Increasing the dimensionality in articulatory phonetics (and what to do next): rtMRI of speech production data

Ryan K. Shosted

Beckman Institute for Advanced Science and Technology

University of Illinois at Urbana-Champaign

Imaging techniques like MRI present us with a potentially large number of dimensions (i.e., many pixels) with which to describe articulatory postures and movements during speech production. Real-time MRI (rtMRI) allows us to capture transitory configurations of the vocal tract and observe them multiple times. Despite the high dimensionality available with rtMRI, we are often tempted to radically reduce data dimensionality in order to answer relatively simple—though often vexing—questions of phonetic/phonological interest: e.g., is the vocal tract open or closed; what is the position of the larynx; what is the position of the velum, etc.? With rtMRI such questions have conventionally been answered by referring to average, time-varying pixel intensity in a region of interest or by detecting boundaries and structures in the vocal tract. I present results of a method for analyzing rtMRI data (reconstructed using partially-separable functions) that leverages the intensity of all pixels in a region of interest (ROI). *N* pixels in a ROI, e.g., placed in the anterior oral cavity, are fed into a principal component (PC) analysis with *i* observations of a variety of speech sounds. The number of PCs is optimized and the resulting data are fed into a linear discriminant analysis using *k*-means. The resulting model can be validated against supplementary observations and used in cluster analysis. In this talk, I will present results from studies of coronal consonants in Beijing Mandarin and oral/nasal vowels in Northern Metropolitan French. I will discuss the challenges of using large numbers of PCs in such analyses while attempting to interpret them in terms of well-studied vocal tract mechanics. While it presents us with a number of technical challenges, the application of this technique to large rtMRI corpora has considerable potential for the study of articulatory phonetics and phonology.