Phonological aspects of nasality: An element-based dependency approach

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Having provided the groundwork for the representation of nasals and nasalization, I now consider in more detail the interaction between nasals and laryngeal articulations. This topic involves two related aspects. First, in this chapter, I examine the issue of laryngeal modifications within the class of nasals. Nasals with a laryngeal modification will be termed “laryngeally modified nasals”. Next, in chapter 6, I consider the issue of nasal modifications in laryngeals, and examine some cases of phonological interaction between nasals and laryngeal segments.

The present chapter is organized as follows. In §5.1, I provide an overview of the kinds of laryngeal modifications found in nasals, based on the UPSID database. This overview serves as the basis for the theoretical interpretation in §§5.2 and 5.3. We will see there that nasals, as well as other sonorants, permit a maximum of two distinctive laryngeal modifications, glottalization and aspiration. In §5.4 I focus in some detail on the segmental status of laryngeally modified nasals, and consider some diagnostics that will help us to determine whether such nasals function as single segments or as clusters.

### 5.1 Laryngeal modifications in nasals

#### 5.1.1 Typological observations

Inspection of the UPSID database reveals that the majority of languages have voiced nasals only (88.4%; cf. Maddieson 1984). Combining the percentage of voiced nasals with, firstly, the percentage of voiced nasals with distinctive length, and, secondly, the percentage of voiced nasals with a secondary articulation, yields 96.6%. Thus, of the languages in UPSID only 3.4% have nasals which are produced with a laryngeal setting other than voice.¹

UPSID distinguishes three types of laryngeally modified nasals: voiceless, laryngealized, and breathy voiced nasals. Based on this categorization, (1)

¹ Maddieson (1984) considers the number of laryngeally modified nasals in relation to the total number of nasals. This yields the same percentage of 3.4%.
provides an overview of languages that have distinctive laryngeally modified nasals (data from Maddieson 1984 and Ladefoged & Maddieson 1996).²

(1) Laryngeal contrasts in nasals: cross-linguistic overview

<table>
<thead>
<tr>
<th>Language</th>
<th>$V_{cd}$</th>
<th>$V_{cls}$</th>
<th>$L_{ar}$</th>
<th>$B_{rVoi}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sui</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Sedang</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Klamath</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Jalapa Mazatec</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Mazahua</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Otomi</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>!Xū</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Iai</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Hmong</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Yao</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Lakkia</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Burmese</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Hopi</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Aleut</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Gbeya</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Hausa</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Haida</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Yawelmani</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Tolowa</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
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<tr>
<td>Nez Perce</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Nootka</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Kwak’wala</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Acoma</td>
<td>✓</td>
<td>-</td>
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<td></td>
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<td>Wappo</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Yuchi</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Southern Nambiquara</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Columbian Salish</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Hindi</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Marathi</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Newari</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Lianchang Yi</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Tsonga</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

A number of observations can be made with regard to (1). First, the presence of a laryngeally modified series of nasals implies the presence of the voiced series

² In (1) $V_{cd}$ denotes “voiced”, $V_{cls}$ “voiceless”, $L_{ar}$ “laryngealized”, and $B_{rVoi}$ “breathy voiced”. I ignore in (1) the distribution of laryngeal modifications in relation to nasal place; this topic is considered in §7.1.1.
of nasals. This, in addition to their cross-linguistically infrequency, demonstrates the markedness of laryngeally modified nasals. Second, the maximum number of laryngeal contrasts in nasals appears to be two, as is illustrated for instance by Sui, Sedang, Jalapa Mazatec, and !Xu. Observe, however, that the categorization in UPSID predicts a maximally three-way contrast, which to the best of my knowledge is unattested.

Inspection of (1) reveals that the key to this problem lies in the categories of voiceless and breathy voiced nasals; UPSID does not contain any examples of languages in which these types of nasals contrast. The remedy that I wish to propose is straightforward: I will argue that voiceless and breathy voiced nasals form a single phonological category. More specifically, I will claim that both types of nasals are characterized by the presence of a dependent element [H], the phonetic realization of which, when combined with nasal manner, varies between voicelessness, aspiration, and breathy voice. I consider this view in more detail in §5.2.

As can be seen in (1), most languages with laryngeally modified nasals have only one such series in addition to the voiced series. In UPSID the number of languages with contrastive laryngealized nasals is somewhat higher than the number of languages with contrastive voiceless nasals. UPSID contains a mere two languages with contrastive breathy voiced nasals, !Xu and Hindi. Other languages in which such nasals are reported to be contrastive include Marathi, Newari, Tsonga, and Lianchang Yi, as well as some Edoid languages (see Ladefoged & Maddieson 1996 and references there).

Typological observations of this kind should be interpreted with care. For instance, before concluding that laryngealized nasals are cross-linguistically more common than voiceless nasals, and that both are vastly more common than breathy voiced nasals, the possibility must be left open that UPSID is skewed by regional biases. For instance, Sapir (1938) noted that laryngealized nasals are an areal feature of North America. This is also what the UPSID sample suggests: of the 17 languages with laryngealized nasals, only 3 are spoken outside North America. However, given that the total number of North American languages in UPSID is 51, it is not unthinkable that the relatively large number of these with laryngealized nasals distorts the cross-linguistic markedness of this segment type.

From the perspective of phonological theory, a more pertinent issue is how and to what extent the figures in UPSID are phonologically relevant. The general point here is that typological observations regarding segmental contrasts are inevitably affected by theoretical interpretation. A case in point is the claim that there is no phonological reason to distinguish between voiceless and breathy voiced nasals. This has obvious implications for the typology of laryngeally modified nasals, both with respect to their categorization and their relative cross-linguistic frequency.

Another issue which requires discussion is that of segmental interpretation. Given that laryngeally modified nasals involve a combination of a nasal and a
laryngeal articulation, these nasals can, in principle at least, function as single segments or as clusters. Since UPSID is a segmental database, the inclusion of a particular sound implies that it is regarded as a single segment. As such it is interesting to see how the complexity of laryngeally modified nasals is interpreted in Element-based Dependency, where there is no level corresponding to that of the segment. I consider this issue in §5.4, after focusing in more detail on the categorization of laryngeally modified nasals.

### 5.1.2 Phonological categorization

In §2.4, a number of claims were made with regard to the representation of laryngeal modifications. The general organization of segment structure that was proposed there is repeated in (2):

\[
\begin{array}{c}
\text{O, N, C} \\
\text{manner} \quad \text{phonation} \\
\text{place}
\end{array}
\]

The organization in (2) expresses the fact that manner and place form the segmental “core”. The phonation component, which subsumes the various laryngeal contrasts, forms a dependent of this core. This is in line with the observation that it is unmarked for a segment to be specified for manner and place, but marked for a segment to be specified for phonation. Manner and laryngeal contrasts are specified in terms of the same set of elements, i.e. |G|, [H], and |L|. The difference between manner and laryngeal specifications is that the latter is restricted to a maximum of one element.\(^3\) Thus, heads permit a greater degree of complexity than dependents.

A crucial assumption is that manner and phonation are dominated by a subsyllabic constituent, i.e. an onset, nucleus, or coda (see also Kehrein 2002). As was observed in §1.2.2, this organization embodies three claims. First, onsets, nuclei, and codas have at their disposal a maximum of one contrastive laryngeal specification. Second, the relative order of laryngeal and supralaryngeal articulations within onsets, nuclei, and codas is never contrastive. Third, within onsets, nuclei, and codas languages never contrast a laryngeal segment with the corresponding laryngeal modification. We will see that these predictions are borne out, at least as far as laryngeally modified nasals are concerned.

The interpretation of |G|, [H], and |L| as dependent phonation elements is given in (3). Once more, note that phonation is limited to a single element:

\(^3\) This holds for those dependent structures that lack a place component (see also §2.6).
(3)  ? :  glottalization, ejection, creaky voice, implosion  
    H :  aspiration, breathy voice, voicelessness  
    L :  voice, nasalization  

The variable realization of phonation elements is in part a matter of language-particular phonetic implementation. This is evidenced for instance by the variation that is found in the realization of nasal manner with dependent |H| (see §5.2.1). Aside from this, variability in the phonetic realization of phonation elements depends on the manner structure to which they are associated. In (4) I offer an overview of the compatibility of manner and phonation types; recall here that I treat nasalization on a par with laryngeal modifications:4

(4)  Segment type  
    |[?]|-headed (stops)  
    |[H]|-headed (fricatives)  
    |[L]|-headed (sonorants) 

<table>
<thead>
<tr>
<th>Glott</th>
<th>Impl</th>
<th>Asp</th>
<th>BrVoi</th>
<th>Voi</th>
<th>Nas</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

The combination of these with a nasal manner component dominating [U] yields the structures in (5b-d) (unless otherwise noted, I assume that consonantal manner types are dominated by an onset position):

(5)  

(5a) represents a voiced non-laryngeally modified labial sonorant stop, as is reflected by the absence of dependent structure and by the intrinsic nature of the voicing. As was argued in §2.2.5, this structure is realized as an oral or nasal sonorant stop, depending on the phonological system of the language. (5b) represents a labial sonorant stop with dependent |L|. This structure represents a nasalized sonorant stop, or “phonologically active nasal”. (5c) represents a labial nasal with dependent |?|; this structure denotes a laryngealized or glottalized nasal.5 A labial nasal with a dependent element |H|, as in (5d), denotes an

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4 In (4) Glott denotes “glottalized” and Impl “imploded”; note in (4) that I limit my attention to supralaryngeal segment types.

5 Below, the segments that I term “glottalized” subsume both glottalized and laryngealized articulations.
aspirated nasal. Aspirated and glottalized nasals have a wide range of phonetic realizations. However, we will see in §§5.2 and 5.3 that this variability is phonologically irrelevant to the extent that these realizations are never contrastive.

Although nasalization, as expressed by dependent [L], is in structural terms equivalent to a laryngeal modification, it is not itself a laryngeal modification in the phonetic sense. For this reason, I will refer only to aspirated and glottalized nasals as laryngeally modified nasals. With this proviso in mind, the range of laryngeally modified nasals precisely matches the cross-linguistically observed contrasts involving these segments.

In the following sections, I will provide both theoretical and cross-linguistic support for the Element-based Dependency representation of aspirated and glottalized nasals.

### 5.2 Aspirated nasals

#### 5.2.1 Phonetic variation and phonological contrast

One of the categories of laryngeally modified nasals recognized in UPSID is that of voiceless nasals. This category is also recognized in Chomsky & Halle (1968), where such nasals, as well as other voiceless sonorants, are specified as [–voice]. There are two problems with this interpretation. First, it relies on a binary-valued feature [–voice]. This, among other things, fails to express the relative markedness of voiceless nasals as compared to voiced nasals. Second, an account in terms of [–voice] fails to offer an adequate characterization of the phonological behaviour of the nasals involved, which is characteristic of aspirated rather than of voiceless segments.

The latter point is supported first and foremost by the (near-) universal implication that the presence of voiceless nasals in a language implies the presence of aspirated stops. UPSID contains 24 languages with voiceless nasals; of these only two, Hopi and Aleut, are described as lacking aspirated stops (cf. Maddieson 1984). However, in these languages, too, there are good grounds for recognizing an aspirated series of stops.6

Phonetically, the relation between voiceless nasals and aspirated stops is supported by the fact that both types of sounds involve vocal fold abduction. This leads Halle & Stevens (1971) to specify both voiceless sonorants and

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6 According to Voegelin (1956), those Hopi dialects which have voiceless nasals also have preaspirated stops, the latter contrasting with a series of plain stops. Preaspirated stops and voiceless nasals pattern together in certain tonal developments (see §5.2.4 below). In §5.2.2 I provide some arguments for treating the voiceless stops of Aleut as being phonologically aspirated.
aspirated stops in terms of the feature [spread glottis].\footnote{Halle & Stevens consider only vowels and glides; however, their observations appear to be equally amenable to other types of sonorants.} As regards this feature, Halle & Stevens (1971:201-2) observe that

[b]y rotation and displacement of the arytenoid cartilages, the vocal cords can be displaced outward relative to their positions for normal voicing, leaving a large glottal width. If the vocal-cord stiffness is sufficiently large, the combination of wide glottis and stiff glottal walls inhibits vocal-cord vibration. On the other hand, slackening of the glottal walls by reducing the stiffness can lead to a condition in which vocal-cord vibration will occur, even with a relatively wide glottal opening.

Thus, segments that are realized with vocal fold abduction may or may not be voiceless. This suggests that a specification in terms of \([-\text{voice}]\) is inappropriate.

In view of these observations, subsequent work has generally reinterpreted voiceless nasals, as well as other voiceless sonorants, as aspirated (see, for instance, Anderson & Ewen 1987, Lombardi 1991). The advantage of this view is that it makes possible a representation in terms of a single-valued feature \([\text{O}]\) in Anderson & Ewen, [spread glottis] in Lombardi), which captures the relative markedness of these nasals. Furthermore, an analysis of these nasals as aspirated better accounts for their phonological behaviour, as we will see in §5.2.2.

Here I take essentially the same view as Anderson & Ewen and Lombardi. I assume that the nasals under consideration, which I will refer to as “aspirated nasals”, are represented in terms of a dependent element \([\text{H}]\).\footnote{Given the range of phonetic variation of (6), the term “[\text{H}]-specified nasal” is perhaps more appropriate. I will nevertheless refer to (6) as “aspirated”, partly for ease of reference and partly because of its structural similarity—and phonological relation—to aspirated stops.} Consider once more the Element-based Dependency representation of a labial aspirated nasal \(/m^{h/}\), together with some possible phonetic realizations:

\[
\begin{array}{c}
O \\
\mid \\
L \quad H \\
\mid \\
? \\
\mid \\
U \\
\end{array}
\]

\([\mathit{Em}, \mathit{mE}, \mathit{hm}, \mathit{mh}, \mathit{mf}, \mathit{fim}]\)

A number of comments are in order regarding (6). First, in line with Kehrein (2002), the structure does not express linear order. Thus, (6) is agnostic with
respect to the overlap and sequencing of nasality, voicing, and aspiration. Note also that association of [H] to an onset constituent implies that no distinction can be made between a single segment /m%/ and a cluster /mh/. If this type of contrast is absent universally, as is claimed by Kehrein, this is an attractive result.

Second, (6) expresses the fact that aspirated nasals, as sonorants, are intrinsically voiced by virtue of the presence of [L] in the nasal manner component. As such, (6) provides a theory-internal argument against a phonological category of voiceless nasals: if the presence of [L] implies the presence of voicing, then a phonologically voiceless nasal would have to be represented as lacking [L]. However, deletion of [L] from the nasal manner component produces a voiceless stop, not a voiceless nasal:\footnote{Essentially the same point is made by Humbert (1995:92).}

\begin{equation}
\begin{array}{c}
O \\
| \\
L & \rightarrow & ? \\
| \\
? & & U \\
\end{array}
\end{equation}

\( /N/ \rightarrow [\emptyset] \)

Examples of processes in which nasals change to, or alternate with, voiceless stops are found in West Greenlandic and the Taz dialect of Selkup (see §2.3.1).

The Element-based Dependency representation of aspirated nasals is also supported by the phonetic characteristics of these segments. Ohala & Ohala (1993:232) observe that a constant factor in phonetically voiceless nasals is that they are voiced for at least part of their duration.\footnote{Ohala & Ohala appear to be referring to prevocalic voiceless nasals, since in some languages nasals are realized as completely voiceless in preconsonantal or word-final position. An example of such a language is Comaltepec Chinantec (cf. Silverman 1997; see also Kehrein 2002). Ohala & Ohala also note that voiceless nasals are generally longer than voiced nasals. This could in fact be due to the fact that, prevocally at least, voiceless nasals are partly voiced.} Cross-linguistic evidence suggests that this voicing is not due to coarticulation with, say, a neighbouring vowel. Rather, Ohala & Ohala maintain that the formant transitions associated with voicing render the place cues of aspirated nasals more salient. The presence of voicing is not surprising if aspirated nasals have the structure in (6), where voicing inheres in the manner component as [L].

Cross-linguistic evidence further shows that the presence of voicelessness, the relative order of voicing and aspiration, and the degree of overlap between
the two are a matter of language-specific phonetic implementation. For instance, Ladefoged & Maddieson (1996:111) note that in Burmese

voiceless nasals … usually have an open glottis for most of the articulation, but some voicing for the period just before the articulators come apart.

The Burmese nasals differ as such from those of Angami, a Tibeto-Burman language of northeastern India. Regarding the latter, Ladefoged & Maddieson (1996:114) note that

there is no voiced portion towards the end of the voiceless nasal consonant. Instead, before the voicing of the vowel begins, the oral occlusion is released while air is still flowing through the nose.

The same kind of variation is observed in nasals which, in phonetic terms, can be described as breathy voiced. Ladefoged & Maddieson (1996:107) report that in the breathy voiced nasals of Hindi

a short period of modal voicing occurs at the beginning of the nasal before breathiness begins.

More generally, Ladefoged & Maddieson’s overview shows that breathy voiced nasals may among other things differ in terms of the degree of vocal fold separation, the degree of breathiness, and the relative timing of oral and laryngeal gestures. The breathy voiced nasals of Tsonga, for instance, are similar to those of Hindi in terms of timing of oral and laryngeal gestures, but involve a lesser degree of glottal aperture (see also Traill & Jackson 1988). By way of contrast, the breathy voiced nasals of Lianchang Yi, a Tibeto-Burman language of China, have a voiceless onset in word-initial position (cf. Ladefoged & Maddieson 1996:108).

Not unsurprisingly, differences in the phonetic realization of aspirated nasals are sometimes reflected in the transcription of these sounds. For instance, in his discussion on the interaction between aspirated sonorants and tone, L-Thongkum (1997:210) provides the following cognates from Kawa and Samtao, two closely related Mon-Khmer languages:

(8)  

<table>
<thead>
<tr>
<th>Kawa</th>
<th>Samtao</th>
</tr>
</thead>
<tbody>
<tr>
<td>smouth</td>
<td>smouth</td>
</tr>
<tr>
<td>smouth</td>
<td>smouth</td>
</tr>
</tbody>
</table>

‘hear’

‘blood’

11 The same holds for other types of sonorants. For instance, Smith (2000) notes that the realization of Scottish English <wh> varies between [hʰ] and [hʱ]. This supports the claim that in sonorants aspiration is basic and voicelessness an optional side-effect.
It is reasonable to assume that L-Thongkum’s transcription reflects a difference in the phonetic realization of the initial nasals, and not a difference in their phonological representation. It is important to observe in this respect that both Kawa and Samtao contrast only one series of nasals in addition to a plain voiced series. I return to the laryngeally modified nasals of Kawa and Samtao in §5.2.4.

In a similar vein, Fushi (1985) gives the following nasal inventories of three closely related Miao dialects, referred to in (9) as “Miao A”, “Miao B”, and “Miao C”:

\[
\begin{array}{cccc}
\text{Miao A} & \text{Miao B} & \text{Miao C} \\
\hline
m & \text{æ} & m & \text{æ} & m & \text{æ} \\
\text{mj, mz} & \text{ø} & \text{ø} & \text{ø} & \text{ø} & \text{ø} \\
\text{n} & \text{ø} & \text{ø} & \text{ø} & \text{ø} & \text{ø} \\
\eta & \eta & \eta & \eta & \eta & \eta \\
\eta & \eta & \eta & \eta & \eta & \eta \\
\eta w & \eta w & \eta w & \eta w & \eta w & \eta w \\
\end{array}
\]

In (9) we see a preferential relation between /m/ and secondary articulations, and an antagonistic relation between /η/ and laryngeal modifications. Dialect A has the most extensive nasal series, which is due partly to the presence of a number of complex nasal segments, and to the presence of a series of retroflex nasals. All dialects have a laryngeal contrast in at least /m/ /ø/. The transcription of the relevant series indicates that there is variation in the phonetic realization of this contrast. The nasals in dialect C appear to involve a period of voicelessness during at least part of the oral closure phase, whereas in dialects A and B voicelessness is maintained until some time after the oral release. Again, there is no reason to take this variation as phonologically relevant, since there is no Miao dialect, nor any other language that I am aware of, which contrasts a nasal realized as [ŋ̃] with a nasal that is realized as [Æ], at least not within the same syllabic position.

