The Epilaryngeal Articulator: A New Conceptual Tool for Understanding Lingual-Laryngeal Contrasts

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SUMMARY

We posit an Epilaryngeal Articulator as a new approach to post-velar sounds. After reviewing previous approaches to post-velars and phonetic data supporting the activity of the epilaryngeal tube in post-velar production, we present a definition of the Epilaryngeal Articulator and present a possible technical implementation. Some key features of our model include the introduction of a feature [cet], which replaces both [RTR] and [constricted glottis], and the ability for a lingual retraction feature to dually-link with Tongue Body and Epilaryngeal Articulator nodes. We then demonstrate the utility of this model in the analysis of pharyngeal genesis in Southern Wakashan languages, the variable vocalic consequences of pharyngeals cross-linguistically, and the structural similarity between /ʔ/ and /ʕ/ as evinced by data from Tigre.

1 INTRODUCTION

The representation of post-velar sounds remains an outstanding issue in segmental phonology. In this paper we propose a remodelling of the phonological representation of post-velar phenomena which involves the inclusion of an Epilaryngeal Articulator as a phonological construct to represent and account for the lingual-laryngeal effects observed in post-velar phonology. Our proposal is based on phonetic evidence identifying the *epilaryngeal tube* as the key articulatory component in the production of post-velars where lingual and laryngeal effects are phonetically evident, and on phonological evidence from languages with post-velars. Our arguments for the Epilaryngeal Articulator are conceptual and empirical in nature; for the sake of concreteness, we demonstrate the model's technical implementation in Revised Articulator Theory formalism (RAT; Halle, Vaux & Wolfe 2000).

2 POST-VELARS , PREVIOUS APPROACHES, AND PHONETIC CONSIDERATIONS

Post-velar refers to a broad category of phonological phenomena generally involving some form of primary or secondary stricture in the pharynx and ranging from uvular to glottal place of articulation. The post-velar category has been identified as constituting a natural class of sounds (McCarthy 1994), which typically includes some combination of phonemes with a

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laryngeal, pharyngeal, or uvular component. Thus emphatics (e.g. Arabic), retracted consonants (e.g. Interior Salish, Chilcotin), and, less commonly, ejectives (e.g. Tigre; Rose 1996) have all been observed to behave as post-velars. Also associated with post-velars is a set of vocalic phenomena exhibiting lingual-laryngeal effects in realization; these include 'ATR' harmony sets (widespread in Niger-Congo and Nilo-Saharan), pharyngealized vowels (e.g. Caucasian, Mongolian, and Tungusic), and tonal registers (e.g. Tibeto-Burman and Mon-Khmer). All these phenomena involve combinations of lingual and laryngeal articulatory components. Pharyngeals, for example, demonstrably involve lower pharyngeal stricture in part produced by tongue retraction and larynx raising, and often are associated with constricted phonation—usually creaky voice (Czaykowska-Higgins 1987; Heselwood 2007: 6-7).

