Laryngeal segments and laryngeal neutralization

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Um, Hye-Young. Laryngeal segments and laryngeal neutralization. *Studies in Phonetics, Phonology and Morphology* 6.2, 353-372.This paper investigates the cross-linguistic distributional patterns of laryngeal segments /ʔ/ and /h/. In the examination of the behavior with regard to the laryngeal neutralization phenomenon, it is shown that in many languages /ʔ, h/ behave differently from laryngeally-marked consonants that have a laryngeal feature [constricted glottis] or [spread glottis]. I suggest that this is due to their lack of an oral place of articulation and that this needs to be reflected in the family of constraints that account for distributional patterns of laryngeal features. (Korea University)

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1. Introduction

The laryngeal segment /ʔ/ is traditionally described as a glottal stop, which is the sound that occurs when the vocal cords are held tightly together (Ladefoged 1982), and /h/ as a voiceless glottal fricative.[1] However, unlike most stop or fricative segments, /ʔ/ and /h/ are unique in that their characterization varies in the literature.

There have been various proposals on the representation of laryngeals. However, with respect to the specification of laryngeal node features, analyses commonly assume the presence of a laryngeal node feature, [constricted glottis] or [spread glottis], in the representation of /ʔ, h/ as shown in (1) (Clements 1985, Sagey 1986)[2]:

(1)

/ʔ/	/h/
[? son (? cons)]	[? son (? cons)]
|	|
LN	LN
|	|
[+cons. gl]	[+spr. gl]

[1] While /h/ is described as a voiceless glottal fricative by many phoneticians and grammarians (to name a few, IPA; Malmberg 1963; Ladefoged 1982), some phoneticians describe it as a voiceless or whispered vowel (Jones 1957; Pike 1943; Abercrombie 1967).

[2] There has been disagreement regarding the specification of major class features. I do not deal with this issue in this paper. For a detailed discussion of this issue, see Bessell (1993, 1996).

According to this view, /ʔ/ and /h/ share a laryngeal feature with glottalized and aspirated consonants, which are represented as having a laryngeal node feature [constricted glottis] in the case of the glottalized consonant and [spread glottis] in the case of the aspirated consonant. That being the case, laryngeals and /C', C^h/ are predicted to pattern together in some phonological processes. For example, one of the most common phonological processes involving laryngeal features is laryngeal neutralization, whereby all laryngeal distinctions are lost in syllable-final position. If laryngeals are represented as in (1), we expect a distribution parallel to glottalized and aspirated consonants, namely, restriction to syllable-initial position. However, there is no systematic survey of the behavior of /ʔ, h/ with respect to laryngeal neutralization. So it is difficult to evaluate this prediction. In this paper, I examine the distribution of laryngeals. My main focus of interest is their laryngeal feature specification and their relation to glottalized and aspirated consonants that share a laryngeal feature with them, or more generally, laryngeally-marked consonants.[3]

This paper is organized as follows: Section 2 examines the distribution of laryngeals as compared with that of laryngeally-marked consonants. I find that there are many languages in which /ʔ/ and /h/ pattern differently from laryngeally-marked consonants. I suggest that this is due to their lack of an oral place of articulation, a fact which needs to be reflected in the Laryngeal Constraint. Section 3 concludes the paper.

2. The Laryngeal Constraint and /ʔ, h/

One of the most common phonological processes involving laryngeal features is laryngeal neutralization, whereby all laryngeal distinctions are lost in syllable-final position. For example, in Korean there is a three-way contrast among obstruents in syllable-initial position, but these distinctions are lost and only plain voiceless obstruents occur in syllable-final position. The following are examples (Kim-Renaud 1977):

(2)	/ap^h-i/	'front (subj.)'	[ap^hi][4]
	/ap^h/	'front'	[ap]
	/ap^h-to/	'front also'	[apt'o]
	/k'ək'-ta/	breaks off'	[k'əkt'a]
	/k'ək'-ə/	'break it off'	[k'ək'ə]

[3] The term 'laryngeally-marked consonants' is borrowed from Lombardi (1991). By this term I mean consonants with laryngeal specification, without implying the notion of markedness. Following Lombardi (1991) I assume that plain voiceless obstruents and voiced sonorants are laryngeally unmarked. Therefore, voiced/glottalized/aspirated obstruents and glottalized/ voiceless sonorants belong to the class of laryngeally-marked segments.