Nevertheless, a transcription such as /hm/ does express one aspect which may be of potential phonological relevance. Since /hm/ involves a combination of /h/ and /m/, this sequence may, in principle at least, function as a cluster rather than as a single segment. I consider this issue in more detail in §5.4.2.

In addition to cross-linguistic variation, there is also language-internal variation in the realization of aspirated nasals. In Comaltepec Chinantec, for instance, aspirated nasals have a period of initial voicing in onsets, but are voiceless throughout in codas, at least in certain tonal patterns (cf. Silverman

---

12 I ignore in (9) the various series of prenasalized stops of Miao, as these involve a subtype of stops rather than a subtype of nasals.

13 I consider this issue in §7.1.1.
A similar kind of variation is observed in the aspirated nasals of Klamath (cf. Barker 1964, Blevins 1993):

\[
\begin{array}{ccc}
\text{Onset} & \text{Coda} \\
\text{Comaltepec Chinantec} & /m⁣/ & [\text{E}m] & [\text{E}] \\
\text{Klamath} & /m⁣/ & [\text{ˀE}] & [\text{E}] \\
\end{array}
\]

In both languages, the different realizations in onset and coda position can be viewed as positional allophones of a single underlying aspirated nasal, i.e. /m⁣/.

The preceding discussion shows that the range of phonetic variation in aspirated nasals is considerable, and includes realizations which may be characterized in phonetic terms as voiceless, aspirated and breathy voiced. However, from the perspective of phonological contrast the important point is that none of the languages considered makes distinctive use of this variation. Thus, there appear to be no languages in which a laryngeally modified nasal of the type in, say, Burmese contrasts with a laryngeally modified nasal of the type in, say, Hindi (i.e. */Ḛ/ ~ */Ḛ/). This supports the hypothesis that we are dealing with one and the same phonological segment type, represented in terms of dependent \(H\).

As was noted earlier, one consequence of this view is that there is no phonological class of breathy voiced nasals. This is in line with the observation that distinctive breathy voice is compatible with stops and affricates only (see §2.4). To illustrate this, consider the distribution of laryngeal contrasts in Hindi. As far as nasals are concerned, Hindi employs a two-way laryngeal contrast which is usually described as involving modal and breathy voice (see e.g. Ladefoged & Maddieson 1996). Two examples of this contrast are given in (11); note that in Hindi, breathy voiced nasals occur only intervocally:

\[
\begin{array}{ll}
\text{Modal voice} & \text{Breathy voice} \\
k\text{umar} & ‘b\text{oy}’ & k\text{u}’\text{ar} & ‘p\text{otter}’ \\
\text{sun\text{ar}} & ‘g\text{oldsmith}’ & ḗ\text{n\text{g}y\text{ai}} & ‘m\text{oonlight}’ \\
\end{array}
\]

One reason for analyzing the laryngeally modified series as breathy voiced is that they involve a period of voiced aspiration. This is confirmed by the description of these sounds in Ladefoged & Maddieson (1996:107):

---

14 Note, however, that Dixit (1975), Maddieson’s source for Hindi, refers to these nasals as aspirated. Hindi also has a breathy voiced \(\text{u}’\); whether or not \(\text{u}\) has a breathy voiced counterpart is not entirely clear (see Ohala 1983).

15 The coronal nasals are phonetically realized as dental. Note that the word \(\text{d\text{g}y\text{y}a}’\text{ai}\) is obsolete and has become \(\text{d\text{g}y\text{y}a}’\text{ai}\) in modern Hindi (Godard Schokker, p.c.).
After the closure is formed, the initial portion of a breathy voiced nasal has modal voicing. The glottal opening gesture for breathy voice starts in the middle of the closure period some 40 ms before oral release. The peak of this glottal opening gesture occurs 30-40 ms after oral release, and 80-90 ms of “voiced aspiration” is observed at the onset of the vowel.

Recall, however, that the relative overlap of voicing and aspiration in nasals is a matter of cross-linguistic variation. Given this, the fact that the laryngeally modified nasals of Hindi involve a period of voiced aspiration does not offer evidence for a phonological category of breathy voiced nasals. Rather, the position here is that the nasals concerned are represented in terms of nasal manner with dependent [H]. Using the labial nasals as example, the relevant contrast in Hindi is therefore as in (12):16

(12)  a.  **Modal voice**  b.  “Breathy voice”

```
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>U</td>
<td>U</td>
</tr>
</tbody>
</table>
/m/ /m̃/
```

According to this scenario, the laryngeally modified nasals of Hindi are phonologically aspirated. The fact that they are realized as breathy voiced is a matter of phonetic implementation.

Another reason why the laryngeally modified nasals of Hindi are sometimes described as breathy voiced is presumably that Hindi has a series of distinctively breathy voiced stops. The Hindi stop system displays a four-way laryngeal contrast, which is illustrated in (13) for the labial series:

(13)  plain /ph/  ‘take care of’

```
<table>
<thead>
<tr>
<th>plain</th>
<th>voiced</th>
<th>aspirated</th>
<th>breathy voiced</th>
</tr>
</thead>
<tbody>
<tr>
<td>/p/</td>
<td>/b/</td>
<td>/pʰ/</td>
<td>/bʰ/</td>
</tr>
<tr>
<td>‘take care of’</td>
<td>‘hair’</td>
<td>‘knife blade’</td>
<td>‘forehead’</td>
</tr>
</tbody>
</table>
```

In Element-based Dependency, these contrasts are represented as follows:

---

16 It is reasonable to assume that the plain nasals of Hindi are specified for dependent [L], since they trigger regressive vowel nasalization in some contexts (see e.g. Ohala 1983). However, this does not affect the point at issue.
The plain voiceless unaspirated stop in (14a) has no laryngeal modification, and thus no dependent structure; the voiced unaspirated stop in (14b) has dependent \( \text{L} \); the voiceless aspirated stop in (14c) has dependent \( \text{H} \); the breathy voiced stop in (14d) also has dependent \( \text{H} \), while its voicing is specified in the manner component (i.e. in terms of inherent voicing).

The representation of breathy voiced stops as in (14d) expresses the fact that breathy voice involves the extension of an aspiration contrast to a (distinctively) voiced series of segments. That is, I interpret breathy voiced stops not so much as “voiced aspirated” but as “aspirated voiced”. Note that this interpretation is supported by an inventory-based implication. Inspection of UPSID reveals that languages with distinctive breathy voiced stops also have distinctive aspirated stops (cf. Maddieson 1984). Recall, too, that the overwhelming majority of languages in UPSID with aspirated (i.e. “voiceless” or “breathy voiced”) nasals also have aspirated stops. No such relation holds between aspirated sonorants and breathy voiced stops, however. In fact, the only language in UPSID that has both aspirated (i.e. “breathy voiced”) nasals and breathy voiced stops is Hindi.

On a final point, it should be observed that the absence of a distinctive category of breathy voiced nasals is well motivated on phonetic grounds. In obstructive stops, vocal fold abduction during the oral closure phase has no acoustic effect. This means that in order for aspiration to be perceived, the oral and laryngeal gestures should not overlap. As a result, aspiration in stops is realized phonetically either as preaspiration or as postaspiration. Unlike obstructive stops, sonorant stops do not involve complete closure. This means that the vocal fold abduction which is characteristic of aspirated sonorants can occur before, during, and after the supralaryngeal constriction. As a result, aspirated nasals are expected to have a variety of phonetic realizations, as is confirmed by the cross-linguistic data considered above.\(^{17}\)

In the following sections, I consider a range of cross-linguistic evidence in support of the Element-based Dependency representation of aspirated nasals. First, in §5.2.2, I examine a number of cases which involve a phonological relation between aspirated nasals and stops. Next, in §5.2.3, I focus on a number of diachronic developments that involve aspirated nasals. Finally, in §5.2.4, I

\(^{17}\) The same argument can be applied to laryngeally modified non-nasal sonorants, where we find the same range of variation as in laryngeally modified nasals.
briefly focus on the interaction between aspiration and high tone. In each of the cases considered, the facts encountered support a representation of aspirated nasals in terms of dependent |H|.

### 5.2.2 Segmental evidence

Given the hypothesis that aspirated nasals consist of a head nasal manner component and a dependent element |H|, consider first some evidence for a componential view of aspirated nasals.

The componential nature of aspirated nasals is supported by processes in which nasal manner and aspiration are independently manipulated. This can be observed in Aleut, a language of Alaska. Proto-Aleut is reconstructed as having what Bergsland (1997:21) terms a series of “aspirated nasals”. In the Atkan dialect of Aleut, these nasals have in most cases been retained. In the Attuan dialect of Aleut, a development has taken place which, according to Bergsland, involved metathesis. Consider the cognates in (15) (data and transcription from Bergsland 1997:21):

(15)  

<table>
<thead>
<tr>
<th>Proto-Aleut</th>
<th>Atkan Aleut</th>
<th>Attuan Aleut</th>
</tr>
</thead>
<tbody>
<tr>
<td>*aʔasix</td>
<td>aʔasix</td>
<td>hamasix</td>
</tr>
<tr>
<td>*aʔak</td>
<td>aʔak</td>
<td>hanisik</td>
</tr>
<tr>
<td>*ul i:</td>
<td>ul i:</td>
<td>huŋi:</td>
</tr>
</tbody>
</table>

The Attuan development supports the componential interpretation of aspirated nasals. The sound change involved can be analyzed as involving transfer of dependent |H| to the word-initial onset position, where it is phonetically realized as [h].

Additional support for the componential structure of aspirated nasals comes from Havasupai, a Hokan language of Arizona. As Buckley (1992) observes, initial aspirated stops in Havasupai have an alternative realization in which the aspiration is dislodged from the stop and realized as [h]. In such cases [h] is separated from the stop by [a], as is shown by the forms in (16a). The forms in (16b) show that the same variation is found in sonorants:

(16)  

a. [kʰaajk ~ hokáajk] ‘moon’  
  [tʰaw ~ hɔtʰaw] ‘gourd’  

b. [E̞aŋ ~ həməŋ] ‘throw (away from speaker)’  
  [ˈaːʔa ~ hɔləʔa] ‘reed, cane’

In Havasupai, aspirated stops and affricates show natural class behaviour with a series of phonetically voiceless sonorants. This can be taken as evidence that the sonorants involved are phonologically aspirated rather than voiceless. Yavapai, a language which is closely related to Havasupai, provides further evidence in
favour of the representation of aspirated nasals in terms of dependent \[ H \]. I
consider the relevant facts in §5.4.2.

Another type of evidence for aspirated nasals comes from processes in
which stops and sonorants undergo aspiration. Consider the following facts from
Pileni, a language of the Solomon Islands. According to the description in Naess
(2000), Pileni contrasts plain and aspirated stops, nasals, and \( /l/ \). The underlying
status of aspiration is not always clear. Naess points out that some surface
occurrences of aspiration result from the deletion of a preceding syllable; this
process, Naess observes, is typical of rapid speech:

\[
\begin{array}{ll}
/tama-na/ & [\text{tama} \sim m^{h}ana] \quad \text{‘his/her father’} \\
/ma-na/ & [\text{mana}] \quad \text{‘for him/her’}
\end{array}
\]

Diachronic evidence for syllable deletion can be observed in the Pileni pronoun
system. In Tokelauan, a language closely related to Pileni, the dual and plural
forms of personal pronouns are preceded by the particle \( ki \). This particle is not
found in Pileni, where we find an initial aspirated consonant instead:

\[
\begin{array}{llllll}
\text{DUAL} & \text{PLURAL} \\
\text{Tokelauan} & \text{Pileni} & \text{Tokelauan} & \text{Pileni} \\
1\text{ST-INCL} & \text{ki taua} & t^{h}aua & \text{ki tautou} & t^{h}atou \\
1\text{ST-EXCL} & \text{ki maua} & m^{h}aua & \text{ki matou} & m^{h}atou \\
2\text{ND} & \text{ki kouluu} & k^{h}ouluu & \text{ki koutou} & k^{h}outou \\
3\text{RD} & \text{ki luaa} & l^{h}aua & \text{ki latou} & l^{h}atou
\end{array}
\]

In both Tokelauan and Pileni, dual and plural possessive pronouns have the
same form as personal pronouns. In Tokelauan, possessive pronouns occur
without \( ki \); in Pileni, they have an initial unaspirated consonant. Naess further
observes that while personal pronouns are sometimes realized without
aspiration, possessive pronouns never occur with aspiration. This suggests that
in Pileni, in the pronoun system at least, aspiration is underlyingly contrastive in
both stops and sonorants.

Another example of patterning of aspirated obstruents and “voiceless”
sonorants can be observed in Burmese. Burmese exhibits a process of causative
formation which, as can be seen in (19a), involves aspiration of verb-initial
voiceless stops. Ladefoged & Maddieson (1996:69) note that “[t]he parallel
alternation in nasals and laterals is usually described as being between voiced
and voiceless counterparts”. Some forms containing initial sonorants are given
in (19b):

\[
18 \text{Except the 2ND-POSS personal pronouns, which in their possessive forms lack the initial velar stop.}
\]

\[
19 \text{Burmese also has initial voiced stops, but these are generally restricted to nouns.}
\]
Clearly, an analysis of causative formation in terms of a single element, e.g. |H|, offers a unified account of the process, and supports an analysis of the sonorants involved as being phonologically aspirated rather than voiceless.

Welsh also provides evidence for a phonological class of aspirated nasals. In common with other Celtic languages, Welsh exhibits a process of initial consonant mutation. This involves a series of morphosyntactically governed alternations which affect the initial consonants of words. Of interest here is the type of alternation termed “nasal mutation”. Nasal mutation applies after the 1-SG-POSS prefix /an-/ and mutates lenis stops to homorganic nasals. In most southern varieties of Welsh, nasal mutation is extended to the fortis stops, which mutate to a series of nasals which is transcribed by Jones as \[\text{\[\text{[m \ η \ ŋ]}. Some examples of nasal mutation are given in (20) (cf. Jones 1984:41):

(20)  a. /an + bærn/ [an mærn] ‘my opinion’
    /an + dærn/ [an nærn] ‘my price’
    /an + gæir/ [an ñæir] ‘my word’

b. /an + pʰæn/ [an ðæn] ‘my head’
    /an + ðæd/ [an əðd] ‘my father’
    /an + kʰæt/ [an læt] ‘my coat’

Jones (1984) points out that voicing is not a constant feature of the lenis stops; rather, the constant feature distinguishing the two stop series is that of aspiration. Hence, it is reasonable to take the underlying contrast in Welsh to be /p t k ~ pʰ tʰ kʰ/, making the stop system not unlike that of English (as analyzed by, for instance, Harris 1994).

Nasal mutation is interpreted here as nasalization of stops. This can be formalized as involving the spreading of dependent |L| of the prefix nasal to the manner component of a following stop, turning that stop into a nasal.\(^{20}\) In this scenario, nasal mutation of a fortis stop results in a nasal with dependent |H|, i.e. a phonologically aspirated nasal. This is shown in (21), where I assume that the prefix nasal occupies the syllable coda:

\(^{20}\) I assume in (21) that the prefix nasal is specified for dependent |L|, since this permits an interpretation of the Welsh facts in which spreading involves dependent rather than head |L|.
The reasoning behind this interpretation is as follows: if the fortis stops of Welsh are underlyingly aspirated, and if nasal mutation involves nasalization of stops, then nasal mutation of aspirated stops yields aspirated nasals. Note, however, that the Element-based Dependency interpretation of nasalization of aspirated stops is not without problems. As was observed in relation to a similar process in Korean, many other conceivable spreading operations of the type in (21) are unattested (see §2.3.1). I leave this problem for further research.

The interpretation of the mutated nasals as being aspirated is also supported by the distribution of aspirated stops in Welsh dialects. Jones notes that aspirated nasals do not occur in dialects of Welsh that lack /h/. One such dialect is South Glamorgan Welsh, where both fortis and lenis stops mutate to voiced nasals. Note that this underscores the observation, made in §5.2.1, that the presence of aspirated nasals implies the presence of aspirated stops.

Phonological interaction between aspirated stops and sonorants can also be observed in languages in which sonorants are aspirated under the influence of a neighbouring aspirated stop. An example of such a language is English, where initial fortis stops transfer their aspiration to a following sonorant, as in clue [kluː] and cry [kriː] (see also §1.3). On the assumption that the consonants involved form a complex onset, we can view this realization as a language-particular phonetic implementation of an aspirated stop-sonorant cluster. This is illustrated in (22) for the initial cluster in the word clue:

\[
\begin{array}{cccc}
\text{O'} & \text{O} & \text{H} \\
\text{?} & \text{H} \\
\text{U} & \text{L} \\
\text{I} \\
\end{array}
\]

\(/(\text{kl})^h/ = [\text{k}']\)
Note that the representation in (22) expresses the fact that dependent |H| has scope over the entire onset, as was outlined in §2.6.1.21.

A more complex distribution of aspiration is observed in Icelandic. Word-initially, Icelandic has an aspiration contrast in both plosives and sonorants, as is illustrated by the forms in (22) (the Icelandic data presented below are taken from Thráinsson 1978, Hermans 1985, Arnason 1986, and Botma 2001):22

(22)

<table>
<thead>
<tr>
<th></th>
<th>Plain</th>
<th>Aspirated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plosive</strong></td>
<td>banna [paːnaː] ‘to forbid’</td>
<td>panna [pʰaːnaː] ‘pan’</td>
</tr>
<tr>
<td></td>
<td>dala [tʰaːla] ‘valley GEN-PL’</td>
<td>tala [tʰaːla] ‘to talk’</td>
</tr>
<tr>
<td></td>
<td>gala [kʰaːla] ‘crow’</td>
<td>kala [kʰaːla] ‘to freeze’</td>
</tr>
<tr>
<td><strong>Sonorant</strong></td>
<td>né [njeː] ‘either’</td>
<td>hné [Øːʔeː] ‘knee’</td>
</tr>
<tr>
<td></td>
<td>ljóð [ljouð] ‘poem’</td>
<td>hljóð [ʼljouð] ‘sound’</td>
</tr>
<tr>
<td></td>
<td>rós [rouːs] ‘rose’</td>
<td>hrós [ʼrous] ‘praise’</td>
</tr>
<tr>
<td></td>
<td>jól [jouːl] ‘Christmas’</td>
<td>hjól [Quːl] ‘Christmas’</td>
</tr>
</tbody>
</table>

Aspirated sonorants occur in word-initial position only. The distribution of non-initial aspirated plosives depends on dialect. Northern dialects (harþmæli, or “hard speech”) permit aspirated stops word-medially and word-finally, as in (24a,b). Southern dialects (línmæli, or “soft speech”) neutralize the aspiration contrast in these positions. In addition, southern dialects only have plain stops between a vowel and any of |j v r’|, as is shown in (24c):

(24)

<table>
<thead>
<tr>
<th></th>
<th>Northern</th>
<th>Southern</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. dýpi</td>
<td>/tɾþʰi/</td>
<td>[tɾþʰi]</td>
</tr>
<tr>
<td>b. sök</td>
<td>/sʰkʰ/</td>
<td>[sʰkʰ]</td>
</tr>
<tr>
<td>c. nepja</td>
<td>/nepʰja/</td>
<td>[nepʰja]</td>
</tr>
<tr>
<td>vökvva</td>
<td>/vʰkʰva/</td>
<td>[vʰkʰva]</td>
</tr>
<tr>
<td>depra</td>
<td>/tɾpʰra/</td>
<td>[tɾpʰra]</td>
</tr>
</tbody>
</table>

It is important to note that main stress in Icelandic falls on the initial syllable of the word. On the assumption that a word-final consonant occupies an onset supported by an empty nucleus, this allows for a unification of the neutralization sites in terms of the foot-internal onset position, and makes it possible to relate neutralization of aspiration to unstressed syllables (cf. Botma 2001).

