Phonological aspects of nasality: An element-based dependency approach
Botma, E.D.

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This dissertation provides a phonological characterization of nasals, nasalized segments, and processes involving nasality, based on a range of cross-linguistic data. The facts encountered are formalized in the framework of Element-based Dependency, a new and highly constrained model of phonological representations that combines insights from Dependency Phonology and Element Theory. The analysis focuses primarily on the manner and phonation properties of segments, both of which are represented in terms of the elements |/, |L|, and |H|. Of particular interest is the element |L|, which, depending on its position in the phonological structure, is interpreted as sonorancy, voice, or nasalization. Evidence for the variable interpretation of |L| comes from a host of phonological processes, including nasal harmony and postnasal voicing, and from the compatibility of manner, laryngeal, and nasalization contrasts in phonological segment types.

Discussing data from a wide range of languages, this dissertation is of interest to a general phonological readership.
Phonological Aspects of Nasality

An Element-Based Dependency Approach
Phonological Aspects of Nasality

An Element-Based Dependency Approach

Academisch proefschrift

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. mr. P.F. van der Heijden
ten overstaan van
een door het college voor promoties ingestelde
commissie, in het openbaar te verdedigen in de Aula der Universiteit
op woensdag 2 juni 2004, te 14:00 uur

door

Engbert Doede Botma

geboren te Vlaardingen
Promotiecommissie

Promotor: prof. dr. P.C. Hengeveld

Co-promotor: dr. N.S.H. Smith

Faculteit der Geesteswetenschappen
For Irene,

who put up with this book,
and who puts up with me.
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<td>Obligatory Contour Principle</td>
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<td>P</td>
<td>Proto(-language)</td>
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<td>Perfective</td>
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<td>Prefix</td>
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<td>Sound Pattern of English</td>
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<tr>
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<td>UCLA Phonological Segment</td>
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<td>V</td>
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0 Introduction

0.1 Setting the stage

The goals of this dissertation are twofold. First, I attempt to provide a phonological characterization of nasals, nasalized segments, and processes of nasalization. Second, I attempt to offer a theoretical interpretation of the phonological interaction between nasal and laryngeal articulations. To this end, I introduce the model of Element-based Dependency, a generative approach to segmental and prosodic structure that combines insights from the framework of Dependency Phonology (see in particular Anderson & Ewen 1987 and Smith 2000) and the framework of Element Theory (see Harris & Lindsey 1995; see also Harris 1994).

The main Element-based Dependency claims regarding nasality are, firstly, that nasal manner consists of a combination of vocalic and consonantal manner properties, and, secondly, that nasalization is expressed by an element that, depending on the structural context, is interpreted either as nasalization or as voicing. This interpretation of nasality thus departs from that of feature-based models (see e.g. Jakobson et al. 1951, Chomsky & Halle 1968), in which nasals and nasalized segment types are characterized by the feature [nasal]. The advantage of the present approach is that it recognizes a smaller number of features, or “elements”, which leads to a more restrictive model of segmental-internal structure. In addition, Element-based Dependency offers a natural and non-stipulative account of the relation between nasal manner and other manner types, between manner, phonation, and place in general, and between segmental and prosodic structure.

With regard to nasalization, I propose that nasalized segment types are characterized by the presence of a dependent element [L]. The interpretation of this dependent [L] is context-sensitive. If [L] is associated to a sonorant manner component, as in (1a), it is interpreted as nasalization. If, on the other hand, [L] is associated to an obstruent manner component, as in (1b), it is interpreted as voicing.¹

¹ There is a complication here, in that dependent [L] is also interpreted as nasalization in case it is associated to a laryngeal manner component (which consists of a placeless obstruent manner component). I discuss this issue in §2.4.3, and in more detail in chapter 6.
An advantage of the dual interpretation of dependent \( L \) is that it accounts for the complementary distribution of nasalization and voice; cross-linguistic evidence suggests that there are no languages with distinctively voiced sonorants, nor do there appear to be any languages with distinctively nasalized obstruents. An additional advantage of a unified approach to nasalization and voicing is that it provides a straightforward interpretation of processes that trigger either voicing or nasalization, depending on the manner type of the affected segment. I will consider a number of such processes in chapters 3 and 4.

Proposals regarding a unified interpretation of nasality and voice can be traced back to an early suggestion regarding the feature-geometric organization of [nasal] and [voice]. Based on a process of denasalization in Toba Batak, Hayes (1986:475) groups both features under the “Peripheral” tier, which “contains the features responsible for the velum and the larynx”. However, this proposal was not followed up in later work in Feature Geometry.\(^2\)

In some versions of Dependency Phonology (see Humbert 1995, Smith 2000), as well as in Radical CV Phonology (see Van der Hulst 1995), it is assumed that nasalization and voice involve the presence of the vocalic “component” \( V \). However, none of these approaches considers nasalization in any detail, nor do they provide an account of the relation between nasalization and laryngeal articulations. The same can be said about Element Theory, although Harris & Lindsey (1995:65) make an interesting suggestion with regard to the location of the element(s) specifying nasality:

\[ \text{[G]iven the current state of our knowledge, it is not clear whether [nasality] should be represented by an autonomous nasal element or is more appropriately subsumed under one of the laryngeal elements.} \]

---

\(^2\) Toba Batak displays an optional process of denasalization which turns a nasal into a voiceless stop in case it precedes a following heterorganic voiceless obstruent (e.g. /mk/ \( \rightarrow \) [pk]). Hayes accounts for this process in terms of spreading of the Peripheral node from the voiceless obstruent (which contains [–voice] and [–nasal]) to the nasal, the Peripheral node of which is delinked. A problem with this approach, as Den Dikken & Van der Hulst (1988:72) note, is that [±voice] is not contrastive in Toba Batak nasals. Within Feature Geometry, Toba Batak denasalization can be handled by underspecification of [±voice] in nasals, which obviates the need for a class node that subsumes both [nasal] and the laryngeal features.
Working within the framework of “Revised Element Theory”, Ploch (1999) provides a unified account of nasalization and voice in terms of the element |L|. I briefly discuss Ploch’s approach in §2.4.3.

Regarding nasals, I propose that the notion of nasal manner is a derived concept, in the sense that nasal manner consists of a combination of more basic building blocks: a dominating vocalic (or “sonorant”) element |L| and a dominated consonantal (or “stop-like”) element |/?|. These two elements, in this specific configuration, represent the basic structure of a segment type that I term a “sonorant stop”:

(2)

\[
\begin{array}{c}
|L\
|\
|/?\
\end{array}
\]

As I will argue in §2.2.5, sonorant stops are in most languages realized as nasals.

The essence of the Element-based Dependency approach to nasal manner is not new. The general conception is based on the representation of nasal manner in Dependency Phonology (see Anderson & Ewen 1987). Compare Anderson & Ewen’s representation of nasal manner with the present approach:

(3)  a. Anderson & Ewen  b. Element-based Dependency

\[
\begin{array}{c}
V\
|\
L\
|\
C\
|\
|/?\
\end{array}
\]

In Anderson & Ewen, nasal manner consists of a structure in which a vocalic manner component |V| dominates a dependent consonantal manner component |C|. This is more or less equivalent to the interpretation of nasal manner here.

The Element-based Dependency representation of nasal manner captures the hybrid phonological behaviour that is displayed by nasals. The fact that nasals contain |L| as dominating element means that they behave as sonorants as regards their prosodic interpretation. Consider for instance the observation that nasals, as consonants, are relatively unmarked in vocalic positions such as nuclei and codas. The fact that nasals contain |/?| as dominated element means that they behave as stops as regards place of articulation. Consider in this light the observation that, in most languages, nasals have available the same set of place contrasts as plosives. The general relation between nasal manner, place, and prosodic structure can thus be represented as in (4):

(4)  a. Anderson & Ewen  b. Element-based Dependency

\[
\begin{array}{c}
V\
|\
L\
|\
C\
|\
|/?\
\end{array}
\]
Prosodic structure

<table>
<thead>
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<th>_</th>
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<tr>
<td>?</td>
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<tr>
<td>place</td>
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Manner, prosodic structure, and place are also interrelated in the case of other manner types. Consider for instance the Element-based Dependency representation of affricate manner:

Prosodic structure

<table>
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<tbody>
<tr>
<td>?</td>
<td>H</td>
</tr>
<tr>
<td>I</td>
<td></td>
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The \(?\)-headed status of affricates expresses the fact that affricates function as plosives for the purposes of prosodic interpretation. This captures the observation that affricates generally have the same distribution as plosives. Similar to the more basic sibilants, affricates have the element \(H\) dominating place. As such, the fact that affricates and sibilants are generally restricted to coronal place can be attributed to \(H\) selecting \(I\).