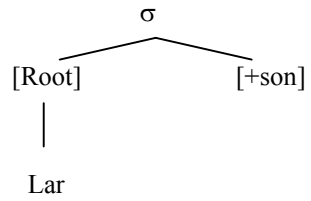
[4] Some surface forms show the results of other phonological rules, Post-obstruent tensing and Intervocalic voicing, which are irrelevant to the neutralization phenomenon.

/pat^{h}-e/	'in the field'	[pat^{h}e]
/pat^{h}/	'field'	[pat]
/puək^{h}-e/	'in the kitchen'	[puək^{h}e]
/puək^{h}/	'kitchen'	[puək]
/ip-ta/	'wears'	[ipt'a]
/ip-ə/	'wear it'	[ibə]

Also in Thai (Henderson 1949), which has voiced, plain voiceless, and voiceless aspirated stops and affricates in its consonant inventory, of the obstruents, only voiceless /p, t, k/ can occur syllable-finally. Even if no alternations show an active process of neutralization, there is some constraint on the occurrence of laryngeal features.

According to the framework of feature geometry, the process of laryngeal neutralization had been described as a process delinking the laryngeal node (Clements 1985). However, Lombardi (1991) formulates it as a positive syllable wellformedness constraint. That is, Lombardi (1991) accounts for this type of restriction of laryngeal feature occurrence, as seen in Korean and Thai and many other languages, by way of a positive constraint which states that laryngeal features are licensed in the following configuration[5]:

(3)



This would predict that laryngeally-marked consonants tend to be restricted to syllable-initial pre-sonorant position. In addition, if laryngeals are represented with laryngeal features, where laryngeal features are the factor in question that is required to describe the distribution of glottalized and aspirated consonants, we would expect that /ʔ/ and /h/ show the same pattern of distribution as glottalized consonants and aspirated consonants, respectively, or as laryngeally-marked consonants as a whole. However, no work concerning the neutralization phenomenon discusses the behavior of laryngeals in this respect as far as I know, though Lombardi (1991) touches on this issue without serious discussion. In addition, there is no

[5] Some of the advantages in expressing the neutralization phenomenon as a positive wellformedness constraint, as Lombardi (1991) claims, are that it accounts for the distributional facts in languages that do not have evidence for distinctions, and that not all environments where neutralization occurs are syllable-final.

systematic survey of the behavior of /ʔ, h/ with respect to laryngeal neutralization. In this section, I examine the distribution of /ʔ, h/, comparing it with that of glottalized and aspirated consonants.

To study the distribution of laryngeals, I performed a crosslinguistic survey of the distribution of laryngeals, at first, in about 30 American indigenous languages mainly as they are described in *International Journal of American Linguistics*. The reason I chose this data set is that many American indigenous languages use laryngeal features, especially glottalization and aspiration, for consonantal contrasts, and that laryngeals exist also in their consonant inventories. However, since this survey is confined to American indigenous languages, I also examine languages that have both laryngeals and laryngeally-marked consonants using Maddieson's (1984) representative sample of the world's languages. The languages in UPSID (UCLA Phonological Segment Inventory Database), which are included in Maddieson (1984), are reported to have been chosen to approximate a properly constructed quota sample on a genetic basis of the world's extant languages, the quota rule being that only one language may be included from each small family grouping. Therefore, Maddieson (1984) seems to be a relatively reliable database on which to calculate the typology of some phonological patterns.

Among the 30 or so American indigenous languages that are examined, 15 languages have both laryngeals and laryngeally-marked consonants. These languages can be divided into two classes, according to the distributional difference between laryngeals and laryngeally-marked consonants. In one class, /ʔ/ and/or /h/ show the same pattern of distribution as C' and/or C^h. In the other class, /ʔ/ and/or /h/ show a different pattern of distribution from C' and/or C^h. The languages in which /ʔ/ and/or /h/ show the same pattern of distribution as C' and/or C^h are further divided into two types. In one group of languages, laryngeals/ laryngeally-marked consonants occur only in syllable-initial position. In the other languages, laryngeals/ laryngeally-marked consonants occur both in syllable-initial and in syllable-final position. While there are languages in which laryngeals/laryngeally-marked consonants appear only in syllable-initial position, we do not find languages in which these segments appear only in syllable-final position. In addition, in languages where laryngeals show a different pattern of distribution from laryngeally-marked consonants, there is a basic asymmetry; in those languages, it is always the case that laryngeally-marked consonants show a more restricted pattern of distribution, i.e. they occur only syllable-initially, while laryngeals occur both syllable-initially and finally. Cases in which laryngeally-marked consonants, but not laryngeals, occur in syllable-final position, are not found.

