The embodiment of phonology: Phonological potentials and the lower vocal tract

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Many view phonology as a computational system of the mind responsible for transforming raw lexical input into a suitable, expressible external form (e.g. Hale & Reiss, 2008). This view externalizes the impact that the body's physical properties might have on phonological organization by positing that the phonological core of language is insulated from these factors. In this paper, in contrast, we propose an approach to phonology that foregrounds the importance of the body in shaping speech sound systems: we propose and elaborate a notion of *phonological potentials* – physical properties of speech which put “pressure” on the development of phonological systems to bias or skew them in predictable directions as languages evolve through time. Through an examination of systems that include sounds produced in the "lower vocal tract" (LVT), we illustrate how a model incorporating the notion of phonological potentials increases understanding of sound system behaviour. In addition to recent discussions about a gradient phonetics-phonology relationship (e.g., Cohn, 2006), what features are and their possible emergent qualities (e.g., Mielke, 2004), our model depends on 1) advances in the understanding of the articulation of the LVT, focusing on the role of the epilarynx (Esling, 2005; Moisik, 2013) and 2) advances in articulatory phonetics and how these relate to the notion of devices proposed in Gick, Stavness, Chiu, Flynn & Fels (in preparation).

The laryngeal-pharyngeal region has long presented a challenge to phonological theory: sounds associated with the LVT are diverse and difficult to analyze with traditional features since they include distinctive phonation and voice qualities, tone systems, laryngeal, pharyngeal, and uvular consonants (and related secondary articulations), and even the so-called ATR languages. A relationship across this broad group of sounds has been speculated upon previously and characterized as pointing to a lingual-laryngeal relationship (Czaykowska-Higgins, 1987; Trigo, 1991), but contemporary phonological models do not adequately characterize the behaviour of such systems or what the link between the “glottal” and “lingual” levels might be. The region thus provides a useful test case for exploring a theory of phonological potentials.

The characterization of a lingual-laryngeal relationship entrenched in models based on Feature Geometry (see Uffmann, 2011) is that the “larynx” is phonologically independent from the rest of the vocal tract in its phonological behaviour. Esling and colleagues (e.g., Esling 2005; Edmondson & Esling, 2006) and more recently Moisik (2013), however, have argued that the epilarynx is critical in the lingual-laryngeal connection. The problem, we suggest, is not that Feature Geometric models lack a distinctive feature or a link expressing this epilaryngeal connection; rather, the problem is that standard models miss many generalizations and details which ought to be part of a complete account of the behaviour of LVT sound systems because they fail to reconcile the phonetic and phonological domains. In our paper, we show that making reference to the notion of phonological potentials allows us to overcome this problem.

Our approach can be thought of as a re-envisioning of “Grounded Phonology” (Archangeli & Pulleyblank, 1994). However, phonological potentials (roughly similar to “grounding conditions”) are not necessarily cognitively real primitives, such as if they were encoded in an OT-style constraint, but instead are determined primarily by the physical realities of the vocal tract. Furthermore, the ostensible categorical nature of phonological systems is likewise not necessarily bound to the cognitive realm, since categorical properties exist in the physical realm. Biomechanical-articulatory quantal relations, familiar from Steven’s ideas about a quantal theory of articulatory-acoustic relations (Stevens, 1989), also pervade the vocal tract, as explained in Gick et al. (in preparation). In particular, Gick et al. argue that there are no speech articulators per se, but rather that there are dedicated "devices" responsible for the reliable execution of speech sounds, speech sequences, and so forth, which favour and exploit vocal tract configurations rich in quantal properties (such as when numerous physical contacts are formed or there is sphincter saturation of an articulator).

We demonstrate how LVT phonological systems reflect both "grounding condition" and device-like phonological potentials, paying particular attention to the epilaryngeal constriction involved in three sets of LVT phenomena. First, we consider epilaryngeal vibration, using this phenomenon to show that speakers can "build" a device (in the sense of Gick et al, in preparation) for its use in spoken language, thus creating a phonological potential which can then be incorporated into phonological systems: in !Xóõ and |Nuu epilaryngeal vibration is a distinctive phonatory quality; in Bai and Zhenhai it is part of a system of vocal register. Second, we argue that the special connection between glottal stop and (relatively) low vowels, and /a/ in particular, should be attributed to the lingual-laryngeal connection and the synergistic phonological potential between relatively retracted (low) vowel articulation and epilarynx-mediated laryngeal closure. This relationship accounts for cross-linguistically common use of glide-like epenthesis of [ʔ] to resolve vowel hiatus in /a/ contexts (e.g., Lombardi, 2002) traditionally attributed to shared PHARYNGEAL status. Finally, we examine the relationship between pharyngeal and palatal segments in some Caucasian languages (underlying the notion of "emphatic palatalization"). In a Feature Geometric [RTR] approach, pharyngeals should not cause vowel fronting, yet their tendency to do so is actually quite common (for details, see Moisik 2013). In our model, a palatal component of pharyngeals is a phonological potential based purely on articulatory strategies in epilaryngeal stricture production. The pharyngeal-palatal link in the Caucasian languages is thus a realization of this potential.

A complete model of phonological potentials will be cross-modal. It will go far beyond the articulatory-oriented considerations given here by demonstrating how varying degrees of alignment across domains (articulatory, aerodynamic, acoustic, and so forth) of phonological potentials leads to more or less frequent types of phonological organization and patterns. We submit this work as a preliminary step.

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