One consequence of representations such as those in (4) and (5) is that laryngeal modifications, which I assume are represented in terms of branching dependent elements, are directly dominated by a prosodic rather than a segmental unit. More specifically, I will follow Kehrein (2002) and assume that laryngeal contrasts such as voice, aspiration, and glottalization are directly dominated by a subsyllabic constituent, i.e. an onset (O), a nucleus (N), or a coda (C). This is illustrated by the general organization in (6), where the phonation component subsumes the various laryngeal distinctions:

O, N, C

manner phonation

place
As Kehrein observes, the prosodic interpretation of laryngeal contrasts expresses
the fact that phonological units should be assigned to the level in the prosodic
hierarchy at which they are minimally contrastive. As Kehrein (2002:71) points
out,

[...]his is a principle widely used in phonological argumentation ...;
and it is (in part) responsible for the development from linear
(SPE-type) to non-linear phonology. Stress, for instance, is never
distinctive below the syllabic level, and thus assigned to rhymes or
syllable nodes rather than segments.

In this dissertation, I will extend Kehrein’s approach to laryngeal contrasts to
include nasalization, which, as was noted above, I treat on a structural par with
voice. In addition, I will argue in chapter 3 that distinctive nasalization can in
some languages be viewed as a property of entire syllables.

0.2 Overview of dissertation

This dissertation consists of three parts. Part I, which consists of chapters 1 and
2, provides the theoretical background. Chapter 1 outlines the basic assumptions
regarding the structure and content of phonological representations. Chapter 2
introduces the main tenets of the Element-based Dependency framework in
respect of the representation of manner, phonation, and place.

Part II, consisting of chapters 3, 4, and 5, forms the core of this dissertation,
and offers an in-depth discussion of the phonological relation between nasality
and laryngeal articulations. Chapter 3 addresses the issue of nasalization, and
consider in some detail how the level of the syllable plays a role in processes of
nasal harmony. Chapter 4 examines the dual interpretation of dependent |L| as
voice and nasalization. Chapter 5 considers the issue of laryngeal modifications
in nasals.

Part III, which consists of chapters 6 and 7, adresses some residual issues.
Chapter 6 examines the status of nasalized laryngeals and considers some
processes that have been argued to fall under the rubric of rhinoglottophilia, the
Finally, chapter 7 focuses on a number of phonological phenomena in which
nasals do not behave as a natural class, but display asymmetric behaviour.

In each of the chapters theoretical issues are considered in combination with
case studies. Some of these case studies are cursory, others offer a more detailed
analysis of the matter at hand. As regards the selection of data, I have not been
guided by any methodological basis. Rather, my objective has been to be as
comprehensive as possible, and to include as many examples of languages and
language families as I could find. Some of the languages and language families
that are examined here, such as Burmese-Loloish and Tai-Kadai, do not figure prominently in the field of generative phonology.

The subject matter of this dissertation makes certain omissions inevitable. The phonology of nasality is a vast topic, and an exhaustive investigation of each of its aspects would easily fill several volumes. Some of the omissions are rather specific. For instance, I do not discuss the issue of nasal place specification in any great detail. This is unfortunate, since nasal place, and its relation to aspects of prosodic and segmental structure, would provide a fruitful testing ground for the Element-based Dependency representations that are proposed here. Another topic that is not discussed concerns the relation between vowel nasalization and vowel place. This has been, and still is, a topic of much debate; for discussion of this issue see, among others, Bhat (1975), Entenman (1975), Hombert (1985), Beddor (1993), and Ploch (1999).

Other omissions are of a more general theoretical nature. For instance, I will have little to say about the relation between underlying and surface forms. The approach advocated here is, in principle at least, compatible with derivational and non-derivational theories, and with rule-based and constraint-based models. The reader will note that throughout this dissertation I use the term “process” and the symbol “–>”. It should be stressed at the outset that I have done this for reasons of convenience, not to make any theoretical claims.
Part I Theoretical background
In this chapter, I provide an introduction to the main ingredients of Element-based Dependency from a general theoretical perspective. On the one hand, this concerns an outline of the basic assumptions regarding the structure of Element-based Dependency representations, which is based in part on Dependency Phonology. On the other hand, this concerns an outline of the basic assumptions regarding the content of Element-based Dependency representations, which is based, again in part, on that of Element Theory.

This chapter is organized as follows. First, in §1.1, I consider some of the challenges confronting theories of segmental structure. These challenges suggest that such theories require relatively abstract features in order to adequately express the relations between different segment types, as well as the relations holding between the manner, phonation, and place properties of which segments are composed. Next, in §1.2, I focus in some detail on the notion of dependency, and consider how this notion can be used to express the relation between manner, phonation, and place. Finally, in §1.3, I outline the main tenets of Element Theory and discuss some problematic aspects of this framework, thereby setting the stage for the Element-based Dependency approach.

1.1 Introduction

A theory of segment specification must account for a number of aspects. First, given a particular language, it must represent the distinctive properties of those segments that are contrastive. Second, it must be capable of expressing the various operations and processes affecting these segments. Third, it must provide an account of how segments are organized in prosodic structure. This last aspect is relevant not only with respect to the prosodic interpretation of segments, but also because many regularities that hold at the level of segmental organization are most appropriately expressed in terms of prosodic structure, in particular that of the syllable. These regularities include the linear order of segments and the distribution of contrastive material in the segmental string.

The above aspects are to some extent related, for instance with respect to the notion of markedness. Consider a language with an underlying contrast between
plain and aspirated stops. In the terminology of Trubetzkoy (1939) this type of contrast involves a privative opposition, in that the aspirated series has a property—aspiration—which the plain series lacks. Since this property is distinctive, it must be represented in the segmental organization. The representation must also convey the fact that the aspirated series is marked with respect to the plain series. This is important, since if the contrast is neutralized, we expect this to occur in the direction of the plain series. In addition, the representation should allow for a natural expression of the neutralization process itself. Consider as an illustration the distribution of aspirated stops in English:

\[\begin{array}{ccc}
\text{a. pit} & [p^h\text{t}] & \text{b. spit} & [s\text{pt}] & \text{c. hit} & [h\text{t}] \\
\text{repeat} & [r^p^h\text{t}] & \text{respite} & [r^s\text{p}\text{t}] & \text{vehicular} & [\text{vih}\text{k}\text{j}\text{o}\text{la}] \\
\text{mutter} & [\text{m}\text{a}\text{t}\text{a}] & \text{muster} & [\text{m}\text{a}\text{t}\text{a}] & \text{vehicle} & [\text{vi}\text{t}\text{k}\text{l}] \\
\end{array}\]

The forms in (1a) show that the distribution of aspiration is prosodically conditioned, in that aspirated stops are found in foot-initial position only. The forms in (1b) show that no aspiration is found in case the stop is preceded by /s/. Here at least two explanations are possible. One would be to say that in this context the stop is not in absolute foot-initial position, so that the lack of aspiration in *spit* and *respite* is due to the same reason as the lack of aspiration in *mutter*. This implies that /s/-plosive clusters are part of the same foot. An alternative explanation would be to say that /s/ is responsible for neutralization of the aspiration contrast. This receives some support when we take into account that the distribution of /h/ parallels that of aspirated stops, as is shown by the forms in (1c). Note, too, that there is cross-linguistic support for a phonological relation between /s/ and /h/; consider for instance the fact that in some dialects of Spanish /s/ is realized as [h] in the coda position of a syllable (cf. Harris 1983). This suggests that the representation of aspirated stops, /s/ and /h/ shares a common structural basis. I will not attempt an analysis of aspiration in English here; however, the facts indicate that such an analysis must include both prosodic and segmental aspects of phonological structure.

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1. Throughout this dissertation, the term “stop” refers to consonantal articulations that involve complete closure of the oral cavity. Unless otherwise noted, I assume that stops function as obstruents (i.e. as plosives) phonologically. The basic manner structure of a nasal, on the other hand, is that of a sonorant stop.

2. Following among others Harris (1994), I assume that the underlying contrast in the English stop system is in terms of aspiration; that is, the fortis stops are aspirated and therefore marked, whereas the lenis stops are neutral and therefore unmarked.