---

21 I assume that laryngeal modifications are positioned in the first available dependent position. That is, single laryngeally modified manner structures such as /pʰh/ do not involve onset projection, since /h/ can form a dependent of O. As a consequence, structures which contain O’ must always involve branching at both the O and the O’ level.

22 Aspiration in sonorants is restricted to segments specified for head |I|, i.e. to coronals and palatals. In the orthography aspirated sonorants are reflected as <n l r j> preceded by <h>.
Independent evidence for the prosodic identity of forms like dýpi, sök, and nepja comes from a process of metrical vowel lengthening which targets stressed vowels in open syllables. This process receives a uniform interpretation if single word-final consonants form the onset of a “metrically dull” (cf. Iverson & Kesterson 1989) or “empty-headed” (cf. Harris & Gussmann 1998) syllable. Metrical vowel lengthening can then be analyzed as applying to all word-initial open syllables.

All dialects of Icelandic have an aspiration contrast in word-internal and in word-final sonorant-stop clusters. The phonetic realization of such clusters depends on dialect. In some northern dialects the stop itself emerges as aspirated. In most dialects the contrast is signalled instead by what Thráinsson (1978:39) terms “devoicing” of a preceding nasal or lateral. In such dialects, the underlingly aspirated stop is realized as deaspirated. Some morpheme-internal examples of sonorant devoicing are given in (25):

(25) /lampʰa/ [lampʰa ~ laÉpi] ‘lamp’
/mjoulkʰa/ [mjoulkʰa ~ mjou’ka] ‘milk’

Sonorant devoicing is also triggered by a number of morphological processes. One such process is the formation of the neuter of adjectives, as in (26):

(26) /ϕymᵗʰ/ [ϕymᵗʰ ~ ‘ϕu/Ét] ‘miserable-NEUT’
/kraintʰ/ [kraintʰ ~ krai/ʊ] ‘green-NEUT’
/sailᵗʰ/ [sailᵗʰ ~ ‘sai’t] ‘blessed-NEUT’

In the present approach, sonorant devoicing is reinterpreted as sonorant aspiration, and is formalized in terms of the leftward transfer of dependent |H| from the stop to the preceding sonorant. This is shown in (27), where I assume that the targeted sonorant occupies the coda position:

(27) C O
   L H ?
   ... ...

Those dialects that display sonorant aspiration also neutralize the aspiration contrast in unstressed syllables. In Botma (2001), it is argued that this is not a coincidence: given that in these dialects aspiration is restricted to stressed syllables, sonorant aspiration can be viewed as a strategy to preserve aspiration by transferring it to the stressed syllable’s coda position. According to this view, the fact that underlingly aspirated sonorants are restricted to the initial position of a stressed syllable is unsurprising, given that in this position languages tend to
display the maximum range of consonantal contrasts (see Harris 1997 and Beckman 1998 for discussion of this issue). Leftward transfer of [H] is not restricted to sonorant aspiration. First of all, those dialects that exhibit sonorant aspiration also devoice voiced dental fricatives preceding /kʰ/. In this case, too, the aspirated stop is itself deaspirated:

(28) maðkur /maðkʰyr/ [maðkyr] ‘worm-NOM-SG’

This suggests that dependent [H] has a variable phonetic realization, depending on the manner component of the segment to which it is associated. In stops, dependent [H] is realized as aspiration, whereas in fricatives and sonorants dependent [H] is realized as voicelessness. From the perspective of phonological contrast, this suggests that we are dealing with a single element, e.g. [H].

The emergence of preaspirated stops offers additional evidence for leftward transfer of [H]. The contexts in which preaspirated stops are found are the same in all dialects of Icelandic. Preaspirated stops occur in word-internal and word-final clusters which consist of an aspirated stop and a following non-continuant. The forms in (29a-c) show that such clusters trigger preaspiration morpheme-internally and in derivational and inflectional morphology. The forms in (29d) show that compounding does not trigger preaspiration:

(29) a. epli /epʰlt/ [epli] ‘apple’
    læknir /laikʰnr/ [laihknr] ‘physician’

b. tappi /tʰapʰpth/ [tʰahpɨ] ‘cork’
    nátt /nautʰth/ [nauht] ‘night’

c. feitt /feitʰ-th/ [feiht] ‘fat-NEUT-SG’
    meitti /maitʰ-þth/ [maiht] ‘meet-INF’

d. reknet /rekʰ-netθ/ [rekʰnetθ] ‘drift net’
    hluttaka /lytʰ-þaka/ [lytʰaka] ‘participation’

If the context in which preaspirated stops emerge is that of a postaspirated stop and a following non-continuant, the implication is that an underlying consonant cluster must be recognized in forms like tappi and nátt. This is the position taken in, among others, Thráinsson (1978), Hermans (1985) and Anderson & Ewen (1987), who refer to these clusters as “aspirated geminates”. This view is abstract to the extent that such geminates are never realized phonetically, at least not in morpheme-internal context. I will not be concerned with the status and representation of preaspirated stops here; see e.g. Thráinsson (1978), Hermans

23 I consider the status of word-initial aspirated sonorants in Icelandic in more detail in §5.4.2.

24 This leads Árnason (1986) to conclude that preaspiration is a lexical process.
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The facts considered so far show that there are a number of contexts in Icelandic in which dependent |H| is transferred from an onset stop to a preceding coda. The fact that this involves transfer rather than spreading suggests that a representation in which dependent |H| is shared by a coda and an onset is illicit; this is expressed by the representation in (30):

(30)  * C O
       ... H ... 

This restriction is corroborated by the fact that fricative-stop sequences in Icelandic are limited to clusters which consist of a voiceless fricative and a following plain stop, as is shown by the forms in (31):

(31)  hefti /heftʰɪ/  ['hefʰɪ]  ‘notebook’ (*[heftʰɪ])
aftur /aftʰʏr/  ['aftʰʏr]  ‘after’ (*[aftʰʏr])
skaða /skʰaða/  ['skʰaða]  ‘to harm’ (*[skʰaða])
flaska /flaskʰa/  ['flaskʰa]  ‘bottle’ (*[flaskʰa])
akta /aктʰa/  ['aктʰa]  ‘to respect’ (*[aктʰa])
október /oктʰouпер/  ['oктʰouпер]  ‘October’ (*[oктʰouпер])

Hence, the generalization is that, with the exception of a few northern dialects, only the first consonant of a cluster in Icelandic can be specified for dependent |H|, at least as far as the level of surface phonology is concerned.

It should be noted at this point that the prohibition on sharing of dependent |H| is corroborated by cross-linguistic evidence. For instance, in those Bantu languages in which clusters of a nasal and a following voiceless stop involve aspiration, such as in Swahili, Pokomo, Shambala, and Sukuma, aspiration is always realized on either the nasal or the stop part, and never on both (cf. Maddieson 1991; see also Huffman & Hinnebusch 1998); that is, realizations such as [Æ] appear to be unattested.25

Aside from sonorant aspiration of the kind found in Icelandic, there are languages in which sonorant aspiration is triggered by voiceless unaspirated stops. Examples of such languages include Bura and Aleut, as well as some Algonquian languages. With regard to Bura, a Chadic language of Nigeria, Maddieson (1983:290) observes that utterance-initial nasals share the voicing category of a following stop, as is illustrated by the forms in (32):

25 More generally, Huffman & Hinnebusch (1998:5) observe that they have found no convincing cases of double-linking of the feature [+spread glottis].
According to Maddieson’s description, Bura contrasts voiced and voiceless stops after nasals. Since the voiceless series is phonetically unaspirated, both in postnasal context and elsewhere, the problem is how to account for the realization of nasals preceding such stops.

One interpretation of the Bura facts would be to represent the voiceless stop series as having dependent \( |H| \), in spite of the fact that they are phonetically unaspirated. This approach predicts that voiceless unaspirated stops can have dependent \( |H| \) only if the language concerned lacks voiceless aspirated stops. In addition, if a language contrasts voiceless unaspirated and voiceless aspirated stops, the prediction is that sonorant aspiration can be triggered only by the aspirated series. In other words, aspiration of sonorants by unaspirated stops is possible only if the language lacks a series of aspirated stops. To the best of my knowledge, there are no languages in which these implications do not hold.

This interpretation can be extended to languages which have a distinctive series of aspirated nasals, but lack a corresponding series of aspirated stops. Aleut is one of the few languages of this type.\(^26\) There is in fact some support for a representation of the Aleut stop series in terms of dependent \( |H| \). Consider to this effect first the stop and nasal inventory of Aleut (cf. Bergsland 1997:17):\(^27\)

\[
\begin{array}{ccccc}
(33) & p & t & \tilde{s} & k & q \\
m & n & \eta & \\
m^h & n^b & \eta^b \\
\end{array}
\]

Bergsland (1997:17) observes that of the stop series, /t k/ are “unaspirated or weakly aspirated” while /\tilde{s} q/ are “strongly aspirated or affricated”. A plausible interpretation of this difference is that affrication (or aspiration) serves to enhance the place contrast between /t \tilde{s}/ and /k q/, a position which is in line with the approach to affrication taken in Kehrein (2002). Note, however, that the phonetic realization of the stops does not necessarily exclude an analysis in which they are viewed as phonologically aspirated. Indeed, the fact that nasals preceding stops are allophonically “devoiced” in Aleut (cf. Bergsland 1997:17), similar to what was observed in Bura, might be taken as support for this analysis.

---

\(^{26}\) According to Maddieson (1984), Hopi is another example of such a language, although I noted in §5.1 that this is probably incorrect. Note, however, that Tryon (1967, 1968) describes Nengone and Dehu, two New Caledonian languages, as having a series of voiceless nasals in the absence of a series of aspirated stops.

\(^{27}\) /p/ is found in (recent) Russian and English loans only.
A final, tentative, argument for |H|-specified stops in Aleut is historical in nature. As Fortescue et al. (1994) note, Proto-Eskimo-Aleut intervocalic *p has developed to /Æ/ in Aleut. Proto-Eskimo-Aleut is reconstructed as having a series of plain stops only. However, if it assumed that these stops, like those of present-day Aleut, have dependent |H|, this development can be represented as in (34) (PEA is short for Proto-Eskimo-Aleut):  

\[
\begin{array}{c|c}
\text{PEA} & \text{Aleut} \\
O & O \\
| & | \\
? H > & L H \\
| & | \\
U & ? \\
| & | \\
& U \\
\end{array}
\]

\[
*VpV > Vm^bV
\]

Interestingly, Aleut has accommodated voiceless labial obstruents (and, in some forms, voiced labial obstruents) in old loans from Russian as aspirated nasals, some of which vary with plain nasals in present-day Aleut:

\[
\begin{array}{ll}
\text{Russian} & \text{Aleut} \\
pila & \text{Eila}_\chi - \text{mila}_\chi & \text{‘file’} \\
lopatka & \text{luEa’ka}_\chi & \text{‘shovel’} \\
tabak & \text{taEa’ka}_\chi - \text{tama’ka}_\chi & \text{‘tobacco’}
\end{array}
\]

This accommodation process can be accounted for if it is assumed that the process in (34) had synchronic status at the time of the first Russian contact. However, this is not the only possible explanation. An alternative, perhaps more plausible, reason might be that /p/ was accommodated as /m^b/ simply because Aleut lacked native labial non-continuants, so that /m/ was the closest match.

The approach to Bura-type sonorant aspiration is not without problems. The main weakness lies in the fact that dependent |H| seems to lack a phonetic interpretation, which raises the question why a language would permit more complex structures than are necessary. This question touches on another, more specific question: whether there is a limit to the freedom of the interpretation of...

---

28 On this interpretation, the change can be interpreted as a rather special case of intervocalic lenition. According to this interpretation, lenition does not involve loss of complexity, but rather involves the addition of [L] to the manner component of the affected stop, similar to what was proposed for Fore lenition in §1.3.2.

29 Bergsland places the first Aleut-Russian contact at the beginning of 19th century. Fortescue et al. estimate that Proto-Eskimo-Aleut was spoken some 4,000 years ago.
elements. While this issue requires careful consideration, it should be observed that plain voiceless and voiceless aspirated stops both involve glottal spreading, so that in languages which have only one of these stop types, either can be plausibly specified in terms of dependent |H|. Note in this respect that the UPSID database contains 19 languages which are described as having a series of voiceless aspirated stops without a corresponding series of plain voiceless stops (cf. Maddieson 1984). Although it must be verified for each of these languages whether aspiration is phonologically relevant, this might be taken to suggest that languages do not always employ minimally complex representations.

A final comment is in order regarding sonorant aspiration. An important difference between Icelandic and Bura is that in Icelandic aspiration of sonorants serves a distinctive function, in the sense that it signals a lexical contrast (which is underlyingly associated to the stop following the sonorant). In Bura-type cases, on the other hand, nasal aspiration is allophonic. Hence, it may be suggested that the latter type of process does not have to be accounted for by the phonology. It is questionable, however, whether this view can be maintained for all Bura-type cases, especially in the face of diachronic developments. As we will see in §5.2.3, aspirated nasals are diachronically unstable, and are prone to lose their aspiration or their nasality in diachronic processes. An example of the latter kind is observed in the development from Proto-Algonquian to Cree and Menomini, where nasals preceding Proto-Algonquian voiceless obstruents have the reflex /h/ (cf. Bloomfield 1946:88-90):

$$\begin{array}{c|c|c}
\text{Proto-Algonquian} & \text{Cree, Menomini} \\
\hline
*\text{mp} & \text{hp} \\
*\text{nt} & \text{ht} \\
*\text{nk} (=\text{[n]k}) & \text{hk} \\
*\text{ntʃ} & \text{htʃ} \\
*\text{ns} & \text{hs} \\
*\text{nʃ} & \text{hʃ}
\end{array}$$

The voiceless obstruents of Proto-Algonquian are generally reconstructed as lenis or unaspirated (see Bloomfield 1946, Proulx 1984). This can be interpreted to mean that in the history of Algonquian a Bura-type process of nasal aspiration took place. The fact that the aspirated nasals subsequently developed into /h/ (which can be expressed in terms of the removal of the nasal manner structure; see also §5.2.3) suggests that, at some point in the development of Cree and Menomini, aspiration in nasals involved the association of dependent |H|; that is, the aspiration became phonologically relevant.31

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30 These are Breton, Farsi, Osmanli, Mongolian, Ewe, Akan, Gã, Luo, Somali, Adzera, Selepet, Klamath, Kwak’wala, Yana, Acoma, Tunica, Wapishana, Kota, and Kabardian.

31 In §6.2 we will see that nasal aspiration in Cree is still active in certain morphophonemic processes.
5.2.3 Diachronic evidence

In this section, I will argue that an examination of diachronic developments involving aspirated nasals provides further support for the representation of these nasals in terms of dependent |H|.

Consider first the historical origin of aspirated nasals. In many languages which have aspirated nasals, these nasals are the result of the merger of a plain voiced nasal and a preceding /s/. This is observed for instance in the development from Indo-European to Pre-Classical Greek and Old Irish, where we find *sm > /mʰ/ and *sn > /nʰ/ (see Ohala & Ohala 1993). In a similar vein, the causative prefix of Burmese, which I analyzed above as consisting of |H|, derives from Proto-Tibeto-Burman *s- (see e.g. Bradley 1979). This suggests that, at some point in the history of Burmese, we find the change *sN > /Nʰ/. In addition, one of the English children investigated in Smith (1973), i.e. Amahl, produces forms like Smith /smθ/ and sneeze /sniːz/ as [ʃIt] and [d]. Paula Fikkert (p.c.) notes that no such realizations have been reported for Dutch children. This suggests that a conditioning factor on the emergence of aspirated nasals is the presence of dependent |H| in the stop system of the language. Note that this ties in with the (near-) universal implication that the presence of aspirated sonorants in a language implies the presence of aspirated stops.

Taking the labial nasal as example, the development *sm>/mʰ/ can be represented as in (37) (where I assume that /s/ and /m/ form a complex onset):

\[
\begin{array}{c}
\text{O} \\
\text{H} \\
\text{I} \\
\text{U}
\end{array} \quad \rightarrow \quad \begin{array}{c}
\text{O} \\
\text{L} \\
\text{?} \\
\text{?}
\end{array} \quad \begin{array}{c}
\text{L} \\
\text{?} \\
\text{?}
\end{array} \quad \begin{array}{c}
\text{H} \\
\text{U}
\end{array}
\]

\[
*\text{sm} > \text{mʰ}
\]

This process effectively involves the removal of the place specification of /s/, i.e. |l|. I assume that the deletion of |l| induces a head-dependency switch. This is motivated by the idea that the dependent manner component can be specified for place only in case the head manner component is specified for place (see §2.6).

Another source of aspirated nasals is a historical sequence of an aspirated stop and a following nasal consonant. An illustration of nasal aspiration in this context can be observed in the development that led to the loss of initial /k/ in English <kn> clusters, as in knack and knife. That the loss of /k/ involved a gradual process is evidenced by 18th-century written records, which contain examples of orthographic <hn>. Dobson (1984:976) accounts for this sound change in the following way:
To facilitate transition to the [n] … the stop was imperfectly made, so that [k] became the fricative [χ], which in turn passed into [h]; the resulting group [hn] then, by assimilation, became voiceless [Ø], which was finally re-voiced under the influence of the following vowel.

This scenario is rather implausible. For one thing, spirantization of /k/ under the influence of a nasal is unexpected, since nasals are normally viewed as non-continuant. It is also unclear what evidence can be adduced for the development /hn/ > /Ø/. Given the occasional occurrence of <hn>, it seems that all that can be said with certainty is that at some point, at least some speakers realized <hn> as a nasal which involved a period of voicelessness or aspiration. Finally, it is doubtful that the subsequent change /Ø/ > /n/ involved assimilation to a following vowel, since the laryngeal specification of vowels does not generally interact with that of consonants. Observe, too, that Dobson’s interpretation presupposes that the nasal is phonologically voiceless, which in my view is incorrect.

As an alternative, I suggest that <kn> clusters, at the time when the <k> was still realized, were underlingly aspirated. On the assumption that <kn> formed a complex onset, this aspiration was a property of the cluster as a whole. According to this interpretation, the first step of the sound change involved the loss of /k/, presumably because English no longer tolerated tautosyllabic stop-nasal clusters. The result of this development was a phonologically aspirated nasal. The second step in the sound change involved nasal deaspiration. This process can be expressed in terms of the deletion of dependent [H], resulting in a less marked segment type. The two stages of the English sound change are represented in (38):

\[
(38) \quad \ \begin{array}{c|c|c|c}
O' & O & O \\
\hline
O & H & L \\
\hline
? & L & ? \\
\hline
A & ? & I \\
\hline
\end{array}
\]

\[\text{(kn)}^b > n^b > n\]

The aspirated consonant cluster in (38) involves branching at two levels. The lower level, represented as O, groups together the manner components of the

---

32 This can be attributed to the relatively small difference in sonority between stops and nasals.
consonants. The higher level, represented as $O'$, links dependent $[H]$ to the cluster. This is in line with the assumption that laryngeal modifications have as their scope entire onset constituents (see §1.2.2).

