The What, Whether, and When of phonological structure in the speech signal

A long-standing assumption in linguistics is that speech articulation imparts to the acoustic signal certain phonologically relevant patterns to which listeners are finely tuned. Bloomfield (1935: 79) put it like this: "The speaker has been trained to make sound-producing movements in such a way that the phoneme-features will be present in the sound waves, and he has been trained to respond only to these features and to ignore the rest of the gross acoustic mass that reaches his ears."

Relating phonological knowledge to the continuous speech signal remains a major challenge, in part because existing phonetic heuristics for phonological structure are typically not robust to natural levels of variation in speech. The path forward, I'll argue, is to develop analytical tools that factor natural variability into the analysis of how phonological structure shapes the phonetic signal.

The What - In the first part of the talk, I use analytical tools from Information Theory (Shannon, 1948) to quantify the entropy of the English vowel system and the information lost (aka equivocation) in transmission from speaker to hearer. The data come from a recent study of vowel perception across accents of English (Shaw et al., 2018). Two findings emerge: (1) the patterns of misperception mirror a hierarchy of phonological features, indicating how listeners' search space is guided by phonological representations; (2) the information lost in the task is high, indicating that errorless vowel perception requires substantial redundancy, presumably from sources such as phonological-, lexical- , contextual-, and talker-based predictability.

The Whether— In the second part of the talk, I develop a general approach to assessing whether the phonetic signal is specified for a particular phonological target or not (Shaw & Kawahara, 2018a). Phonological specification in this approach is assessed through simulation and classification of phonetic signals based on competing phonological representations. I demonstrate the approach through an analysis of the articulation of high vowels in devoicing contexts in Japanese, resolving a longstanding debate over whether these vowels are phonologically deleted or present in the phonetic signal despite devoicing (Shaw & Kawahara, 2018b).

The When— In the third part of the talk, I turn to the distribution of phonological information in time, where it has been found that syllable structure conditions the temporal organization of consonants and vowels. Using stochastic time models of syllable structure, I show how phonetic heuristics for syllables break down under certain conditions but that distinct syllable structures can still be distinguished in the signal from the way that variability is structured (Shaw, Gafos, Hoole, & Zeroual, 2011). Time permitting, I'll finish by presenting a new set of studies showing how syllabically-conditioned timing guides listeners to information in the signal about talker identity, i.e., who is talking, much in the way that phonological representations structure the search space for vowels.

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