3. It has been proposed for instance that /s/, /h/, and aspirated stops are specified for the feature [spread glottis]. Neutralization of the aspiration contrast after /s/ can then be analyzed in terms of a cooccurrence restriction involving this feature; see Iverson & Salmons (1995) for an account along these lines.
It has proved a challenge to adequately combine the various aspects of segmental structure into a coherent framework of segment specification. A problem faced by all theories is that of overgeneration, in terms of the number of segments and the number of operations. Two strategies can be employed to counteract this problem: reduction of the number of feature values, and reduction of the number of features themselves.

Taking the reduction of the number of feature values first, since *The Sound Pattern of English* (Chomsky & Halle 1968; henceforth SPE) the main development has been the position that features are unary-valued (or “monovalent”). This position has been defended most extensively by proponents of Dependency Phonology as well as related frameworks such as Government Phonology (see e.g. Kaye et al. 1985, 1990), Particle Phonology (Schane 1984), and Element Theory (Harris & Lindsey 1995).4

Consider the issue of feature values in relation to the SPE feature \[+\text{nasal}\]. The fact that nasals typically act as a natural class is an argument for taking \[+\text{nasal}\] or \[\text{nasal}\] to be relevant. However, given that there appear to be no instances where non-nasals act as a natural class, the evidence tips the balance in favour of a unary-valued feature [nasal].5 The point is that a binary-valued feature results in overgeneration, since \[-\text{nasal}\] predicts a segment class that is phonologically irrelevant; hence, a binary-valued feature \[\pm\text{nasal}\] is empirically inadequate.

A further problem of binary feature theories is that in such theories it is impossible to take relative segmental complexity as a diagnostic for phonological markedness. As was noted above, in languages with contrastively aspirated stops we expect neutralization to be in the direction of the plain series of stops, making the aspirated series marked. This type of markedness difference is straightforwardly expressed in a unary feature theory. In such a theory aspirated stops are literally marked, in the sense that they have an extra feature, for instance [spread glottis], as compared to plain stops. Thus, as far as relative markedness is concerned, unary feature theories have an inherent evaluation metric. In binary feature theories, on the other hand, relative markedness must be accounted for by additional theoretical machinery such as underspecification and redundancy rules. Clearly, having unary features is the more restrictive option.

Another strategy to prevent overgeneration is to minimize the number of features themselves. The extent to which this is possible depends on the theory of segment specification. Feature minimization is inherently problematic for frameworks in which features are explicitly defined in terms of articulatory phonetic categories, such as in the Articulator Model of Feature Geometry (see for instance Sagey 1986, Halle 1992, Halle et al. 2000). In this approach, feature

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4 See Den Dikken & Van der Hulst (1988) for an overview; for a more recent discussion see Ewen & Van der Hulst (2001).

5 See e.g. Rice & Avery (1991a) and Steriade (1993) for arguments against \[-\text{nasal}\].
minimization goes against the fundamental hypothesis that phonologically relevant categories are shaped by the configuration of the vocal tract.

There are other reasons why strictly articulatory feature theories are problematic. One, as observed by Smith (1988), is that an articulatory interpretation of phonological phenomena often conceals rather than reveals the nature of the process involved. The point here is that segmental phonology is driven not only by articulatory, but also by acoustic factors. Consider in this respect the frequently observed interaction between rounded segments and labials (and sometimes velars). An example of such interaction can be found in the Dravidian language Tulu. As is noted by Clements (1990), in Tulu the high unrounded central vowel /i/ surfaces as rounded when preceded by a labial consonant, or by a rounded vowel in the preceding syllable. Thus, in the forms in (2a) /i/ is retained, while in the forms in (2b) /i/ is realized as [u].

(2)  a. kaṭṭi ‘bond’  b. kappu ‘blackness’
    kaṇṇi ‘eye’  porṇu ‘girl’
    arinī ‘rice-ACC’  tūru-n-u ‘country village-ACC’

This interaction between labials and rounded vowels is difficult to express in terms of articulatory features, since the relation between the relevant features, say [labial] and [round], remains essentially stipulative. No such problems are encountered in a theory where features express both acoustic and articulatory properties of sounds, since here the link between labiality and roundness can be characterized in acoustic terms, i.e. by the fact that both involve a “diffuse-falling” spectral pattern.6

Features that refer to both articulatory and acoustic properties of segments do not have a single phonetic correlate. In this sense, such features are less concrete than strictly articulatory or acoustic features.7 A shift away from phonetic concreteness has three general advantages. First, as noted, it permits feature reduction. Second, it allows an interpretation of phonological interaction between segments that is not motivated by superficial phonetic similarities. For instance, I will argue in §5.2 that the type of nasal which is analyzed as voiceless in SPE is more properly regarded as aspirated. As such, this type of nasal is characterized by the same feature that characterizes sibilants, fricatives, and aspirated stops. Support for this view comes from the observation that these segment types show natural class behaviour. Furthermore, sibilants, in particular

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6 See e.g. Blumstein & Stevens (1981) for the acoustic similarity between labiality and roundness.

7 This point is underscored by the observation that vowels traditionally classified as [+round] (or [+labial] for that matter), are in some languages produced with little or no lip rounding. Consider for instance the high back vowel of Japanese, which is phonetically realized as [ut] even though its phonological behaviour is that of an unmarked peripheral vowel.
/s/, are frequently involved in the creation of distinctively aspirated nasals. The relation between aspirated nasals and sibilants does not follow straightforwardly from their shared phonetic characteristics, however. A third advantage of a model that employs relatively abstract features is that such a model circumvents a problem that is faced by SPE-type feature theories, i.e. the fact that some features lack a clear phonetic correlate. A case in point concerns the feature [(+)sonorant]. According to Chomsky & Halle (1968:302), segments specified for [(+)sonorant] are “produced with a vocal tract cavity configuration in which spontaneous voicing is possible”. This definition is both unspecific and imprecise, however, since it classifies /g/ as sonorants. Subsequent work has attempted to provide an acoustic definition of sonorancy (see e.g. Ladefoged 1971), but no clear phonetic correlate has been found to date (see Malsch & Fulcher 1989 and Nathan 1989 for discussion of this issue).

It has also proved difficult to find a clear phonetic correlate of the feature [(+)nasal], which in SPE-type feature theories characterizes both nasal and nasalized segments. Ladefoged & Maddieson (1996) observe that a prime characteristic of nasals is their formant structure, an acoustic property that is generally associated with sonorants. The identification of nasals as being sonorant is essential with respect to their phonological behaviour, as we will see in §2.3. Ladefoged & Maddieson further observe that the unifying characteristic of nasalized segments is the articulatory property of a lowered velum, the point being that there is little acoustic similarity between, say, a nasalized vowel and a nasalized fricative. Ladefoged & Maddieson (1996:136) thus conclude that the feature specifying nasality must have both an acoustic and an articulatory correlate:

Nasals, nasalized vowels and approximants are all [(+)nasal], but fricatives are obstruents and the acoustic signature of their obstruency is poorly compatible with nasality. The similarities between nasals and nasalized consonants arise from articulatory considerations, whereas the differences arise from acoustic considerations.

This interpretation presupposes that nasalized fricatives are phonologically relevant, i.e. that such sounds must be given a specific segmental representation. Nevertheless, the fact that nasalized fricatives are articulatorily possible does not imply that they qualify as a phonological class. In fact, I will argue in §2.4.3 that segments such as /g/ and /2/, which may be described as voiced nasalized fricatives phonetically, function as sonorants phonologically. This suggests that

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8 Chomsky & Halle do not consider the glottis to form part of the vocal tract. The problem with this view is that whereas the vocal tract configuration of /h/ is typically that of a neighbouring vowel, the glottal configuration of /h/ rules out spontaneous voicing.
an articulatory characterization of nasality in terms of a lowered velum is inadequate from the viewpoint of phonology.

The lack of an adequate articulatory characterization of nasality is underscored by the fact that velopharyngeal opening is also found in the context of oral vowels (see e.g. Moll 1962, Van Reenen 1981, Clumeck 1976, and Huffman 1989). This leads Huffman to posit an orality threshold, i.e. a limit above which nasal flow rates reflect nasalization that is phonologically relevant. However, given that Huffman’s findings show that nasal airflow rates are speaker-dependent and, in addition, are dependent on vowel quality and vowel place, it is questionable whether this account sheds any light on a universal articulatory correlate of nasality (see also Ploch 1999).

An acoustic definition of nasality is equally problematic. As Entenman (1977) and Ploch (1999) point out, nasality does not appear to have a unique acoustic correlate, neither in terms of an upward shift in F₁ (see e.g. Dickson 1962, Delattre 1966, House & Stevens 1971), nor in terms of lowering of F₁ intensity (see e.g. Hattori et al. 1958, Dickson 1962). A further complicating factor is that it has been shown that many of the acoustic cues associated with nasalization can also be achieved by other means (see Schwartz 1971, Beddor 1993). For instance, we will see in §6.2 that the lack of a clear acoustic correlate of nasality may give rise to spontaneous nasalization, a phenomenon whereby vowels are nasalized by a neighbouring glottal, sibilant or aspirated consonant.