The second step in the English sound change, i.e. deaspiration of the nasal, is cross-linguistically quite common. This is unsurprising, since aspirated nasals are perceptually non-salient speech sounds. We will see a number of other examples of this type of process below, where I consider in some detail the origin and development of aspirated nasals in the Kadai language family.

### 5.2.3.1 Kadai

Kadai is a language family of South-East Asia, with Thai as its best-known member. The genetic relationship among Tai and a number of other Kadai languages is given in (39), after Edmondson & Solnit (1997:2); the internal division of Thai follows Li (1977):34

![Diagram of Kadai language family]

The internal relationships between the various Tai languages have been the subject of extensive study (see e.g. Li 1977, Brown 1965, Edmondson & Solnit 1997). Internal relationships between the Kam-Sui languages are described in Li (1948, 1965). Other relationships shown in (39) are more tentative, for instance the grouping of Kam-Sui and Thai to the exclusion of Hlai, and the lumping

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33 A complementary articulatory explanation of the markedness of aspirated nasals is that such sounds involve a high rate of airflow which, when combined with velic lowering, requires considerable articulatory effort.

34 Below, “Tai” refers to the language family of which Thai is a member, while “Thai” refers to the principal language of Thailand and its dialects. Whether a language is Tai or Thai is therefore essentially a matter of geography.
together of the as yet relatively unknown languages Geyang, Gelao, and Lachi (see Edmondson & Solnit 1997).

Of interest here are the origin and development of the laryngeally modified nasals of Kadai. Consider the following cognates (cf. Solnit 1988:232-4) (below, SW Thai is shorthand for southwestern dialects of Thai):

(40)  

<table>
<thead>
<tr>
<th>Language</th>
<th>Sui</th>
<th>Kam</th>
<th>Lakkia</th>
<th>SW Thai</th>
</tr>
</thead>
<tbody>
<tr>
<td>m(\text{b}a)</td>
<td>(\text{m}w)</td>
<td>k(\text{b}ow)</td>
<td>m(\text{a})</td>
<td>‘dog’</td>
</tr>
<tr>
<td>m(\text{b}u)</td>
<td>(\text{nu})</td>
<td>k(\text{b}u)</td>
<td>m(\text{u})</td>
<td>‘pig’</td>
</tr>
<tr>
<td>m(\text{i})</td>
<td>(\text{me})</td>
<td>k(\text{u})</td>
<td>m(\text{i})</td>
<td>‘bear’</td>
</tr>
<tr>
<td>n(\text{b}o)</td>
<td>n(\text{o})</td>
<td>k(\text{iu})</td>
<td>n(\text{u})</td>
<td>‘rat’</td>
</tr>
</tbody>
</table>

In (40) the odd-numbered tones belong to the high tone series, which suggests that there is a relation between aspiration and high tone (see §5.2.4). Note further that the aspirated nasals of Sui correspond to plain nasals in Kam and in southwestern dialects of Thai. Note also that Lakkia is the only language which lacks initial nasals; here the nasals in other Kadai languages correspond with an initial velar stop which, in most forms, is followed by a nasalized vowel. Importantly, some Kam cognates also reflect an initial velar in the form of /\(\text{n}\)/. As was argued in §3.1, the nasalized vowels in Lakkia are the result of nasal lenition; note in this respect the presence of a rounded vowel or glide as the reflex of historical *\(\text{n}\).”.

The correspondences in (40) suggest that Proto-Kadai had two initial velar stops, *k and *\(\text{k}\), which were retained in Lakkia and which, in some cases at least, were nasalized to /\(\text{n}\)/ in Kam under the influence of a root-initial nasal. In Sui and southwestern dialects of Thai, all segmental traces of these velars are lost, but their imprint has been left as a laryngeal modification of the root-initial nasal. The relevant developments can be summarized as follows (see also Solnit 1988:233):

(41)  

<table>
<thead>
<tr>
<th>Proto-Kadai</th>
<th>Sui, SW Thai</th>
</tr>
</thead>
<tbody>
<tr>
<td>*(\text{k})-(\text{m})(\text{V})</td>
<td>m(\text{i})(\text{V})</td>
</tr>
<tr>
<td>*(\text{k})-(\text{b})-(\text{m})(\text{V})</td>
<td>m(\text{b})(\text{i})(\text{V})</td>
</tr>
</tbody>
</table>

This suggests that Proto-Kam-Sui/Tai had a three-way contrast in its nasal series. This contrast has been partially neutralized in most dialects of Kam-Sui, and completely in modern dialects of Thai.

As regards the origin of the aspirated nasals, I propose that the fusion of the aspirated stop and the following nasal in Proto-Kam-Sui/Thai triggered the deletion of the stop manner structure, yielding an aspirated nasal. This process is

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35 Like Solnit, I assume that Lakkia forms without nasalized vowels have undergone a subsequent process of denasalization.
essentially equivalent to the development observed in the history of English, and can be represented as in (42):

\[
\begin{array}{c}
O' \\
- \\
O \\
(?) \\
(A) \\
U
\end{array}
\]

\[(42)\]

\[*{(km)^h > m^h}\]

The development of glottalized nasals is similar, and will be dealt with in §5.3.2.

The aspirated nasals of Proto-Kam-Sui/Thai have been retained in a limited number of Sui dialects only. According to the classification of Li (1965), Kam-Sui includes Kam, Sui, Then, and Mak, with Sui being further divided into Li-Ngam, Jungchiang, and Pyo. Li-Ngam and Pyo exhibit a three-way contrast between aspirated, glottalized, and plain nasals. In other Kam-Sui languages, as well as in all dialects of Thai, these contrasts have been lost (though the original contrasts left different tonal imprints on the vowels following the nasals). The various correspondences of initial nasals in Kam-Sui are summarized in (43):

\[
\begin{array}{cccccccc}
\text{Li-Ngam} & \text{Jungchiang} & \text{Pyo} & \text{Mak} & \text{Then} & \text{Kam} \\
\hline
\text{Plain nasals} \\
\text{m} & \text{m} & \text{m} & \text{m} & \text{m} & \text{m} \\
\text{n} & \text{n} & \text{n} & \text{n} & \text{n} & \text{n} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{Glottalized nasals} \\
\text{m'} & \text{m} & \text{m} & \text{m} & \text{m} & \text{m} \\
\text{n'} & \text{n} & \text{n} & \text{n} & \text{n} & \text{n} \\
\text{ŋ'} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{ŋ'} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{Aspirated nasals} \\
\text{m} & \text{m} & \text{m} & \text{m} & \text{m} & \text{m} \\
\text{n} & \text{n} & \text{n} & \text{n} & \text{n} & \text{n} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\end{array}
\]

All cases which involve neutralization of a laryngeally modified series of nasals can be expressed in terms of the loss of the dependent manner component. Note
in (43) the phonetic variation in the correspondences of what is reconstructed as an aspirated velar nasal in Proto-Kam-Sui. This suggests that, relative to other types of aspirated nasals, the aspirated velar nasal is diachronically unstable. I will consider some other examples of this instability directly below, and in §§6.1 and 7.1.1.

Turning now to Thai, it was observed in §5.2.2 that Proto-Thai is generally reconstructed as having a series of aspirated nasals in addition to a plain series (see e.g. Brown 1965, Li 1977). The aspirated nasal series has been lost in all modern Thai dialects. Aside from comparative data, evidence for an aspirated nasal series in Proto-Thai is threefold. First, aspirated nasals in Thai have left a different tonal imprint on vowels than plain nasals (see also §5.2.2). Second, the aspirated nasals of Thai have been retained in early loans in a number of neighbouring non-Tai languages, such as Khmu, Palaung, and Mal (see e.g. Svantesson 1983, Filbeck 1978). Third, aspirated nasals are still differentiated from plain nasals in the Thai writing system.

Disregarding tone, the development from Proto-Thai to the various present-day Thai dialects involved the following mergers (in (44) PT is short for Proto-Thai and MT is short for Modern Thai):

\[
\begin{array}{ccc}
\text{PT} & \text{MT} & \text{PT} \\
^*m & m & ^*\eta \\
^*m^h & m & ^*\eta^h \\
^*n & n & ^*\eta \\
^*n^h & n & ^*\eta^h \\
\end{array}
\]

In most present-day Thai dialects, \(^*\eta\) has merged with \(^*j\), although \(^*\eta\) is retained in some dialects such as Black Thai, Nung, and the now extinct Ahom (cf. Li 1977). It is plausible that this merger occurred after the merger of \(^*\eta^h\) and \(^*\eta\). Nasal deaspiration receives a straightforward interpretation in terms of deletion of the dependent manner structure, as is shown in (45):

\[
\begin{array}{ccc}
\text{O} \\
\text{L} & \text{H} \\
\text{?} \\
^*N^h > N
\end{array}
\]

As was observed with respect to English above, this change yields a less marked structure.
Another, less typical type of nasal deaspiration has affected the aspirated velar nasal, which in some Thai dialects has developed into /h/. This change also yields a less marked structure, but this is achieved through deletion of the head rather than of the dependent:

\[
\begin{array}{c}
\text{Proto-Mal} \\
\begin{array}{c}
\star \eta^h \\
\star m^h
\end{array}
\end{array}
\begin{array}{ccc}
A & B & C \\
\star \eta^h \text{ (series 1)} & > & h & \eta & \eta \\
\star \eta^h \text{ (series 2)} & > & \eta^h & \eta & \eta \\
\star m^h \text{ (series 1)} & > & m^h & m^h & h \\
\star m^h \text{ (series 2)} & > & m^h & m & m \\
\end{array}
\]

Brown (1965) observes that in some southern dialects of Thai, both \(\star \eta^h\)- and \(\star \eta^h\)- have developed into /h/. In addition, some dialects have a nasalized reflex /H/; I will discuss the latter development in more detail in §6.1.1.

A similar scenario is found in Mal, a Mon-Khmer language that is spoken in northern Thailand. Filbeck (1978) reconstructs Proto-Mal as containing the aspirated nasals \(\star m^h, \star \eta^h, \star \eta^h, \star \eta^h\). Synchronic variation between three Mal dialects leads Filbeck to suggest that for each of these nasals, two separate proto-series must be distinguished. In Mal, as in Thai, changes affecting \(\star \eta^h\) differ from those affecting other aspirated nasals. Compare for instance the development of \(\star \eta^h\) and \(\star m^h\) (in (47) A, B, and C refer to the Mal dialects examined by Filbeck):

The Thai and Mal developments suggest that nasality in aspirated velar nasals appears to be less stable than that in other aspirated nasals. This is confirmed by typological evidence; as we will see in §7.1.1, inspection of UPSID reveals that of /m n /\(\eta^h/\), /\(\eta^h/\) is least suitable to be combined with a laryngeal modification. In addition, we will see that if a language has a gap in a series of laryngeally modified nasals, this gap is at the velar place of articulation.

One avenue of approach to account for this asymmetry would be to posit a cooccurrence restriction between velar place and aspiration. Given that we are dealing here with a strong cross-linguistic tendency, we can view this restriction in terms of a rankable markedness constraint, in the spirit of Optimality Theory.
An alternative approach would be to view velar nasals as being underlyingly unspecified for place, as in (48):

(48) a. O | b. O  
       |   |    
       L | L | H  
       ? | ?   

The relative markedness of /η/ can then be interpreted to mean that it is marked for a placeless structure to have a laryngeal modification. This would also account for the fact that distinctively nasalized laryngeals are cross-linguistically infrequent (see also §6.1). An advantage of the latter approach is that it brings the Thai and Mal facts in line with other correspondences between nasals and /h/. Consider once more the Algonquian languages Menomini and Cree, where the nasals of Proto-Algonquian nasal-consonant clusters have developed into /h/. The relevant developments are repeated in (49) (see also §5.2.2):

(49)  

This development becomes more natural if these nasals, like preconsonantal nasals in many other languages, are underlyingly placeless. On this assumption, the change from a nasal to /h/ would involve an intermediate stage in which the nasals underwent “devoicing” under the influence of the following obstruent. This would imply that the triggering consonants have dependent [H], as was already suggested in §5.2.2.

---

36 The same point can be raised with respect to glottalized velar nasals; typological evidence suggests that these are more marked than their labial and coronal congeners (see §7.1.1).
5.2.3.2 Bisoid

The representation of laryngeally modified nasals in terms of dependent [ʔ] and [H] implies that such nasals are not nasalized (or “phonologically active”), the latter being characterized by the presence of dependent [L]. This means that cases where aspirated nasals are apparently involved in nasalization processes are problematic for the current proposal.

In fact, nasalization processes that are triggered by laryngeally modified nasals appear to be rare. A potential example of such a process can be observed in the development from Proto-Loloish (the proto-language of the Loloish family of Tibeto-Burman) to Proto-Bisoid (the proto-language of the Bisoid subfamily which includes Phunoi and Bisu). However, we will see that an interpretation of the facts in terms of Element-based Dependency accounts for the nasalization process in a straightforward fashion.

Proto-Tibeto-Burman is generally analyzed as containing only a voiced series of nasals (see e.g. Bradley 1979). However, the fusion of certain prefixes with root-initial nasals produced glottalized and aspirated nasals in Proto-Burmese-Loloish and Proto-Loloish. The relevant prefixes are reconstructed by Bradley as *g115- and *g47-, which, when added to a nasal-initial stem, yielded *g115g109 and *g47g109 in Proto-Loloish. The table in (50) shows the subsequent development of these clusters in a number of Loloish languages (cf. Bradley 1979:144); the forms in (50) are based on Bradley’s transcription; observe that bilabial place represents all places of articulation:

\[
\begin{array}{lllll}
\text{Proto-Loloish} & *m & *C-m & *s-m & *ʔ-m \\
\text{Burmese} & m & m & hm & m \\
\text{Phunoi, Bisu} & m & b & hm & hm \\
\text{Yi} & m & m & Æ & Æ \\
\text{Lisu, Akha, Lahu, Mpi} & m & m & m & m \\
\end{array}
\]

Note that Bradley distinguishes between /hm/ and /Æ/. This presumably reflects a difference in the phonetic realization of these nasals. Given that these nasals never contrast with each other, it is reasonable to assume that they consist of a nasal manner component and dependent element [H] (see §5.2.1).

In (50) we see that the Proto-Loloish three-way contrast in the prefix series (which according to Bradley is needed to account for certain pitch reflexes) has developed into a maximally binary contrast in nasals in modern Loloish, as is illustrated by Phunoi, Bisu, and Yi. In other Loloish languages, such as Lisu, Akha, Lahu, and Mpi, the original contrasts have been lost and only a single voiced nasal series remains.\(^{37}\) Burmese, which is a Tibeto-Burman but not a

\(^{37}\) Bradley (1979) points out that the two prefixes have left different tonal effects.
Loloish language, is included in (50) to show that the distinction between *sm and *ʔm as reconstructed for Proto-Burmese-Loloish has a synchronic reflex.38

In the remainder of this section, I examine the diachronic development of nasality in Phunoi and Bisu in more detail. Both languages are classified by Bradley (1979) as Bisoid (see also Bradley 1985a). Whereas Bisu has generally retained Proto-Loloish *-g, *-ŋ, *-ʔ, in Phunoi *-ŋ has merged with a preceding vowel to produce a nasalized vowel. It is the development of Proto-Bisoid *-ŋ that yields some important insights into the status of laryngeally modified nasals. Consider as an illustration the cognates in (51), extracted from Bradley (1979:294-389) (each of the forms in (51) is accompanied by the reference number to the wordlist in Bradley 1979; here and below, PL is short for Proto-Loloish and PB is short for Proto-Bisoid):

| PL   | PB   | Phunoi | Bisu
|------|------|--------|------
| a. 17 | 17   | mi     | meŋ   | m> |
|      | 321  | mo     | mʊŋ/bʊŋ | mʊ thə |
| b. 84 | 84   | s-mo   | hmʊŋ  | hnmʊŋ  |
|      | 152  | s-nap  | hnàp   | hnnàw |
|      | 113  | s-ŋo   | là hnpû | là hnpû |
| c. 257 | 257 | ?-mi(a) | hmja   | hmja |
|      | 85   | ?-nwe  | hmʊ(t) | ñ̕ə hmʊt |
|      | 323  | ?-mre  | hmʊŋ(t) tsha | hmʊŋ tsha |
|      | 461  | (?)-ne | hnnʊŋ | hnnʊŋ |
|      | 526  | ?-nak  | hna  | ñ̕ə hno |

Note first of all that Proto-Loloish rhymes consisting of a nasal and a following vowel have the reflex /-Vŋ/ in Bisu and /-ʔ/ in Phunoi, as is shown in (51a).39 The forms in (51b,c) show that we find the same scenario in case such rhymes are preceded by *-m, *-n, *-ŋ, in Phunoi *-ŋ has merged with a preceding vowel to produce a nasalized vowel. It is the development of Proto-Bisoid *-ŋ that yields some important insights into the status of laryngeally modified nasals. Consider as an illustration the cognates in (51), extracted from Bradley (1979:294-389) (each of the forms in (51) is accompanied by the reference number to the wordlist in Bradley 1979; here and below, PL is short for Proto-Loloish and PB is short for Proto-Bisoid):

38 In Maru, a Burmese (but not a Loloish) language, *sm and *ʔm have developed into laryngealized nasals with creaky voice in the following vowel (see also §5.3.2).

39 In (51a) some Bisoid forms are preceded by /ʔ/ ~ /ʔ/ŋ-. This concerns a prefix which derives from Proto-Tibeto-Burman *ʔa-. The semantic contribution of this prefix is unclear (see Matisoff 1975). Note that this prefix shows the same variation in terms of nasalization as nasal-initial stems, which suggests that initial /ʔ-, like initial nasals, has triggered vowel nasalization. I consider this type of nasalization in §6.1.1.
In order to account for the variation between Bisu and Phunoi in forms of the kind in (51a), Bradley reconstructs *-Vɲ for Proto-Bisor. Implicit in this reconstruction is that the subsequent development *Vɲ > ə is specific to Phunoi, and that the development of Proto-Loloish to Proto-Bisor involved the excrescence of final -ɲ.40

One might wonder at this point whether this is indeed the order in which these two processes occurred. Given (51a-c), it is also conceivable that *-Vɲ > ə applied prior to excrescence of /-ɲ/. According to this interpretation, Proto-Loloish *-Vɲ would have the Proto-Bisor reflex *-ə; these nasalized vowels would then be retained in Phunoi, and develop into /-Vɲ/ sequences in Bisu.

