A REINTERPRETATION OF LOWER-VOCAL-TRACT ARTICULATIONS IN CAUCASIAN LANGUAGES[1]

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ABSTRACT

The articulatory interpretation and transcription of lower-vocal-tract sounds in Caucasian languages has long been a source of confusion. The Russian literature, notably by Kibrik and Kodzasov, provides insight into the auditory distinctions in Archi, Agul, and Dargwa, among others. However, the model of vocal tract articulatory function and the experimental techniques available in their time lacked precision in identifying the laryngeal and pharyngeal strictures and movements responsible for laryngeal/pharyngeal sounds. We reinterpret the pharyngeal, epiglottal, and pharyngealized contrasts in Caucasian languages using a model of laryngeal articulation that specifies degrees of laryngeal constriction, vibratory effects, and larynx height parameters. We focus on Archi, Agul, and Dargwa languages Mehweb and Shiri. Phonetic categories in the earlier inventories are assigned remapped articulatory definitions. The Russian researchers' observations of degrees of epiglottis lowering are seen as an indication of the laryngeal articulatory mechanism constricting, with larynx raising, to form constriction.

Keywords: Caucasian, laryngeal, pharyngeal, epiglottal, pharyngealization.

1. LOWER-VOCAL-TRACT PHONETICS

1.1. General lower-vocal-tract research background

Early work at UCL [17] drew a relationship between increasing constriction and ventricular activity, and Sapir & Swadesh described Ahousaht Nuuchahnulth pharyngeals as 'laryngealized glottals' [26]. Jacobsen [16], citing Sapir, called Nuuchahnulth /ʕ/ a 'pharyngealized glottal stop'. Gaprindashvili [13] described a 'pharyngealized glottal stop', and Kodzasov [21] described a 'strong glottal stop' in Nakh-Daghestanian languages. All of these descriptions imply a component added to glottal stop somewhere above the glottis. Hockett [15] recognized that 'a complete closure can be made in the lower pharyngeal region', and characterized /ʕ/ as a 'pharyngeal catch' in Arabic, in parallel to 'glottal catch' [ʔ], but he assumed the tongue root closed against the rear pharyngeal wall. Catford's term, 'epiglottopharyngeal' [3] implies stricture deeper than the lingual pharynx. Later laryngoscopic research identified the sphincteric action of the aryepiglottic folds in airway closure [28]. Roach observed that some glottalized consonants are 'made with closure not only of the true vocal folds but also of the false vocal folds and the aryepiglottic folds' [25]. Gauffin specified that protective airway closure by sphincteric laryngeal tightening constricts 'larynx tube opening' [14]. These lines of evidence point to full aryepiglottic closure as the maximum stricture in swallowing or gagging, and as a speech sound. Catford termed this full closure a 'pharyngealized glottal stop' or 'strong glottal stop' in languages of the Caucasus, a 'pharyngeal stop' in Chechen [5], and a 'ventricular (plus glottal) stop' [4].

1.2. A revised lower-vocal-tract model

Phonetically we term this full engagement of the laryngeal sphincter an *epiglottal stop*. Experimental investigations of the lower vocal tract over the past 20 years have resulted in a model that defines the articulatory functioning of the laryngeal constrictor mechanism, with degrees of closure of its various parts from open to fully closed [8, 9]. The model defines a range of manners of articulation: fricative, approximant, tap, trill; glottal stop, ventricular stop, epiglottal stop; concomitant phonatory vibrations; and moderating larynx height adjustments to alter resonance quality. Rather than specifying different places in the pharynx where articulations are made, this scheme identifies a single lower-vocal-tract stricture point, compressing and eventually shutting for stricture and unfolding for opening. We use this mechanism in reinterpreting the sound-symbol associations in the Caucasian phonetic inventories.

2. CAUCASIAN PHONETIC DESCRIPTIONS

2.1. Early Russian research on Caucasian phonetics

Russian research has identified lower-vocal-tract consonantal articulations, syllabic properties, and

secondary vocalic qualities that characterize the languages of the Caucasus [18, 19, 20]. Kibrik and Kodzasov's schema (Table 1) compares glottal state with observed epiglottal lowering (and lingual retraction). They list 20 languages having a 4-way laryngeal/pharyngeal opposition: /ʔ h ʕ ʜ/. Budukh adds /ʔ̆/; Burshag and Burkikhan Agul add /ʔ ȟ x̆/; Richa Agul adds /ȟ x̆/. Each phonemic category is given an expanded, qualified phonetic description for each language.