The lack of clear phonetic correlates suggests that an account in which sonorancy and nasality are characterized in terms of single, phonetically motivated features such as [sonorant] and [nasal] must be rejected, and that a more abstract characterization of these concepts is required. To this end it has been proposed that sonority, i.e. relative sonorancy, is derivable from the relative complexity of segments. This is the position in Dogil (1988), Rice (1992), and in Element Theory (Harris & Lindsey 1995). Dogil and Rice assume that the more sonorous a segment is, the more structure it has. Element Theory takes the reverse view, assuming that the most sonorous segments, i.e. vowels, consist of the smallest number of “elements”.

The relation between segmental complexity and inherent sonority is less straightforward in Dependency Phonology, since here the representation of segments at the two ends of the sonority scale, i.e. voiceless stops and vowels, is maximally simple. In Dependency Phonology it is assumed that the degree of sonority depends on the presence of the component [V] in the representation of a segment, and, more specifically, on the position of |V| within that representation (see e.g. Anderson & Ewen 1987).

Element Theory and Dependency Phonology also offer a more abstract approach to nasality. For instance, in the “Revised” version of Element Theory

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9 For more discussion bearing on this issue see, among others, Entenman (1977), Van Reenen (1981), Huffman & Krakow (1993), and Ploch (1999).
in Ploch (1999) nasality is characterized by the same element which characterizes voicing in obstruents, i.e. |L|, with the difference in interpretation depending on the context in which |L| appears. In Dependency Phonology, on the other hand, nasality is a “derived” concept, in the sense that it consists of a combination of more basic building blocks. For instance, Anderson & Ewen represent nasal manner in terms of a combination of the components |C| and |V|, in such a way that |C| is dependent on |V|. Here |C| and |V| are defined in extremely general phonetic terms, and it is only in this relation that they represent nasal manner.  

The interpretation of nasality in Element-based Dependency is in many respects a combination of that in Dependency Phonology and Element Theory. Like Dependency Phonology, nasal manner involves a combination of more basic building blocks. Like Element Theory, one of these building blocks is the element |L|, which, depending on its context, is interpreted as sonorancy, voicing, or nasalization. In the remainder of this chapter, I focus in more detail on a number of aspects of Dependency Phonology and Element Theory which are also relevant in Element-based Dependency.

1.2 Dependency

Recent work in Dependency Phonology (e.g. Humbert 1995, Smith 2000) assumes that phonological structure is maximally binary branching and consists of head-dependency relations (see also Van der Hulst 1989, 1995, Dresher & Van der Hulst 1995, Van de Weijer 1996). The distinction between heads and dependents makes it possible to reduce the number of features, since the same feature can be assigned a different (but related) interpretation depending on whether it occurs as a head or as a dependent. This type of approach reduces the number of features, and thus restricts the range of possible segments. In addition, it allows for a straightforward interpretation of a number of featural relationships, both positive and negative, in that these can be expressed by instantiations of the same feature in different structural positions. In this section, I consider the notion of dependency in Dependency Phonology in more detail; I then proceed to make explicit how this notion figures in Element-based Dependency.

In linguistic theory the notion of dependency refers to a binary asymmetric relation in which one element in a construction is the head and the other the dependent. Within segmental phonology the notion of dependency figures in a number of frameworks, although these differ as to the specific interpretation of

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10 Note that I am concerned here with the Dependency Phonology representation of nasal manner, not nasalization. Anderson & Ewen represent the latter in terms of the component |n|, which they assume is located in the “articulatory gesture”. See Davenport (1995) for an alternative account.
the dependency relation (see Ewen 1995 for an overview). Consider for instance
the kind of dependency used in Feature Geometry (see e.g. Clements 1985, Sagey 1986, McCarthy 1988), which Ewen terms “structural dependency”:

\[(3)\]
\[
\begin{align*}
\text{a.} & \quad X & \text{b.} & \quad \text{[coronal]} \\
& \quad | & \quad | \\
Y & \quad \text{[distributed]}
\end{align*}
\]

In Feature Geometry, (3a) is interpreted as a representation in which \(Y\) is structurally dependent on \(X\), in the sense that the presence of \(Y\) implies the presence of \(X\). A concrete example of this type of dependency is given in (3b). (3b) expresses the fact that segments specified for [distributed], the traditional feature which distinguishes between apical and laminal articulations, are a subset of segments specified for [coronal]; that is, any segment that is [distributed] is also [coronal]. Hence, in this scenario dependency is equated with immediate dominance.

How does this relate to the conception of dependency in Dependency Phonology? In Dependency Phonology the notion of dependency must be viewed in relation to the reduced number of features which this theory employs. Anderson & Ewen (1987:151) assume that the representation of segmental manner involves two components: “\(V\), a component which can be defined as ‘relatively periodic’, and \(C\), a component of ‘periodic energy reduction’”\(^{11}\). These components are retained in more recent work in Dependency Phonology (see e.g. Humbert 1995, Bolognesi 1998, and Smith 2000). In each of these models the interpretation of \(C\) and \(V\) depends on the structural position in which they occur. It is in this respect that dependency becomes relevant. In Anderson & Ewen we find representations of the type in (4):\(^{12}\)

\[(4)\]
\[
\begin{align*}
\text{a.} & \quad C & \text{b.} & \quad C & \text{c.} & \quad V & \text{d.} & \quad V \\
& \quad | & \quad | & \quad | \\
& \quad V & \quad | & \quad C
\end{align*}
\]

\(V\) \text{ \textit{Voiceless stop} } \quad \text{\textit{Voiced stop} } \quad \text{\textit{Nasal} } \quad \text{\textit{Vowel}}

(4a,d) show that voiceless stops and vowels, the segment types that occupy the two extremes of the sonority scale, are represented in terms of a single \(C\) and a single \(V\). The assumption that the representation of voiceless stops and vowels

\(^{11}\) The notions of “component” and “element” are equivalent to the notion of “feature” to the extent that each refers to the smallest unit in the phonological organization. I adopt the convention of representing components and elements between vertical lines.

\(^{12}\) The arborescent notation used here is formally equivalent to the notation in terms of arrows used by Anderson & Ewen. I ignore the structural relation which Anderson & Ewen refer to as mutual dependency, which plays a role in their representation of fricatives and liquids.
is maximally simple entails that the representation of intermediate manner types is more complex, as is shown by the representation of voiced stops and nasals in (4b,c). In voiced stops |C| dominates |V|. Anderson & Ewen refer to this relation as one in which |C| “governs” |V| or, alternatively, as one in which |V| is “dependent on” |C|. Thus, in voiced stops |C| is the head and |V| is the dependent. The reverse relation, i.e. one in which |V| dominates |C|, represents nasal manner.

This scenario shows that the interpretation of |C| and |V| is context-sensitive. Head |C| involves maximum energy reduction; a segment with a manner structure consisting of |C| only is therefore maximally consonantal, i.e. a voiceless stop. Head |V| involves maximum periodicity; a segment with a manner structure consisting of |V| only is therefore maximally vocalic, i.e. a vowel. When dominated by |C|, as in (4b), |V| is interpreted as voicing. Dependent |V| thus increases the periodicity of a stop, but leaves its obstruent status intact. When governed by |V|, as in (4c), |C| implies a reduction of energy. This dependent |C| does not affect the sonorancy of the segment concerned, however; the resulting structure is interpreted as nasal manner.13 In terms of traditional features, |C| in (4c) is therefore roughly equivalent to [–continuant]. Note that all the distinctions in (4) are expressed in terms of two unary features, combined with the notion of dependency.

The preceding discussion indicates that the interpretation of the dependency relation in Dependency Phonology differs from that in Feature Geometry. In both frameworks there is a relation of implication between the head and the dependent, in the sense that the presence of a dependent implies the presence of a head. Observe, however, that in Dependency Phonology, unlike in Feature Geometry, there is no implication as regards the content of the components. In the representation of nasal manner for instance, |C| is present by virtue of |V| because a dependent requires a head, but not because the content of |C| requires it to be a dependent of |V|; rather, it is the configuration as a whole which identifies a segment as nasal. Note that the lack of implication in terms of content is due to the lack of phonetic concreteness of the manner components that are assumed in Dependency Phonology.