While Bradley does not discuss the order of excrescence of /-ɲ/ and vowel nasalization, his reconstructions support Proto-Bisor *-Vɲ rather than *-ə. The evidence for Proto-Bisor *-Vɲ comes from the development of Bisor rhymes consisting of a vowel and a following nasal. Bradley notes that in Proto-Loloish such rhymes had lost both the vowel length and the mid-vowel contrasts which are generally reconstructed for Proto-Tibeto-Burman. The range of Proto-Loloish vowel-nasal rhymes is essentially reduced to the peripheral vowel system plus *-m, *-n, *-ɲ. These rhymes have the following reflexes in Phunoi and Bisu (cf. Bradley 1979:188):

\[
\begin{array}{ccc}
\text{PL} & \text{Phunoi} & \text{Bisu} \\
a. & *-im & -um & -um \\
 & *-um & -um & -um \\
 & *-am & -am & -am \\
b. & *-in & -in & -en \\
 & *-in & -an & -en \\
 & *-in & -ən & -en \\
c. & *-iɲ & -iɲ & -iɲ \\
 & *-oɲ & -ə & -əɲ \\
 & *-aɲ & -a & -aɲ
\end{array}
\]

For present purposes, the crucial development is *-iɲ > -iɲ, as found in Phunoi. This change can be interpreted as fronting of the nasal under the influence of /i/, and can be expressed as in (53):

40 Paradis & Prunet (2000), who focus on the accommodation of loans with nasalized vowels in languages that lack underlyingly nasalized vowels, refer to this phenomenon as “nasal unpacking.” We will see in §7.2.1 that [ɲ] is the unmarked consonantal spell-out of nasalization in syllable-final position.
Bradley’s wordlist contains four forms which exhibit this process, given in (54a) below. The forms in (54b) and (54c) show irregular developments: (54b) involves nasalization and centralization of the vowel. Form 419 in (54c) shows velar fronting to /ŋ/ rather than /ŋ/; form 461 is perhaps another example of this type of change.

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The forms in (54a) demonstrate that the development from Proto-Loloish to Phunoi did not involve a single-step process of vowel nasalization with concomitant loss of final /ŋ/. If it did, the occurrence of final /ŋ/ in Phunoi would be left unexplained. We may therefore conclude that Proto-Bisoid had final /Vŋ/ clusters. These clusters were retained in Bisu, but were lost in Phunoi as the result of a subsequent process of vowel nasalization. Bisu has undergone a different change, which at the time of Bradley’s fieldwork was still in progress. This involves the replacement of initial nasals by voiced stops, thus obliterating the original source of final /ŋ/. Some examples are given in (55).

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<table>
<thead>
<tr>
<th>(53)</th>
<th>PL</th>
<th>Phunoi</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>C</td>
<td>N</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>&gt;</td>
</tr>
<tr>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>A</td>
<td>I</td>
</tr>
</tbody>
</table>

*in > ñ

Bradley’s wordlist contains four forms which exhibit this process, given in (54a) below. The forms in (54b) and (54c) show irregular developments: (54b) involves nasalization and centralization of the vowel. Form 419 in (54c) shows velar fronting to /ŋ/ rather than /ŋ/; form 461 is perhaps another example of this type of change.

<table>
<thead>
<tr>
<th>(54)</th>
<th>PB</th>
<th>Phunoi</th>
<th>Bisu</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 104</td>
<td>liŋ</td>
<td>?â liŋ</td>
<td>...</td>
</tr>
<tr>
<td>115</td>
<td>sîŋ</td>
<td>la shîŋ</td>
<td>pa stuŋ</td>
</tr>
<tr>
<td>167</td>
<td>sîŋ</td>
<td>khô sîŋ</td>
<td>(jokha)</td>
</tr>
<tr>
<td>547</td>
<td>m-bîŋ</td>
<td>?â pîŋ</td>
<td>plûŋ</td>
</tr>
<tr>
<td>b. 89-2</td>
<td>kriŋ</td>
<td>kh@</td>
<td>khuŋ</td>
</tr>
<tr>
<td>c. 419</td>
<td>?-m(j)iŋ</td>
<td>?â hmin</td>
<td>?âŋ hmeŋ</td>
</tr>
<tr>
<td>461</td>
<td>hnu(ŋ)</td>
<td>hini</td>
<td>hnu(ŋ)</td>
</tr>
</tbody>
</table>

The forms in (54a) demonstrate that the development from Proto-Loloish to Phunoi did not involve a single-step process of vowel nasalization with concomitant loss of final /ŋ/. If it did, the occurrence of final /ŋ/ in Phunoi would be left unexplained. We may therefore conclude that Proto-Bisoid had final /Vŋ/ clusters. These clusters were retained in Bisu, but were lost in Phunoi as the result of a subsequent process of vowel nasalization. Bisu has undergone a different change, which at the time of Bradley’s fieldwork was still in progress. This involves the replacement of initial nasals by voiced stops, thus obliterating the original source of final /ŋ/. Some examples are given in (55).

<table>
<thead>
<tr>
<th>(55)</th>
<th>PL</th>
<th>PB</th>
<th>Phunoi</th>
<th>Bisu</th>
</tr>
</thead>
<tbody>
<tr>
<td>329</td>
<td>(C)-mi</td>
<td>bi/mi (tô)</td>
<td>bi</td>
<td>bi tô</td>
</tr>
<tr>
<td>598b</td>
<td>(C)-ni</td>
<td>d=(ŋ)=n-n</td>
<td>ni</td>
<td>d=ŋ</td>
</tr>
<tr>
<td>675</td>
<td>m-(b)u</td>
<td>b’ ŋ</td>
<td>...</td>
<td>b’ ŋ</td>
</tr>
<tr>
<td>767</td>
<td>(C)-no</td>
<td>dúŋ/ñuŋ</td>
<td>nânâ</td>
<td>dúŋ</td>
</tr>
</tbody>
</table>
The forms in (55) show the typical development of Proto-Loloish nasals preceded by a consonantal prefix other than *s- or *ʔ-. In such forms the typical initial reflex in Bisoid is a homorganic voiced stop. Thus, the development of nasalized vowels and excrescent /ŋ/ in Bisoid can be represented as in (56):

\[(56) \quad \begin{array}{cccc}
\text{PL} & \text{PB}_1 & \text{PB}_2 & \text{Phunoi} \\
*\text{NV} & *\text{N} & *\text{NV}\tilde{\eta} & \\
\text{Bisu} & \text{NV}\tilde{\eta} & \text{~ ©V}\tilde{\eta} & \\
\end{array} \]

Proto-Bisoid is of course a hypothetical stage. All that can be said for certain is that no nasal vowels were tolerated in Proto-Bisoid. Instead, the nasalizing effect exerted by initial nasals was phonologized by nasal excrescence in the form of /ŋ/. It was only at a later stage that Phunoi developed nasalized vowels through incorporation of this /ŋ/ (but not /m/ and /n/) into the preceding vowel.

With this background, I now return to the contexts in which Proto-Bisoid developed laryngeally modified nasals. Consider once more the forms in (51), repeated in (57):

\[(57) \quad \begin{array}{cccccccc}
\text{PL} & \text{PB} & \text{Phunoi} & \text{Bisu} \\
\text{a.} & 17 & \text{mi} & \text{mεŋ} & \text{mØ} & \text{'cat'} \\
& & 321 & \text{mo} & \text{mǔŋ/bǔŋ} & \text{mØ thä} & \text{mǔŋ} & \text{'sky'} \\
\text{b.} & 84 & \text{s-mo} & \text{hmǔŋ} & \text{hmû} & \text{hmǔŋ} & \text{'mushroom'} \\
& & 152 & \text{s-nap} & \text{hnâp} & \text{hnâw} & \text{'mucus'} \\
& & 113 & \text{s-no} & \text{lá hńûŋ} & \text{lä hńû} & \text{lä hńûŋ} & \text{'finger'} \\
\text{c.} & 257 & \text{ʔ-mi(a)} & \text{hmjá} & \text{hmjá} & \text{hmjá} & \text{'knife'} \\
& & 85 & \text{ʔ-mwe} & \text{hmū(t)} & \text{ʔā hmot} & \text{ʔäm hmûw} & \text{'feathers, fur'} \\
& & 323 & \text{ʔ-mre tsa} & \text{hmû(ŋ) tsha} & \text{hmítâ} & \text{hńûŋ tsha} & \text{'earth'} \\
& & 461 & \text{ʔ-ne} & \text{hmû(ŋ)} & \text{hini} & \text{hńûŋ(ŋ)} & \text{'day'} \\
& & 526 & \text{ʔ-nak} & \text{hna} & \text{ʔā hno} & \text{ʔäm hna} & \text{'deep'} \\
\end{array} \]

Observe in (57) that excrescent /ŋ/ occurs after both plain and aspirated nasals, but not after glottalized nasals. As in Burmese, the aspirated nasals of Proto-Bisoid result from the merger of an initial nasal with the prefix *s.-

Based on Bradley’s reconstructions it is impossible to make out whether nasalization was triggered by plain nasals only, and thus preceded a subsequent merger with *s-, or whether this merger occurred first, with subsequent nasalization being triggered by both plain and aspirated nasals. What I would like to suggest is that nasal aspiration and vowel nasalization are in fact part of a

---

41 This prefix derives from Proto-Tibeto-Burman *s- which, as was observed in §5.2.2, was also responsible for the creation of aspirated nasals in Burmese.
single, complex change. Following the loss of |l|, merger of |H| with the nasal manner component dislodged the dependent |L| of the nasal; this |L| underwent rightward transfer, thereby nasalizing the following vowel:

\[(58)\]

\[
\begin{array}{cccc}
| & | & | & | \\
H & L & L & L \\
I & ? & place & <l> & ? & place \\
| & place & place \\
\end{array}
\]

According to this account, aspiration of the nasal induces vowel nasalization. We may think of this nasalization as being compensatory, in the sense that the loss of the nasal’s perceptual salience is compensated for by nasalization of the following vowel.

Note finally that glottalization did not trigger nasalization. I suggest that this is due to one of the following reasons: either */?- only affected root-initial nasals when vowel nasalization was no longer active, or the merger of */?- with a nasal produced glottalized nasals, which later merged with aspirated nasals. I leave this issue for further research.

### 5.2.4 Interaction with tone

Following Kaye et al. (1985), I have so far proceeded on the assumption that aspiration is represented in terms of the “high tone element” |H|. This choice of terminology raises the question whether there is phonological support for a relation between high tone and aspiration. Lack of space precludes a detailed discussion of this complex issue. The facts considered in this section indicate that while there is some support for representing both in terms of |H|, the relation between high tone and aspiration is at best indirect.42

One type of support for a phonological relation between high tone and aspiration comes from segment phonotactics. In many languages with aspirated sonorants, these sonorants are predictably followed by a high tone. Two such languages are Lakkia, a Kadai language, and Mien-Yao, a Miao-Yao language, both spoken in southern China. In both languages, vowels following aspirated sonorants are limited to a tone from the high tone series, while vowels following plain sonorants are limited to a tone from the low tone series (the data in (59) are

---

42 There is also support for a relation between low tone and voicing. This is observed, for instance, in a number of Bantu languages in which voiced stops act as “tone depressors”; see Bradshaw (1999) for discussion of this issue.
taken from L-Thongkum 1997:210-11; the high and low tone series are marked by odd and even numbers respectively):

(59) Lakkia                   Mien-Yao

<table>
<thead>
<tr>
<th>high series</th>
<th>low series</th>
<th>high series</th>
<th>low series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø</td>
<td>/g97/g78</td>
<td>1</td>
<td>'outside'</td>
</tr>
<tr>
<td>/g110/g105/g78</td>
<td>4</td>
<td>'sit'</td>
<td></td>
</tr>
<tr>
<td>/g105/g171/g110</td>
<td>1</td>
<td>'face'</td>
<td></td>
</tr>
<tr>
<td>/g109/g117/g78</td>
<td>4</td>
<td>'housefly'</td>
<td></td>
</tr>
<tr>
<td>/g97</td>
<td>3</td>
<td>'after'</td>
<td></td>
</tr>
<tr>
<td>/g108/g105/g78</td>
<td>2</td>
<td>'monkey'</td>
<td></td>
</tr>
<tr>
<td>/g109/g97/g110</td>
<td>1</td>
<td>'bow'</td>
<td></td>
</tr>
<tr>
<td>/g97</td>
<td>3</td>
<td>'man'</td>
<td></td>
</tr>
<tr>
<td>/g110/g79/g109</td>
<td>2</td>
<td>'leaf'</td>
<td></td>
</tr>
<tr>
<td>/g97/g201/g105</td>
<td>5</td>
<td>'quick'</td>
<td></td>
</tr>
<tr>
<td>/g119/g97/g110</td>
<td>2</td>
<td>'day'</td>
<td></td>
</tr>
<tr>
<td>/g108/g79</td>
<td>6</td>
<td>'big'</td>
<td></td>
</tr>
<tr>
<td>/g108/g79</td>
<td>6</td>
<td>'look for'</td>
<td></td>
</tr>
<tr>
<td>/g110/g79</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/g108/g119/g101/g105</td>
<td>6</td>
<td>'look for'</td>
<td></td>
</tr>
</tbody>
</table>

In addition, L-Thongkum maintains that in languages with a two-tone system, vowels following aspirated sonorants always have a high tone. Examples of such languages are Kawa and Samtao (cf. L-Thongkum 1997:210):

(60) Kawa       Samtao

a. hmòŋ  ñÈhòŋ  ‘hear’
   hnam  ñhám  ‘blood’
   hl¹?  ñh²?  ‘leaf’

b. m)²?  mà?  ‘mother’
   æ²k  ñ²k  ‘neck’
   ñ³ŋ  lùŋ  ‘black’

On the basis of the facts encountered so far, it is tempting to interpret the high tones as allophonic, and to analyze them as the result of spreading of \( |H| \) from the preceding aspirated sonorant. This scenario is illustrated in (61):

(61) O   N
    |
    | L   H   L
    |
    ?

\[ /N³⁵V/ \rightarrow [ N³⁴ ] \]

Note that subsequent delinking of \( |H| \) from the sonorant would result in the creation of a tone contrast on the vowel. This scenario might be argued to form part of the complex of tone splitting; I will discuss this phenomenon shortly. While the spreading account suggested here seems feasible for languages with two-tone systems, it cannot be extended to languages that have more complex tone systems. As we will see, there are a number of reasons for this.
First of all, there are languages such as Mazateco in which high tone and aspiration are both distinctive in vowels. For instance, Jalapa Mazatec exhibits contrasts of the kind in (62) (cf. Ladefoged & Maddieson 1996:317):

\[
\begin{align*}
\text{high tone} & \quad \text{já} & \text{‘tree’} \\
\text{aspiration} & \quad \text{jÂ} & \text{‘he wears’} \\
\text{high tone + aspiration} & \quad \text{nd’} & \text{‘horse’}
\end{align*}
\]

This indicates that high tone and aspiration cannot be universally reduced to a single element, at least not within the same structural position.

Second, the effect of aspirated segments on the $F_0$ of a following vowel is cross-linguistically variable. Kingston & Solnit (1988) argue that this holds not only for aspirated stops, but also for laryngeally modified sonorants. Equating high tone directly with aspiration is thus too strong a position, as it incorrectly predicts a universal raising effect of aspirated segments on a following vowel. Observe in this respect that some languages in fact show a correspondence between a low tone and aspiration. For instance, in some Hopi dialects historical *h, preaspirated stops, and aspirated sonorants have a low tone reflex on the second mora of stressed syllables (cf. Manaster-Ramer 1986).

A third, to some extent theory-internal, problem is that breathy voiced stops seem to have a universal lowering effect on a following vowel (cf. Kingston & Solnit 1988). Given the assumption that breathy voiced segments, like aspirated segments, have a dependent element |H|, it follows that the interaction between tone and other laryngeal articulations cannot be expressed in terms of dependent structure alone. I leave this topic for further research.

There is, nonetheless, another respect in which tone may shed light on the phonological status of aspirated nasals. In a number of languages of South-East Asia, historical aspirated nasals can be reconstructed on the basis of synchronic tonal evidence. Most tonal languages of South-East Asia, including Chinese, Tibeto-Burman, Miao-Yao, Vietnamese, and Kadai languages, have at some point in their history undergone a process of tone splitting. This concerns a diachronic process whereby tone contrasts in vowels emerge under the influence of a preceding consonant. The typical conditioning factor of tone splitting is voicing, in such a way that after tone splitting has occurred, one tone series is associated with preceding voiceless consonants, and the other with preceding voiced consonants. This variation is initially allophonic, although subsequent changes affecting the preceding consonants have in many languages led to distinctive tone contrasts.

43 Following Ladefoged & Maddieson, I transcribe the aspirated vowels in (62) as breathy voiced.

44 The same is true of low tone and nasalization, which can be simultaneously distinctive; compare Snyman’s (1975) description of Zhu’hôasi !Xû, for instance.
In many Thai languages, the conditioning of tone splitting is more complex than a contrast in terms of voice. Li (1977) reconstructs Proto-Thai as having a four-way tone contrast, referring to the tones as A, B, C, and D.\(^45\) Here A, B, and C occurred in syllables ending in a nasal or a vowel, while D occurred in syllables ending in a stop. A subsequent process of tone splitting resulted in two tone series, A1-D1 and A2-D2. Based on correspondences between a number of Thai dialects, Li divides the consonants triggering tone splitting into five classes:

\[(63)\]

1. voiceless aspirated stops
2. voiceless continuants
3. unaspirated voiceless stops
4. glottalized consonants
5. voiced consonants

Here class 2 includes voiceless fricatives and, in Li’s terms, “voiceless sonorants”.

In most Thai dialects the consonant classes triggering tone splitting do not each have a specific tonal reflex. Instead, combinations of classes are associated with a particular tonal reflex. These combinations thus exemplify natural class behaviour of aspirated nasals, and as such may be taken as a diagnostic for their phonological representation. As regards tones A, B, and C, Li (1977:24-55) distinguishes four basic combinations:\(^46\)

\[(64)\]

\[\begin{align*}
\text{Combinations} \\
a. & 1, 2, 3, 4 \sim 5 & \text{White Thai, Black Thai, Lungchow, Wu-ming} \\
b. & 1, 2, 3 \sim 4 \sim 5 & \text{Chiengmai, Chiengrai, T’ien-chow, Yay, Po-ai} \\
c. & 1, 2 \sim 3, 4 \sim 5 & \text{Siamese, Songkhla, Krabi, Hua Sai} \\
d. & 2, 3 \sim 1, 3 \sim 4 \sim 5 & \text{T’ien-pao}
\end{align*}\]

Of interest are the combinations involving class 2, and in particular (64c). Consider as an illustration the development of tone A1 from Proto-Thai to

\(^{45}\) Observe here the abstract categorization of proto-tones. Whereas the various Thai dialects show regular correspondences, making it possible to reconstruct the Proto-Thai tone system, it is difficult to establish the precise phonetic character of the proto-tones (cf. Li 1977).