Experimental methods to image the lower vocal tract were not available to assist in the identification of categories established in early Russian research. The schema in Table 1 presumed the epiglottis to be an indicator, if not an articulator. Its increasing lowering below 'upper' (uvular) indicated tightening in the pharynx, together with tongue backing for 'middle' (pharyngeal sounds). The assumption was for 'lower' (epiglottal) sounds to be accompanied by general tension in the pharyngeal walls, perhaps with generalized laryngeal lowering.

Table 1: Kibrik and Kodzasov's diagram and table (translated) for describing Caucasian 'laryngeal sounds': row 1: 'glottal laryngeals', rows 2-3: 'emphatic laryngeals' [18, p. 312].

Articulation zones of the pharynx
А = upper [zone] (uvular sounds)
Б = middle [zone] (pharyngeal sounds)
В = lower [zone] (epiglottal sounds) →
→ rows 2 and 3 in table below

Vocal folds / Epiglottis	Closed	Adducted	Abducted
Neutral position	ʔ		h
Moderately lowered	ʔ̵	ᶜ	h̵
Strongly lowered	ʔ̶	ʕ	ʜ

For all languages, [ʔ h] were defined as 'plain (glottal) laryngeals'. [ʔ] could be 'strongly occluded' or 'weakly occluded'. 'Pharyngeal' and 'epiglottal' places of articulation were identified for many languages, and uvulars were viewed as having more or less deep localization in the upper pharynx, sometimes replaced by or varying with pharyngeals. [ȟ x̆], specific to the three Agul dialects, were defined as pharyngeal spirants (fricatives), produced by narrowing the pharyngeal passage at the level of the tongue root, presciently described in 1986 as 'a sphincteric compression of the pharynx' as well as 'a strong retraction of the tongue body' [20]. 'Epiglottals' (traditionally 'emphatic laryngeals') were seen as produced by displacing the epiglottis backwards and downwards, resulting in narrowing the lower pharynx and covering the laryngeal inlet. The term 'pharyngeal' was viewed as ambiguous, since different authors applied it variably to zone А, Б or В. This is a telling observation, suggesting that the pharyngealization mechanism was not yet well understood but that its auditory presence pervaded all lower-vocal-tract zones that existed at the time.

Voiced [ɦ] in row 1 and [ɦ̵] in row 2 were identified as possible voiced variants of 'aspiration' (of [h] and [h̵], respectively). The voiced [ᶜ][2] in row 2 was described as a glide, while all three elements in row 3 were classified as 'obstruents'. [ʕ ʜ] were identified as 'spirants' (i.e. fricatives). It is safe to say, based on Kodzasov's and Catford's writings, that rows 2 and 3 were viewed as fundamentally glottal-laryngeal, with observed increases in 'strength' of lingual and epiglottal retraction/lowering corresponding to auditorily 'deeper' sounds. Row 3 values were held to differ in degree from row 2 values, potentially varying allophonically but not contrasting phonemically in any one language. In Burshag and Richa Agul (also Inkhokvari and Chirag Dargwa), a laryngeal quality accompanying vowels and sonorants in certain lexical items was called 'compressed voice', described auditorily as 'hoarse-gravelly' (*«сиплый»*) and 'tense' [18, 20].