In addition to these two classes, some languages from Maddieson constitute a third class in which the aspirated consonant or /h/ behaves differently from the glottalized consonant or /ʔ/. In three languages,

Klamath, Hupa and Wichita, the glottalized consonant and the aspirated consonant pattern differently with regard to the Laryngeal Constraint. This observation is against the prediction that all the laryngeal features under the laryngeal node behave the same with regard to the neutralization phenomenon, which most of the works on laryngeal neutralization would make.

The following summarizes the attested patterns:

(4) Summary of the distribution of laryngeals and laryngeally-marked consonants

a. Class A: ʔ, h = C', C^h
   i) Syllable-initial position only (Section 2.1)
   ii) Syllable-initial and final (Section 2.2)
b. Class B: ʔ, h ≠ C', C^h
   C', C^h syllable-initial only,
   ʔ, h both syllable-initial and final (Section 2.3)
c. Class C: C' ≠ C^h (ʔ = h or ʔ ≠ h)

In the following, I will discuss each language and provide an analysis for each pattern. I will call the languages that belong to group (Ai) Laryngeal Constraint type languages, and the languages in group (Aii) No restriction type languages. For the languages that belong to (B), where laryngeals and laryngeally-marked consonants pattern differently, I suggest that the difference in their behavior with regard to the Laryngeal Constraint is due to the presence/absence of an oral place of articulation and that this needs to be reflected in the constraint system.

2.1. Laryngeal Constraint type (Class Ai)

2.1.1 Distribution

In Maidu (Shipley 1964), Tojolabal (Supple and Douglass 1949), and the Cuzco dialect of Inca (Rowe 1950, Parker and Weber 1996), laryngeal features are restricted to syllable-initial position. That is, in these languages, the Laryngeal Constraint as in (3) is active.

Northeastern Maidu (Shipley 1956) has the following consonant inventory: /p, t, c, k, b, d, p', t', c', k', ʔ, s, h, m, n, l, w, y/[6]. The following consonants occur only syllable-initially: /b, d, p', t', c', k', ʔ/. That is, /ʔ/ and glottalized consonants (/p', t', c', k'/) are limited to syllable-initial position, meaning /ʔ/ patterns the same as the glottalized consonant in its distribution. In addition, voiced implosives (/b, d/) are also limited to

[6] /b, d/ in this language are voiced implosive stops. In this language, the laryngeal feature [voice] will distinguish implosives from other obstruents.

syllable-initial position, as are all other consonant phonemes except /h/ which involve glottal articulation[7].

Tojolabal (Supple and Douglass 1949) has the following consonant inventory: /p, t, k, ts, č, p', t', k', ts', č', ʔ, s, š, h, m, n, l, r, w, y/. Any consonant, except glottalized consonants (/p', t', k', ts', č'/) and /ʔ/, may occur as the first member of word-medial biconsonantal clusters, which means that glottalized consonants and /ʔ/ occur only in syllable-initial position.

In the Cuzco dialect of Inca (Rowe 1950), laryngeals and glottalized/ aspirated consonants appear only in syllable-initial position.[8]

2.1.2. Analysis

In this section, I analyze the laryngeal neutralization phenomenon in the framework of Optimality Theory (McCarthy and Prince 1995). I adopt the constraint-based approach of Optimality Theory, since it accounts for languages which do not show laryngeal alternations as well as those which do. The Laryngeal Constraint can be expressed as in (5). I assume that the laryngeal feature is privative following Lombardi (1991).:

(5) *Lar]σ: Laryngeal features are not allowed syllable-finally.

This constraint, which prohibits any laryngeal feature in syllable-final position, in interaction with the Faithfulness constraints, provides two types of laryngeal distribution: 1. syllable-initially restricted laryngeal distribution; 2. unrestricted distribution. The Faithfulness constraint Parse-segment which was used in Prince and Smolensky (1993), is reformulated as the constraint MAX-IO in McCarthy and Prince (1995). MAX-IO is defined as follows in Myers (1997)[9]:

(6) MAX-IO (X): Every element of type X in the input has a correspondent of type X in the output.

If the constraint *Lar]σ dominates MAX-IO, the effect of the Laryngeal Constraint is visible. On the other hand, if it is dominated by MAX-IO, its effect is not visible. Since laryngeal distribution is restricted to the syllable-initial position, in Maidu, Tojolabal, and the Cuzco dialect of Inca, *Lar]σ is ranked above MAX-IO. The following tableau illustrates

[7] I will discuss /h/ in Section 2.1.3.