\(^{46}\) (64d) exhibits a split in class 3. Here the voiceless unaspirated consonants that developed into aspirated consonants or /h/ pattern with class 2; consonants that did not undergo this development pattern with class 1. The only known dialect that shows this development is T’ien-pao. The languages listed in (64) exemplify the basic consonant class combinations, although most exhibit additional mergers of specific tone groups; see Li (1977:24-55) for further discussion.
Siamese, Lunchow, and Po-ai (cf. Li 1977:29) ("24" denotes a mid-rising tone, "33" a mid-level tone, and "31" a mid-falling tone; PT is short for Proto-Thai):47

(65) a. **Class 1, 2**

<table>
<thead>
<tr>
<th>PT</th>
<th>Siamese</th>
<th>Lungchow</th>
<th>Po-ai</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>*kʰ_</td>
<td>kʰaau</td>
<td>kʰaau</td>
<td>haau</td>
<td>24</td>
</tr>
<tr>
<td>*tʰ_</td>
<td>fon</td>
<td>pʰin</td>
<td>hin</td>
<td>24</td>
</tr>
<tr>
<td>*mʰ_</td>
<td>maa</td>
<td>maa</td>
<td>maa</td>
<td>24</td>
</tr>
<tr>
<td>*lʰ_</td>
<td>laan</td>
<td>laan</td>
<td>laan</td>
<td>24</td>
</tr>
</tbody>
</table>

* /g107/g238 __/g107/g238/g97/g97/g117 24 'white'
* /g102 __/g102/g111/g110 24 'rain'
* /g104/g233/g110 24 'dog'
* /g108/g238 24 'grandchild'

b. **Class 3**

<table>
<thead>
<tr>
<th>PT</th>
<th>Siamese</th>
<th>Lungchow</th>
<th>Po-ai</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>*p_</td>
<td>pai</td>
<td>pai</td>
<td>pai</td>
<td>24</td>
</tr>
<tr>
<td>*t_</td>
<td>taa</td>
<td>taa</td>
<td>taa</td>
<td>24</td>
</tr>
<tr>
<td>*k_</td>
<td>kin</td>
<td>kin</td>
<td>kin</td>
<td>24</td>
</tr>
</tbody>
</table>

* /g112 __/g112/g97/g105 33 'to go'
* /g116 __/g116/g97/g97 33 'mother’s father'
* /g107/g105/g110 33 'to eat'

c. **Class 4, 5**

<table>
<thead>
<tr>
<th>PT</th>
<th>Siamese</th>
<th>Lungchow</th>
<th>Po-ai</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>*(t)b_</td>
<td>bin</td>
<td>bin</td>
<td>min</td>
<td>31</td>
</tr>
<tr>
<td>*(t)d_</td>
<td>dii</td>
<td>dai</td>
<td>nii</td>
<td>31</td>
</tr>
<tr>
<td>*(t)l_</td>
<td>?au</td>
<td>?au</td>
<td>?au</td>
<td>31</td>
</tr>
</tbody>
</table>

* /g47 __/g98/g105/g110 33 'to fly'
* /g47 __/g47/g97/g117 33 'good'
* /g47 __/g47/g97/g117 33 'to take'

The Siamese reflexes illustrate that aspirated stops and “voiceless continuants” pattern together to the exclusion of other segment types. If “voiceless sonorants” are viewed as being aspirated, then the natural class behaviour of these sounds with aspirated stops and fricatives can be expressed in terms of the presence of the element [H].

The tonal developments that are observed in Thai are representative of tone splitting processes in general. In their overview of tone splitting, Kingston & Solnit (1988) distinguish between two-way splits and three-way splits. In two-way splits, proto-tones have high and low reflexes. Here plain sonorants and voiced obstruents function as tone depressors while other segments, including aspirated sonorants, function as tone elevators. The table in (66), which is based on Kingston & Solnit (1988:4), summarizes the effect of consonants in two-way tonal splits:

---

47 Following Li, I assume that the voiced stops of Proto-Thai were preglottalized.
Tone splitting: two-way splits

<table>
<thead>
<tr>
<th>Category</th>
<th>Tone elevators</th>
<th>Tone depressors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstruent stop</td>
<td>p, pʰ, b</td>
<td>b</td>
</tr>
<tr>
<td>Prenasalized stop</td>
<td>p²p</td>
<td>b²p</td>
</tr>
<tr>
<td>Fricative</td>
<td>f</td>
<td>v</td>
</tr>
<tr>
<td>Nasal</td>
<td>mʰ, m'</td>
<td>m</td>
</tr>
<tr>
<td>Approximant</td>
<td>wʰ, w'</td>
<td>w</td>
</tr>
</tbody>
</table>

In two-way splits, the tonal reflex of vowels is therefore determined primarily by the presence of voicing in the preceding consonant.

In three-way splits, proto-tones have high, mid, and low reflexes. The table in (67), based on Kingston & Solnit (1988:5), indicates that here, too, plain sonorants and voiced obstruents invariably condition a low reflex. Languages vary as to whether aspirated segments condition a high reflex and glottalized segments a low reflex (type a), or vice versa (type b). Languages further vary with respect to the behaviour of plain stops, which may pattern together with aspirated segments (a₁, b₁) or glottalized segments (a₂, b₂). Observe that in these languages aspirated sonorants always pattern together with aspirated stops. The only exception to this is type b₃, where aspirated sonorants pattern with plain stops, and aspirated stops with glottalized segments. Kingston & Solnit note that the only known language to display this pattern is T’ien-Pao. Recall, however, that those voiceless stops in T’ien-Pao which developed into aspirated stops do pattern with aspirated sonorants (see n.46). It is therefore unclear whether T’ien-Pao constitutes a true counterexample (in (67) Vcls denotes voiceless and Ved denotes voiced):

Tone splitting: three-way splits

<table>
<thead>
<tr>
<th>Category</th>
<th>a₁</th>
<th>a₂</th>
<th>b₁</th>
<th>b₂</th>
<th>b₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vcls obstruent stop</td>
<td>high</td>
<td>p</td>
<td>p</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>Vcd obstruent stop</td>
<td>b'</td>
<td>b'</td>
<td>pʰ</td>
<td>pʰ</td>
<td></td>
</tr>
<tr>
<td>Nasal</td>
<td>m’</td>
<td>m’</td>
<td>mʰ</td>
<td>mʰ</td>
<td>mʰ</td>
</tr>
<tr>
<td>Vcls obstruent stop</td>
<td>mid</td>
<td>p</td>
<td>p</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>Vcd obstruent stop</td>
<td>pʰ</td>
<td>pʰ</td>
<td>b’</td>
<td>b’</td>
<td>b’</td>
</tr>
<tr>
<td>Nasal</td>
<td>mʰ</td>
<td>mʰ</td>
<td>m’</td>
<td>m’</td>
<td></td>
</tr>
<tr>
<td>Vcd obstruent stop</td>
<td>low</td>
<td>b</td>
<td>b</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>Nasal</td>
<td>m’</td>
<td>m’</td>
<td>m</td>
<td>m</td>
<td>m</td>
</tr>
</tbody>
</table>

For present purposes, the important observation is that the tone splitting facts argue against a category of voiceless nasals, and in favour of a category of aspirated nasals.

Summarizing, we have seen that there are two types of support in favour of the representation of aspirated nasals in terms of dependent [H]. First, the fact
that aspirated sonorants often cooccur with a following high-toned vowel might be taken to suggest that high tone and aspiration share a common structural basis, e.g. [H]. Second, the class behaviour of aspirated sonorants with aspirated stops in tonal split phenomena can be expressed by reference to the element [H]. However, given the complex nature of the interaction between tonal and laryngeal articulations, it must be emphasized that a dual interpretation of [H] as high tone and aspiration must be regarded as tentative at best.

5.3 Glottalized nasals

5.3.1 Phonetic variation and phonological contrast

Following Halle & Stevens (1971), glottalized nasals in traditional feature theory are characterized as being specified for the feature [+constricted glottis]. This feature is also characteristic of glottalized stops, the realization of which includes tensed, ejective, and implosive articulations. Regarding [+constricted glottis], Halle & Stevens (1971:202) observe that

\[
\text{adduction of the arytenoid cartilages relative to the position for normal voicing … can cause the vocal cords to be pressed together and the glottis to narrow or to close. When the vocal-cord stiffness is large in this situation, vocal-cord vibration does not occur, and no air passes through the glottis. For a lower coupling stiffness, vocal-cord vibration can be initiated, probably with narrow, peaked pulses.}
\]

According to this characterization, the glottal constriction, when incomplete, may or may not be accompanied by voicing. If it does, then the realization of a glottalized nasal involves a period of creaky voice. This is for instance found in Comaltepec Chinantec (Silverman 1997) and Klamath (Barker 1964, Blevins 1993). The optional presence of creaky voice in sonorants has led Steriade (1997) to propose that ejectives are specified for the feature [ejection] while glottalized sonorants are specified in terms of the feature [creak]. However, the available evidence suggests that this distinction is unwarranted.

First, inspection of UPSID reveals that the presence of a series of glottalized sonorants implies the presence of a corresponding series of glottalized stops.\(^{48}\) It is not clear how this relation can be expressed if glottalization in sonorants is expressed in terms of a different feature than glottalization in obstruents. In addition, there is abundant phonological evidence that shows that sonorants and

\(^{48}\) UPSID contains 15 languages with glottalized nasals. Of these, 11 have a corresponding series of voiceless ejective stops; the remaining 4 have a corresponding series of voiced glottalized or implosive stops.
stops pattern together in glottalization processes. For instance, Buckley (1992) observes that the assertive morpheme in Kashaya is signalled by glottalization of stem-final consonants. The forms in (68) indicate that this process targets both stops and sonorants:

\[
\begin{align*}
\text{(/j/} + \text{?/} & \rightarrow [\text{j ah mot}] \quad \text{‘it’s a cougar’} \\
\text{(/t’/} + \text{?/} & \rightarrow [t’i j i k a n’] \quad \text{‘it’s pretty’}
\end{align*}
\]

Similar processes are found in Klamath, Kwak’wala, and Nisga’a (see Howe & Pulleyblank 2001). The fact that stops and sonorants pattern together in these processes strongly suggests that a single glottalization feature is involved.

In Element-based Dependency, glottalization is expressed by dependent |\(\text{?/}\) (see §2.4.1). Consider once more the representation of a labial glottalized nasal /m’/, together with some possible phonetic realizations:

\[
(69) \quad \begin{array}{c}
\text{O} \\
\text{L} \\
\text{?} \\
\text{?} \\
\text{U}
\end{array}
\]

\[
[\text{?m, m?, m?m, 3 m, ?3 }]
\]

Cross-linguistic evidence shows that the degree of glottal constriction (and, related to it, the presence of voicelessness), the relative timing of the nasal and laryngeal articulation, and the degree of overlap between the two are a matter of both language-particular and language-internal variation. Consider for instance Jalapa Mazatec, which contrasts a series of aspirated and glottalized sonorants in onset position. While the former are invariably realized with an initial voiceless portion (e.g. [Æm]), the realization of the latter is variable. Silverman (1997:86) describes the situation as follows:

Glottalized nasals (and, indeed, all the glottalized sonorants) were very variable in their articulation. Sometimes ... there were creaky voice pulses before the nasal. Sometimes there was a single glottal pulse and then a long glottal closure before a modally voiced nasal. On some occasions there was almost no modal voicing, and much of the nasal was pronounced with creaky voice; on other occasions the glottalization spread even further so that the neighbouring segments had creaky voice.

---

49 Buckley analyzes the morpheme as a floating [constricted glottis] feature. In Element-based Dependency, the morpheme can be analyzed as a single, dependent element |\(\text{?/}\).
Similarly, the realization of glottalized nasals in Squamish, an Interior Salish language, appears to be a matter of free variation (cf. Kuipers 1967). Squamish differs in this respect from Shuswap, another Interior Salish language, where the variation is prosodically conditioned, in such a way that preglottalization occurs in onsets and postglottalization in codas. As Kuipers (1974:24) notes:

In the glottalized resonants [i.e. sonorants] the glottal closure falls at the implosion in prevocalic position; otherwise (before a consonant or word-end) the glottal closure falls at the end.

The variation found in Shuswap appears to be the predominant pattern in North American languages. As far as prevocalic glottalized nasals are concerned, Sapir (1938:249) already observed that

the glottal closure is synchronous with the momentarily voiceless initial phase of the continuants [i.e. sonorants], its release being immediately followed by the voiced phase of the continuant.

Howe & Pulleyblank (2001) observe that while this is the typical scenario in prevocalic context (i.e. __V), glottalized sonorants tend to show the reverse timing pattern preconsonantally (i.e. __C) and word-finally (i.e. __#). An example of a language that displays this variation in the realization of glottalized sonorants is Yawelmani. This is illustrated in (70), where the bilabial nasal represents all places of articulation:

(70)  
Yawelmani  
#_V  __C  __#  
[ʔm] [mʔ] [mʔ]

Other North American languages with the same pattern of variation include Kutenai, Kashaya, Klamath, Kwak’wala, Oowek’yala, Coatlan-Loxicha Zapotec (cf. Howe & Pulleyblank 2001).

Different interpretations of this variable timing pattern have been offered. Silverman (1997) takes the source to be phonetic, in that it serves to optimize the perceptual cues for uninterrupted airflow (see also Kingston 1990). This view is criticized by Howe & Pulleyblank (2001), who maintain that the variable timing of glottalization is regulated by the syllable, and must therefore be expressed in phonological rather than in phonetic terms. For present purposes, the point to note is that the attested variation in phonetic realization is context-sensitive, and never contrastive.

The data considered show that there is considerable variation in the way glottalized nasals are realized. However, the important observation is that this variation is phonologically irrelevant to the extent that it never plays a role in the formation of underlying contrasts. In the following section, I will show that an
examination of diachronic developments involving glottalized nasals provides further support for the Element-based Dependency approach to glottalization.

5.3.2 Diachronic evidence

It is reasonable to suppose that at least a number of glottalized nasals are derived from a historical combination of a nasal and a glottal stop (i.e. *ʔ+N > N’). However, it should be observed that this assumption is in some cases impossible to verify. For instance, while Sapir (1938), in his discussion of Wakashan, argues that some instances of glottalized nasals derive from a cluster of a nasal and a glottal stop, lexicostatistical evidence from Swadesh (1953) and Embleton (1985) suggests that some glottalized sonorants in Wakashan date back at least as far as 1,500 years (see Howe & Pulleyblank 2001). This time-depth is too great for reliable reconstruction.

In other cases, there is more solid comparative and historical evidence to support an earlier stage of *ʔ+N. For instance, it was noted in §5.2.3.2 that Proto-Tibeto-Burman contained only a voiced series of nasals, and that the fusion of the prefixes *ʔ- and *s- with root-initial nasals resulted in a series of glottalized and aspirated nasals in Proto-Burmese. In Maru, a Tibeto-Burman language of India, the *ʔ- prefix combined with an initial nasal to form a glottalized nasal, the presence of which conditions creaky voice in a following vowel (see Bradley 1979). This scenario can be represented as in (71):

(71) | (PFX) | O | N | O | N |
    | ?   | L | L  | ? |  L | L |
    | ?   |   |    | ? |    |

*ʔ+NV > N’V

In synchronic terms, Maru has a distinctively glottalized nasal, which spreads its dependent [H] rightwards to a following vowel.

Another, probably less frequent, source of glottalized nasals is a historical sequence of a stop and a nasal. An example of this source can be found in the development from Proto-Kadai to Proto-Kam-Sui/Tai, which, according to the scenario laid out in §5.2.3.1, involved the creation of glottalized nasals from a sequence of *k and a following nasal (see also (41) above):

(72) Proto-Kadai         Proto-Kam-Sui/Tai
    *k-m’V > *m’V
As regards this development, I assume that fusion of the stop and the nasal triggered debuccalization of the stop, producing a glottalized nasal. This is illustrated in (73):

\[
(73) \quad \begin{array}{c}
O^* \\
O \\
(?) L \\
(A) ? \\
U \\
\end{array} \quad *(km)^{\prime} > m^{\prime}
\]

A similar development occurred in Navajo, where we find *dm, *dn > /m', /n' (cf. Harris 1945). Note that these processes are similar to those responsible for the creation of aspirated nasals in Proto-Kam-Sui/Thai and English.

The facts considered in §5.2.3.1 indicate that glottalized nasals have been lost in the majority of present-day Kadai languages (although glottalization has in each of these languages left a tonal residue on a following vowel). Nasal deglottalization can be straightforwardly expressed in terms of the deletion of dependent |, as is shown in (74):

\[
(74) \quad \begin{array}{c}
O \\
L \\
? \\
N^{\prime} > N \\
\end{array}
\]

Given that deglottalization involves a loss of markedness, the development in (74) is not unexpected. Aside from Kadai, it can be observed in a number of language families of North America. For instance, Krauss & Leer (1981) note that Proto-Athapaskan-Eyak employed a phonological contrast between plain and glottalized sonorants, including nasals. Glottalization in sonorants was retained in Proto-Eyak, but was lost in Proto-Athapaskan.

A rather more recent phenomenon which involves both the development and the loss of glottalized nasals can be observed in Sedang. Smith (1973b) notes that Proto-North-Bahnaric, the ancestor of a subgroup of Mon-Khmer languages of Vietnam including Sedang, is reconstructed as having final sequences of plain vowels followed by /m n n/. These vowels have developed into laryngealized tense register vowels in early Sedang as well as in some present-day Sedang
dialects. Other dialects of Sedang show a further development, in which, as Smith (1973b:55) observes:

[a] strengthened laryngealization of the vowel has affected the final nasal consonant to the point of cutting it off prematurely with a glottal stop, or sometimes entirely dropping the nasal and replacing it with a final glottal stop.

Given that final glottal stops do not occur elsewhere, laryngealization of the preceding vowel becomes redundant. For this reason, Smith terms this process “denasolaryngealization”. The forms in (75) represent the change /VN/ > /V/ in more detail. Stage 1 of the process corresponds to the situation as reconstructed for Proto-North-Bahnaric. According to Smith (1973b), all four stages are still attested synchronically in present-day Sedang dialects.

(75)  Stage 1  Stage 2  Stage 3  Stage 4
a. pun > p, n > p, ñ > puʔ  ‘four’
b. patam > patám > patám > pataʔ ~ pataʔ  ‘five’

For present purposes, the change from stage 3 to stage 4 is of interest, since it shows that glottalized nasals cannot only be deglottalized, but also denasalized. The latter process is expressed in terms of deletion of the head component, yielding a glottal stop:

(76)  

Denasalization, like deglottalization, results in a less marked structure. It is reasonable to assume that the rare occurrence of this process is due to the fact that it involves the loss of head component, whereas the rather more frequent process of deglottalization involves the loss of the dependent component.

---

50 There is evidence that speakers retain an underlying representation with a final nasal in at least some Sedang dialects. Smith notes that some speaker fluctuate between such realizations as [V̟ʔ~Vm], [V̟eʔ~Vm], and [V̟~On]. Note that in some of the forms without nasals the nasal appears to have vocalized rather than having been deleted; this is not the case in other forms, such as (75a).
5.4 The interpretation of laryngeally modified nasals

In this section, I discuss two remaining issues regarding the interpretation of laryngeally modified nasals. First, in §5.4.1, I address the question whether these nasals function as sonorants or as obstruents. Next, in §5.4.2, I provide evidence for the hypothesis that laryngeally modified nasals function as clusters only in case the nasal and the laryngeal parts belong to different subsyllabic constituents (see §2.6.1).

5.4.1 Head-dependency relations

Given that laryngeally modified nasals consist of a nasal and a laryngeal part, and given that branching structures consist of a head and dependent, two representations of such nasals are possible. Taking the labial aspirated nasal as an example, these are given in (77a,b):

\[(77) \quad \begin{array}{c}
\text{a.} & \text{O} \\
& \text{L} \quad \text{H} \\
& \text{?} \\
& \text{U} \\
\text{b.} & \text{O} \\
& \text{H} \quad \text{L} \\
& \text{?} \\
& \text{U}
\end{array}\]

(77a) is the Element-based Dependency representation of a labial aspirated nasal. Note that the presence of [L] in the head manner structure identifies the nasal as sonorant. By way of contrast, (77b) is headed by [H], which identifies the nasal as an obstruent (more specifically, as a fricative).

In a similar vein, there are two conceivable ways in which a labial glottalized nasal can be represented. These two possibilities are given in (78a,b):

\[(78) \quad \begin{array}{c}
\text{a.} & \text{O} \\
& \text{L} \quad ? \\
& \text{?} \\
& \text{U} \\
\text{b.} & \text{O} \\
& ? \quad \text{L} \\
& \text{?} \\
& \text{U}
\end{array}\]

(78a), the Element-based Dependency representation of a glottalized nasal, expresses that glottalized nasals are sonorants. (78b), on the other hand, expresses that glottalized nasals are obstruents (more specifically, stops).

