# LARYNGEAL FEATURES AND LARYNGEAL NEUTRALIZATION

Linda Lombardi

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# PREFACE

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# CHAPTER 1

# LARYNGEAL FEATURES OF OBSTRUENTS

## 1.1 Introduction

The laryngeal features and laryngeal phonology have not been investigated in detail since the development of autosegmental phonology and feature geometry. Feature geometry provides the means to deal with some generalizations about laryngeal phonology that it was impossible to capture in previous systems. The most common phonological process involving laryngeal features is laryngeal neutralization, wherein all laryngeal distinctions are lost in syllable-final position. In a theory where segments consist of an unorganized set of feature specifications, there is no way to refer to the laryngeal features as a group that patterns together distinct from other possible groups of features. This makes it impossible to write the neutralization rule in a way that reflects its phonological naturalness.

In the framework of feature geometry, these groupings of features are part of the structure of a segment, expressed as dependency relations among features and abstract nodes dominating groups of features. It is thus possible to manipulate the laryngeal distinctions as a group, by manipulating the abstract Laryngeal Node that dominates the laryngeal features. This advance in phonological theory allows a vastly improved analysis of laryngeal neutralization as delinking of the Laryngeal node, as proposed by Clements (1985).

However, many questions remain as to the precise formulation of this rule. More detailed analysis, both of the phonology of individual languages and of the cross-linguistic phonological patterns involving neutralization, is required to answer this question. These issues are addressed in chapters 2 and 3. There I propose that neutralization is the result of a wellformedness condition that I call the Laryngeal Constraint: In languages that have laryngeal neutralization, a laryngeal node is only licensed in a particular syllabic configuration; elsewhere the node will delink to repair the violation of well-formedness. As I show in chapters 2 and 3, this approach to neutralization is required to correctly explain the typology of laryngeal neutralization.

Neutralization brings up questions about the segments that are unmarked in phonological rules and in the phoneme system of a language. Current theory has two ways of accounting for this kind of issue: underspecification and privative features. I will argue that in the case of laryngeal phonology these facts are accounted for by the hypothesis that the laryngeal features are privative. This is a necessary aspect of the delinking analysis of neutralization: it explains why neutralized obstruents are always voiceless unaspirated, and neutralized sonorants are always plain voiced (see chapters 3 and 4). If the features are privative, the negative values of these features are not present because they are nonexistent, and this explains both types of markedness facts. Underspecification theory predicts that [-voice] can be active in phonological derivations, and that [+voice] could sometimes be the output of neutralization. Since these predictions are both false, privative features rather than underspecification is the correct solution. The issue of the privativeness of the laryngeal features is addressed at many points throughout this study, as it is a central fact in laryngeal phonology. Privativeness of [voice] is discussed in in chapter 2, neutralization of multiple laryngeal contrasts in chapter 3, and the supporting evidence from sonorant neutralization in chapter 4. The remainder of chapter 1 will address the predictions of privative features with respect to patterns of laryngeal distinctions in phoneme systems.

Before the behavior of the laryngeal features in rules can be addressed, however, it is necessary to determine what the correct features are. Past work on laryngeal features has tended to be heavily influenced by questions of how these distinctions are produced physically. This has obscured the basic phonological issues that must be considered in postulating a feature system. This earlier attention to a very fine level of phonetic detail--much finer than is usually considered for, say, the place features--has obscured cross-linguistic generalizations and made these feature systems far more detailed than is correct for phonological purposes. The remainder of this chapter examines this issue, discussing why it is important to distinguish phonological from phonetic distinctions. I will argue that the correct feature system consists of three features, [voice], [glottalization] and [aspiration], which, as I have already mentioned, are single-valued.

The most influential past treatments of laryngeal features are those of Halle and Stevens (1971) and Lisker and Abramson (1964). Halle and Stevens propose four features: [stiff vocal cords], [slack v.c.], [spread glottis] and [constricted glottis]. Lisker and Abramson (1964) show that voiceless, voiced, and voiceless aspirated consonants can be distinguished by differences in Voice Onset Time. Although these are the standard references, phonologists rarely adopt either of these systems in phonological analyses. This suggests that these feature systems have not had much success in explaining phonological facts.

To begin I will discuss the problems with each of these theories, in sections 1.1.1 and 1.1.2. Section 1.1.3 will discuss the theory first proposed by Kingston (1985, 1990) that laryngeal distinctions are bound to the release of a consonant. Section 1.2 will then argue for a feature system consisting of three privative laryngeal features of voicing, aspiration and glottalization.

### 1.1.1 Halle and Stevens (1971)

The feature system of Halle and Stevens (1971) (H&S) for obstruents is given in (1), using the features [spread glottis], [constricted glottis], [stiff vocal cords], [slack vocal cords].