[8] Parker and Weber (1996) did not include /ʔ/ in the consonant inventory. /ʔ/ is restricted to word-initial position. According to Rowe (1950), no Inca words begin with a vowel and the words commonly written with an initial vowel actually begin with a glottal stop. Therefore, it seems that the glottal stop does not have a phonemic status and works just as an epenthetic consonant.

[9] As footnoted by Myers (1997), this version differs from McCarthy and Prince (1995) only in that correspondence is generalized to all entries in a phonological representation.

the constraint interaction resulting in laryngeal neutralization (I provide examples from Korean which show alternations, since examples from Maidu or Tojolabal that show morphological alternations are not available):

(7) *Lar]σ >> MAX-IO

a.

/pak'/ 'outside'	*Lar] σ	MAX-IO
A. pak'	*!	
---> B. pak		*

b.

/pak'+e/ 'outside'	*Lar] σ	MAX-IO
---> A. pak'e		
B. pake		*!

In (7a) candidate (A) violates the highly ranked Laryngeal Constraint *Lar]σ, since the laryngeal node feature [constricted glottis] occurs in syllable-final position. Losing the laryngeal node feature, candidate (B) violates MAX-IO, but it is selected as the optimal output, since it does not violate the higher constraint *Lar]σ. In (7b) candidate (A) does not violate any constraint, having the laryngeal node feature in syllable-initial position, and therefore is chosen as the optimal output, whereas (B) violates MAX-IO due to the loss of the laryngeal node feature.

2.1.3. Maidu and Tojolabal /h/

There is a problem in the above analysis for Maidu and Tojolabal. Unlike /ʔ/ and glottalized consonants, /h/ does occur in syllable-final position in these languages. Since /h/ has a laryngeal feature [spread glottis], it is predicted not to occur in syllable-final position according to the Laryngeal Constraint *Lar]σ. This seems to be a case in which the Laryngeal Constraint has to refer to a specific laryngeal feature such as [constricted glottis]. However, restricting the Laryngeal Constraint so that it applies to a specific feature fails to capture the generalization that all laryngeal features are neutralized in syllable-final position. For example, in Maidu, voiced implosive stops as well as glottalized consonants are not allowed in syllable-final position, which suggests that the Laryngeal Constraint applies to all laryngeally-marked consonants, as is usually the case. I will consider two possible analyses for the syllable-final occurrence of /h/.

An interesting fact about Tojolabal and Maidu is that they do not have aspirated consonants in their consonant inventories. Bessell (1993) claims that /ʔ, h/ are represented with laryngeal features only when there are phonological reasons for the presence of phonation features, such as inventory contrast or reference in a phonological rule. Therefore,

according to her, when there is no phonological contrast with C' or C^h, laryngeals are represented as follows:

(8)

/ʔ/	/h/
[-son (+cons)]	[-son (+cons)]
|	|
[-cont]	[+cont]

Representing /h/ with a laryngeal node in Maidu and Tojolabal gives the wrong prediction that it will pattern together with /ʔ/ and C' in its distribution. Note, however, that Maidu and Tojolabal do not have aspirated consonants in their inventories. Therefore, adopting Bessell, it can be proposed that /h/ is represented as a placeless continuant without a laryngeal node, unlike /ʔ/, in Tojolabal and Maidu. If so, the Laryngeal Constraint does not apply to /h/, which will account for the distributional fact of /h/.

Using a different approach, in an Optimality account, the following constraints and constraint ranking can be proposed:

(9) MAX-spread glottis >> *Lar]σ >> MAX-IO

The highly ranked faithfulness constraint for the feature [spread glottis] will save the occurrence of /h/ in syllable-final position. The following is an example from Maidu involving the /h/ in question:

(10)

/juhju/ 'quail'	MAX-spread glottis	*Lar]σ	MAX-IO
---> a. juhju		*	
b. juju	*!		*

Cases in which /h/, but not /ʔ/, is allowed in coda position are very rare; Maidu seems to constitute a marginal case. In addition, Shipley (1964) reports that /h/ in syllable-final position is very rare. In the case of Tojolabal, /h/ appears very frequently in syllable-final position. Lombardi (1998), in her discussion of the unmarkedness of laryngeals, reports that Yucatec Maya epenthesizes [h] in loans to meet the requirement that words end in a consonant. Therefore, it seems that the fact that /h/ occurs in syllable-final position is related to its unmarked status in Tojolabal which is also a Mayan language.