As was argued in §2.6.2, structures of the kind in (77b) and (78b) are ill-formed, since they contain dependent place but lack head place. This argument
is of course theory-internal. However, the fact that the representations make different claims with regard to the sonorant status of laryngeally modified nasals means that there is an additional tool to evaluate the two types of structures. In this section, I will argue that the available evidence suggests that laryngeally modified nasals function as sonorants. This claim is contrary to the position taken in Ohala & Ohala (1993) and Humbert (1995), where such nasals are viewed as obstruents.

Ohala & Ohala (1993) maintain that the presence of aspiration affects the sonorant status of nasals. Based on the historical origin of what they term “devoiced” nasals, Ohala & Ohala conclude that these segments, as well as other “devoiced” sonorants, are phonetically fricatives. The reason for this, so Ohala & Ohala argue, is aerodynamic: given a particular vocal tract configuration, the presence of turbulent airflow—the prime characteristic of fricatives—depends on the velocity of the egressive airstream, in such a way that the greater the velocity, the greater the turbulence is at the constriction. In voiced sonorants, the vibration of the vocal cords offers sufficient resistance to the egressive airstream; hence, the velocity of the air which flows past the constriction is relatively low. However, the glottal opening that is characteristic of devoiced sonorants results in much higher velocity levels of egressive airflow. Given the same vocal tract configuration, devoiced sonorants thus involve local turbulence while voiced sonorants do not.

Ohala & Ohala go on to argue that the phonetic characteristics of devoiced nasals affect the phonological behaviour of these segments. For instance, they observe that in a number of languages devoiced nasals are historically derived from plain voiced nasals preceded by *s (see §5.2.3). The problem with this argument, it would appear, is that diachronic developments do not constitute evidence for synchronic behaviour. That is, the observation that devoiced nasals are historically derived from the combination of a fricative and a nasal does not imply that they function as fricatives synchronically. For instance, we saw in §5.2.4 that aspirated nasals typically pattern with voiceless fricatives in tone splitting. Such natural class behaviour does not imply that aspirated nasals are fricatives; it merely suggests that aspirated nasals and fricatives share a common structural basis (e.g. the element [H]).

The same point can be made with regard to glottalized nasals. The class behaviour of glottalized nasals with glottalized stops in tone splitting processes does not imply that glottalized nasals are stops. Rather, it suggests that the two share a particular element (e.g. dependent [ʔ]). This aside, there is evidence that glottalized sonorants pattern as sonorants. For instance, in Montana Salish the plain sonorants /m n l w j ʃ ʂ/ and their glottalized counterparts are both separated from a preceding obstruent by an epenthetic vowel (cf. Flemming et al. 1994). Similarly, sonorants in Montana Salish are generally separated from adjacent sonorants by an epenthetic schwa, unless the sonorants are identical. Glottalization is ignored for identity, so that an underlying sequence such as
/m’m/ is realized without an intervening vowel. Thus, for the purposes of vowel epenthesis glottalized sonorants pattern with plain sonorants.\footnote{I am grateful to Edward Flemming for bringing these facts to my attention.}

Humbert (1995) advances the claim that all laryngeally modified sonorants are obstruents phonologically. In Humbert’s approach, laryngeally modified sonorants are headed by the component $[C]$, parallel to stops and fricatives. $[C]$-headed structures are identified as obstruents for the purposes of syllabification. This, Humbert argues, is supported by the fact that laryngeally modified sonorants are never syllabic. Note that this view embodies the claim that any segment that is syllabic is a sonorant.

Humbert’s approach to laryngeally modified sonorants raises a number of questions. First, it is doubtful whether a ban on syllabic laryngeally modified nasals is empirically justified, given that there appear to be Salish languages in which, under certain specific circumstances, glottalized nasals can be syllabic.\footnote{Ladefoged & Maddieson (1996:109) report “an utterance from Columbian Salish that includes two syllabic laryngealized nasals (and also a voiceless nasal).” They go on to observe that “[p]honologically speaking … laryngealization of the nasal could be regarded as an effect of a glottal stop segment, or the phonetic sequence could be labeled a ‘postglottalized’ nasal.” Columbian Salish, then, might qualify as a language with syllabic laryngeally modified nasals, at least at the level of surface structure.}

For instance, Kuipers (1974) observes that in Shuswap sonorants can be syllabic in case they are preceded by a homorganic consonant, as in the forms in (79a). If there is no preceding homorganic consonant, the nucleus is $[\text{u}]$ or $[\text{e}]$, as in the forms in (79b):

\begin{align*}
(79) & \quad \text{a. } /\tilde{\text{i}}'\text{upm}/ [\tilde{\text{i}}'\text{úp}\tilde{\text{o}}] \quad \text{‘to twist’} \\
& \quad /\text{ntes}/ [\text{iQèes}] \quad \text{‘he places it’} \\
& \quad \text{b. } /\tilde{\text{i}}'\text{upns}/ [\tilde{\text{i}}'\text{'upns}] \quad \text{‘he twisted it’} \\
& \quad /\text{ntes}/ [\text{kènt}s] \quad \text{‘he touches it’}
\end{align*}

As the forms in (80a,b) show, the same variation is found in glottalized sonorants; that is, the forms in (80a) contain syllabic glottalized sonorants:

\begin{align*}
(80) & \quad \text{a. } /\text{xpln’tes}/ [\text{xplCtèes}] \quad \text{‘he puts rocks in the sweathouse’} \\
& \quad /\text{txixw’pm}/ [\text{txix}: ‘\text{p}\tilde{\text{o}}] \quad \text{‘I trim its tail’} \\
& \quad /\text{tlxw-us-tn’}/ [\text{tlx’ustC}] \quad \text{‘globe of kerosene lamp’} \\
& \quad \text{b. } /\text{tjق”eq”jm’x}/ [\text{tjق”aq”jom’x}] \quad \text{‘red pigment’} \\
& \quad /\text{swekmn’st}/ [\text{sw( kman’st}] \quad \text{‘lightning’} \\
& \quad /\text{p’n’sqèxe’t}/ [\text{pÒn’sq” çèx’}] \quad \text{‘find one’s horses’}
\end{align*}

I suspect that the phonetic realization of these syllabic glottalized sonorants involves the sequencing of modal voice and glottalization, similar to what has been observed for those Mazateco vowels which involve a combination of high...
tone and creaky voice (see Silverman 1997). However, given that languages do not appear to make distinctive use of the ordering of the voiced and glottalized portions of laryngeally modified sonorants, there is no need to specify such sequencing in their phonological representation.

Humbert’s approach also raises two more general questions. The first concerns the fact that some languages, such as Imdlawn Tashlhiyt Berber (Dell & Elmedlaoui 1985) and Bella Coola (Bagemihl 1991), are described as having syllabic obstruents. While it is true that in these languages consonant sequences are typically broken up by transitional vowels, it is questionable whether, as Kenstowicz (1994:289) observes, “these vowels reflect a syllabic organization in any phonologically useful sense of the term”. Although Humbert is aware of the existence of syllabic obstruents (cf. Humbert 1995:35), it is unclear how her approach deals with such segments.

The second question concerns the interpretation of laryngeally modified vowels. The view that such segments are obstruents, and thereby banned from the nucleus, is clearly untenable: in languages with laryngeally modified vowels, there is no reason to assume that these vowels occupy any position other than the nucleus. Humbert claims instead that laryngeal modifications in vowels are never distinctive. Such modifications, she argues, are due to the influence of an adjacent consonant, or to a phonetic effect that is associated with a particular place of articulation. To support this view, Humbert notes that in a number of Mon–Khmer languages, first and second register distinctions can be interpreted as a contrast in terms of the feature \( \text{ [+ATR]} \) rather than in terms of a laryngeal contrast (see also Gregerson 1976).

The question, however, is whether laryngeal modifications in vowels can always be derived from other phonological contrasts. Consider for instance the vowels of Jalapa Mazatec, which, according to the description in Ladefoged & Maddieson (1996), have a three-way contrast in terms of modal, creaky, and breathy voice, as is illustrated by the (near-) minimal pairs in (81).

\[
(81) \quad \begin{array}{ccc}
\text{Modal voice} & \text{Creaky voice} & \text{Breathy voice} \\
já & ‘tree’ & j> & ‘he carries’ & jÅ & ‘he wears’ \\
ñt̞ & ‘seed’ & nd’ & ‘arse’ & nd’ & ‘horse
\end{array}
\]

If these contrasts are allophonic, it is unclear what the conditioning factor is. In a similar vein, Huautla Mazatec is analyzed by Golston & Kehrein (1998) as having distinctive aspiration and glottalization in both consonants and vowels.

53 In Trigo (1991), the pattern of vowel harmony in Turkana, a Nilo-Saharan language of Kenya, is analyzed as involving a register contrast which is phonetically realized as laryngeal lowering, raising, or as a pharyngeal [ATR]-like feature. This scenario is the reverse of that proposed by Humbert.

54 Ladefoged & Maddieson (1996:317) erroneously transcribe the breathy voiced vowels as creaky voiced, and vice versa.
In consonants, the relevant contrasts are phonetically realized as preaspiration and preglottalization. In vowels, the relevant contrasts are phonetically realized as breathy voice and creaky voice. Some examples are given in (82a,b):

\[(82)\]
\[
\begin{align*}
\text{a. Aspiration} & \quad \text{Breathy voice} \\
\text{bti ‘fish’} & \quad \text{b}\text{‘light in weight’} \\
\text{bka ‘stubble’} & \quad \text{b* ‘bad smelling’}
\end{align*}
\]

\[
\begin{align*}
\text{b. Glottalization} & \quad \text{Creaky voice} \\
\text{b’ka ‘hook’} & \quad \text{b’ ‘I hit’} \\
\text{i’ja ‘rainbow’} & \quad \text{j> ‘I carry’}
\end{align*}
\]

Golston & Kehrein’s analysis departs from earlier accounts by Pike & Pike (1947) and Steriade (1994), where the laryngeal distinctions are restricted to consonants. According to these earlier accounts, Huautla Mazatec has a contrast between preaspirated and postaspirated stops, and between preglottalized and postglottalized stops. Golston & Kehrein point out that the problem with this analysis is that there is no cross-linguistic evidence to support the contrastive order of laryngeal and supralaryngeal articulations, neither in stops nor in other segments (see also §1.2.2). This suggests that the lesser evil would be to permit distinctive laryngeal modifications in vowels. In Element-based Dependency, the Huautla Mazatec contrasts can be represented as follows:

\[(83)\]
\[
\begin{align*}
\text{a. N} & \quad \text{b. N} & \quad \text{c. N} \\
\text{L} & \quad \text{L} & \quad \text{L} & \quad \text{H} \\
\text{A} & \quad \text{A} & \quad \text{A} \\
\text{/a/} & \quad \text{/a’/ (=\text{[>])}} & \quad \text{/a\text{b}/ (=\text{[Å])}}
\end{align*}
\]

The facts encountered suggest that vowels, parallel to other sonorants, permit laryngeal modifications. That is, like other sonorants, vowels can be glottalized (as expressed by dependent [?]!) and aspirated (as expressed by dependent [H]).

As regards the syllabic status of laryngeally modified sonorants, I suggest that we are dealing with the following scenario. Cross-linguistically, syllabic vowels are unmarked while syllabic consonants are marked. A similar relation can be said to hold between laryngeally modified vowels and consonants. That is, if laryngeally modified vowels are marked, then syllabic laryngeally modified nasals are more marked. According to this line of reasoning, there is no a priori reason why laryngeally modified nasals should be denied syllabic status. Indeed, the facts from Shuswap and Columbian Salish suggest that, although decidedly rare, syllabic laryngeally modified nasals are not altogether absent in languages

\[\text{55 Of course, vowels can also be nasalized, in which case they are specified for dependent [L].}\]
of the world. The marked status of syllabic laryngeally modified vowels can be attributed to the presence of consonantal material in their representation (i.e. dependent [ɾ] or [h]). This holds a fortiori for syllabic laryngeally modified nasals, which contain [ɾ] as part of their manner component.56

A comment is also in order regarding the occurrence of laryngeally modified nasals in other vocalic positions. I observed earlier that the unmarked status of sonorants in coda position can be interpreted to mean that the coda is a vocalic position, i.e. a position which prefers [L]-headed material (see §2.3.2). In this light, it is interesting to note that in some languages with laryngeally modified sonorants, these sonorants are permitted in coda position only. An example of such a language is Kashaya (see Buckley 1992, Howe & Pulleyblank 2001). In other languages, such as Yawelmani, glottalized sonorants are found in word-final, preconsonantal and intervocalic position, but not in word-initial and postconsonantal position (see Newman 1944, Howe & Pulleyblank 2001). In the approach of Harris (1997), the contexts in which glottalized sonorants occur in Kashaya and Yawelmani involve positions with a “weaker licensing potential”. Such positions disprefer consonantal material, and they are as such more or less equivalent to what I call a “vocalic position” here. According to this view, the distribution of laryngeally modified sonorants in these languages offers further supports for the claim that glottalized nasals are sonorants.

The facts considered in this section lead me to conclude that there is no compelling evidence to regard laryngeally modified nasals as obstruents. Rather, their phonological behaviour and their distribution suggest that these nasals are sonorants. This is expressed by the Element-based Dependency representation of this segment type, in terms of the presence of [L] in the manner component.

5.4.2 Prosodic interpretation

As was noted in §2.6.1, Element-based Dependency constitutes a non-segmental approach to phonology, since there is no level in the phonological organization which corresponds to the segment. In this section, I consider this view in more detail in relation to laryngeally modified nasals. Consider the representation of a labial aspirated nasal in (84):

56 Note that this argument does not say anything about the sonorant status of laryngeally modified nasals, since we have seen that there are languages which permit syllabic obstruents.
An important point with respect to (84) is that there do not appear to be any languages which have a contrast between /mh/ and /mh/, at least not within the same subsyllabic constituent. From the viewpoint of phonological contrast, this suggests that a single representation /m+h/ is sufficient.\textsuperscript{57} Thus, Element-based Dependency representations of the kind in (84) are suitably non-specific, given that they cannot distinguish between a single segment and a cluster analysis of laryngeally modified structures.

Consider this last observation in relation to the distribution of aspirated sonorants in Icelandic. We saw in §5.2.2 that most dialects of Icelandic display a process of transfer whereby aspiration shifts leftwards from an underlingly aspirated stop to a preceding sonorant. This is not the only environment in which aspirated sonorants are found, however. Aspirated sonorants als occur word-initially, where they are reflected in the orthography as <n l r j> preceded by <h>. The (near-) minimal pairs in (85) show that aspiration is distinctive in word-initial sonorants:

(85) hnota [Øx̂a] ‘nut’ cf. nota [nx̂a] ‘to use’
hné [Øe:] ‘knee’ cf. né [əe:] ‘either’
hljóð [jouθθ] ‘sound’ cf. ljóð [jouθθ] ‘poem’
hrópur [ouðøy] ‘fame’ cf. rópur [rouðøy] ‘row’
hró [ouus] ‘praise’ cf. rós [rous] ‘rose’
hjól [øuː] ‘wheel’ cf. jól [jouː] ‘Christmas’
hjarta [q̂ta] ‘heart’ cf. jarma [jarma] ‘to bleat’

The question is whether these segments are aspirated underlyingly, or whether they are the result of fusion of a plain sonorant and a preceding /h/. Árnason (1980:10-1) does not commit himself to either view, but he does observe that a cluster interpretation is in line with the distribution of /h/, which occurs only word-initially. Rögnvaldsson (1993) derives the aspirated sonorants through the “coalescence” of a sonorant and /h/. The point to note is that no such process needs to be recognized in the present proposal, given that the Element-based Dependency representation of aspirated sonorants cannot distinguish between a cluster and a single segment interpretation. Bearing in mind that main stress in

\textsuperscript{57} The same holds for glottalized nasals, which involve a combination of nasal manner and dependent [i].
Icelandic falls on the first syllable, I propose that aspirated sonorants have the following general representation:

\[(86)\]

\[\sigma\]

O

\[\overset{\text{L}}{\overset{\text{H}}{\text{}}}\]

\[(86)\] expresses the fact that sonorants, i.e. structures that contain \(\text{[L]}\) as part of their manner component, are compatible with dependent \(\text{[H]}\) only in case they are dominated by an onset which is itself dominated by a stressed syllable. The fact that aspirated sonorants are restricted to this context is unsurprising, given that the onset of a stressed syllable is the position which licenses the maximum range of consonantal contrasts (see e.g. Harris 1997 and Beckman 1998 for discussion of this issue). Recall in this respect that southern dialects of Icelandic neutralize the aspiration contrast in stops in all positions except in word-initial position (see §5.2.2).

Sedang is another example of a language in which laryngeally modified sonorants are restricted to the onset position of a stressed syllable. According to Smith (1973:54), Sedang has the consonant inventory in (87):

\[(87)\]

\[
\begin{array}{cccccc}
\text{p} & \text{t} & \text{d} & \text{g} & \text{d} & \text{r} \\
\text{b} & \text{d} & \text{s} & \text{h} & \text{n} & \text{l} \\
\text{m} & \text{n} & \text{n} & \text{n} & \text{l} & \text{r} \\
\end{array}
\]

Maddieson (1984), whose description is based on that of Smith, provides a much larger consonant inventory which contains an additional series of voiceless aspirated stops and voiced laryngealized stops (except \(\text{/g'/}\), as well as a series of voiceless and laryngealized sonorants. Thus, where Maddieson (1984) describes Sedang as having laryngealized and voiceless nasals, Smith (1973) interprets these as clusters consisting of a nasal and a preceding \(\text{/d/ or /h/}\). Smith (1973:54) notes that this analysis expresses that “the modification [of these nasals] occurs before … the onset of voicing”. It is dubious, however, whether the phonetic realization of these nasals constitutes evidence for their underlying organization; I return to this point shortly. Aside from phonetic support, there are also a number of distributional arguments for a cluster analysis of laryngeally modified sonorants. However, we will see that on closer inspection these arguments turn out to be unconvincing.
In Sedang, the phonological word consists of a stressed main syllable which is optionally preceded by an unstressed presyllable. The onset position of a main syllable permits the maximum range of consonantal contrasts; in this position, we find both plain and laryngeally modified nasals. In addition, the onset position of main syllables permits a number of consonant clusters, three of which contain a nasal: /ml mr nr/. The absence of clusters with laryngeally modified nasals could be taken as an argument for analyzing such nasals as clusters, since this permits the generalization that complex onsets in Sedang contain a maximum of two segments. This account can be generalized to laryngeally modified stops, which also cannot occur as the first member of a cluster. However, I claimed in §2.6.1 that this asymmetry between plain and laryngeally modified representations can also be expressed by a prohibition on O-projection. That is, the fact that Sedang permits sequences such as /pl ml/ and /p^b ml^b/, but not /pl^b (ml)^b/, suggests that onsets which contain O’ are illicit. This is illustrated in (88) for */(ml)^b/:

(88) *O’

According to this interpretation, laryngeally modified obstruents and sonorants do not function as segmental clusters; rather, they form branching manner structures which are directly dominated by an onset constituent.

Another argument for a cluster interpretation of laryngeally modified nasals in Sedang comes from distributional restrictions on the final position of main syllables and on the initial position of presyllables. In the final position of main syllables, Sedang permits plain stops, nasals, and glides, as well as some

58 Presyllables are a characteristic trait of Mon-Khmer. Such syllables typically consist of one or two consonants and a neutralized vowel, which in some languages may be left unrealized. Presyllables are sometimes referred to as “minor syllables”; the combination of a presyllable and a following main syllable is sometimes termed a “sesquisyllable” (see e.g. Shaw 1993).

