

and /u/) and five Greek and Korean vowels (/a/, /e/, /i/, /o/ and /u/) from word-initial fricative-vowel sequences produced by ten adults and twenty children (2-year-olds and 5-year-olds) were extracted. The duration of vowels was normalized to have seven different proportional time points. In order to minimize the effect coming from the preceding or following consonants, only the formant frequency values measured from the second time point to the vowel midpoint were used for the subsequent analysis. Results will be discussed with respect to the language-specificity in the vowel spectral movements and possible gestural differences across age groups. [Work supported by a Fulbright fellowship, NIDCD Grant No. 02932 and NSF Grant No. 0729140.]

**4pSC12. Physiological constraints explain order of Mandarin tone acquisition in 3-year-old children.** Pusan Wong (Dept. of Otolaryngol.—Head and Neck Surgery, The Ohio State Univ., 915 Olentangy River Rd., Columbus, OH 43212)

Careful analyzes of childrens' lexical tones revealed a more protracted developmental course than previously described. This study examined reasons for that late acquisition by performing acoustic analyzes on 289 monosyllabic Mandarin tones that were produced by 13 children and 4 adults and, subsequently, judged by 10 native listeners. Eight acoustic parameters that yielded strong correlations with the judges categorization of the tones were compared among adult correct productions, child correct productions, and child incorrect productions. Results revealed that childrens' tone 1 (T1, high level) errors involved reduced  $f_0$  height and inability to sustain a level  $f_0$ . Childrens' tone 2 (T2, rising) errors reached minimum  $f_0$  later in the syllable and had either reduced rising or falling  $f_0$  slopes. Childrens' tone 3 (T3, dipping) errors involved reduced syllable length, failing to reach a low  $f_0$ , and having a much higher mean  $f_0$ . Childrens' incorrect tone 4 (T4, falling) productions had reduced negative  $f_0$  slopes. Even childrens' correctly identified T1, T2, and T3 productions were not adultlike. The order of the four tones from the most to the least adultlike was T4, T2, T1, and T3, corresponding to the order of ease of speech motor control for the production of the tones.

**4pSC13. A test of formant frequency analyzes with simulated child-like vowels.** Kate Bunton and Brad H. Story (Dept. Speech, Lang., and Hear. Sci., Univ. of Arizona, Tucson, AZ)

Speech production by children is typically characterized by a fairly high fundamental frequency of phonation and a short vocal tract length that produces high formant frequencies. Together these two characteristics contribute to the difficulty of making accurate measurements of the formants because the vocal tract transfer function may be undersampled by the voice source harmonics. In addition, the close proximity of the low-numbered harmonics (including the fundamental) to a formant may lead to strong nonlinear interaction of the acoustic pressures in the vocal tract and the glottal airflow. The purpose of this study was to use standard spectrographic and LPC techniques, as well as new pitch-synchronous method, to measure formant frequencies of child-like vowels that have been simulated with a speech production model. Each vowel will be simulated with two different representations of the voice source: a glottal area model that allows for nonlinear source-tract interaction and a glottal flow model in which vocal tract characteristics cannot affect the source. The results of the analyzes will be

compared to the actual formant frequencies calculated directly from the known vocal tract area functions used to generate the vowels. [Research supported by NIH R01-DC04789.]

**4pSC14. Repetition of words from dense and sparse phonological neighborhoods in children with hearing loss and normal hearing.** Mark VanDam (Boys Town Natl. Res. Hospital, 555 N 30 St., Omaha, NE 68131, mark.vandam@boystown.org), Noah H. Silbert (Univ. of Maryland, College Park, MD 20742, nsilbert@umd.edu), and Mary Pat Moeller (Boys Town Natl. Res. Hospital, Omaha, NE 68131)

4 and 7 year-old children with normal and impaired hearing performed a listen-and-repeat task with words from dense and sparse phonological neighborhoods. Response accuracy was measured as a function of age, hearing loss, and neighborhood density. Accuracy was higher for older children, children with normal hearing, and for words from dense phonological neighborhoods. Age was evaluated cross-sectionally. Older children with normal hearing were consistently more accurate than younger children with normal hearing; children with hearing loss showed much smaller age-related differences. For children with normal hearing, accuracy for sparse neighborhoods was significantly higher for 7 year-olds than for 4 year-olds, but no such effect was observed for children with hearing loss; a similar pattern holds for words from dense neighborhoods. Relationships between accuracy, productive phonology (GFTA-II), expressive vocabulary (EVT-II), and degree of hearing loss (PTA dBHL) are also explored. These results suggest that phonological predictability, as measured by neighborhood density, is an important factor in the ability of children to perceive and reproduce words, interacting with both age and presence or absence of hearing loss. Absence of age-related performance improvement for children with hearing loss has theoretical implications for the role of auditory experience in development. [Work supported by NIH/NIDCD Grant Nos. R01DC006681 and P30DC04662.]

**4pSC15. A nonword is a word is a word: Perceptual evidence for neighborhood density effects in preschool-aged children.** Melinda D. Woodley (Linguist. Dept., Univ. of California, Berkeley, 1203 Dwinelle Hall, Berkeley, CA 94720)

Work with infants has suggested that children as young as 9 months are sensitive to phonotactic probability [Jusczyk *et al.* (1994)], yet there is little direct evidence for phonotactic facilitation effects in preschoolers [Munson *et al.* (2005)]. One possible explanation for this discrepancy is that as infants begin to assign meaning to lexical items, low level phonetic processing is essentially discontinued until competition among lexical items necessitates finer grained phonological representations [Werker and Stager (2000), among others]. However, another possible reason is methodological; work with toddlers has almost exclusively focused on production tasks. Adults clearly exhibit phonotactic facilitation effects in production [Vitevitch *et al.* (2004)], but any processing effects in children could be masked by noisiness in motor command implementation. The present study therefore examines the effects of phonotactic probability/neighborhood density on lexical access in preschoolers using a purely perceptual ("same/different") task. Whereas adults exhibit a lexical competition effect for words and a phonotactic facilitation effect for nonwords in speech perception [Vitevitch and Luce (1999)], the present results demonstrate a significant lexical competition effect for both words and nonwords, suggesting that the lexical level is indeed the primary mode of processing for young children.