Introduction

Background
- Speech perception is influenced by the acoustic salience of phoneme sequences (Burnham, 1986) and by native language phonotactic regularities (Dupoux et al., 1999; Wagner et al., 2012).
- Sonority, an acoustic property of sound segments that is correlated with intensity, affects speech perception (Berent et al., 2007). Vowel phonemes are highest on the sonority scale followed by liquids, nasals, fricatives, and stops (Ladefoged, 1975). Sonority generally rises from the onset consonant, peaks at the vowel, and then declines toward the coda. These sonority patterns are termed unmarked. For example, in the word "plank" sonority rises from /p/ to /k/ to /a/, and then declines from /p/ to /n/ to /k/. Listeners have difficulty perceiving consonant clusters with marked sonority patterns relative to unmarked patterns (Berent et al., 2007).
- Language exposure leads to the development of language-specific phonotactic constraints, the expectation that certain phoneme sequences occur in specific phonemic contexts. For example, English listeners have difficulty perceiving /pt/ clusters at word-onset despite /pt/ occurring word-medially in English (Wagner et al., 2012).

Purpose and Hypothesis
- We examined the acoustic-phonetic and phonological influences on speech perception by English listeners using event-related potentials (ERPs). An oddball paradigm with two deviants was used to elicit a Mismatch Negative (MMN), a detection response that is influenced by both acoustic-phonetic and phonological factors (Hsiag et al., 2010; Naatane et al., 1997). One deviant involved a vowel lengthening (/ɡɫ/ → /ɡʃ/) and the other, a vowel reduction (/ɡɡ/ → /ɡ/). Larger MMN responses reflect greater phonetic/phonological distinctions by the listener. The consonant cluster /ɡ/ has an unmarked sonority pattern: the sonority rises from /ɡ/ to /ʃ/ in the word. The consonant cluster /ɡ/ has a marked sonority pattern: sonority plateaus from /ɡ/ to /ʃ/. Thus, we predicted an effect of sonority, with the unmarked vowel reduction pattern /ɡɡ/ showing a larger MMN and P3a relative to the marked vowel reduction pattern /ɡʃ/.
- Both clusters violate English phonotactic constraints in word-onset position. However, the vowel-lengthened deviant is phonological in other word positions in English (e.g., gator) while the vowel reduction is not. Thus, we predicted a larger MMN and P3a response to vowel lengthening relative to vowel reduction.

Methods

Participants
- 14 native speakers of American English (monolingual) living in New York.
- Mean age: 22 years (range 20 to 28); all right-handed subjects; 10 female

Stimuli
- Naturally produced speech stimuli. Standards are real German words (Geschenke, Getränke), and deviants were synthetically modified from the standards.

Data Acquisition
- EEG recorded from 128 channels referenced to Geodesic EEG System, EGI
- Processing: 500 Hz sampling rate; segmentation -200 to 800 ms; baseline correct: 100 ms; artifact corrected; bandpass filtered: 3-30Hz; re-referenced off-line to average reference

Results

No differences were observed between /ɡ/ and /ʃ/ stimuli. Larger mismatch responses were found for the lengthened vowel compared to the reduced vowel for both the /ɡ/ and /ʃ/ conditions. This supports the idea that the phonotactic probabilities influence speech perception more than the acoustic-phonetics of the stimuli.

We are currently testing native German and native Russian speakers. In German, the stimuli are lexical and the phonotactic probabilities differ from English. In Russian, /ɡ/ and /ʃ/ are phonemic, so an MMN and P3a are expected for both long and short deviants.

Understanding the contributions of acoustic salience and native-language phonology to perception of complex speech patterns can help us examine speech-language disorders like Auditory Processing Disorders, dyslexia, and specific language impairment. Electrophysiology during passive listening is an effective way to measure these factors in speech perception, especially in children, because it does not rely on higher-order cognitive processes.

References & Acknowledgments

We thank Yana Gil’ in Moscow, Oksan Rybak-in Liss, Georgia Drakopoulos, and Ashra Coghlan for help with the design and Jasmine Williams for help with testing and graphing.

Acoustic-phonetic versus phonological influences on perception of consonant clusters

Eve Higby1, Monica Wagner2, Anne Gwinner3, Tanja Rinker3, Valerie L. Shafer4

1University of California, Riverside, 2St. John’s University, 3University of Konstanz, 4The City University of New York Graduate Center

SoCal Hearing Conference, September 23, 2017 | Contact: evehigby@gmail.com or val.shafer@gmail.com