preceded by CV syllable, the phonetic fact known as "half-long vowel" in Finnish [Suomi *et al.* (2003)]. [Work supported by Finlandia Foundation National Scholarship.]

4pSC5. Listener's variation in phoneme category boundary as a source of sound change: A case of /u/-fronting. Reiko Kataoka (Dept. of Linguist., Univ. of California, Berkeley, 1203 Dwinelle Hall, Berkeley, CA 94720-2650)

Previous work examined listeners' recognition of a vowel in a series of [dVt] and [bVp] syllables varying perceptually from /CiC/ to /CuC/ in four different conditions (without precursor phrase, with precursor phrase, and in fast, medium, and slow speech), and found that ambiguous vowel stimuli were more often heard as /u/ in the [d_t] context as opposed to the [b_p] context (compensation for coarticulation). This paper reports the results of further analysis of the data and shows that although listeners varied in their /i/-/u/ category boundaries, their perceptual responses were systematic so that a group of listeners who had the category boundary closer to the /i/-end than the rest of the listeners in the "no-precursor" condition consistently had it this way in other conditions as well. This study also investigated the listeners' response in vowel repetition task, where the listeners were asked to listen to the same [CVC] stimuli as used in the vowel recognition task and to repeat only the vowel. Results of this part of the study will be presented and the implications for a listener-based theory of sound change will be discussed.

4pSC6. Perceptual adaptation to a spoken passage's long term spectral average. Jingyuan Huang (Dept. of Psych., Carnegie Mellon Univ., 5000 Forbes Ave., Pittsburgh, PA 15213, jingyuan@andrew.cmu.edu), Lori Holt (Carnegie Mellon Univ., Pittsburgh, PA 15213), and Andrew Lotto (Univ. of Arizona, Tucson, AZ 85721-0071)

The current study demonstrates that listeners adapt to a passage of speech such that subsequent speech categorizations are made relative to the passage's long-term average spectrum (LTAS). Native-English participants listened to a passage from Harry Potter for about 2 min. Next, they completed a categorization task across a series of natural speech tokens from the same talker, manipulated to vary perceptually from /ga/ to /da/. The passage was filtered to emphasize or de-emphasize regions of the LTAS without altering perceived talker identity or intelligibility. Following exposure to a passage with greater high-frequency energy, listeners more often categorized targets as /ga/ compared to target categorization following the same passage with lower high-frequency energy. Thus, listeners exhibit sensitivity to long-term spectral distributions and categorize subsequent speech relative to the LTAS of the exposure context. The spectrally contrastive directionality of the effect is consistent with earlier work demonstrating the influence of adjacent context on speech categorization, but this study extends the findings to the LTAS of a passage (across minutes) and demonstrates that context need not be adjacent to influence speech categorization. The implications for this work for talker and accent normalization will be discussed. [Work supported by NIH R01DC004674].

4pSC7. Autistic traits predict individual differences in speech categorization. Dan Hufnagle, Lori L. Holt, and Erik D. Thiessen (Dept. of Psych., Carnegie Mellon Univ., Pittsburgh, PA 15213)

Investigating individual differences in speech perception using measures of "autistic" traits in neurotypicals can gauge natural variability in speech processing [M. Stewart and M. Ota, Cognition **109**, 157–162 (2008)]. Using the autism-spectrum quotient (AQ) [Baron-Cohen *et al.*, J. Autism & Dev. Disord. **31**, 5–25 (2001)], which measures autistic traits in neurotypicals, we investigated individual differences in context-dependent speech processing. Twenty-eight neurotypicals categorized a nine-step da/ga series in the context of non-speech tone precursors [following L. Holt, Psychol. Sci. **16**, 305–312 (2005)] and completed the AQ. Context included three tone groups, including relatively high (shift toward ga), medium, and low (shift toward da) tones. Overall, the temporally adjacent tone grouping shifted perception more than distant context ($p<0.001$). Effects correlated with AQ ($r=0.53$). Lower AQ (fewer autistic traits) is associated with near-zero context dependence for endpoint categorization and large context-dependence for ambiguous speech-target categorization. Higher AQ is associated with intermediate influence of context across the series. Individual differences in context-dependent phonetic processing can be predicted from a personality trait scale, suggesting that phonetic processing is not immune from the influence of higher-order cognitive processes associated with these traits or that lower-level perceptual processing varies with these traits. [Work supported by NIH.]