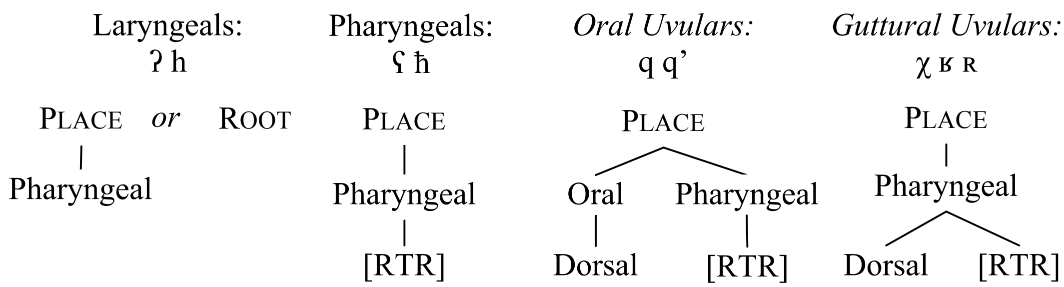
2.1 MODELS OF THE POST-VELAR CLASS

Models of the post-velar class have attempted to account for why such a disparate set of stricture locations (dorso-uvular, dorso-pharyngeal, and glottal) should result in sounds that pattern as a unit in the phonology of many languages. The most significant development on this issue occurred during the 1990s, when McCarthy (1994) claimed that a model of post-velars must be framed in terms of an articulatory region, rather than a specific articulator. He ascribed the fact that the post-velar class is non-articulatorily uniform to the orosensory impoverishment that distinguishes the pharynx (in contrast with the oral cavity). Concurrently, several other researchers proposed feature geometric models that *did* implicate a specific articulatory structure. Bessell (1992) elaborated a model including a Tongue Root articulator associated with the advanced [ATR] and retracted [RTR] tongue root features (see also, Czaykowska-Higgins 1987, Herzallah 1990; Goad 1993; Halle 1995; Ladefoged & Maddieson 1996; McCarthy 1997; Paradis & LaCharité 2001), which originated from work documenting tongue root harmony patterns in African languages (Steward 1967) and also applied to the analysis of tonal register (Gregerson 1976; Trigo 1991). Others (Lindau 1978; Keyser & Stevens 1994; Davis 1995) proposed that the entire pharynx should be granted articulatory status and proposed a feature [constricted pharynx] to represent this.

Recent research has generally maintained the *tongue root approach* to modeling post-velars, and it is also common to see reference to a superordinate class node designated PHARYNGEAL or GUTTURAL. The model in Rose (1996), presented in Fig. 1 below, is typical of this type of approach; we use it here to serve as a formal basis of comparison for the implementation of our proposed model. In Rose (1996), post-velars are unified by the presence of the PHARYNGEAL node, which only activates (in accordance with the Node Activation Condition; p 78) when other dependent features are required to establish a segmental contrast. Thus laryngeals possess a PHARYNGEAL node when there are 'guttural' uvulars /χ ʁ ʀ/ and/or pharyngeals /ʕ ħ/ in the inventory; uvular stops /q/ do not force this activation since they are also ORAL, and thus distinguished from laryngeals. This allows Rose to claim that laryngeals /ʔ h/ will not pattern as post-velars unless there is another post-velar present in the phonological inventory, a claim generally well supported by evidence.

Vowel alterations are a key phonological effect of post-velars, and Rose (1996: 81) identifies two basic types: [RTR]-spreading and PHARYNGEAL node spreading. While spread of [RTR] is phonetically variable in its realization, it necessarily yields a retracted vowel allophone; the spread of PHARYNGEAL results in lowering to [a]. Rose's model thus gives us the expectation that the [RTR] post-velars are a uniform class in their vowel interaction effects and that we should not expect to find subgroups straying from the general pattern, e.g. pharyngeals and uvular fricatives triggering different vowel effects in a given language.

Figure 1: Rose's (1996: 80) Representations of Post-Velars



2.2 PHONETIC EVIDENCE FOR EPILARYNGEAL

The epilaryngeal tube (or laryngeal vestibule) is the upper part of the larynx immediately above the vocal folds. The ventricular folds constitute its lower margin while the rim formed by the epiglottis and aryepiglottic folds form the upper margin. The primary action of this structure is to form a protective closure over the airway by folding and buckling in both the front-back and vertical dimensions (Fink 1974). The stricture can vary in degree, which allows for a range of manners of articulation, from approximant to full stop (Esling 1996). It is important to note that the function of the epilaryngeal tube is independent of the adduction-abduction parameter of the vocal folds, allowing epilaryngeal stricture to occur with either voiced or voiceless glottal conditions.

Laryngoscopy, videofluoroscopy, and laryngeal ultrasound have been used to attest to the occurrence of epilaryngeal stricture in numerous types of post-velars (e.g., Carlson & Esling 2003; Clements & Osu 2005; Esling & Harris 2003; Edmondson & Esling 2006; Moisik et al. 2011). The production of glottal stop involves the vocal folds, and the epilaryngeal mechanism: the ventricular folds adduct—sometimes completely—and impinge upon the upper surface of the vocal folds inhibiting their movement (Lindqvist-Gauffin 1972; Clements & Osu 2005; Moisik et al. 2011). For true pharyngeals, the epilaryngeal tube is manifestly the key stricture location, as documented in Heselwood (2007) for realization of the 'ayn /ʕ/ phoneme in numerous Arabic varieties. Aryepiglottic and epiglottal trilling have been attested for both /ʕ ħ/ phonemes in Arabic (Hassan et al. 2011), Caucasian (Ladefoged & Maddieson 1996: 167-169), and Somali (Edmondson & Esling 2006: 183), and are reported to be a voice source in Khoisan languages !Xóõ (Traill 1986) and Ju|hoansi (Miller 2007). A wide array of languages use epilaryngeal stricture as the primary exponent of contrast: its occurrence is documented in ATR harmony languages Kabiye, Akan and Bor Dinka, tonal register languages Bai and Yi, and the Amis (Formosan) (see Esling and

Edmondson 2006). Uvular consonants found in Interior Salish can occur with simultaneous epilaryngeal stricture: Carlson & Esling (2003) document this in the production of Thompson River Salish uvular resonants. They suggest their data helps to explain the historical shift from uvulars to pharyngeals in Nuuchahnulth (see Section 5.1).