2.2. No Restriction type (Class Aii)

There are languages in which /ʔ, h/ and glottalized consonants can occur both in syllable-initial and in syllable-final position. Tsotsil, Mayan Chontal, and Hokan Chontal belong to this type.

Tsotsil (Weathers 1947) is a member of the Mayan family, which has the following consonant inventory: /b, p, t, k, c, č, ʔ, p', t', k', c', č', m, n, s, š, h, v, y, l, r/. Glottalized consonants, as well as /ʔ/ and /h/, can occur in syllable-final position as well as syllable-initial position. As the first member of biconsonantal onset clusters, /h, s, š, č, c/ may occur. Some examples are /cm, hn, sn, šm/ and /čm/. This indicates that /h/ patterns with other [+continuant] obstruents.

Mayan Chontal (Keller 1959) has the following consonant inventory: /p, t, k, p', t', k', b, d, g, ʔ, c, č, c', č', s, š, h, w, y, m, n, l, r/. Glottalized consonants occur both in syllable-initial and in syllable-final position. The distribution of /ʔ, h/ is exactly the same as that of glottalized consonants.

Hokan Chontal (Waterhouse and Morrison 1950) has the following consonant inventory: /f', c', č', ɬ', k', ʔ, f, s, š, x, p, t, c, tʸ, č, k, b, d, r, g, m', n', ñ', l', w', n̥, ɬ, ɬʸ, y̥, w̥, m, n, ñ, r, ř, l, lʸ, y, w/. Glottalized consonants and voiceless sonorants as well as /ʔ, h/ can occur both in syllable-initial and syllable-final position. They also occur as a member of word-medial triconsonantal clusters such as /nk'm, nk'l, nk'w, nk'p, yʔty/. That is, their occurrence is not restricted to any particular position in the syllable, suggesting that the Laryngeal Constraint is not active in this language.

As seen above, in these languages, laryngeal features do not obey any specific constraint on distribution. Therefore, the constraint MAX-IO dominates *Lar]σ in this type of language so that *Lar]σ does not have any effect. This constraint ranking is opposite to the one in languages that show the laryngeal neutralization effect. The following illustrates the constraint interaction which results in the appearance of the optimal output:

(11) Mayan Chontal: MAX-IO >> *Lar]σ

a.

/yuʔ/ 'kind of nut'	MAX-IO	*Lar]σ
⟶ A. yuʔ		*
B. yu	*!	

b.

/nok'/ 'cloth'	MAX-IO	*Lar]σ
⟶ A. nok'		*
B. nok	*!	

With the higher ranking of MAX-IO, the first candidates in (11a) and (11b), which have a laryngeal feature in syllable-final position are selected as optimal, although they violate the constraint *Lar]σ.

2.3. Unmarked laryngeals (Class B)

There are languages in which /ʔ, h/ show a different pattern of distribution from that of laryngeally-marked consonants. In some languages /ʔ, h/ occur in syllable-final position, while aspirated and glottalized consonants do not. Some examples are Washo, Tolowa (Smith River Athapaskan), Tewa (Santa Clara dialect), Kiowa-Apache, Navaho, Slave, Siona and Tututni (Oregon Athapaskan).

Washo (Jacobsen 1958) has the following consonant inventory: /p, t, k, b, d, g, p', t', k', s, š, h, m, n, ŋ, m̥, n̥, ŋ̥, w, l, y, w̥, l̥, y̥/. Syllable-finally, the following consonants may occur: /p, t, k, ʔ, s, š, h, m, n, n, w, l, y/; voiced and glottalized obstruents and voiceless sonorants do not occur syllable-finally. All consonants excluded from syllable-final position are laryngeally-marked consonants. On the other hand, /ʔ, h/ occur in syllable-final position.

In Navaho (Sapir and Hoijer 1967), there is a three-way contrast of plain voiceless, voiceless aspirated, and glottalized stops and affricates. Glottalized sonorants /m', n', y'/ also occur. Syllable-finally, only plain voiceless consonants /t, k/ and /s, z, š, ž, ɬ, l, n, ʔ, h/ are allowed[10]. That is, laryngeally-marked consonants occur only in syllable-initial position, while /ʔ, h/ may occur in syllable-final position. This is also true in Kiowa-Apache (Bittle 1963). In Kiowa-Apache, although there is a three-way contrast syllable-initially among plain voiceless, voiceless aspirated, and glottalized stops, only plain voiceless stops and /ʔ, h/ occur in syllable-final position.