4pSC8. Predicting perceptual outcomes from acoustic measures of vowels in dysarthria: A classification analysis. Kaitlin L. Lansford and Julie M. Liss (Dept. of Speech and Hearing Sci., Arizona State Univ., P.O. Box 870102, Tempe, AZ 85287, kaitlin.lansford@asu.edu)

Reductions in vowel space presumably obscure the distinctiveness of vowels produced by individuals with dysarthria. This represents a source of intelligibility decrement to the extent that more ambiguous vowels influence access of correct lexical items. The present study sought to examine (1) whether vowel formant frequencies predict perceptual decisions through classification analysis and (2) whether different forms of dysarthria are associated with different classification outcomes. Productions of phrases containing the target vowels /i/, /ɪ/, /ɛ/, /æ/, /u/, /o/, /ɑ/, and /ʌ/ in strong syllables were obtained from patients whose speech was affected by one of four neurological impairments: Parkinson disease, Huntington disease, amyotrophic lateral sclerosis, or cerebellar degeneration. The first two formant frequencies of each vowel were measured at its midpoint and then subjected to a classification analysis. Classification rules based on the acoustic measurements were used to classify each token as one of the eight target vowels. For each speaker group, the performance patterns obtained by the classification analysis were compared to those made by 15 listeners in an open transcription task. The ability of the classification analysis to predict perceptual outcomes specific to each dysarthric speaker group will be discussed. [Work supported by NIH/NIDCD.]

4pSC9. Children need coherence masking protection. Eric W. Tarr and Susan Nittrouer (Dept. of Otolaryngol.-Head & Neck Surgery, The Ohio State Univ., 915 Olentangy River Rd., Columbus, OH 43212, tarr.18@osu.edu, nittrouer.1@osu.edu)

Listeners can recognize speech targets at poorer signal-to-noise levels when more signal components are present, even if the additional components are spectrally distant and contribute no new information, but only if all components can be grouped together. [P. C. Gordon, Percept. Psychophys. **59**, 232–242 (1997)]. This phenomenon (coherence masking release) was studied in adults and children using the first formant (F1) of [ɛ] and [ɪ] as targets. Formants were presented in low-pass white noise for vowel labeling, with and without a consistent F2/F3 component above the noise cutoff. Synthetic-speech and sine-wave stimuli were used. Thresholds for accurate labeling were obtained with an adaptive procedure for F1-only and for all 3-formants. For synthetic speech, adults had 3.3 dB of masking release for 3-formants compared to F1-only. Children showed a 6.5-dB effect in the same direction, due to higher thresholds for F1-only. All listeners heard sine waves as non-speech, showed similar thresholds, and had reduced masking release (1.5 dB), but in this case F1-only had the advantage over the 3-formant condition. Conclusions were as follows: (1) children need coherent signals to recognize speech in noise and (2) when combined with Gordon's results, it seems masking release for speech signals likely has a phonetic explanation.

4pSC10. Gaze distribution patterns for audiovisual speech stimuli in preschool children with and without hearing loss. Nicholas A. Smith, Mark VanDam, and Mary Pat Moeller (Boys Town Natl. Res. Hospital, 555 North 30th St., Omaha, NE 68131, smithn@boystown.org)

Visual information plays an important role in the perception of speech. Many studies have shown that the addition of visual information increases speech intelligibility, and that the visual channel alone (as in the case of speechreading) is capable of conveying meaning. The goal of this study was to examine whether children with hearing loss use visual information in speech perception differently from children with normal hearing. An eye-tracking system (faceLAB) was used to record the looking behavior of 3- to 5-year-old listeners while they watched video samples of speech. Children with hearing loss used a variety of assistive devices, including cochlear implants and hearing aids. A group of normal-hearing peers was also tested. Preliminary results reveal that children with hearing loss distribute their gaze fixations more narrowly around the talker's mouth region, whereas

children with normal hearing scan the talker's face more broadly. These differences may reflect hearing-impaired children's ability to compensate for degraded auditory signals through increased reliance on visual cues.