(1)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| | $b_1$ | b | p | $p_k$ | $b^h$ | $p^h$ | ɓ | ?b | p? |
| [sg] | - | - | - | + | + | + | - | - | - |
| [cg] | - | - | - | - | - | - | + | + | + |
| [stiff] | - | - | + | - | - | + | - | - | + |
| [slack] | - | + | - | - | + | - | - | + | - |

$b_1$: lax voiceless stop
$p_k$: lightly aspirated (Korean)
b?: voiced laryngealized
p?: ejective

In this system, aspiration is marked by [spread glottis] and glottalization by [constricted glottis]. Voicing is not marked by a single feature, but is determined by the combination of the values for the features [stiff] and [slack].

A number of objections to this system have been summarized by Keating (1988)[1]. The main problems have to do with the feature system's representation of voicing. The phonetic issue is simply that voiced sounds are not always made with the state of the vocal chords that H&S assume. H&S developed their system using mainly modeling of the vocal tract, rather than instrumental data of actual glottal configurations. Keating points out for instance that although stiffening of the vocal chords would indeed prevent voicing, this is not how people actually produce voiceless sounds. Usually a spreading gesture is used, but the H&S feature [spread] entails aspiration.

There are also phonological problems with the representation of voicing in the Halle and Stevens features. There is no simple description of voiced sounds: no one feature will group all voiced sounds as opposed to all voiceless sounds. H&S give no evidence that these are the features that are needed to write phonological rules. (The only uses I know of them is Hayes (1984)[2] and unpublished work by Levin (1984).) Finally, there are major problems with the systems of contrasts that can be represented with this system. The features allow phonological representation of laryngeal distinctions that are never used contrastively, such as implosive/voiced laryngealized, and yet they do not allow representation of all possible phonetic contrasts. In Section 1.2 I will discuss why this is an important theoretical issue, and what contrasts need to be accounted for.

The practice of phonologists has mostly been to simply use a feature [voice] rather than the H&S system. Writers also use the features [constricted glottis] and [spread glottis] to designate glottalized and aspirated consonants, without adopting the whole system. This is basically equivalent to having a feature system consisting of [voice], [asp] and [gl]. As I will show later, this intuition seems to be correct.

### 1.1.2 Lisker and Abramson (1964): Voice Onset Time

The other standard framework of laryngeal distinctions is that of Voice Onset Time, following the work of Lisker and Abramson (1964). This theory is based solely on phonetic data. As far as I know this framework has never been incorporated into phonological analysis except in the work of Goldstein and Browman (1986, also Browman and Goldstein 1986), discussed below. Nonetheless phonologists do seem to consider this one of the basic references on the subject of laryngeal distinctions, despite the fact that they make no attempt to integrate it into their own analyses. Because of this it is important to make it clear that the VOT framework, though it is a correct phonetic generalization, does not allow the construction of a usable phonological theory.

It should be understood that I am not denying that VOT is a phonetic fact; there is ample experimental evidence that the onset of voice is soonest in voiced sounds, later in voiceless unaspirated, and latest in voiceless aspirates. I am arguing that VOT is not what is represented in or manipulated by the phonology. The fact that differences in voice onset time exist does not allow us to conclude that this is crucial to phonology. In fact, just because the differences in timing exist, it does not logically follow that these are the crucial facts even for phonetic representation. Consider that when you aspirate a voiceless consonant, this happens on the release of the closure. Since the aspiration takes up some amount of time between the release and the onset of voicing, certainly the onset of voicing will be later than if you did nothing between the release and the voicing, instead of doing aspiration between the release and the voicing. VOT differences may be the result of doing something, and not the thing that is being done. I am not arguing that this is true in the phonetic representation; I am taking no stand on the phonetic representation of laryngeal distinctions. I am simply trying to make it clear that the VOT facts do not logically require that timing is the factor that is being manipulated, even in the phonetics, so these facts cannot be taken as evidence that this is the representation in the phonology.

Abramson (1977) argues that many later investigators have misunderstood and oversimplified the importance of the VOT phenomenon and Lisker and Abramson's claims for it. There are a number of interrelated phonetic cues for voicing (see for example Stevens and Klatt 1974, Lisker and Abramson 1970). Abramson argues that what is crucial to laryngeal distinctions is laryngeal timing, and that VOT is the utterance-initial manifestation of this. They used the voice onset measurement because it is an acoustic manifestation of laryngeal timing which it is possible to measure accurately, and never claimed that it was totally independent of other interrelated acoustic results of laryngeal timing. (Although Lisker (1975) argues that VOT is more important than formant transition, another frequently investigated perceptual cue to voicing.) Although I refer to VOT, my arguments apply to it as a theory of laryngeal timing regardless of the phonetic manifestation of laryngeal timing measured.