59 The only exception concerns a sequence which is transcribed by Smith (1973a:55) as /hnr/, phonetically presumably [l N]; Smith notes that this sequence occurs in only two lexical items.
marginal occurrences of /r/ and /l/.\textsuperscript{60} Hence, the absence of laryngeally modified nasals can be attributed to the fact that only a single consonant is allowed word-finally. In the initial position of presyllables, Sedang permits plain stops and /s h l r m/. Here, too, the lack of laryngeally modified stops and sonorants might be argued to be related to the fact that only a single position is available—but, once more, this is not the only possible interpretation.\textsuperscript{61} The restrictions can also be stated in terms of a prohibition on branching manner structures in specific prosodic environments.\textsuperscript{62}

The preceding discussion shows that there is no compelling evidence to analyze the laryngeally modified nasals (as well as other laryngeally modified structures) of Sedang as clusters. The observed restrictions are equally amenable to an analysis in which the representation of these nasals, i.e. their branching manner structure, makes them ill-suited to occur in consonant clusters. In terms of Element-based Dependency this can be formalized by means of a prohibition on projected onset constituents (i.e. *O').

The facts encountered so far suggest that laryngeally modified nasals do not function as clusters in syllable-initial context. This is in line with the hypothesis that a sequence of a supralaryngeal and a laryngeal articulation functions as a cluster only if the two articulations are dominated by different subsyllabic constituents (see §2.6.1). Given that laryngeally modified nasals consist of a combination of consonantal articulations, this typically involves a coda-onset sequence. With this in mind, consider the combinations of /m/ and /l/ in (89). Here only the structures in (89b,c), where /m/ and /l/ are dominated by different subsyllabic constituents, function as clusters (in (89) “.” denotes a syllable boundary):

\textsuperscript{60} The exception here is word-final laryngeally modified /j/, which Smith analyzes as a single segment. The problem with this analysis is that it fails to provide a unified interpretation of laryngeally modified sonorants. An alternative would be to view /j/ as an off-glide of the preceding vowel, leaving /l/ and /j/ to occupy the final position.

\textsuperscript{61} The fact that the onset of a presyllable licenses /m/ but not /n p ny/ might be related to the “consonantal strength” of /m/. I discuss this issue in §7.1.

\textsuperscript{62} The restrictions on onsets of presyllables and codas of main syllables can be unified on the assumption that the final consonant of a main syllables forms the onset of an empty-headed minor syllable. On this interpretation, Sedang words would consist of an optional presyllable, an obligatory main syllable, and an optional minor syllable. This interpretation requires further research.
Determining the status of a laryngeally modified structure therefore means determining the syllabic affiliation of its component parts. In the remainder of this section, I consider the syllabic affiliation of laryngeally modified nasals in a number of languages.

Consider first some fairly straightforward cases of tautosyllabic laryngeally modified nasals. As is noted by Shaterian (1976), Yavapai, a Yuman language of Arizona, displays a process in which underlying stem-final stops are fused with a following /h/ to form an aspirated stop. An example is provided in (90a). The fact that the realization of this stop fluctuates between postaspiration and preaspiration suggests that the stop forms a branching onset rather than a coda-onset sequence. The same process fuses a stem-final /h/ with a following nasal, as in (90b). For reasons of pattern congruity, it is plausible that the result, an aspirated nasal, also forms a branching onset:

(90)  a. /\theta^h\kappa/ - /m'/ 'throw (toward speaker)'
b. /\theta^h\mathcal{M}/ - /m.?'/ 'throw (away from speaker)'

A similar fusion process can be found in Korean. Rhee (2002) observes that in Korean [h] occurs only in morpheme-initial context. However, evidence from morphological alternations suggests that some morphemes contain a final underlying /h/. Consider the pattern of allomorphy displayed by the declarative suffix /-ta/ (cf. Rhee 2002:120):

(91)  \textbf{STEM + DECL.}  

a. /\kappa\text{-}\text{ta}/ [\kappa\text{\text{-}ta}] 'to go' 
   /\n\text{-}\text{ta}/ [\n\text{-}ta] 'to fly'

b. /\mathcal{M}\text{-}\text{ta}/ [\mathcal{M}\text{\text{-}ta}] 'to eat' 
   /\mu\kappa\text{-}\text{ta}/ [\mu\kappa\text{\text{-}ta}] 'to tie' 
   /\text{t}\text{\text{-}}\text{ta}/ [\text{t}\text{-}ta] 'to cover'

c. /\mathcal{N}\text{-}\text{ta}/ [\mathcal{N}\text{\text{-}ta}] 'to remain' 
   /\an\text{-}\text{ta}/ [\an\text{-}ta] 'to hug'

d. /\mathcal{N}\text{-}\text{ta}/ [\mathcal{N}\text{\text{-}ta}] 'set free' 
   /\text{m}\text{\text{-}}\text{ta}/ [\text{m}\text{-}ta] 'be much'
The declarative suffix surfaces as [-ta] following vowel-final and liquid-final stems, as is shown by the forms in (91a). The forms in (91b,c) show that after nasals and stops a process of “tensification” takes place which produces the allomorph [-t’a]. Note here that tensification triggers laryngeal neutralization of stem-final stops. A third allomorph, i.e. [-t’a], is found in forms of the kind in (91d). Such forms must have a different underlying shape than vowel-final forms; a reasonable assumption is that they contain a final /h/, the fusion of which with /-t/ produces a single aspirated stop. This stop, like all single intervocalic stops, is syllabified as an onset:

(92) C O O
     H ? → ? H
     I I

/h-t/ → [b]

The syllabic affiliation of [b] as an onset is supported by the observation that Korean does not have any coda-onset sequences which consist of a stop and a following /h/.

Let us next examine some examples of fusion processes which involve glottalization. Consider first the pattern of allomorphy displayed by the durative suffix in Yawelmani. Archangeli (1984) analyzes this suffix as /-ʔa/, with /ʔ/ being a floating glottalization feature. All things being equal, /ʔ/ is associated to the rightmost sonorant of a stem, as is shown by the forms in (93a-c):

(93) STEM+DUR
a. /ʃawʔa/ [ʃaw’ʔa] ‘shout’
   /ninʔa/ [nin’ʔa] ‘quieten’
b. /ʔiːkʔa/ [ʔiːk’ʔa] ‘sing’
   /mojʔa/ [moj’ʔa] ‘get tired’
c. /jawlʔa/ [jaw’la] ‘follow’
   /hoŋʔa/ [hoŋ’ʔa] ‘make’
   /ʔajʔa/ [ʔaj’ʔa] ‘pull’

Note in (93c) that glottalization skips the rightmost sonorant, since Yawelmani does not tolerate postconsonantal glottalized sonorants. If there is no available sonorant, as in the forms in (94), the suffix is realized as [-ʔa:]. Note in (94a)

63 Note the alternation [l-ɾ]: [ɾ] occurs intervocally, [l] occurs elsewhere.
64 Recall that glottalized sonorants in Yawelmani are restricted to word-final, intervocalic, and preconsonantal position (see §5.4.1); hence, durative suffixation does not produce outputs such as *[hɔŋ’ʔa].
that glottalization does not skip across the vowel, as this would yield an illicit word-initial glottalized sonorant:

(94) \text{STEM+DUR}
\begin{enumerate}
\item \(/\text{max}+\#a/\) [max\#a] ‘procure’
\item \(/\text{dos}+\#a/\) [dos\#a] ‘report’
\item \(/\text{hot}+\#a/\) [hot\#a] ‘build a fire’
\end{enumerate}

Strong evidence for a tautosyllabic interpretation of the derived glottalized sonorants comes from an inspection of the Yawelmani syllable template. Yawelmani permits CVV and CVC syllables, but not CVVC syllables. The prohibition on CVVC syllables can be held responsible for vowel shortening in forms of the kind in (95):

(95) \text{STEM+DUR}
\begin{enumerate}
\item \(/\text{t\#lk}+\#a/\) [t\#l\#k] ‘sing’ (cf. (93b))
\item \(/\text{max}+\#a/\) [max\#a] ‘procure’ (cf. (94a))
\end{enumerate}

In (95a), vowel shortening serves to incorporate the combination /\#t\#l/, which suggests that the resulting glottalized sonorant is tautosyllabic. In (95b), vowel shortening serves to incorporate /\#x/ into the initial syllable. Observe here that Yawelmani does not permit the combination of a fricative and a glottal stop in the same onset.\textsuperscript{65} Thus, vowel shortening supports a tautosyllabic analysis of glottalized sonorants.

Klamath has a glottalization process which is similar to that observed in Yawelmani. Consider first the status of Klamath /?/. Blevins (1993) observes that /?/ surfaces in prevocalic context, as in the forms in (96a). In word-final and preconsonantal context, /?/ is deleted with compensatory lengthening of the preceding vowel, as in the forms in (96b):\textsuperscript{66}

(96) \begin{enumerate}
\item \(/\text{sle}?-\text{a}\) /s\#e\#t\#w/ /s\#\text{eto}/ ‘sees’
\item \(/\text{hes-sle}?/\) /hes\#le\#c/ ‘come to see, show!’
\end{enumerate}

Blevins (1993) argues that in addition to /?/, Klamath has a morphophonemic glottal stop, which she represents as /\#t\#. Like /\#t\#, /\#t\#/ is realized before vowels only. In case of a preceding stop, /\#t\#/ is fused with this stop and the combination

\textsuperscript{65} Another way of putting this would be to say that Yawelmani does not have glottalized fricatives.

\textsuperscript{66} Blevins (1993:238) notes that the sequence /s\#t\#/ can also be analyzed as /s\#t\#. 
is phonetically realized as an ejective (i.e. a phonologically glottalized stop). An example of a morpheme which contains /\n/ is the diminutive suffix, as is shown by the examples in (97):

(97)  a. /juhu/ ‘buffalo’ /juhu?ak/ ‘DIST-buffalos-DIM’
     b. /?anku/ ‘stick’ /?anku?ak/ ‘DIST-sticks-DIM’
     c. /p'et\n/ ‘foot’ /pep'ak/ ‘DIST-feet-DIM’

The point to note here is that in intervocalic context, as in (97a), the realization of /\n/ is identical to that of /\n/. The only reason to analyze the diminutive suffix as /-\n\n/ instead of /-\n/ seems to be that /\n/ when combined with a stop, yields a single glottalized segment rather than a cluster. However, the distinction between /\n/ and /\n/ appears to be warranted only in case there is evidence for a contrast between a glottalized segment and a cluster of a stop plus /\n/. Blevins argues that such evidence can indeed be found. The relevant forms are those in which a sonorant-final stem is combined with a /-\n/ initial suffix, as in (98):

(98)  a. /\n\nulu/ ‘star’
     b. [\n\nulu?ak] ‘DIST-stars-DIM’
     c. [\n\nul\n\n] ‘star-GEN’

(98a) is the morpheme for ‘star’. In (98b), suffixation of /-\n\n/ (or /-\n/) produces a glottalized [l], while in (98c) suffixation of /-\n/ (or /\n/) results in a sonorant-[\n] cluster. With regard to this contrast Blevins (1993:265) notes that

the surface realizations of the … lateral are noticeably distinct … the first is preglottalized, while the second is postglottalized.

However, there are good grounds to assume that another distinction between (98b) and (98c) is their syllabic affiliation. Blevins (1993:239) observes that glottalized sonorants in Klamath are realized as preglottalized before vowels and as postglottalized elsewhere. This suggests therefore that the glottalized [l] in [\n\nulu\n\n] forms a single, branching onset structure. At the same time, it suggests that the sonorant-[\n] sequence in [\n\nulu?am] is heterosyllabic, and hence a cluster. Regarding the syllabic affiliation of clusters, Blevins (1993:256) notes that “syllable-sensitive rules of Klamath show consistent evidence for syllabification of all C1C2 clusters into distinct syllables”. The relevant evidence includes the location of stress, a phenomenon of closed syllable laxing, and morphologically conditioned processes of vowel reduction and vowel deletion. Thus, it seems reasonable to conclude that (98c) is syllabified as [\n\nulu?am].

Two points emerge from the preceding discussion. First of all, reference to syllable structure obviates the need for a contrast /\n\n/ in Klamath. Second,

67 Following Blevins, I assume here that [a] is epenthetic.
glottal stop and glottalization do not contrast in the onset position of a Klamath syllable. The latter observation receives a natural interpretation if laryngeal contrasts are analyzed as a property of subsyllabic constituents rather than as a property of individual segments.

In languages such as Yawelmani and Klamath, the phonetic realization of glottalized sonorants depends on their prosodic position. As was already noted in §5.3.1, in both languages sonorants are phonetically realized as preglottalized before vowels and as postglottalized elsewhere. This pattern of variation is illustrated in (99) (see also (70) above):

(99)  
\[
\begin{array}{cccc}
\# & \_V & \_C & \# \\
\text{Yawelmani} & [?m] & [m?] & [m?] \\
\text{Klamath} & [?m] & [m?] & [m?] \\
\end{array}
\]

The variation in the relative order of the laryngeal and the supralaryngeal gestures can be taken as additional evidence against a cluster analysis. A cluster analysis would have to account for this variation in terms of metathesis. It is questionable whether such a “powerful” operation is suitable for this purpose, particularly since the variation in the order of laryngeal and supralaryngeal gestures is never phonologically contrastive in the same subsyllabic constituent.

The phonetic support that can be advanced in languages like Yawelmani and Klamath is not available in those languages in which laryngeally modified sonorants have a more restricted distribution. For instance, we saw that the laryngeally modified sonorants of Sedang are permitted only in the onset position of a main syllable. The result of this restricted distribution is that the phonetic realization of these sonorants is “fixed”. As a consequence, the argument that Smith (1973a:54) advances in support of a cluster interpretation, i.e. that “the modification [of the sonorants] occurs before … the onset of voicing”, is rather weak. The fact that the laryngeally modified sonorants of Sedang are consistently preglottalized and preaspirated—the cross-linguistically typical realizations in prevocalic position—is insufficient to conclude that these sonorants are clusters. This aside, I have argued that the segment-cluster issue in Sedang is simply irrelevant, given that the laryngeally modified structures are tautosyllabic.

Another example of a language where laryngeally modified sonorants have a restricted distribution—and thus a “fixed” phonetic realization—is Hindi.68 In Maddieson (1984), Hindi is described as having the breathy voiced nasals /\dot{\text{\textbar}}/. By way of contrast, Ohala (1983) interprets these nasals as clusters, i.e. /m\text{nh}/, although she notes that there are arguments for both analyses. Below, I briefly evaluate the arguments for both positions, and conclude that the crucial observation is that the breathy voiced nasals of Hindi are tautosyllabic.

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68 I am grateful to Godard Schokker for answering some of my questions regarding Hindi. Of course, any error in fact or interpretation is solely my responsibility.
As was noted in §5.2.1, the realization of breathy voiced nasals in Hindi involves an initial period of modal voicing. The glottal opening gesture for breathy voice occurs approximately halfway during the oral closure phase and reaches its peak after the oral release, resulting in what Ladefoged & Maddieson (1996:107) term a period of “voiced aspiration”. Thus, in narrow transcription the breathy voiced nasals can be represented as [mʰi] and [nɭi]. Essentially the same stages can be identified in the realization of the breathy voiced lateral. For this reason, Ladefoged & Maddieson (1996:201) regard breathy voiced /ɭ/ as “a genuine lexical segment of Hindi”. Although they do not state this, we may therefore surmise that Ladefoged & Maddieson also consider breathy voiced nasals to be single segments. As was noted with regard to Sedang, the phonetic evidence for this view is rather unconvincing. For one thing, the realization of breathy voiced nasals is open to other interpretations. The fact that the first part of these nasals has modal voicing, for instance, could also be taken as an argument in favour of a cluster analysis.

A more promising avenue of approach is to examine the distribution and behaviour of breathy voiced nasals. While breathy voiced stops, parallel to other stop types, are found in word-initial, word-medial and word-final position, breathy voiced sonorants are limited to word-medial and word-final position. The reason for this is that they derive from Sanskrit /-mbh-/ and /-ndh-/, which did not occur in word-initial position (see Arun 1961). The fact that breathy voiced sonorants derive from clusters could be taken as an argument for a synchronic cluster analysis. However, it is dubious whether historical origin, in Hindi as well as in other languages, provides definitive evidence for the synchronic organization of laryngeally modified sonorants.

Ohala (1983) takes the absence of initial breathy voiced sonorants as an argument for their cluster status, although she remains silent about the nature of this argument. Presumably, Ohala’s point is that an analysis of word-medial breathy voiced sonorants as heterosyllabic accounts for their absence in word-initial position. In Ohala’s approach, which, except for the feature [-syllabic], does not incorporate syllable structure, this explanation cannot be extended to include word-final breathy voiced sonorants. One way to account for these would be to postulate a following empty nucleus, making final breathy voiced sonorants positionally identical to medial ones. However, this does not take away the main problem facing the cluster analysis: the fact that Hindi has very few other consonant-/h/ clusters. The list of attested clusters in Ohala (1983) contains only four such clusters, i.e. /ph bh fh zh/, of which /bh fh zh/ are Perso-

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69 Recall that the nasals which are realized as breathy voiced in Hindi are aspirated phonologically (see §5.2.1).

70 Only some of these clusters developed into breathy voiced nasals while others were retained. The historical origin of breathy voiced /ɭ/ is less clear, and is ignored here.

71 Note that I am not claiming that diachronic evidence does not offer any insights into the internal structure of laryngeally modified sonorants.
Arabic loans; each of these clusters is found in word-medial position only. In view of these observations, it is questionable whether a cluster interpretation yields a more insightful analysis of the distributional restrictions on breathy voiced sonorants. Note in this respect that there are no distributional restrictions on the vowel preceding breathy voiced nasals, neither in length nor in quality.\footnote{According to the description in Kelkar (1968), breathy voiced nasals may also result from optional vowel deletion in words like [məharə] ~ [məəarə]. However, as Godard Schokker (p.c.) notes, vowel deletion in such forms is impossible.}

Summarizing, we have seen that a cluster analysis can account for the word-initial absence of breathy voiced sonorants only if the sonorant and the breathy voiced part are viewed as being heterosyllabic. However, the problem with this view is that it leads to a haphazard distribution of /h/. Observe also that an underlying cluster analysis would imply that Hindi lacks a separate category of breathy voiced sonorants altogether. This seems unwarranted, since it fails to express the symmetrical organization of stops and sonorants in terms of laryngeal contrasts. These observations lead me to conclude that the breathy voiced sonorants of Hindi are most appropriately analyzed as tautosyllabic. That is, these nasals consist of a nasal manner component with a dependent element [H], dominated by a single onset constituent.

5.5 Summary

In this chapter, I have argued that Element-based Dependency provides a restrictive approach to the compatibility of manner and phonation types. More specifically, I have argued that nasals and other sonorants are compatible with distinctive aspiration, i.e. with dependent [H], and distinctive glottalization, i.e. with dependent [ʔ]. Thus, while the phonetic variation observed in laryngeally modified nasals is extensive, this variation is reduced in phonological terms to just two categories. The Element-based Dependency approach to laryngeally modified nasals is supported by synchronic and diachronic evidence. The natural class behaviour displayed by laryngeally modified nasals supports a representation of these nasals in terms of dependent [H] and [ʔ]. Evidence from the phonetic variation and the phonological distribution of laryngeally modified nasals supports a representation in which the nasal manner structure and the laryngeal modification are dominated by a single subsyllabic constituent.