In Burkikhan Agul [18, p. 340], 'emphatic laryngeals' [ʕ ʜ] are realized in all positions within a word as 'obstruent spirants'; [ȟ x̆] originate from pharyngealized uvulars, 'middle' [ȟ] effectively alternating with 'lower' [ʕ]; and [x̆] is produced with more noise than [ȟ] [20]. Voiceless [x̆] therefore fills the slot of /h̵/, equivalent to IPA [ħ], and in contrast to /ʜ/. Burkikhan Agul in the UCLA archive [27] includes sounds transcribed as /ʕ ħ ʜ ʔ/: [ʕ] as a voiced pharyngeal fricative (or approximant, since [ħ] is called a voiceless pharyngeal fricative); [ʜ] as an epiglottal fricative; and [ʔ] as an epiglottal stop; although not all distinctions have been attested as phonemic in recent Russian fieldwork. Generally, in Northeast Caucasian languages, distinctions are not so much a phonemic issue as whether there is pharyngealization on the root and whether the word is native or borrowed. In a pharyngealized root, the more extreme phonetic variants from Table 1 are realized. These may include [ʔ] for the stop and [ʜ] for the fricative; although no [ʕ] symbol was included in Table 1 in parallel to [ʜ] and in contradistinction to [ʕ ħ].

2.2. Recent Russian research on Caucasian phonetics

Archi [1] has glottals /ʔ h/ in plain roots (/baʔbos/ 'to kiss', /barhas/ 'to babysit') and in pharyngealized roots (/ʔiˤʔuˤbos/ 'to crow', /haˤhtʼi/ 'breath'), where the glottals take on pharyngeal characteristics: more strongly constricted [ʕ ħ]. Archi 'epiglottals' are a fully constricted stop (/raʔ/ 'dishes') or glide [ʢ]

(/baʔaj/ ‘ram’), and a pharyngeal fricative (/ħubus/ ‘to growl’) or slightly trilled [ʜ] (/ħiħibos/ ‘to neigh’) [audio embedded].

Shiri Dargwa [2] demonstrates the enhancing effect that pharyngealized roots (symbolized as /ˤ/ on the vowel) bring to glottals, rendering /ʔ/ in /ʔatːa/ ‘father’ as [ʔ] in /ʔaˤtʼa/ ‘frog’, and /h/ in /habaxiʒ/ ‘to go up’ as a pharyngeal fricative ([ħ] with variable quality, possibly with trilling) in /haˤrhaˤ/ ‘arrow’. Other examples of the strengthened stop [ʔ] are: /duˤʔ/ ‘wilderness’, /ʔaˤrʔaˤ/ ‘hen’, /ʔuˤrʔni/ ‘hens’; and of derived pharyngeal [ħ]: /huˤlkːa/ ‘flat cake’.

Mehweb Dargwa [7, 24] also illustrates how root pharyngealization, word position and lexical origin influence the strength of stops and laryngeally constricted continuants. In native roots, [ʔ] may or may not surface before an initial vowel and intervocalically. If so, it is weak (/(ʔ)a/ ‘colostrum’). A final /ʔ/ can be stronger (/muʔ/ ‘back’). In the context of pharyngealized vowels, /ʔ/ yields a weak epiglottal stop or approximant (/ʔaˤtʼa/ ‘frog’, /ʔoˤri/ ‘hare’). A stronger epiglottal stop [ʡ] appears in several non-pharyngealized roots such as /ʡala/ ‘behind’ or an Avar borrowing /ʡatʼ/ ‘flour’. Mehweb contrasts glottal /h/ (/warhi/ ‘cloak’) and pharyngeal /ħ/ (/qʼaħa/ ‘turnip’). The latter can increase in laryngeal constriction, possibly with larynx raising as [ʜ], especially in pharyngealized roots (/daˤħ/ ‘face’, /doˤrħo/ ‘cub’), resulting typically in a flat spectrum between 1–3 kHz and peak at 3–3.5 kHz (vs. a deep valley above 1 kHz and peak at 2.5 kHz for [ħ]). Another option for strengthening a pharyngeal is aryepiglottic trilling, which may appear, depending on the speaker, in non-pharyngealized roots only (/meħ/ ‘two handfuls’), or sporadically in both contexts (cf. /doˤħi/ ‘snow’), or not at all.

Huppuq Agul glottals in /ʃeʔ/ ‘thing’ and /buhu/ ‘owl’ contrast with pharyngeal stop (or trill) in /ʡub/ ‘rope’, approximant in /myʕ/ ‘bridge’, and fricative in /ħur/ ‘flour’. Aryepiglottic trilling occurs variably (by speaker) in voiced or voiceless contexts.