Differences in VOT and other facets of laryngeal timing are clearly the phonetic result and/or evidence of differences in underlying representation, since they serve to distinguish segments which differ in laryngeal features. But the evidence is overwhelming that the underlying *phonological* representation does not manipulate VOT or laryngeal timing (again, I make no claims about the phonetic representation). The arguments for this are presented below. A theory based on laryngeal timing cannot make the proper phonological distinctions in consonants, and therefore, it does not allow us to analyze the facts of laryngeal phonology in the world's languages. In the first place there are more than three phonologically distinctive phonation types; but more important, even adding the necessary features to the VOT system to describe these additional types, it does not predict the correct natural classes.

*1.1.2.1 VOT and consonant systems: voiced aspirates.* Consider the laryngeal contrasts made by the languages of the world, compared to the contrasts that can be made in a VOT framework. Glottalized consonants are not included in this system, and there are voiced and voiceless glottalized consonants. If voicing distinctions are a matter of voice onset, it would have to be shown that voice onset is shorter in voiced glottalized consonants than in voiceless glottalized consonants. This appears to be correct (Pinkerton 1986). However, we would then expect that the third, longest type of VOT could also combine with glottalization, but this does not happen: there are no aspirated glottalized consonants. Abramson (1977) says that laryngeal timing is involved in glottalized stops: timing between the closure of the vocal folds and the oral closure. However, no explanation of the cross-classification of glottalization and voicing is offered.

But even if glottalization is ignored, since VOT theory does not make a serious attempt to address this question, there is still a serious omission in the theory: the voiced aspirates (also called 'murmured' sounds). There is a good deal of data, both phonological and phonetic, that shows that these sounds are voiced and aspirated. The fact that VOT does not deal with these sounds is a major flaw, since voicing and aspiration are the very things it is a theory of.[3]

Some authors (for example, Ladefoged 1971) deny that voiced aspirates are aspirated sounds. (It should be noted that in later work (Ladefoged et. al. 1976, Ladefoged 1979) Ladefoged revises his view of aspiration and accepts that "voiced aspirated" is the correct characterization of these sounds.) This conflict exists both in traditional grammars and in the phonetic literature.[4] Although an explicit feature system is rarely used, a frequent assumption seems to be that "murmur" is some entirely separate phonation feature. There are a number of phonetic and phonological reasons that support the contention that these sounds are voiced and aspirated. The arguments come from patterning of consonant systems, phonetic evidence, and evidence from phonological rules.

The argument from patterning is that in general, languages that have the voiced aspirate also have voiced stops and aspirated stops; thus, considerations of markedness necessitate considering them to have the same feature for voice and the same feature for aspiration. The few exceptions can probably be explained as voiced sounds with unusual phonetic realizations.[5]

The weight of phonetic evidence also supports the contention that voiced aspirates have something in common with voiced sounds and something in common with aspirated sounds. Catford (1977) points out that Ladefoged objects to the use of the term "voiced aspirated" because it does not use either "voiced" or "aspirated" with the same meaning that they have elsewhere. But even if we assume delay in voice onset as the theory of aspiration, Catford notes that both voiced aspirated and voiceless aspirated stops involve a delay in the onset of *normal* voice; in the former, there is a period of whispery voice during the stop and for a certain time after the release. In addition, there is the same difference in intra-oral air pressure between the members of the pairs in voiced-voiced aspirated and voiceless-voiceless aspirated. (Catford, p113).

Dixit (1975; see also 1989), in a study of the phonetics of Hindi stops, makes the implicit assumption that voiced aspirates are parallel to voiceless aspirates. He claims that VOT is not actually similar for voiced and voiceless aspirates, but he says that there is a "long period of breathy voice" after a voiced aspirate (p.399) This is exactly Catford's point: Dixit is being particular about what a 'similar' VOT is, but the point is that it is longer for both of the aspirates than for the corresponding unaspirated sound. Since the state of the various parts of the larynx is not exactly the same due to the fact that one sound is voiced and one is not, we would not necessarily expect the exact same VOT, but the pattern of difference that is found is what is expected if a delay in voice onset is one of the results of aspiration.

Aside from VOT, Dixit shows various types of phonetic evidence of the expected correspondences: he finds that levels of muscle activity in the larynx correspond to the classes aspirated/unaspirated and voiced/voiceless, providing additional evidence that voiced aspirates are aspirates. The interarytenoid, lateral cricoarytenoid, and thyroarytenoid muscles show lower levels of activity for the aspirated class of consonants, and the cricothyroid muscle shows higher levels of activity for voiceless consonants (293 ff).