2.3 PROBLEMS WITH PREVIOUS APPROACHES

In light of the phonetic evidence discussed above, the major approaches to phonologically modeling post-velars—the tongue root model and the pharyngeal constriction model—cannot be said to be phonetically adequate[1]. While the tongue root is involved in epilaryngeal stricture, as we will see below, it is not a sufficient condition for it, nor is general pharyngeal stricture sufficient. From a phonetic view, these models describe only components of pharyngeal production and thus mischaracterize the nature of post-velars in general.

A more serious problem from a phonological view, especially for the tongue root model, is the fact that, in these models, pharyngeals are fundamentally associated with tongue root retraction and therefore should retract vowels. This approach does not fully account for pharyngeal behaviour and does not properly distinguish uvulars from pharyngeals. For example, in languages such as Arabic, pharyngeals do not trigger retraction even though uvulars do. In Caucasian languages, pharyngeals can cause vowel fronting to occur and can pattern with palatal segments (Colarusso 1975); see Section 5.2.

Finally, and perhaps most importantly, the lingual-laryngeal connection inherent to the post-velar sound class is not encoded at the phonological level in previous models. For example, in Halle (1995: 18), even though the connection is considered to be important, it is expressed by the domination of LARYNGEAL and TONGUE ROOT articulator nodes by a GUTTURAL class node. This entails that lingual features (such as [RTR]) have no direct relationship or bearing on the status of laryngeal features (such as [constricted glottis]) and can only show simultaneous spreading or delinking behaviour. Such relationships are therefore arbitrary and unconstrained by this geometry.

In our approach, we assume that a model of segmental representation should account for the lingual-laryngeal connection directly to correctly characterize data involving the interaction of post-velar features. In what follows we discuss our proposal for integrating the concept of the epilaryngeal tube into segmental phonology and demonstrate its application in three cases where other models have failed to take the epilaryngeal tube into account.

3 PROPOSAL: AN EPILARYNGEAL ARTICULATOR

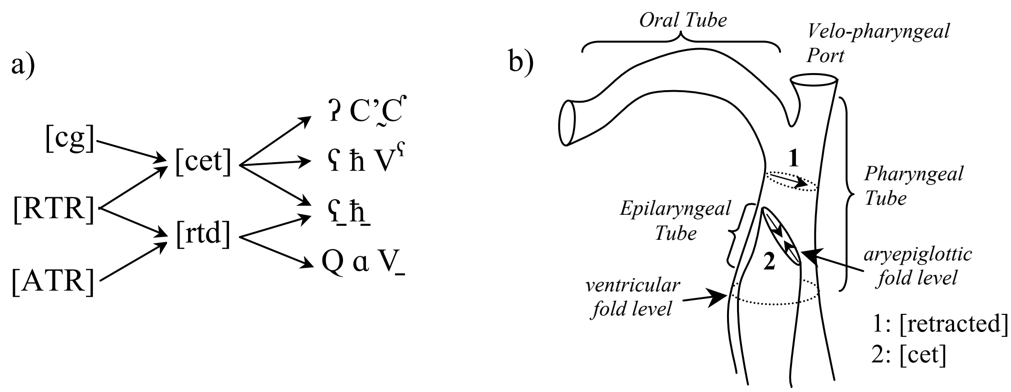
The proposed new epilaryngeal articulator receives the same status as other phonological articulator categories, such as [labial] or [coronal]; thus we posit an articulatory category [epilaryngeal] (EPL) and identify a new distinctive feature [constricted epilaryngeal tube] or

[1] It is worth pointing out that the overwhelming majority of these models are phonetically grounded on mid-sagittal x-ray data, which does not adequately image the epilaryngeal tube. It is not surprising, given the salience of the lingual and pharyngeal tube profiles in the x-ray view, that these components have been identified as central to the production of post-velars.

[cet] to denote the function of the epilaryngeal tube. The [cet] feature partially overlaps in function with the features [RTR] and [constricted glottis] from other models; therefore, we suggest replacing these with [cet]. The feature [cet], however, cannot be considered to determine lingual activity on the phonological level since it is not strictly a lingual feature; thus a feature [retracted] denoting general tongue retraction (importantly, not tongue *root* retraction) is suggested. Since these modifications run parallel to the *Laryngeal Articulator Model* (*LAM), a* phonetic articulatory model developed by Esling (2005), we refer to our model as *the Phonological version of the Laryngeal Articulator Model*, or *PLAM*.