3. REVISED CAUCASIAN PHONETIC DESCRIPTIONS

3.1. The nature of laryngeal constriction

We replace earlier assumptions of lingual/epiglottal stricture in the pharynx with a model of aryepiglottic laryngeal constriction with concomitant lingual and larynx-raising effects. As the laryngeal articulator mechanism tightens, lingual retraction and *larynx raising* increase, producing pharyngealization or pharyngeal/epiglottal consonants. This is the articulatory ‘paradox of the larynx,’ since the two primary articulators (tongue and larynx) approach each other during increasing laryngeal constriction instead of both moving downwards. The epiglottis-lowering concept in Table 1 is thus reinterpreted to represent laryngeal articulator constriction, with increasing tongue retraction, and (normally) larynx raising.

The model offers multiple parameters that can combine to account for the distinctions that occur in the lower vocal tract [12, 23]. Our first premise is that (a) aryepiglottic stricture is the primary agent of laryngeal constriction, that pharyngeal and epiglottal are not separate places of articulation, and that distinctions are a matter of degree of stricture. Since tongue retraction and larynx raising inherently accompany laryngeal constriction, (b) the tongue retracting into the pharynx can be a parameter affecting sound quality, and (c) voluntarily altering larynx height will also substantially affect the resonance properties of the sound. Finally, (d) increasing laryngeal constriction normally increases the potential for aryepiglottic trilling to occur, unless competing contrasts proliferate in the laryngeal region (which they do in Caucasian languages, therefore requiring elaboration of potential combining parameters); and (e) pitch is a parameter that influences how constriction and larynx height are perceived auditorily, although it plays less of a role in languages with pharyngeal consonants than in those with tonal register [12].

3.2. Reinterpreted articulatory categories

Since the tongue is not the primary articulator in the lower vocal tract, and the epiglottis is not the agent of airway closure, we must reinterpret Table 1. The ‘zones of the pharynx’ are therefore not increments of lingual retraction or epiglottis lowering per se, but reflexes of the folding action of the laryngeal articulator. Pharyngealization in any of the 3 zones results from laryngeal articulator action. Zone A may yield pharyngealized uvulars. Zone Б is not an accurate representation of pharyngeal articulation (Б and В being a function of the laryngeal articulator) and is therefore redundant. Zone B represents the aryepiglottic folds tightening forwards and upwards beneath the epiglottis, with tongue retraction and larynx height displacement. Kibrik and Kodzasov [18] were correct in their auditory interpretation of progressive degrees of pharyngealization, ultimate closure being in the lowest region of the vocal tract. The observational methods available at the time gave an accurate impression of one element of laryngeal constriction, i.e. concomitant tongue retraction. But the essential element of pharyngealization is aryepiglottic sphincteringing, with the tightest phase being full closure, normally with the larynx fully raised [8, 11, 12]. We thus find an earlier formulation by Kodzasov in [19] more accurate, referring to the ‘supraglottal passage’ being open vs. narrowed.

3.2.1. Stop categories

Table 1, Column 1 accurately portrays the sequential adduction of the laryngeal constrictor as a whole to generate glottal stop [ʔ], reinforced (ventricular) stop [ʡ̰], and epiglottal stop [ʡ] (in IPA notation [10]). Table 1 depicts the progression correctly, and also the fact that only two phonemic contrasts will occur, whatever gradations along the continuum may occur phonetically. The notion, however, that the epiglottis actively descends to accomplish closure is not accurate. In fact, the arrow at B in the diagram should be pointing the other way, to represent aryepiglottic compression of the epilaryngeal tube and progressive closure of the airway. And Б can be combined as a function of aryepiglottic epilaryngeal tube compression. Burkikhan Agul, described in [22, p. 38, 167–170] and archived in [27], illustrates clear examples of epiglottal stop [ʡ].