In Tewa (Hoijer and Dozier 1949), the following consonants occur: /b, d, r, g, p, t, tʸ, k, kʷ, ʔ, p', t', k', kʷ', m, n, nʸ, v, f, ɵ, s, š, x, xʷ, w, y, h, hʷ/. Syllable-finally, only /ʔ, h/ and /n/ occur. This language shows not only that /ʔ, h/ show a different pattern of distribution from laryngeally-marked consonants, but that they are uniquely allowed in coda position in contrast to other consonants. In this language, a special condition for the coda consonant seems to be required. Slave (Rice 1989) and Siona (Wheeler and Wheeler 1962) are also cases where only /ʔ/ (and /h/) is (are) allowed in coda position.[11]

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[10] In some cases, fricatives pattern differently from stops with respect to the neutralization phenomenon, as can be seen in Navaho. That is, the voiced fricative /z/ occurs syllable-finally unlike other laryngeally-marked obstruents. Fricatives present plenty of material on which to realize a voice distinction and are not reliant on VOT cues as much as stops are. Therefore, they may pattern differently from stops. However, I will not go into detail about this issue.

[11] There are some languages where laryngeal segments are the only consonants that are allowed in coda position. Um (1998) proposes that the Coda Condition (Ito and Mester

All of these languages show that laryngeals behave differently from laryngeally-marked segments with respect to laryngeal neutralization. Lombardi (1991) argues that the Laryngeal Constraint can be further restricted in some languages so that it applies only to a specific class of segments such as obstruents. For example, in Tolowa, glottalized obstruents are restricted to syllable-initial position, whereas glottalized nasals (/m', n'/) and /ʔ, h/ occur in syllable-final position. In order to account for this, she suggests that the Laryngeal Constraint applies only to obstruents, assuming that /ʔ, h/ are sonorants in this language. However, whether /ʔ, h/ act as sonorants in this language is questionable since no information is available indicating that /ʔ, h/ act as sonorants. In addition, her proposal still cannot account for languages such as Washo and Navaho. As seen above in Washo and Navaho, both laryngeally-marked obstruents and laryngeally-marked sonorants are not allowed in syllable-final position.

An interesting observation obtained from the languages examined is that while there are quite many languages in which /ʔ, h/ occur syllable-finally to the exclusion of laryngeally-marked consonants, we do not find the reverse, namely, cases where laryngeally-marked consonants are allowed in syllable-final position to the exclusion of laryngeals[12]. This suggests that /ʔ, h/ are relatively less marked than laryngeally-marked consonants, glottalized and aspirated. With the Laryngeal Constraint proposed earlier that refers to the laryngeal feature, the occurrence of laryngeals in syllable-final position cannot be described correctly. Therefore, it is necessary to formulate a constraint that differentiates laryngeals from laryngeally-marked consonants. The difference between laryngeals and laryngeally-marked consonants is respectively the absence and presence of an oral place of articulation. The constraint that restricts the laryngeally-marked consonants to syllable-initial position can be formulated as follows:

(12) * Oral place
Lar] σ

The above constraint prohibits laryngeally-marked consonants with an oral place of articulation from occurring in syllable-final position, but it does not affect laryngeals, since they do not have an oral place of articulation. This constraint is ranked higher than the general Laryngeal Constraint *Lar]σ[13].

1994), which is motivated by facts of syllable structure conditions in many other languages, can account for the special occurrence of laryngeals in coda position.

[12] Only one language from Maddieson (1984), i.e. Georgian, is an exception to this observation. In Georgian (Robins and Waterson 1952), /h/ does not appear in syllable-final position, while aspirated and glottalized consonants occur in syllable-final position. This may be related to the general perceptual weakness of syllable-final /h/.

[13] This general Laryngeal Constraint also prohibits laryngeally-marked consonants from occurring in syllable-final position. However, with the higher ranking of the constraint (12)

(13) * Oral place
Lar]σ >> *Lar]σ

This ranking is universal and reflects the relative unmarkedness of laryngeals. That is, in syllable-final position, laryngeals are less marked than laryngeally-marked consonants.

In the languages where laryngeals are allowed in syllable-final position to the exclusion of laryngeally-marked consonants, the ranking of the relevant constraints is as follows:

(14) * Oral place
Lar] σ >> MAX-IO >> *Lar]σ

The following are examples from Korean and Washo, respectively.

(15)
a.

/pat^{h}/ 'field'	* Oral place Lar] σ	MAX-IO	*Lar]σ
A. path	*!		*
--> B. pat		*	

b.

