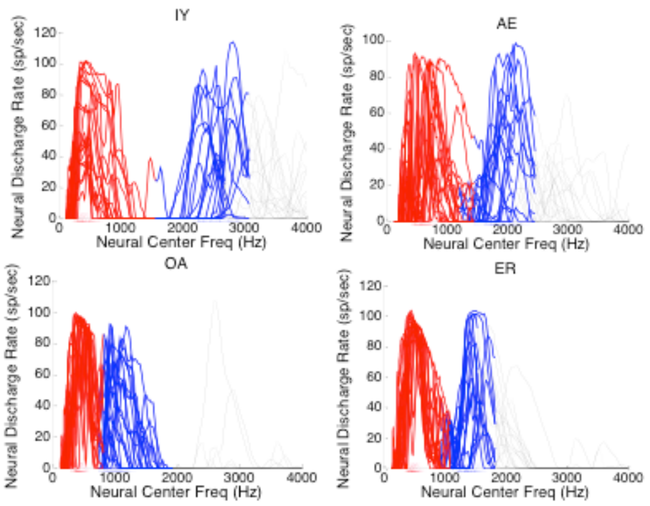
The pre-lexicon: the coding of vowel contrasts in midbrain input to the cortex.

An essential aspect of a discussion of the mental lexicon is the nature of the signal that the cortex receives from the lower auditory system. This study of the coding of vowels in the midbrain combines phonetics, physiology and modeling (Zilany et al 2014; Nelson & Carney 2004). Vowel contrasts were chosen for three reasons: 1) vowels carry rich information important to lexical representations including pitch, meter & stress; 2) vowel spaces in linguistic systems have strong cross-linguistic generalities and consistent asymmetries (Lilenjcrants & Lindblom 1972; Klatt 1982; Lindblom 1990, 1986; de Boer 2000; Schwartz et al 1997a,b; Becker-Kristal 2006; Dielh & Lindblom, 2004; Deilh et al 2003); 3) studies exist that model the responses of the auditory nerve, but not the neural signal beyond that point. Understanding the nature of that signal will help disambiguate the information received by the cortex, and the integration of articulatory versus acoustic information, in the representation of word forms in the lexicon (Browman & Goldstein 1990, 2000; Ghosh et al 2011; Poppel & Monahan 2008; Luo et al 2013).

Our goal is to extend our knowledge of the neural representations of the lexical representation of the vowel space using realistic computational models of auditory-nerve and midbrain neurons. Crucially, the representation of formant frequencies differs between the auditory nerve (AN) and the midbrain (Inferior Colliculus, IC). IC cells are tuned to temporal fluctuations on their inputs which vary across the neural population for different vowels. (*Figure left*) model IC responses for 20 speakers of 4 vowels from the Hillenbrand (1995) dataset, based on interactions of excitatory and inhibitory signals, show that acoustical variability associated with vowel contrasts is maintained in the neural vowel space (arpabet symbols). Frequency ranges for F1 and F2 are highlighted in red and blue. In particular, our results support a version of Dispersion-Focalization Theory (Schwartz 1997; Becker-Kristal 2010).



This works emphasizes the importance of modeling the mechanisms that code information that form the basis of speech perception and the auditory input to lexical representations, lexical storage and access.

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