By way of contrast, most of the dependency relations assumed in Feature Geometry follow from the articulatory definition of the features involved; recall [distributed] and [coronal], for instance. Ewen (1995:581) notes in this respect that in Feature Geometry “the interpretation of the dependency relations represents an attempt to formalize the constraints on human articulators”. The problem with this interpretation concerns the characterization of features in terms of concrete articulatory phonetic categories. This becomes apparent when

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13 Anderson & Ewen cite Jakobson & Halle (1956:56), who observe that “nasality, by super-imposing a clear-cut formant structure upon the consonantal pattern, brings consonants closer to vowels".
we consider the various Feature Geometry proposals regarding the location of the feature [nasal]. Within Feature Geometry it has been proposed that [nasal] is located under the Manner node (Clements 1985), the Peripheral (or Laryngeal) node (Hayes 1986), the Root node (McCarthy 1988, Piggott 1988), the Supralaryngeal node (Trigo 1993), the Soft Palate node (Sagey 1986), the Spontaneous Voice node (Rice & Avery 1989, Rice 1993), under either the Spontaneous Voice node or the Soft Palate node (Piggott 1992), or under both (Tourville 1991).\(^{14}\) Each of these proposals has its merits, but, as Humbert (1995:13) points out, they cannot all be correct.

The variety of proposals regarding the location of the feature [nasal] indicates that the structural principles underlying Feature Geometry are not sufficiently constrained. In Feature Geometry, motivation for a particular feature organization comes both from articulatory phonetic considerations and from the behaviour of features in processes.\(^{15}\) There are, however, no independent principles that help restrict the range of possible structures. This problem demonstrates that a restrictive model of segment specification benefits from having relatively abstract features, since the structural principles of such a model can be motivated independently from the content of the features involved. In this respect Dependency Phonology is, in principle at least, more adequate than Feature Geometry.

In §1.2.1 I consider the role of dependency in Element-based Dependency, paying particular attention to the interpretation of the dependency relations that hold between the manner, phonation, and place properties of segments.

### 1.2.1 Dependency relations between manner, phonation, and place

In this section I will take as my starting point recent work in Dependency Phonology, in particular Humbert (1995). This model assumes the following general organization of segmental structure (cf. Humbert 1995:31; see also Smith 2000:240-1):

\[
\begin{array}{c}
\text{manner} \\
\downarrow \\
\text{place} \quad \text{phonation}
\end{array}
\]

\(^{14}\) The Spontaneous Voice node, abbreviated SV, has also been referred to as Spontaneous Voicing node (Piggott 1992) and as Sonorant Voice node (Piggott 1993); this variation appears to be terminological only.

\(^{15}\) With regard to the location of [nasal] articulatory phonetic evidence is difficult to find, since in articulatory terms [nasal] is not dependent on any other feature. Note, incidentally, that this presupposes—incorrectly, in my opinion—that there is an adequate articulatory definition of phonologically relevant nasality.
The organization in (5) expresses the fact that manner functions as the segmental head. Place is dominated by manner and, in Anderson & Ewen’s terms, is therefore dependent on it. The interpretation of phonation, which subsumes the various laryngeal distinctions, is less straightforward. I return to this issue shortly; first, I consider some arguments for the headedness of manner.

A first and general argument for according manner head status is that manner is the most characteristic aspect of a segment. This is reflected in the standard description of speech sounds: a sound like [p], for instance, is a labial stop, not a “stopped labial”.

A more specific argument for the primacy of manner is that the manner properties of a segment determine to a large extent its position in prosodic structure. As such one expects manner properties to be visible for the purposes of syllabification. Consider for instance the distribution of vowels and consonants in syllable structure, the fact that many languages only permit sonorants in the syllable coda (see e.g. Fudge 1969, Selkirk 1982, Goldsmith 1990), or the fact that in some languages the set of weight-bearing codas is restricted to sonorants (see Zec 1991). According manner properties the status of segmental head provides a way to formalize their prosodic visibility.

A third argument for the head status of manner concerns the observation that place assimilation processes typically operate in the context of a particular manner type.16 A case in point is English in-prefixation; here the prefix nasal surfaces as homorganic with a following stop, as in (6a), and as [n] before fricatives and vowels, as in (6b,c). Before nasals and liquids, the prefix nasal undergoes complete assimilation with concomitant degemination, as in (6d,e):17

(6)  a. impartial [impʰɑːt] inglorious [ɪŋɡlɔːriəs]
    b. infertile [ɪnfɜːtɪl] invalid [ɪnvəld]
    c. inactive [ɪnəktɪv] inelegant [ɪnəlɛŋkt]
    d. immoral [ɪmɔrəl] innumerate [ɪnjuːmərət]
    e. illegal [ɪlɪɡəl] irregular [ɪrɪɡjʊlə]

Hence, place specification of the nasal takes account of the manner properties of the stem-initial segment. By way of contrast, processes affecting manner usually, although not exclusively, apply without regard to place.18 Consider for

16 This point is also made by Smith (2000:238).
17 This is the scenario of Borowsky (1986). Note that in-prefixation applies to a restricted number of forms of predominantly Latin origin; for present purposes it is immaterial whether the process has synchronic status. Note also that nasal place assimilation is optional before fricatives, e.g. invalid [ɪnvəld] ~ [ɪnvəld].
18 In chapter 7 I consider a number of processes in which only a subset of nasals is targeted. While this suggests that such asymmetries result from differences in place, I will argue that at least some of them may in fact be the result of a difference in manner.
instance a typical process of intervocalic lenition in which voiced stops are
turned into fricatives, as in Spanish.

It could be argued that a further argument for the primacy of manner
concerns the observation that the manner properties of a segment determine the
range of possible place distinctions. Consider for instance the observation that
sibilants, affricates, and laterals are limited to coronals. Taking sibilants as an
example, this can be expressed in informal terms by making coronal place
dependent on sibilant manner, as in (7):

\[
\begin{array}{c}
\text{sibilant} \\
\mid \\
\text{coronal}
\end{array}
\]

We can interpret (7) to mean that sibilant manner, in the capacity of segmental
head, “selects” the dependent coronal place specification. The selectional
properties of heads are of course familiar from other linguistic domains;
consider for instance the selection of complements by verbs.

Similarly, there appear to be good grounds to regard manner as selecting
phonation, given the observation that the distribution of the various laryngeal
distinctions—voice, aspiration, glottalization, breathy voice, and implosion—
depends on the manner type of the segment involved. That is, whereas stops and
affricates are compatible with any laryngeal contrast, fricatives permit only a
contrast in terms of voice, aspiration, and glottalization, and sonorants only in
terms of aspiration and glottalization.

In Dependency Phonology the fact that obstruents, but not sonorants, are
compatible with distinctive voice has been interpreted to mean that a structure
with head \(|C|\) and dependent \(|V|\) is well-formed, whereas a structure with head
\(|V|\) and dependent \(|V|\) is ill-formed. This is the position of Humbert (1995), who
assumes that (8a) denotes a voiced obstruent, and that the structure in (8b)—a
“voiced sonorant”—is illicit:

\[
\begin{array}{c}
a. \quad \begin{array}{c}
\text{C} \\
\mid \\
\ldots\ \text{V}
\end{array} \\
b. \quad \begin{array}{c}
\ast\text{V} \\
\mid \\
\ldots\ \text{V}
\end{array}
\end{array}
\]

The cooccurrence restriction between head and dependent \(|V|\) is motivated by
the observation that voicing is redundant in sonorants, and hence should not
form part of their phonological specification. Nevertheless, this does not take
away the fact that the impossibility of head and dependent \(|V|\) as a phonological
structure must be stipulated in Humbert’s approach.

A further argument against a cooccurrence restriction between head and
dependent \(|V|\) is that such a restriction is at odds with the Dependency
Phonology assumption that components lack phonetic concreteness. This can be
illustrated by considering the interpretation of place components. In recent
versions of Dependency Phonology, as well as in related approaches, it is assumed that the components \(|U|\), \(|I|\), and \(|A|\) specify place in both consonants and vowels. As such, one and the same component, say \(|A|\), can be dominated by a consonantal or by a vocalic manner structure, as is represented in informal terms in (9a,b):

(9) a. consonant b. vowel

\[
\begin{array}{c|c|}
| & A & A \\
\end{array}
\]

The advantage of this approach is that it restricts the number of components, but at the same time it means that the interpretation of components is variable: \(|A|\) is interpreted as velar when it is dominated by a consonantal manner structure, and as low when it is dominated by a vocalic manner structure. More generally, this scenario shows that place components have a context-sensitive interpretation, depending on the manner type by which they are dominated. In Humbert (1995), however, this context-sensitivity is not extended to include phonation, where dependent \(|V|\) is restricted to distinctive voice.