/baʔ/ 'mitts'	* Oral place Lar] σ	MAX-IO	*Lar]σ
----> A. baʔ			*
B. ba		*!	

In (15b), the first candidate does not violate the constraint (14) since the glottal stop lacks the oral place of articulation. It does not violate MAX-IO, either and so is chosen as the optimal output.

The following summarizes each distributional pattern of laryngeals and laryngeally-marked consonants and the relevant ranking of the constraints:

as in (13) its effect to laryngeally-marked consonants is not visible. In other words, it vacuously applies to laryngeally-marked consonants.

(16)
1. Class Ai: ʔ, h = C', C^h / syllable-initial only

*Lar]σ >> MAX-IO

2. Class Aii: ʔ, h = C', C^h / syllable-initial and syllable-final

MAX-IO >> *Lar]σ

3. Class B: ʔ, h ≠ C', C^h / C', C^h syllable-initial only,
ʔ, h both syllable-initial and final

* Oral place
Lar]σ >> MAX-IO >> *Lar]σ

2.4. Remaining problems

In discussing the effect of the laryngeal constraint on the behavior of laryngeals compared with that of laryngeally-marked consonants, interesting phenomena -- phenomena which can be the problems for the present analysis as well as other relevant analyses -- are observed.

First, there are languages in which the aspirated consonant and the glottalized consonant behave differently with regard to the Laryngeal Constraint. For example, in Hupa and Wichita, the glottalized consonant can occur in syllable-final position, while the aspirated consonant cannot[14]. In Hupa (Woodward 1964), there is a three-way contrast between plain voiceless, aspirated, and glottalized stops and affricates. However, only a two-way contrast between plain voiceless consonants and glottalized consonants is found syllable-finally. That is, the laryngeal constraint applies only to a single laryngeal feature [spread glottis]. The following constraint can be proposed in this language:

(17) *[spread glottis]]σ

This contraint is ranked with respect to the other constraints as follows:

(18) *[spread glottis]]σ >> MAX-IO >> *Lar]σ

This ranking allows the glottalized consonant, but not the aspirated consonant, in syllable-final position. Languages such as Hupa, in which aspirated consonants and glottalized consonants show different patterns in their distribution, suggest that the laryngeal features [constricted glottis]

[14] In the case of Klamath, the opposite pattern arises. Aspirated consonants occur in syllable-final position, while glottalized consonants do not. Syllable-final consonants which are described as aspirated seem to indicate voiceless consonants with strong release.

and [spread glottis] may have different constraints on their occurrences. It is likely to be related to their phonetic properties.

A second problematic case comes from languages in which the glottalized obstruent and the glottalized sonorant behave differently. As pointed out by Urbanczyk (1992), in some languages the laryngeal neutralization of glottalized sonorants is not determined by the same constraint as that of obstruents. For example, in Klamath, glottalized obstruents are neutralized in syllable-final position, but glottalized sonorants are not (Blevins 1993). In addition, there are some languages in which glottalized sonorants are restricted to syllable-final position. Tolowa (Bright 1964) is one of these languages. In Tolowa, the distribution of glottalized nasals is limited to coda position.

The different behavior between glottalized obstruents and glottalized sonorants is not properly accounted for by the constraints suggested so far. It can be proposed that the laryngeal constraint applies only to obstruents. However, this proposal also cannot explain the Tolowa case where the glottalized sonorant is restricted to the syllable-final position. These cases where the glottalized obstruent and the glottalized sonorant have different distributional patterns, suggest that the laryngeal feature behaves differently according to where it is realized. They also suggest that the phonetic properties of the context in which the laryngeal feature occurs should be considered in order to provide an explanation for their behavior.

3. Conclusion

In this paper, I have shown that in many languages laryngeals pattern differently from laryngeally-marked consonants. This suggests that the laryngeal features that laryngeals are assumed to have are different from those which laryngeally-marked consonants have (i.e. phonation features). Specifically, the larynx may work as a place of articulation in /ʔ, h/, while simultaneously serving as the source of phonation.

However, I do not propose that the place feature LARYNX is needed for laryngeals. The reason that introducing a new place feature LARYNX is not necessary, comes from the observation of a difference in behavior between laryngeally-marked obstruents and sonorants. The difference with respect to the laryngeal constraint, as seen in the case of Tolowa, suggests that laryngeal features have different effects according to the particular class of segments they are realized on. Therefore, it is plausible for the laryngeal feature of laryngeals to exhibit unique behavior, since it is on a segment without an oral place of articulation. In conclusion, the findings in this paper show that it is problematic to use certain features in describing phonological processes or facts without taking into consideration inherent phonetic properties that vary depending on the context.