Fig. 2a depicts the alterations we propose in the PLAM and makes their segmental associations explicit. Fig. 2b situates the features [cet] and [retracted] in the tube idealization of the vocal tract.

Figure 2: Post-velar Feature Structure in the PLAM[2]



We can now be more precise about the phonetics of the [cet] and [retracted]. Constriction of the epilaryngeal tube is produced through synergistic activity of three phonetic components: (1) retraction of the tongue and epiglottis (tongue retraction means a downwards and backwards motion of the tongue produced primarily by the hyoglossus muscle; see Fig. 2b), (2) contraction of certain intralaryngeal muscles[3], and (3) larynx raising.

While tongue retraction is a component of epilaryngeal stricture, *it is not a sufficient condition*. This is evident in the fact that the vowel [ɑ] is produced with strong tongue retraction (e.g. Gauffin & Sundberg 1978)—enough such that the epiglottis may come into contact with the posterior pharyngeal wall—yet it does not result automatically in epilaryngeal stricture. Rather, lingual retraction is only a sufficient condition for *pharyngeal tube stricture*, and merely plays a facilitating role in *epilaryngeal tube stricture*. This idea is essential to understanding our model since it stands as the phonetic basis for our proposal that pharyngeals are phonologically uncoupled from specific lingual effects; in previous treatments pharyngeals are phonologically bound to vowel retraction (implied, for example, by their specification as [RTR]). One might think of the three phonetic components of

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[2] Abbreviations: [cet] = [constricted epilaryngeal tube]; [cg] = [constricted glottis]; [rtd] = [retracted]; Q = uvulars; C̰ˤ= laryngealized implosives (see Clements & Osu 2005); ʕ̠ = retracting pharyngeal.

[3] Specifically, the thyroarytenoid, aryepiglottic, and thyroepiglottic muscles (see Esling et al. 2007).

epilaryngeal stricture as collaborating to produce what is phonologically called for: depending upon the environment, one might need more or less of one of the components. For example, if epilaryngeal stricture is required in the context of an [ɑ] vowel, which normally employs strong tongue retraction, larynx raising and the intralaryngeal component may not need to be strongly engaged. Conversely, in the context of an [i], if vowel quality is to be preserved, tongue retraction cannot be heavily involved, so the other two components must compensate with extra effort to produce the stricture.

This leads us to the identification of an articulatory incompatibility between the lingually advanced configuration of palatal constrictions and epilaryngeal stricture. We thus would expect to find most phonologies favouring epilaryngeal stricture in the context of retracted vowels; however, languages will likely vary considerably on exactly how the conflict gets resolved depending upon, among other things, the specific combination of epilaryngeal stricture components. We can also state that there is a high possibility that the relatively uncommon nature of those post-velars sounds employing epilaryngeal stricture may very well reflect the fact that their physiological mechanism is complex, especially in comparison to basic tongue retraction. Thus it is not surprising to see pharyngeals lost through sound change to sounds of reduced articulatory complexity (as in some Interior Salish languages; e.g. see Kinkade 1967).

Finally, the role of larynx height in epilaryngeal stricture plays a key role in altering the dynamics of the vocal folds. As noted before, there are two key dimensions of epilaryngeal stricture: frontwards movement of the aryepiglottic folds to the backwards moving epiglottis and a vertical component. The vertical component is largely governed by the height of the larynx, and this parameter determines the relationship between the vocal folds and the bottom of the epilaryngeal tube—i.e. the ventricular folds. With larynx raising, the vocal folds and ventricular folds effectively compress into each other and buckle outwards towards the glottal midline[4]. Larynx lowering undoes this effect by exerting a lateral pull on both structures as the soft tissues of the larynx are vertically stretched due to traction from above and downwards pulling[5]. Larynx height also changes global vocal tract resonances, which yields additional acoustic cues to the state of the epilaryngeal structure.

Thus, the Epilaryngeal Articulator encapsulates the lingual-laryngeal relationship directly by virtue of the nature of its control mechanism—retraction, intralaryngeal contraction, and larynx raising—and this relationship is reflected in a redefinition of key post-velar features. This conceptual analysis is reflected in the phonological patterning of post-velar sounds and in the nature of the post-velar phonetics-phonology interface. Before we discuss these matters, we consider a technical implementation of these ideas to frame the discussion of the data in terms of feature geometry.

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[4] The mechanical effects of this include (i) additional mass and damping in the oscillating system, (ii) the introduction of new modes of oscillation, and (iii) interference with the mucosal wave of the vocal folds (see Moisik & Esling 2011).