Two points emerge from the preceding discussion. First, cooccurrence restrictions between manner and phonation are required only in case a dependent component lacks a context-sensitive interpretation. Given that cooccurrence restrictions are by their nature stipulative, the challenge for a dependency-based approach is to exploit context-sensitivity to its fullest potential. This challenge is met in Element-based Dependency, where the element \(|L|\), which specifies voicing in obstruents, has the complementary interpretation of nasalization in sonorants. This dual interpretation of \(|L|\) obviates the need for any cooccurrence restrictions between manner and phonation.

The second point concerns the relation between manner, phonation, and place. In an approach in which the interpretation of dependent structures is completely derivable from their structural context, there is no sense in which the head, i.e. manner, can be said to select the range of phonation. This suggests that phonation does not necessarily have to be viewed as being structurally dependent on manner. Indeed, there is reason to assume that the organization in (10) offers a more adequate representation of the relation between manner, phonation, and place:

(10) |O| |A| |N| |C|

---

19 See for instance Van der Hulst (1988a,b), Van der Hulst & Smith (1990), Smith (1988, 2000), Smith et al. (1989), Humbert (1995), and Van de Weijer (1996); I make a similar assumption in §2.5.

20 I assume, in (10) as well as below, that manner and phonation are dominated by a subsyllabic constituent, i.e. an onset (O), a nucleus (N), or a coda (C). This organization will be motivated in §1.2.2.
(10) O, N, C
    manner phonation
    place

(10) conveys that manner and place form what may be termed the segmental “core”.^{21} 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.

One argument in favour of (10) is to some extent theory-internal, and concerns the Element-based Dependency interpretation of dependent |L| as voice and nasalization. This interpretation is motivated by the observation that sonorants permit a nasalization contrast but not a voicing contrast, whereas obstruents permit a voicing contrast but not a nasalization contrast. Consider as an illustration the Element-based Dependency representations of a nasalized vowel, a voiced obstruent stop, and a voiced sibilant:

    L  L  ?  L  H  L
    place  place  place

Nasalized vowel  Voiced stop  Voiced sibilant

In (11a) vocalic manner is represented in terms of the head element |L|, which is more or less equivalent to head |V| in Anderson & Ewen (1987). The fact that the manner structure is |L|-headed implies that dependent |L| is interpreted as nasalization. The manner structure of the (obstruent) stop in (11b) is represented in terms of the element |ʔ|. The fact that the structure is |ʔ|-headed implies that dependent |L| is interpreted as voice. The manner structure of an (obstruent) sibilant is represented in terms of the head element |H|, as in (11c). The fact that this structure is |H|-headed implies that here, too, dependent |L| is interpreted as voice.

While the complementary interpretation of |L| can be maintained for supralaryngeal articulations, matters are complicated when we consider the status of dependent |L| in relation to laryngeal segments, in particular /h/. To the best of my knowledge, there are no languages which have an underlying contrast between voiced and voiceless /h/. There are, however, languages with an underlying contrast between plain and nasalized /h/, such as Seimat (Blust 1998)

^{21} In this respect, (10) is similar to the segmental structure assumed in Smith (2000). Smith (2000:241) views phonation as “a dependent of the entire segment”, but does not provide any arguments for this claim.
and Kwangali (Ladefoged & Maddieson 1996). In addition, there are languages that have a single /h/ which is underlyingly nasalized, such as Sui (Haudricourt 1967), Sedang (Smith 1973a), Gourmantché (Dell 1993), and some southern dialects of Thai (Brown 1965, Matisoff 1975). In Element-based Dependency, nasalized /h/ can be represented as in (12):

\[(12) \quad \begin{array}{c}
\overset{O}{\hspace{1em}} \\
\overset{\text{H}}{\hspace{0.5em}} \hspace{0.5em} \overset{\text{L}}{\hspace{0.5em}} \\
\overset{/h/}{\hspace{1em}} 
\end{array}\]

The representation in (12) shows that laryngeals consist of a placeless (or “degenerate”) manner component (see also Humbert 1995, Smith 2000). More specifically, I assume that the manner structure of /h/ consists of the same element which specifies sibilant manner, i.e. [H].22 Given this, the important observation is that dependent [L] is interpreted as voice in case [H] dominates a place element, as in sibilants, but as nasalization in case the segmental core consists of [H] only, as in /h/. This shows that the interpretation of dependent [L] takes account not only of the manner type of the segment involved, but also of the presence of place. The fact that both manner and place are relevant suggests that phonation forms a dependent of the entire segmental core, rather than of manner alone. More generally, the preceding discussion shows that Element-based Dependency representations involve two distinct types of dependency. The first type, i.e. dominance, is observed in the relation between manner and place. The second type, i.e. branching, is observed between manner and place on the one hand, and phonation on the other. I consider branching dependency in more detail in §2.6.

An additional advantage of the structure in (10) is that phonation can now be viewed as being dominated by a subsyllabic constituent, as can be seen in the representations in (11) and (12) above. In the following section, I will argue that this organization permits a restrictive approach to the distribution of contrastive laryngeal specifications.

### 1.2.2 The prosodic interpretation of laryngeal contrasts

Aside from context-sensitive features and formally restrictive structures, another way to prevent overgeneration is to limit the scope of features to those domains in which they are contrastive. To this end I assume, following Kehrein (2002), that the distribution of laryngeal distinctions is regulated by subsyllabic rather than by segmental positions (see also Golston & Kehrein 1998, 1999). This is

22 This makes it possible to express phonological interaction between /s/ and /h/ of the kind discussed in §1.1.
expressed in (13), where the phonation component is dominated by an onset (O),
a nucleus (N), or a coda (C):

(13) \[ \text{O}, \text{N}, \text{C} \]

\[ \text{manner} \quad \text{phonation} \]

\[ \text{place} \]

An important consequence of the direct link between syllable structure and
contrastive feature specifications is that there is no longer a level which
corresponds to that of the segment. Another important consequence is that
syllables form part of the underlying representation, instead of being projected
in the course of the phonological derivation. Hence, this approach constitutes a
move towards a non-segmental phonology.\(^{23}\)

The structure in (13) makes a number of predictions. First, onsets, nuclei,
and codas have at their disposal a maximum of one laryngeal contrast. This
predicts for instance that we never find an onset constituent such as */p^za/,
where both aspiration and voice are contrastive. Second, within onsets, nuclei,
and codas the order of supralaryngeal and laryngeal articulations is never
contrastive. This predicts for instance that languages do not contrast
preaspiration and postaspiration within the same onset, e.g. *h^p/~p^h/, or creaky
voice and postglottalization within the same nucleus, e.g. */^h/~/a^h/. Third, within
onsets, nuclei, and codas languages never have a contrast between a laryngeal
segment and the corresponding laryngeal modification. This predicts for
instance that contrasts such as */ph/~p^h/ and */m/~m/ are unattested. Kehrein
surveys a wide range of languages and concludes that these predictions are
borne out.

Adopting a version of Feature Geometry, Kehrein formalizes his approach
by making the Laryngeal node, which he assumes dominates the features
[voice], [spread glottis], and [constricted glottis], a dependent of a subsyllabic
constituent. Some examples of this organization are given in (14), where LAR is
short for the Laryngeal node and [cg] is short for the feature [constricted glottis];
in (14) I ignore supralaryngeal specifications.

\[^{23}\] See e.g. Jensen (1994), Van der Hulst (1995, 2000), and Golston & Van der Hulst (1999)
for a discussion of some of the advantages of this type of approach.
The assumption that [constricted glottis] is dominated by the onset introduces a degree of indeterminacy in the phonetic realization of the phonological material contained in that onset. For instance, the realization of the combination of /m/ and [constricted glottis] may include, among other things, preglottalization, postglottalization, and creaky voice. According to Kehrein, this variability is irrelevant to the extent that it is never phonologically contrastive. I return to this issue in chapter 5, where I focus in some detail on the phonological status of laryngeally modified nasals.

