for the "posterior vowel" than "anterior vowel." Thus, the correlation between a larger $F2$ and the advanced tongue position is not applicable to these "apical vowels." The main difference between the two "apical vowels" is in $F3$, where the value is much smaller for the "posterior vowel" than "anterior vowel." It is assumed that the smaller $F3$ value for the "posterior vowel" is due to pharyngealization.

4pSC24. Vocal tract length development during the first two decades of life: A magnetic resonance imaging study. Houri K. Vorperian (Waisman Ctr., Univ. of Wisconsin-Madison, Madison WI 53705), Moo K. Chung (Univ. of Wisconsin-Madison, Madison, WI 53705), Lindell R. Gentry (Univ. of Wisconsin Hospitals and Clinics, Madison, WI 53792), Ray D. Kent, Celia S. Choih, Reid B. Durtschi and Andrew J. Ziegert (Univ. of Wisconsin-Madison, Madison, WI 53705)

As the vocal tract length (VTL) increases more than twofold from infancy to adulthood, its geometric proportions change. This study assesses the developmental changes of the various hard and soft tissue structures in the vicinity of the vocal tract (VT), and evaluates the relational growth of the various structures with VTL. Magnetic resonance images from 327 cases, ages birth to age 20, were used to secure quantitative measurements of the various soft, cartilaginous and bony structures in the oral and pharyngeal regions using established procedures [Vorperian *et al.* (1999), (2005)]. Structures measured include: lip thickness, hard- and soft-palate length, tongue length, naso-oro-pharyngeal length, mandibular length and depth, and distance of the hyoid bone and larynx from the posterior nasal spine. Findings indicate: (a) ongoing growth of all oral and pharyngeal structures with changes in growth rate as a function of age; (b) a strong interdependency between structure orientation and its growth curve; and (c) developmental changes in the relational growth of the different VT structures with VTL. Findings provide normative data on the anatomic changes of the supra-laryngeal speech apparatus, and can be used to model the development of the VT. [Work supported by NIH-NIDCD Grants R03-DC4362 R01-DC006282, and NIH-NICHHD P30-HK03352.]

4pSC25. Improving automatic speech recognition via better analysis and adaptation. Douglas O'Shaughnessy, Wayne Wang, William Zhu, Vincent Barreaud, T. Nagarajan and R. Muralishankar (INRS-EMT, 800 de la Gauchetiere West, Ste. 6900 Montreal, QC, Canada H5A 1K6)

One way to improve automatic speech recognition (ASR) systems is to reduce the mismatch between system training and operating conditions, as such mismatch seriously degrades performance. We have developed model adaptation techniques able to adapt to various speech environments without modifying ASR systems, and have developed an appropriate feature transformation scheme for the Mel-frequency cepstral coefficients (MFCC), a popular front-end feature of ASR systems. We use maximum a posteriori model adaptation and a method based on Bayesian parametric representation. Feature transformation aims to maximize the desired source of information for a given speech signal in the front-end features and to minimize undesired sources. Frequency-domain autoregressive modeling and a segmentation algorithm are being developed, e.g., to segment a speech signal into syllablelike units. We also introduce a new speech-processing front-end feature that performs better than the existing MFCC, as well as a log-energy dynamic range normalization technique for ASR in adverse conditions. In addition, we have developed a continuous ASR method that exploits the advantages of syllable and phoneme-based subword unit models. [Work supported by NSERC-Canada and Prompt-Quebec.]

4pSC26. The effects of the glottal geometry on intraglottal pressure distributions. Li Sheng (Dept. of Biomed. Eng. School of Life Sci. and Technol., Xi'an Jiaotong Univ., 28 West Xianning Rd., Xi'an, 71004R, P.R. China), C. Ronald Scherer (Bowling Green State Univ., Bowling Green, OH 43403), MingXi Wan, and SuPin Wang (Xi'an Jiaotong Univ., China)

The purpose of this study is to explore the effects of the glottal geometry on intraglottal and transglottal pressures using a Plexiglas model and a commercially computational fluid dynamics code, FLUENT. Nine glottal angles (uniform, as well as convergent and divergent 5, 10, 20, and 40 deg), 18 inferior vocal-fold angles varied from 87.5 to −10 deg, and 19 superior vocal-fold surface angles varied from −85 to 45 deg for uniform, convergen 10- and divergent 10-deg glottal angle, and a wide range of entrance radii varied from 0.26 to 0.005 cm for different divergent glottis were selected separately to examine their pressure distribution effects. The empirical data were supported by computational results using FLUENT. The results suggest that the 10-deg divergence angle may correspond to least flow resistance, the vocal-fold surface pressures are essentially independent of the inferior and superior vocal-fold surface angles realistic for human phonation, and a small glottal entrance radius tends to lower the transglottal pressure, move the minimal pressure near the glottal entrance more upstream, and make the pressure dip more negative in value. These results suggest that the glottal geometry should be well specified when using physical, mathematical phonatory models.