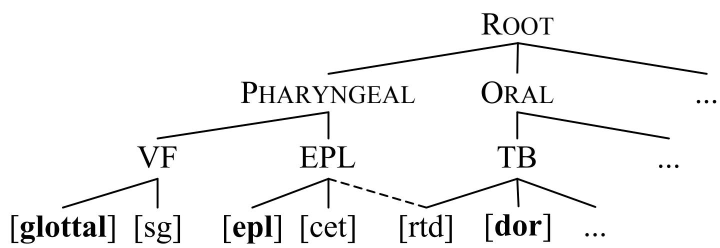
[5] Of course, ventricular fold incursion over the vocal folds is also driven by front-back reduction of the epilaryngeal tube, but the larynx height mechanism is important for regulating the vertical separation of the two sets of folds.

4 ILLUSTRATION OF A TECHNICAL IMPLEMENTATION OF THE PLAM

We use the Revised Articulator Theory (RAT) as a framework for implementing our proposals about an epilaryngeal tube articulator due to its assertion that phonological features must be defined in articulatory terms. The implementation of the PLAM using the RAT (Halle et al. 2000) as a foundation is presented in Fig. 3 with some minor alterations to names; features in bold are designated articulator features, irrelevant features are not shown.

There are two essential points: First, there is no [constricted glottis] feature; glottal stop is the realization of [cet] with [**glottal**]. Phonetically this is interpreted as moderate epilaryngeal stricture yielding ventricular incursion suitable to inhibit vocal fold motion. The result should be [ʔ], but creaky phonation is also a phonetic possibility. The glottal fricative /h/ entirely lacks EPL specification and is, hence, the most 'purely glottal' sound possible.

Figure 3: Technical Implementation of the PLAM[6]



Second, we propose that the feature [retracted] is doubly dependent, or exhibits *dual-linking* with the EPL and TB nodes. Dual-linking has been proposed by many researchers working with feature geometry in the past (e.g. Goad 1993: 3). Rose allows for the feature [dorsal] to be a dependent of either the ORAL or PHARYNGEAL nodes[7], and describes [dorsal] as "the bridge between these two regions" (1996: 76). In our model, [retracted] is properly a Tongue Body feature, but it can associate with EPL[8], and we propose that a pharyngeal specified for [retracted] will tend to exhibit spreading of this feature onto neighbouring TB nodes—hence causing vowel retraction. However, there is no *a priori* reason for pharyngeals to be specified [retracted], since their phonological identity is represented by the feature [cet].

This model leads to three predictions regarding post-velars, each of which we will provide an account for in section 5: (i) loss of the ORAL node should leave EPL features untouched and permit [retracted] to survive as a dependent of EPL; (ii) pharyngeals proper, might show vowel effects independent of those effects caused by uvulars since pharyngeals and uvulars are characterized primarily by different features, [cet] and [retracted], respectively; (iii) we should be able to find cases of /ʔ/ and /ʕ/ interacting to the exclusion of

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[6] [rtd] = [retracted]; [sg] = [spread glottis]; EPL = EPILARYNGEAL; TB = TONGUE BODY; VF = VOCAL FOLDS; dotted-line = association of [retracted] with EPL node.

[7] This is done so that guttural uvulars in her model trigger PHARYNGEAL node activation on laryngeals (hence rendering them part of the guttural/post-velar class), yet can still bear the [dorsal] feature.

[8] This does not entail that [retracted] is a secondary articulator feature for pharyngeals; rather, it entails that there are phonologically two basic types of pharyngeals (one non-retracting and one retracting).

other sounds, since these sounds are unique in sharing the [cet] feature, even though they have different places of articulation.

5 PHONOLOGICAL EVIDENCE FOR EPILARYNGEAL

We now present three cases that match the three predictions outlined above and provide an analysis using the PLAM formalism to demonstrate the empirical coverage of our model. The first case (prediction (i)) demonstrates the utility of dual-linking of [retracted] in accounting for both the likelihood and aftermath of Pharyngeal genesis in Southern Wakashan (Section 5.1). The second case (prediction (ii)) elaborates on how the PLAM does not bind pharyngeals to vowel retraction effects (Section 5.2). The third case (prediction (iii)) demonstrates the relationship between glottal and epilaryngeal stricture entailed by the PLAM by examining neutralization data from Tigre (Section 5.3).