Although restrictive, one problem of Kehrein’s approach to laryngeal contrasts is that it is based on phonetically concrete features. As a consequence, Kehrein is forced to stipulate that manner types differ as regards their compatibility with laryngeal contrasts. For instance, in order to account for the irrelevance of voicing in sonorants, Kehrein must assume that [voice] is incompatible with [sonorant]. Similarly, Kehrein accounts for the absence of distinctive breathy voice in fricatives in terms of a cooccurrence restriction between fricative manner (i.e. [–sonorant, +continuant]) and breathy voice (i.e. [voice, spread glottis]. Note that these restrictions do not follow from the structure and the content of the representations. In addition, Kehrein must stipulate that some manner types permit a greater number of laryngeal features than others; that is, while stops and affricates may contrast in terms of breathy voice (i.e. [voice, spread glottis]) and creaky voice (i.e. [voice, constricted glottis]), fricatives and sonorants are limited to a maximum of one laryngeal feature. Again, these asymmetries do not follow from the structure and the content of the representations assumed by Kehrein.

Element-based Dependency provides a more restrictive approach to the compatibility of manner and phonation types. This is due first and foremost to the context-sensitive interpretation of dependent |L| as voice and nasalization. Treating nasalization on a par with laryngeal modifications not only extends the prosodic scope of elements to nasalization, but also obviates the need for a cooccurrence restriction between [voice] and [sonorant]. Furthermore, I will argue in §2.4 that the asymmetric distribution of breathy voice and voiced creak can be attributed to the structural position that voicing (i.e. [L]) may have in stops, but not in fricatives and sonorants. As we will see, an important consequence of this view is that the number of laryngeal dependents can be limited to a maximum of one, regardless of the manner type to which they are attached.
I consider the Element-based Dependency approach to phonation in more
detail in §2.4. In the remainder of this chapter I outline the main tenets of
Element Theory.

1.3 Element Theory

Following Dependency Phonology, I assume that phonological representations
are maximally binary-branching and consist of head-dependency relations.
However, I depart from Dependency Phonology as regards the content of these
representations. Rather than by $|C|$ and $|V|$, I assume that the manner and
phonation properties of segments are expressed by the elements $|/g|$, $|H|$, and $|L|$, a
subset of the elements used in Element Theory. We will see that the recognition
of three rather than two elements, although less restrictive, leads to a more
insightful interpretation of segmental structure. I introduce the Element-based
Dependency interpretation of $|/g|$, $|H|$, and $|L|$ in §2.1. To set this proposal on a
concrete footing, I first introduce the relevant Element Theory background here,
based on Harris & Lindsey (1995).24

Element Theory elements are like SPE-type features to the extent that they
constitute the smallest building blocks of phonological organization. An
important assumption of Element Theory is that elements are monovalent. As
was noted in §1.1, monovalency has two advantages: it reduces the risk of
overgeneration, and it offers an evaluation metric to measure the inherent
complexity of segments, in the sense that the more elements a segment requires
in its specification, the more complex that segment is.

In Element Theory relative segmental complexity corresponds by and large
to relative sonority, in such a way that the least complex segment type is the
most sonorous.25 Hence, vowels are maximally simple and voiceless stops are
maximally complex. This relation between segmental complexity and sonority is
motivated primarily by lenition processes, which in Element Theory are
uniformly characterized as involving reduction in complexity. Some
representative lenition trajectories are given in (15):

---

24 Since Harris & Lindsey (1995) is, in their own words, the first “full-blooded version of
element theory” (cf. Harris & Lindsey 1995:36), I take this article as the basis for the
following discussion. It should be noted, however, that Element Theory is in many
respects a continuation of the theory of “charm and government” of Kaye et al. (1985). An
earlier Element Theoretical proposal can be found in Harris & Lindsey (1992).

25 I use the qualification “by and large” since, as noted in §1.1, sonority is not a primitive of
Element Theory.
In terms of Element Theory, each step in the lenition trajectories involves the removal of an element. Thus, in Element Theory vocalization is equated with loss of complexity.

The Element Theory interpretation of segmental complexity is not without problems. Its main weakness lies in the relation between complexity and markedness. That is, whereas the interpretation of peripheral vowels as maximally simple is in line with markedness observations, the interpretation of voiceless stops as maximally complex is not. A more appropriate relation between complexity and markedness would be to have minimally complex representations at both the vocalic and the consonantal end of the segmental spectrum, as in Dependency Phonology.°

This implies that in Dependency Phonology lenition cannot be expressed as involving across-the-board reduction. Ewen & Van der Hulst (2001:107) observe that this is not necessarily problematic, since not all types of lenition are equally amenable to an analysis in terms of feature reduction:


In the morphologically related forms in (16a,b), final [p t k] correspond to intervocalic [β r ϱ], which suggests that [β r ϱ] are the lenited counterparts of [p t k]. However, the forms in (16c) indicate that lenition does not apply in any intervocalic context. This leads Harris to analyze the lenition context as foot-

° This approach to complexity is also assumed in Radical CV Phonology (see e.g. Van der Hulst 1995).
internal, noting that foot structure in Ibibio is independently motivated by verbal morphology and by certain phonological processes. This analysis implies that the intervocalic consonants in (16c) are not foot-internal; as such, Harris considers the nominalizing prefix /u-/' to lie outside the verbal foot template.

Consider next how an analysis in terms of spreading accounts for the Ibibio facts. The assumption underlying a spreading analysis is that the property which spreads is realized as continuancy in the targeted stop. In traditional feature theory, the relevant feature would then be [+continuant]. The problem with this interpretation is that the continuancy of vowels is usually considered redundant, so that their [+continuant] specification is not expected to play a role in the phonology. In Dependency Phonology this problem can be circumvented by assuming that the [V] component of the vowel spreads to a dependent position in the stop, in such a way that the resulting structure is phonetically interpreted as a fricative. This aside, the major problem that is faced by any spreading account of the Ibibio facts concerns the identification of the trigger of the lenition process. The spreading operation must refer to both the vowel preceding and following the affected stop, because both are relevant with respect to the segmental environment in which lenition occurs. Even so, it remains unclear which of the vowels does the spreading: the first, the second, or both. Given this, and given the fact that Ibibio lenition is crucially prosodically conditioned, it seems more feasible to relate the lenition of consonants to their occurrence as foot-internal onsets, as Harris does, than to their segmental environment. Note that such an interpretation does not necessarily commit us to the view that foot-internal lenition involves feature loss, as is assumed by Harris. Indeed, in §1.3.2 I will analyze a similar lenition process in Fore as involving the addition of the “vocalic” manner element [L].

1.3.1 Autonomous interpretation

Another basic assumption of Element Theory is referred to by Harris & Lindsey (1995) as the “autonomous interpretation hypothesis”. This involves the idea that elements are phonetically interpretable in isolation. Element Theory differs in this respect from traditional SPE-type feature theories (but not from Dependency Phonology), where a particular feature is interpretable only in combination with other features.

The autonomous interpretation hypothesis predicts that each element is capable of independently defining a segment. This is an attractive result, establishing as it does a relation between segmental complexity and markedness. Nevertheless, the notion of autonomous interpretation as used in Element Theory has some problematic aspects. First, Harris & Lindsey (1995:35) assert that autonomous interpretation figures “with varying degrees of explicitness” in related approaches such as Dependency Phonology, Government Phonology and Particle Phonology. However, it should be observed that in Element Theory, too, only a limited number of elements have stand-alone phonetic interpretation. This
concerns first of all the peripheral vowels /u i a/, which consist of the place elements [U], [I], and [A] respectively. The second class of segments which consists of a single element are the laryngeals /h/ and /ʔ/, which are represented by the “noise element” [h] and the “amplitude drop element” [ʔ]. Harris & Lindsey maintain that the single-element status of laryngeals is supported by lenition processes in which [h] and [ʔ] form the pre-final stage of the lenition trajectory. Recall, however, that lenition does not necessarily provide a good diagnostic for segmental complexity.

Importantly, the lack of complexity of /h ʔ/ has a different motivation than the lack of complexity of /i a/. On the one hand, complexity in Element Theory is related to sonority, in such a way that the more vocalic a segment is, the fewer elements it contains. On the other hand, autonomous interpretation dictates that each element is interpretable in isolation, regardless of its sonority. This suggests, then, that the Element Theory approach to complexity is incompatible with the autonomous interpretation hypothesis.\(^{27}\)

Below, I will suggest two modifications to avoid this problem. First, I take the head status of manner to imply that segments must be minimally specified for manner at the level of underlying structure. This automatically reduces the number of autonomously interpretable elements to the set of manner elements. As regards these, I assume that segmental manner is characterized in terms of a subset of Element Theory elements, i.e. [ʔ], [H], and [L], to which I assign a more general interpretation. Second, I propose a more refined interpretation of the relation between complexity and markedness, in the sense that [ʔ], [H], and [L] each correspond to a particular unmarked segment type. To appreciate these modifications, it is useful to first consider the role of [ʔ], [H], and [L] in Element Theory.