Appendices

Distribution of laryngeals and laryngeally-marked consonants

A. Languages from *IJAL (International Journal of American Linguistics)*

1. Languages in which both /ʔ, h/ and C'/ C^h occur only in syllable-initial position

✓: occurrence *: non-occurrence
n/a: non-existence in the inventory

	syllable-initial				syllable-final			
	ʔ	C'	h	C^h	ʔ	C'	h	C^h
Maidu	✓	✓	✓	n/a	*	*	(✓)	n/a
Tojolabal	✓	✓	✓	n/a	*[15]	*	(✓)	n/a
Cuzco	✓	✓	✓	✓	*	*	*	*
Yuchi[16]	✓	✓	✓	✓	*	*	*	*

2. languages in which both /ʔ, h/ and C'/C^h occur both in syllable-initial and syllable-final position

	syllable-initial				syllable-final			
	ʔ	C'	h	C^h	ʔ	C'	h	C^h
Tsotsil	✓	✓	✓	n/a	✓	✓	✓	n/a
Mayan Chontal	✓	✓	✓	n/a	✓	✓	✓	n/a
Hokan Chontal	✓	✓	✓	n/a	✓	✓	✓	n/a

[15] Even if /ʔ/ cannot be syllable-final within a word, it can be syllable-final at the edge of a word. Lombardi (1994) provides an analysis for languages that show word-final exceptionality.
[16] There are no closed syllables in this language.

3. Languages in which /ʔ, h/ show a different pattern of distribution from that of C'/ C^h

	syllable-initial				syllable-final			
	ʔ	C'	h	C^h	ʔ	C'	h	C^h
Washo	✓	✓	✓	✓	✓	*	✓	*
Tolowa	✓	✓	✓	✓	✓	R'[17]	✓	*
Tewa	✓	✓	✓	n/a	✓	*	✓	n/a
Kiowa-Apache	✓	✓	✓	✓	✓	*	✓	*
Navaho	✓	✓	✓	✓	✓	*	✓	*
Slave	✓	✓	✓	✓	✓	*	✓	*
Siona	✓	✓	✓	n/a	✓	*	*	n/a
Tututni	✓	✓	✓	✓	✓	*	✓	*

B. Languages from Maddieson (1984)

1. Languages in which both /ʔ, h/ and C'/ C^h occur only in syllable-initial position

	syllable-initial				syllable-final			
	ʔ	C'	h	C^h	ʔ	C'	h	C^h
Korean	n/a	✓	✓	✓	n/a	*	*	*
Haida	✓	✓	✓	✓	*	*	*	*
Maidu	✓	✓	✓	n/a	*	*	✓	n/a
Tiwa	✓	✓	✓	✓	*	*	*	*
Dakota	✓	✓	✓	✓	*	*	*	*
(Klamath)	✓	✓			*	*R'ok		
Yuchi	✓	✓	✓	✓	*	*	*	*
Acoma	✓	✓	✓	✓	*	*	*	*
Zulu	n/a	✓	✓	✓	*	*	*	*

[17] In this language, glottalized sonorants are allowed in syllable-final position, whereas glottalized obstruents are not.

2. Languages in which both /ʔ, h/ and C'/C^h occur both in syllable-initial and syllable-final position

	syllable-initial				syllable-final			
	ʔ	C'	h	C^h	ʔ	C'	h	C^h
Yana	✓	✓	✓	✓	✓	✓	✓	✓
Zuni	✓	✓	✓	n/a?	✓	✓??	✓	n/a?
(Klamath)			✓	✓			✓	✓
(Hupa)	✓	✓			✓	✓		
(Wichita)	✓	✓			✓	✓		

3. Languages in which /ʔ, h/ show a different pattern of distribution from that of C'/ C^h

	syllable-initial				syllable-final			
	ʔ	C'	h	C^h	ʔ	C'	h	C^h
Tolowa	✓	✓	✓	✓	✓	*R'ok	✓	*
Navaho	✓	✓	✓	✓	✓	*	✓	*
Wintu	✓	✓	✓	✓	✓	*	✓	*
Quechua	n/a	✓	✓	✓	n/a	*	✓	*
Georgian	n/a	✓	✓	✓	n/a	✓	*	✓
(Hupa)			✓	✓			✓	*
(Wichita)			✓	✓			✓	*

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