4aSC8. Extracting tongue muscle contraction patterns from tagged cine MRI. Maureen Stone (Univ. of Maryland Med. School, 16 S. Eutaw St., Rm. 500, Baltimore, MD 21201), Danielle Dick, Andrew S. Douglas, Guy Shechter (Johns Hopkins Univ., Baltimore, MD 21218), Cengizhan Ozturk (Bogazici Univ., Istanbul, Turkey), and Michael Guttman (Natl. Inst. of Health, NHLBI, Bethesda, MD 20892)

This study presents mechanically modeled 3-D volumetric strains for the tongue during speech for the syllable ''sha.'' Multiplanar tagged cine MRI (tMRI) provided input data for a B-spline, geometry-independent, cardiac tag tracking method, devised for the heart, which has been adapted for the tongue. Three sets of tMRI images with orthogonal tag planes were collected in 10 axial and 5 sagittal slices for 24 consecutive time phases. The sagittal slices were recorded twice, once each with a series of horizontal and vertical tag planes. The axial slices were recorded once with lengthwise (anterior-to-posterior) tag planes. These tag planes reflect deformations in the SI, AP, and RL directions, respectively. Within the tongue we tracked 3-D motion, calculated 3-D strains in each image plane, and reconstructed 3-D deformation for the entire volume. From the model muscle contraction patterns are inferred for genioglossus anterior, verticalis, and transverse. To infer muscle contraction we determined the lines of action for each muscle, and tracked their linear strains in the appropriate planes for all 24 time phases. Results showed that muscle compressions are consistent with expected muscle contractions, and we were able to distinguish between transverse and verticalis activity. [Work supported by NIH/NIDCD Grant No. DC01758.]

4aSC9. Stability of intra- and inter-articulatory timing for contiguous jaw cycles. Susan Shaiman (Dept. of Commun. Sci. and Disord., Univ. of Pittsburgh, 4033 Forbes Tower, Pittsburgh, PA 15260, shaiman@shrs.pitt.edu)

The current study compared how contiguous cycles of jaw movement, composed of different phonetic contexts, were impacted by global changes across the entire utterance and by more local, phonetic changes. Specifically, articulatory kinematics were examined to determine if patterns of intra- and inter-articulatory timing across manipulations of speaking rate were maintained for both jaw cycles, while being reorganized for phonetic changes (i.e., in coda composition) specific to the second jaw cycle. Five normal speakers repeated the syllables /paep/, /paeps/, and /paepst/, embedded in the carrier phrase, ''Now say —- again,'' using slow, normal, and fast speaking rates. Changes in speaking rate impacted the utterance globally, with both jaw cycles evidencing similar patterns of kinematic change. Conversely, changes in coda composition for the second jaw cycle resulted in local changes to that cycle only, without impacting the first cycle. Individual speakers demonstrated distinct, but systematic patterns of intra- and interarticulatory timing as a function of coda composition and speaking rate. While functional groupings of articulators may be broken apart and reconfigured for subsequent movements, global suprasegmental changes result in timing patterns which are consistent across these reorganized functional groupings. [Work supported by CRDF–University of Pittsburgh and NSERC.]

4aSC10. Schwas with and without active gestural control. Iris Smorodinsky (Dept. of French and Italian, Univ. of California, Santa Barbara, CA 93106; Yale Univ.; and Haskins Labs., smorodin@humanitas.ucsb.edu)

This study investigates whether some epenthetic vowels are targetless, that is, whether they can arise from the timing of the surrounding consonants [C. P. Browman and L. Goldstein, Papers in laboratory phonology II: Gesture, segment, prosody, 26–56 (1992)]. Specifically, the difference in targetlessness between past tense and lexical schwas in American English is examined. Articulatory data were collected from three speakers of American English using an electromagnetic midsagittal articulometer. The stimuli included phrases with past tense and lexical schwas embedded in a common environment: for example, ''If cheated even once'' (past tense schwa) and ''If Cheetah'd even known'' (lexical schwa). If the tongue body is assumed to be controlled continuously by the targetful vowels, the tongue body position ''during a schwa'' should not differ significantly from the tongue body position during the preceding vowel in the epenthetic schwa tokens while it would in the lexical schwa tokens. In addition, if the lexical schwas have tongue body gestures associated with them but the past tense schwas do not, a significant interaction between schwa type and vowel context is expected. These results would provide evidence of a difference in targetlessness between the past tense and lexical schwas in American English. [Work supported by NIH.]

4aSC11. The phonetics of stress clash in spontaneous speech. Lesley M. Carmichael (Dept. of Linguist., P.O. Box 354340, Univ. of Washington, Seattle, WA 98195-4340, lesley@u.washington.edu)

This study examines the rhythm rule (RR) in spontaneous speech to determine its acoustic correlates and phonetic robustness in conversational intonation. RR in English is a phonological process that accommodates stress clash. It has been primarily investigated in controlled speech. Both analyses of RR were considered in this study: (1) accent reversal—the relative prominence of key syllables is reversed, (2) accent deletion—the relative prominence of key syllables is neutralized. Two hypotheses were investigated: (1) RR is always indicated by measurable acoustic properties. (2) RR is subject to intonational factors and depends upon the attraction of a pitch accent for realization. Duration, f0, and amplitude were measured on relevant syllables. ToBI labeling was used to indicate pitch accents and phrase boundaries. Duration was the most consistent acoustic cue to stress clash resolution. When the target phrase attracted a pitch accent, duration indicated stress clash resolution by accent reversal. When the target phrase did not attract a pitch accent, f0 and duration indicated accent deletion. Crucially, when the phrases did not attract pitch accents (were not intonationally prominent), stress clash was resolved. This finding provides support for hypothesis (1): RR is pervasive in the acoustic signal independently of intonational factors.

4aSC12. Vocal tract length development: MRI procedures. Houri K. Vorperian (Waisman Ctr., Univ. of Wisconsin–Madison, 1500 Highland Ave., Madison, WI 53705), Cliff M. Kalina, Ray D. Kent, Brian S. Yandell, and Lindell R. Gentry (Univ. of Wisconsin–Madison, Madison, WI)

From infancy to adulthood, vocal tract length increases by about twofold. The purpose of this study is to assess the developmental changes in the various hard and soft tissue structures in the vicinity of the vocal tract that contribute toward its length. Magnetic resonance images (MRI) from children (birth to 6 years) and adults were used since MRI provides detailed visualization of the soft tissues in the oral and pharyngeal regions along with adequate visualizations of related bony and cartilaginous structures. Using previously established measurement procedures (Vorperian *et al.*, 1999), the following structures were measured: lip thickness, hard and soft palate length, tongue length, oro- and naso-pharyngeal length, mandibular length, and position of the hyoid bone and larynx in relation to the nasal spine. Findings will be discussed in terms of: (a) the relative contribution of the various structures toward vocal tract length and how the extent of contribution changes with age; and (b) the relative and relational growth of the different structures. Findings provide normative data on the various vocal tract structures measured; also, they contribute toward understanding the anatomic changes that may be a substrate to speech emergence and development. [Work supported by NIDCD Grant No. R03-DC 4362.]