5.1 PHARYNGEAL GENESIS IN SOUTHERN WAKASHAN

In the history of the Southern Wakashan languages, uvular ejectives /*q' *q^{w}'/ and fricatives /*χ *χ^{w} / changed into pharyngeals /ʕ/ and /ħ/, respectively, but uvular stops /*q *q^{w}/ were preserved (e.g. Trigo 1991: 125; Davidson 2002: 75). Table 1 shows that not all descendent languages exhibit the full set of changes[9]. This example very clearly highlights the role of the epilaryngeal tube in relating lingual and laryngeal articulation.

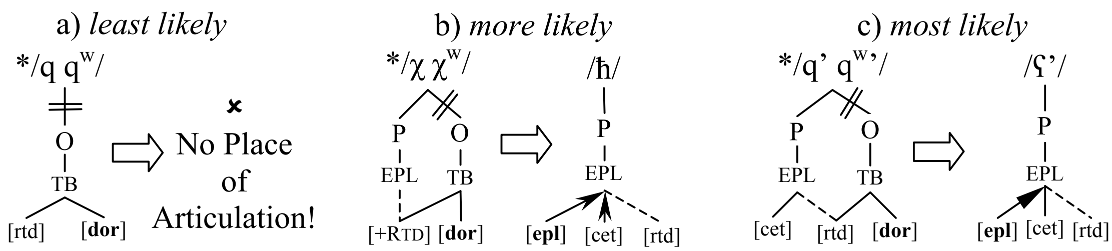
Table 1. Pharyngeal genesis in Southern Wakashan

Proto South Wakashan		Makah	Nitinaht	Nuu-chah-nulth
*q', *q^{w}'	→	q' q^{w}'	[illegible]	[illegible]
*χ, *χ^{w}	→	χ χ^{w}	χ χ^{w}	ħ

The Southern Wakashan uvular series exhibits a continuum of likelihood to undergo change: uvular ejectives are most prone to change followed by uvular fricatives; uvular stops resist changing. The change must be considered a form of debuccalization or oral depletion (Trigo 1991) since both dorsal stricture and labialization are lost in the change (resulting in merger of the labialized and non-labialized proto-phonemes). Fig. 4 illustrates the PLAM analysis[10].

[9] ,The process is still synchronically active in Nuuchahnulth and Nitinaht (Davidson 2002).
[10] While there is no reason *a priori* for stops and fricatives to receive different representation, we follow Rose (1996: 80) in distinguishing between /χ/, a 'guttural uvular' and /q/, an 'oral uvulars'.

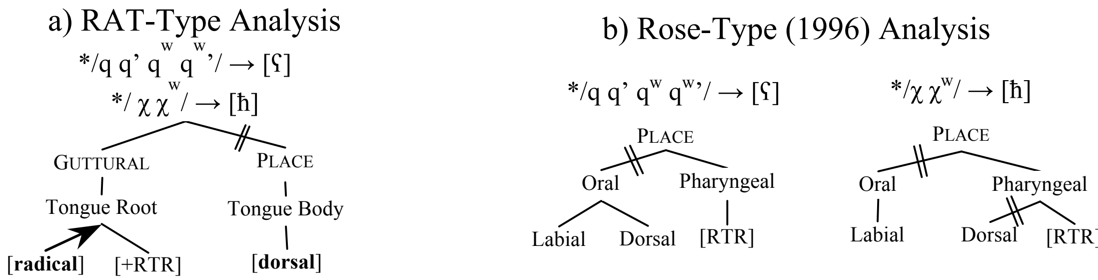
Figure 4: PLAM Analysis of Southern Wakashan Pharyngeal Genesis



Uvular stops (4a) lack EPL specification and [retracted] is only associated with the TB node. Delinking of ORAL is avoided since no other articulator node is available for reassignment of placehood. Uvular fricatives (4b) do have EPL by virtue of dual-linking of [retracted] (representing their 'guttural'/post-velar status; c.f. Rose 1996: 80). Oral-depletion is possible, but requires insertion of both epilaryngeal features. Uvular ejectives (4c) are the most likely to change since, as ejectives, they already possess [cet] and the dually-linked [retracted] feature. They are thus most prone to oral-depletion as place reassignment involves only the adoption of a new designated articulator feature. The [retracted] feature survives oral-depletion by virtue of dual-linking. Synchronic evidence of its presence comes from the fact that pharyngeals in Nuuchahnulth trigger vowel retraction effects (Davidson 2002: 14).