4pSC11. Identification of asynchronous monaural and dichotic vowel pairs across the adult lifespan. Daniel Fogerty, Diane Kewley-Port, and Larry Humes (Speech and Hearing Sci., Indiana Univ., 200 S. Jordan, Bloomington, IN 47405, dfogerty@indiana.edu)

Temporal onset asynchrony is one cue that listeners use to identify concurrent vowels. Young (N=80; 18–31 years), middle-age (N=40; 40–55 years), and older (N=150; 60–88 years) adults identified vowel pairs in a temporal-order paradigm under monaural and dichotic stimulus presentations. Experiments used forced-choice constant-stimuli methods to determine the smallest stimulus onset asynchrony (SOA) between brief 70-ms vowels that enabled identification of the stimulus sequence. Vowels modified from four words (pit, pet, pot, and put) served as stimuli. All listeners identified the vowels in isolation with better than 90% accuracy. Results indicated that older listeners performed significantly poorer on monaural and dichotic temporal-order identification tasks than young listeners, with middle-age listeners in between. Correlations of performance with age across the full age span were moderate. For all three groups, SOAs for the dichotic task were significantly longer than those for the monaural task. A significant main effect of vowel pair was observed, indicating that not all vowel pairs were equally identifiable. Patterns of vowel pair identification were similar across all groups for both monaural and dichotic presentations; however, interactions with age group were observed. Effects of vowel order and dominance were also observed. [Work supported, in part, by NIA R01 AG022334.]

4pSC12. Effect of frequency selectivity on the perception of spectrally/temporally interrupted speech. Michelle Hsieh and Su-Hyun Jin (Dept. of Commun. Sci. and Disord., University of Texas, 1 University Station A1100, Austin, TX 78712, michellehsieh@mail.utexas.edu)

Compared to normal hearing (NH), hearing impaired (HI) listeners have shown significantly less masking release, even when the speech and noise were amplified to compensate for their hearing loss [J. Nelson (2004)]. According to Jin (2003), the reduced masking release of HI listeners was highly related to auditory filter bandwidths, which is an indicator of frequency selectivity. As a follow-up, the present study examined whether the reduced frequency selectivity might influence on spectrally-based perceptual strategies for speech recognition of NH and HI listeners in complex noise. We hypothesized that even with mild hearing loss, HI listeners would show significantly different spectral weight which would be significantly correlated with individual's hearing loss. In this study, signal processing was carried out in the digital domain and involved splitting of the signal spectra into five frequency bands for both speech and noise (band 1: 100–250 Hz, band 2: 250–750 Hz, band 3: 750–1750 Hz, band 4: 1750–3750 Hz, and band 5: 3750–7750 Hz). The subject's task was to identify the sentences heard in quiet, steady, and fluctuating noise in each band. The hypothesis will be examined and its implication on speech perception of HI listeners and signal processing strategy for the amplification system.

4pSC13. Looking for phoneme-level inhibition in spoken word recognition using auditory lexical decision. James White (Dept. of Linguist., UCLA, 3125 Campbell Hall, Los Angeles, CA 90095-1543, jameswhite@ucla.edu)

The TRACE model of spoken word recognition [McClelland & Elman (1986)] contains phoneme-level inhibition while the MERGE model [Norris *et al.* (2000)] does not include active competition between phonemes. Previous work found evidence for facilitation at the phoneme level and competition at the lexical level, but little research has been conducted looking for the existence of inhibition between phonemes. Using an auditory lexical decision task, the current study looks for phoneme-level inhibition by giving participants English target words preceded by isolated English sounds as primes. There are three conditions depending on how related the prime sound is to the final phoneme of the target word: identical (e.g., [s] before "gas"), similar (e.g., [s] before "cash"), and unrelated (e.g., [m] before gas). Facilitation, or faster average reaction times (RTs), is expected in the identical condition relative to the baseline unrelated condition. If facilitation is also found in the similar condition, the results will provide evidence against phoneme-level inhibition, supporting an approach with gradient activation of phonemes. However, if the average RT for the similar condition is greater than or equal to that of the unrelated condition, the results will support models of spoken word recognition containing phoneme-level inhibition.