3.2.2. Continuant categories

Two other elements of laryngeal constriction give the continuant sounds identified in Table 1 the freedom to exhibit varied resonance/noise or vibratory characteristics: by variation in larynx height or by trilling of epilaryngeal (supraglottic) tissues within the laryngeal articulator. One way pharyngeal fricatives can be differentiated is to contrast resonances by adjusting larynx height. It is entirely possible that the 'middle zone' pharyngeals and the 'lower zone, moderately lowered' epiglottals have a *lower* (more open) larynx position than sounds in the tightest ('strongly lowered') set, which may have the *highest* larynx position. A low larynx position yields lower spectral resonances, while a high larynx position increases them. Without instrumental corroboration, the [x̌~ħ] set is likely to have sounded/appeared higher in the pharynx because lowering the larynx does not engage the laryngeal constrictor as much as when the larynx is elevated. The 'lowered' [ʜ] likely sounded/looked 'deeper' because *raising* the larynx (and the high frequencies associated with reduced resonating spaces) is the default position for the tightest, most extreme constriction.

A second way to differentiate pharyngeal quality is by adding a supplementary vibration source: aryepiglottic trilling at the top of the epilaryngeal tube. In Caucasian languages, it is the less-tight [ħ] category that seems most often to attract enhanced aryepiglottic trilling, while the [ʜ] remains more tightly constricted (with raised-larynx compression), inhibiting trilling. The voiced equivalents can have aryepiglottic trilling, but the contrasts seem more difficult to realize when glottal voicing is present. The incidence of trilling on /ʕ/, and whether [ħ] or [ʜ] is trilled, can vary by language, environment, or individual speaking style. These elements of laryngeal constriction are not entailments; they are available options that can be exploited in a sound system by virtue of 'articulatory proximity'.

Thus, the notion that 'epiglottal sounds' are incrementally 'deeper' is accurate if reinterpreted to describe progressive aryepiglottic tightening of the constrictor mechanism, which incrementally engages tongue retraction (lowering at the back) and larynx raising. The portrayal of 'epiglottis lowering' (Table 1, B) also presages the action of the laryngeal constrictor, but the direction should be turned upwards to be opposite to tongue retraction. The introduction of laryngeal constrictor behaviour also allows the possibility of aryepiglottic trilling to be added to key sounds. The occurrence of 'compressed voice' or 'hoarse-gravelly' 'tense' voice on a pharyngeal or neighbouring vowel can also be accounted for by the propensity for epilaryngeal vibration to occur under certain conditions of laryngeal constriction. The fact that [x̌] may have 'more noise' could also be a function of the incidence of aryepiglottic trilling.

The voiceless pharyngeal continuants in Agul symbolized as pharyngeal /ħ/ (earlier [x̌] or [ʜ]) can be described, using our revised terminology, as a voiceless pharyngeal (aryepiglottic) fricative with lowered larynx (expanded lower cavity resonance), with the potential for aryepiglottic trilling. The more constricted fricative symbolized as epiglottal /ʜ/ is a voiceless pharyngeal (aryepiglottic) fricative with raised larynx. In some data sets [27], or for some speakers, both can be trilled. Otherwise, only /ħ/ is trilled. The voiced pharyngeal approximant /ʕ/ in Agul is slightly trilled in some examples [27]. In some formulations [3], /ʜ ʕ/ have been represented as trills for symbolic purposes. This derives from Catford's auditory evaluation that /ʜ/ and /ʕ/ are more 'genuinely fricative' than /ħ/ and /ʕ/ [6]. But it is not obligatory for either larynx-height posture of a pharyngeal to attract trilling more than the other. Since aryepiglottic trilling mimics glottal phonation as a vibratory source, contrasting elements can differ between voiceless and voiced sounds.

The Archi, Agul, Mehweb and Shiri observations demonstrate that the phonetic options for lower-vocal-tract contrast exploit the range of constrictive movement of the laryngeal articulator, adding the parameter of enhanced vibration at the aryepiglottic folds, and supplemented by quality changes induced by producing pharyngeals with a lowered larynx posture vs. an elevated larynx posture. The critical factor is to view acoustic shifts in pharyngeal quality as a function of the degree of laryngeal articulator stricture (folding) and to interpret vibratory effects as a function of the propensity of the aryepiglottic folds at the top of the epilaryngeal tube to vibrate.

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[2] The [ˁ] symbol was most likely intended typographically as the upper half of the 'reversed glottal stop' symbol [ʕ].

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