Neither the original formulation of the RAT (Fig. 5a) nor Rose's (1996) model (Fig. 5b) can account for the pattern correctly. Both predict that all uvulars will undergo the sound change equally since there is no graded difference in structure amongst the sounds. The flaw here is embodied by Halle's (1995: 18) declaration: "uvulars are pharyngeals with secondary dorsal articulation". There is an extra draw-back to Rose's model in that two delinking operations are required to account for the loss of [dorsal], since Rose represents uvular fricatives with a PHARYNGEAL-linked [dorsal] feature, but uvular stops and ejectives have an ORAL-linked one. In the PLAM, uvular stops are not inherently pharyngeal because a true pharyngeal requires epilaryngeal stricture features in its specification. Uvular fricatives and pharyngeals do share an affinity in terms of tongue retraction, which is a component of epilaryngeal stricture. The PLAM represents this with the dual-linking of [retracted]. The PLAM is also distinguished by making a connection between glottal stricture and epilaryngeal stricture that no other model provides, which turns out to be critical in predicting which member of the uvular sound class (i.e. uvular ejectives) is most prone to change.

Figure 5: The Failure of the RAT or Rose (1996) to Account for Pharyngeal Genesis



5.2 PHARYNGEALS ARE VOCALICALLY FICKLE

Tongue root models predict that pharyngeals should produce vowel retraction effects. As we have seen, this is true for pharyngeals in many languages. Such effects, however, are neither a physiological requirement nor a phonological expectation. Caucasian languages contain counter-examples to the prediction that pharyngeals cause retraction: In ‘mmphatic palatalization’ phenomena, for example, pharyngeals may cause fronting of back vowels; and in Lak (Anderson 1997: 974) and Bezhta (Kibrik & Testelets 2004: 221-222) pharyngeals pattern with palatal segments, which presumably involve advancement of the tongue root. Comrie (2005) aptly observes: “quite the opposite of what I would have expected…[epiglottalization] leaves most of the tongue free to do other things, including the production of more fronted vowel qualities”. This is not an isolated effect in a single family of languages: for example, the Arabic low vowel /a/ is realized as more front default [æ] near pharyngeals and as [ɑ] in the context of uvulars (e.g. [ħæ:l] ‘condition’ vs. [χɑ:l] ‘maternal uncle’; McCarthy 1994: 197). In the PLAM, pharyngeals are not specified with [retracted] by default, and this is evidently the case in Arabic; uvulars on the other hand are inherently [retracted], and hence are predicted to retract local vowels. Vowels do not consistently retract in languages that employ harsh register—a function of epilaryngeal stricture—such as Bai (Tibeto-Burman; Edmondson & Esling 2006) or Akha (Tibeto-Burman; Trigo 1991): in Bai, /i/ is [i], not [ɪ], in harsh register, and in Akha, the ‘head’ or harsh register corresponds with centralized /ɪ ʊ a/ and ‘chest’ register vowels are realized as peripheral [i u ɑ]. This pattern is similar to that encountered in the Caucasian language Tsez, which has been observed to retract its front vowels and front its back vowels under pharyngealization (Maddieson et al. 1996).

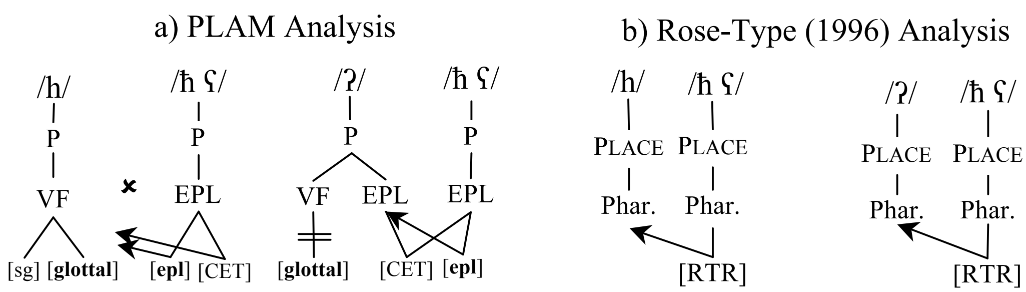
The fickleness of pharyngeals lies in the fact that they clearly have an association with lingual retraction, which is, nevertheless, not as strong as what the tongue root retraction model posits. The PLAM encodes the retraction component of epilaryngeal stricture as a possible phonological association between EPL and TB nodes via the [retracted] feature. This means that pharyngeals may become phonologically [retracted], but do not need to be specified as such; therefore patterns where pharyngeals do not retract vowels are the expected patterns, as the above cases suggest.

