Modeling the emergence of cognitive structures for the acquisition of vowel dynamics during early infancy using manifold alignment

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Vowel dynamics is a complex concept ranging over the physical specification of the articulatory dynamics involved in the production of vowels, typically described at several levels of motor control, to the formulation of acoustic measures that are meant to encode the transitional aspects of familiar "static" acoustic properties, e.g., the measurement of formant frequencies at several temporal locations within a vowel production, and on to the modeling of the dynamic perceptual capacities of the auditory system, which capture its sensitivity to a number of temporal aspects of sound internalization. While much insight has been achieved in each of these respective endeavors over the last 150 years, very little is known about how such dynamic information is represented cognitively, and even less is known about how infants acquire cognitive structures that undergird the cognitive representation of vowel dynamics, regardless of the sensory domain under consideration. In this presentation, we put forward a computational model of the emergence of cognitive structures, called "manifolds", that facilitate the acquisition of vowel dynamics during early infancy and are derived from an infant's vocal interaction with caregivers. The principle computation within the framework, called "manifold alignment", generates new manifolds that provide the means for representing preliminary relations between the vowel dynamics of infants and their caregivers. We demonstrate the main computations and discuss the potential applications of the approach.