Another instrumental study is Yadav (1984) (also Ingemann and Yadav 1978). A fiberoptic study of Maithili stops, this work also finds the expected correspondences. Voicing correlates with adduction/abduction of the larynx; aspiration correlates with glottal width. The greatest glottal width is at or shortly after release. In voiced aspirates, the glottal opening is at the posterior, with cords continuing to vibrate throughout. Yadav argues from these results that glottal width is what is crucial to aspiration, and that VOT is just a consequence of this.[6]

Thus there is ample support for a phonetic argument that "murmured" sounds are voiced and aspirated. The confusion seems to have resulted from the fact that the definitions of what is crucial to aspiration have previously been made on the basis of evidence from languages that have voiced sounds and voiceless aspirates, but not voiced aspirates. Such languages would not provide the evidence needed to tease apart the factors responsible for the distinctions voiced/voiceless and aspirated/unaspirated.

However, since the object of this exercise is to arrive at a theory of phonological features, it is phonological evidence that should be given the greatest weight. The evidence above about phonological patterning is one type of phonological evidence, since it has to do with underlying phonological representation. Evidence from phonological rules also shows that aspiration should be marked with the same feature in voiced aspirates and voiceless aspirates. In chapter 3, the phonological evidence from neutralization shows that aspiration is marked with the same feature for voiced aspirates and voiceless aspirates: in languages where only aspiration is neutralized, they become plain voiced and voiceless. For example, Marathi (Houlihan and Iverson 1979) has final deaspiration, which applies to both voiced and voiceless aspirates:

(2)

| | | | |
|---|---|---|---|
| tap | 'fever' | tapala | 'to the fever' |
| top | 'cannon' | top$^h$ela | 'to the cannon' |
| vad | 'discussion' | vadala | 'to the discussion' |
| dud | 'milk' | dud$^h$ala | 'to the milk' |

Other languages with the same process are discussed in Chapter 3, supporting the claim that voiced and voiceless aspirates pattern together phonologically. More phonological evidence comes from the Tibeto-Burman language Limbu (Weidert and Subha 1985), where morphophonemic rules of voicing apply to plain voiceless and voiceless aspirated consonants, yielding voiced and voiced aspirated consonants. In Hindi (Ohala 1983) aspirated consonants cannot be the second consonant in stop-stop clusters; this includes both voiced and voiceless aspirates. The phonology of aspirated sonorants is discussed in chapter 4; the evidence from neutralization and other phonological rules supports marking these with the same feature as aspirated obstruents also.

I conclude that the evidence is clear that 'murmured' sounds should be marked voiced and aspirated. Abramson (1977) notes that voiced aspirates cannot be distinguished by VOT alone, and require an added dimension of glottal aperture. However, while this would allow a description of the sounds, it would not account for the fact that they pattern with voiceless aspirates phonetically and phonologically, since glottal aperture is not a feature of voiceless aspirates in their system. Thus the VOT framework fails in this important respect.

*1.1.2.2 VOT and phonology.* Since a fully detailed phonological theory using VOT for laryngeal contrasts has never been proposed, it is difficult to evaluate it. Consider two possible routes to take in creating a phonological theory based on VOT. One would be to represent the differences in timing directly in the phonological representation. This is attempted by Browman and Goldstein, discussed below. Another possibility would be to abstract away from the physical facts somewhat, and manipulate the scalar relationship of the three phonation types that the theory accounts for. We could represent this by giving each type a number in order:

(3)

| | |
|---|---|
| b | 1 |
| p | 2 |
| $p^h$ | 3 |

This is more or less Ladefoged's (1973) proposal, where features are points along a continuum, designated by numbers, although he makes many more distinctions. If this is the relationship, the rules one can imagine acting on these representations would be the usual manipulations of integers, such as addition and subtraction, that would move the sounds to different points on the scale. This is not intrinsically absurd, since some rules of lenition do something that looks roughly like this. But in the case of laryngeal phonology examples of such rules do not give known phonological processes. For example, the rule that adds 1, or moves the sounds over one place on the scale has the following effect:

Add 1: b -> p, p -> $p^h$, $p^h$ -> ?

This process does not exist in any known language; neither does the rule that subtracts 1:

Subtract 1: b -> ?, p -> b, $p^h$ -> p

And it is not clear how known phonological processes could be represented, for example syllable-final laryngeal neutralization whereby /p,$p^h$,b/ all become [p], which as I have already mentioned is the most common phonological process involving the laryngeal features. One could represent this by a rule stipulating that all sounds change to the value 2 on the scale above. But this would not explain why neutralization always results in plain voiceless stops, because we could just as easily write a rule making all sounds change to some other value. It is also not clear how this theory could explain the fact that in languages with laryngeally marked sonorants, the result of neutralization is plain voiced sonorants. In the remainder of this study it will be shown that all of these facts can be given a principled explanation assuming a system of three privative laryngeal features and the basic mechanisms of autosegmental phonology and feature geometry.[7]

Current phonological theory does not use scales; the exception is the sonority hierarchy, but even this has been argued to be a result of binary features (Steriade 1982). Since laryngeal phonology can also be analyzed in terms of binary features, and