4pSC14. Competition among variant word forms in spoken word recognition. Micah Geer (Dept. of Psych., Univ. at Buffalo, State Univ. of New York, Park Hall, Buffalo, NY 14260, mgeer@buffalo.edu)

Words in casual speech exhibit considerable variation in articulation. For example, alveolar stop consonants (/t/ and /d/) in certain phonetic environments may be realized as taps, glottal stops, careful /t/s and /d/s, or they may be deleted altogether. Thus, words containing non-word-initial alveolar stops may be represented in memory as multiple specific variants. Whether these multiple representations of variant forms compete for recognition, and at what level of representation such competition might occur, was investigated. Processing time was measured for monosyllabic words ending in either alveolar or non-alveolar (bilabial or velar) stops. Alveolar-ending words were responded to more slowly than carefully matched non-alveolar ending words in both lexical decision and same-different matching tasks. This result did not hold for similarly composed nonwords. In a follow-up experiment, the proportion of alveolar-ending neighbors in a word's phonological neighborhood was manipulated. Overall, the results suggest that variant word forms compete at a stage beyond sublexical processing. Implications for characterizing competition in spoken word recognition are discussed.

4pSC15. Phonological reduction in spoken word recognition. Malte C. Viebahn and Paul A. Luce (Dept. of Psych., SUNY at Buffalo, Park Hall, Buffalo, NY 14260-4110, mviebahn@buffalo.edu)

In casual speech, speakers often produce reduced phonological variants of the intended spoken words. Although these reductions are not obligatory, they occur in a regular way and only in certain phonological environments. Nasal tapping is one of these allophonic processes. During nasal tapping words such as "center" are pronounced as "cenner." Recent studies suggest that the recognition of word forms that have undergone nasal tapping is associated with substantial processing costs. The present set of experiments explores potential causes that may contribute to this effect. It is suggested that the perception of allophonic variants depends on the phonetic conditions under which they are produced and encountered.

4pSC16. At which processing level does extrinsic speaker information influence vowel perception? Matthias J. Sjerps, Holger Mitterer (Max Planck Inst. for Psycholinguistics, Wundtlaan 1, 6525 XD, Nijmegen, The Netherlands, matthias.sjerps@mpi.nl), and James M. McQueen (Radboud Univ. Nijmegen, Nijmegen, The Netherlands)

The interpretation of vowel sounds depends on perceived characteristics of the speaker [e.g., average first formant (F1) frequency]. A vowel between /ɪ/ and /ɛ/ is more likely to be perceived as /ɪ/ if a precursor sentence indicates that the speaker has a relatively high average F1. Behavioral and electrophysiological experiments investigating the locus of this extrinsic vowel normalization are reported. The normalization effect with a categorization task was first replicated. More vowels on an /ɪ/-/ɛ/ continuum followed by a /papu/ context were categorized as /ɪ/ with a high-F1 context than with a low-F1 context. Two experiments then examined this context effect in a 4I-oddity discrimination task. Ambiguous vowels were more difficult to distinguish from the /ɪ/-endpoint if the context /papu/ had a high F1 than if it had a low F1 (and vice versa for discrimination of ambiguous vowels from the /ɛ/-endpoint). Furthermore, between-category discriminations were no easier than within-category discriminations. Together, these results suggest that the normalization mechanism operates largely at an auditory processing level. The mismatch negativity (an automatically evoked brain potential) arising from the same stimuli is being measured, to investigate whether extrinsic normalization takes place in the absence of an explicit decision task.

4pSC17. Sensitivity to input distributions and decision boundaries in auditory category learning. Sung-joo Lim and Lori L. Holt (Dept. of Psych., Carnegie Mellon Univ., 5000 Forbes Ave., Pittsburgh, PA 15213, sungjol@andrew.cmu.edu)

Previous research demonstrates the sensitivity of adults and infants to the statistical regularity of input distributions defining speech categories [D. L. Grieser and P. K. Kuhl, Dev. Psychol. **25**, 577–588 (1989)] and even non-