5.3 GLOTTAL CONSTRICTION IN THE PLAM

Tigre (Semitic) has an optional process that neutralizes the contrast between /ʔ/ and /ʕ/ in the presence of pharyngeals and ejectives anywhere else in the word. For example, /ʔaddaħa/ 'noon' is variably realized as [ʕaddaħa] or [ʔaddaħa] (Raz 1983: 5; also see McCarthy 1994). Critically, /h/ and /ħ/ do not show neutralization under the same conditions. The significance of this is that /ʔ/ and /ʕ/ share a degree of phonological similarity not shared by their voiceless counterparts, and since the PLAM recognizes the Epilaryngeal Articulator, it can inherently account for this fact.

In the PLAM, neutralization is viewed as a case of spreading and conflation of Epilaryngeal node features,[11] as depicted in Fig. 6a. Critically, the asymmetry between the behaviour of /ʔ/ and /h/ is directly expressed in the PLAM feature geometry: /ʔ/ possesses EPL specification in the form of [cet], but /h/ only has VF features.

Figure 6: Analysis of Tigre Neutralization



The traditional model, where /h/ and /ʔ/ each are associated with their own laryngeal features, [spread glottis] and [constricted glottis] respectively, does not allow for such asymmetry (Fig. 6b). In such models there is no means of stating the relationship between /ʔ/ and /ʕ/, or why /h/ and /ħ/ do not also have a phonological affinity.

Paradis & LaCharité (2001: 285-286; c.f. Halle 1995: 18) also raise the issue of structural similarity between /ʔ/ and /ʕ/ in analyzing adaptations of post-velars in loan word phonology. An important part of their analysis is that /ʕ/ is specified with a [constricted glottis] feature, which allows them to easily account for conversions between these sounds in various adaptation processes[12]. Despite this parallel between the PLAM and Paradis & LaCharité (2001), their model does not account for the Tigre data. Since they argue for a model where post-velars are always in possession of PHARYNGEAL

[11] The RAT assumes terminal spreading. We do not take a stance on whether this is the best analysis. What is important is the asymmetry between /ʔ/ and /h/ with respect to EPL features.
[12] They discuss Fula, which converts Arabic /ħ/ and /ʕ/ to /h/ and /ʔ/ due to lack of an [RTR] feature, and Afar, where the reverse adaptation occurs (Paradis & LaCharité 2001: 285-286).

(contra Rose 1996), they incorrectly predict both /h/ and /ʔ/ should undergo neutralization. Since there is no structural asymmetry between these sounds in their model, both /h/ and /ʔ/ should be capable of receiving a spreading [RTR] feature[13]. Rose's (1996) model, which serves as the basis for that of Paradis & LaCharité (2001), makes the same prediction since, in Tigre (by virtue of the Node Activation Condition), laryngeals must bear the Pharyngeal node due to their contrast with pharyngeals proper.

The integration of an Epilaryngeal Articulator into a model of feature geometry comes with the understanding that /ʔ/ and /ʕ/ are unified by their shared dependence of epilaryngeal stricture for their production. In the case of /ʔ/, the degree of epilaryngeal stricture is much less than that for /ʕ/, but they are fundamentally on a phonetic continuum of degree of epilaryngeal stricture (assuming the vocal folds are not abducted). The Tigre case provides evidence of the phonological reality of this mechanism and its consequences for the behaviour of laryngeal and pharyngeal sounds.

6 CONCLUSION

We have presented a conceptual model of articulator-based phonology that introduces an Epilaryngeal Articulator to explain the phonology of post-velar sounds. The model has a strong foundation in recent empirical phonetic research that examines post-velar articulatory activity. Much of the debate and indeterminacy over how to model post-velar sounds articulatorily comes from the fact that, up until the past 15 years, these sounds were not adequately characterized with imaging techniques. Since there is no longer a need to be vague about what is responsible for the production of post-velars, what governs the connection between lingual and laryngeal activity, and what fundamentally characterizes pharyngeal sounds, phonological models would benefit by granting the epilaryngeal tube phonological status.

In fact, doing so raises numerous avenues of research that need to be pursued and suggests the kinds of phonological evidence that need to be examined to fully support our model. Following the vein of Denning's (1989) work, the Epilaryngeal Articulator may serve to provide a unifying explanation for the connection between phonation type, voice quality, and vowel quality in ATR languages, languages with pharyngealized vowels, and tonal register languages and help to account for the evolution of these systems. Also, the epilaryngeal tube can serve as a voice source modulator, which turns out to be both phonetically and phonologically active in Khoisan languages (Traill 1986) and several dialects of Ningpho-region Wu Chinese (Rose 1989 and p.c.). A model that does not refer to the epilaryngeal tube cannot hope to account for the nature of these phonological possibilities.

[13] Rose (1996: 94) suggests that ejectives in Tigre bear [RTR], which would explain the fact that they also trigger neutralization.

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