Harris & Lindsey (1995:69) assume that the element [ʔ] characterizes those segments which involve “an abrupt and sustained drop in overall amplitude”. This corresponds to the class of segments that is traditionally specified as [-continuant], i.e. stops, nasals, and, in some languages at least, laterals.\(^ {28}\) In isolation [ʔ] is interpreted as /ʔ/, while combined with a place element [ʔ] is interpreted as a complete closure of the oral cavity. The combination of [ʔ] and a place element thus produces a stop, either oral or nasal, depending on the presence of an additional element specifying nasality.

This scenario shows that the phonetic interpretation of elements is context-sensitive; in this respect, Element Theory elements are like Dependency Phonology components. A further similarity between both frameworks is that elements, like components, lack a specific articulatory phonetic correlate. As Harris & Lindsey (1995:70) observe:

\(^ {27}\) It should be noted that the incompatibility between segmental complexity and autonomous interpretation is to some extent masked by the limited number of elements which enjoy autonomous interpretation—but this, surely, is not a desirable state of affairs.

\(^ {28}\) I will argue in §2.2.3 that the continuant status of laterals is a language-specific matter.
To say that each element is independently interpretable is not to say that it can be targeted by executing a unique articulatory gesture. The performance of a particular elemental pattern typically involves the arrangement of one or more of an ensemble of gestures.

Like Harris & Lindsey, I assume that \text{\$\$} is a property of non-continuants. For reasons outlined in chapter 2, I further assume that head \text{\$\$} is present in the manner structure of non-sibilant fricatives, and that dependent \text{\$\$} is interpreted as glottalization.

The role of |H| and |L| in Element Theory is discussed in Harris (1994). As regards their interpretation Harris follows Kaye et al. (1985), where |H| and |L| are referred to as the “high-tone” and the “low-tone” element. This terminology is motivated by the relation between high tone and aspiration, and between low tone and voice.\textsuperscript{29} Harris is primarily concerned with the interpretation of |H| and |L| as laryngeal articulations. He assumes that the articulatory phonetic interpretation of |H| and |L| corresponds to that of the features [stiff vocal cords] and [slack vocal cords], respectively.\textsuperscript{30}

As far as the role of |H| and |L| in laryngeal contrasts is concerned, Harris observes that in English the lenis stops /b d g/ are in fact rarely voiced, but usually phonetically voiceless. The fortis stops /p t k/, on the other hand, are always realized as voiceless, and in foot-initial position are aspirated. Furthermore, there is evidence to suggest that in English it is aspiration rather than voicing that is phonologically active, since initial fortis stops transfer aspiration to a following sonorant, as in clue [k\text{"}u:] and cry [k\text{"}a:\text{"}i]. English differs in this respect from a language like French, where lenis stops always surface as voiced and fortis stops are never aspirated.

According to Harris, the difference between English and French corresponds to a difference in the kind of laryngeal contrast that these languages employ. In English the element |H| is active, so that the fortis series is phonologically marked for |H| and the lenis series is neutral. In French the element |L| is active, so that the lenis series is phonologically marked for |L| and the fortis series is neutral. The relevant contrast is illustrated in (17) (cf. Harris 1994:135):

\begin{tabular}{|l|l|l|}
\hline
Element & English & French \\
\hline
voiced & L & <beau> ‘beautiful’ \\
neutral & - & <bye> <peau> ‘skin’ \\
voiceless aspirated & H & <pie> - \\
\hline
\end{tabular}

\textsuperscript{29} The relation between laryngeal features and tone is for instance observed in the development of distinctive tone contrasts (see e.g. Matisoff 1973a, Kingston & Solnit 1988, and Yip 2002). I offer a brief discussion of this issue in §5.2.4.

\textsuperscript{30} See Halle & Stevens (1971) for a discussion of these features.
In languages with more than a two-way laryngeal contrast |H| and |L| are both active, and both may appear in the representation of a single segment. This is illustrated in (18) for Thai and Gujarati (cf. Harris 1994:135):

(18)  

<table>
<thead>
<tr>
<th>Element</th>
<th>Thai</th>
<th>Gujarati</th>
</tr>
</thead>
<tbody>
<tr>
<td>voiced L</td>
<td>/bāː/</td>
<td>‘shoulder’ /bät/</td>
</tr>
<tr>
<td>neutral</td>
<td>/pāː/</td>
<td>‘forest’ /pät/</td>
</tr>
<tr>
<td>voiceless aspirated H</td>
<td>/pʰāː/</td>
<td>‘split’ /pʰɔːtɛ/</td>
</tr>
<tr>
<td>breathy voiced L, H</td>
<td>-</td>
<td>/bʰəːt/</td>
</tr>
</tbody>
</table>

This approach offers a straightforward account of how languages may differ in the way that they employ laryngeal contrasts, although some aspects of it are problematic. One, as noted by Ewen & Van der Hulst (2001), is that |H| and |L| do not refer to distinct articulatory and acoustic parameters. That is, Harris’ characterization of |H| and |L| appears to imply that the contrast between the two is equipollent, contrary to the Element Theory position that elements are monovalent. As a consequence, it must be stipulated that |H| and |L| are in some languages mutually exclusive within a segment; compare Brockhaus (1995) with respect to German, for instance. For this reason, Ewen & Van der Hulst propose to replace |H| by the Dependency Phonology component |O|, denoting glottal opening (see also Anderson & Ewen 1987).

A more general problem is that the function of |H| and |L| is limited to laryngeal articulations, which means that they are exceptions to the autonomous interpretation hypothesis. Subsequent work has attempted to provide a more general interpretation of these elements. In the “Revised” Element Theory of Ploch (1999) for instance, |H| has taken over the function of the noise element |h|, in that it has been assigned the variable interpretation of stiff vocal cords, frication, and, in voiceless stops at least, oral release. As far as the interpretation of |L| is concerned, Ploch assumes that this depends on whether |L| is a head or an operator, and on whether |L| is linked to an onset or to a nucleus. This leads to the following context-sensitive interpretation of |L| (cf. Ploch 1999:169):31

(19)  

<table>
<thead>
<tr>
<th>Onset</th>
<th>Nucleus</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-operator nasality</td>
<td>low tone/pitch</td>
</tr>
<tr>
<td>L-head voicing, prenasalization</td>
<td>nasality</td>
</tr>
</tbody>
</table>

I will discuss this interpretation of |L| in more detail in §2.4.3. The point to note here is that in Ploch’s approach, too, |L| requires the presence of other elements in order to be phonetically interpretable.

31 Ploch attributes this interpretation of |L| to Kaye (1993); this reference concerns a series of lectures held at SOAS. Ploch’s distinction between head and operator is more or less equivalent to the distinction between head and dependent made here.
Similar to “Revised” Element Theory, Element-based Dependency assigns a more general function to $|L|$ (as well as to $|H|$ and $|\tilde{r}|$), relying on the assumption that the interpretation of elements is derivable from their position in the phonological structure. I return to this issue in §2.1.

### 1.3.2 Phonetic interpretation

As regards phonetic interpretation, I share with Harris & Lindsey the assumption that different elemental compositions may map onto identical patterns in the acoustic signal (see also Harris & Lindsey 1992). This essentially means that the internal structure of a particular segment is determined by its phonological behaviour, and not by its phonetic realization. This implies, then, that a particular phonetic entity does not have a unique phonological representation. Rather, this representation depends on the phonological system of the language concerned.

Consider in this light the relation between sonorancy and voice, and more specifically the observation that sonorants pattern with voiced obstruents in some languages, but not in others. In traditional feature theory, the absence of class behaviour of voiced obstruents and sonorants is generally accounted for by making [voice] redundant in sonorants, while in those languages where voiced obstruents and sonorants do pattern together, it is assumed that the process concerned applies after the specification of redundant [voice] (see e.g. Kiparsky 1985, Itô & Mester 1986).

This interpretation has been challenged on a number of occasions, most notably by proponents of the SV-hypothesis (see e.g. Rice & Avery 1989, 1991b, and Rice 1993). Rice (1993) points out certain cases in which sonorant voicing plays a role in the lexical component of the phonology. Consider as an illustration the following data from the Puyo-Pongo dialect of Quechua. As the forms in (20) show, Puyo-Pongo Quechua contrasts voiceless and voiced stops following nasals (cf. Rice 1993:315):

\[
\begin{align*}
\text{(20) a.} & \quad \text{pampalina} & \text{‘skirt’} \\
& \quad \text{finki} & \text{‘soot’} \\
& \quad \text{tʃuntina} & \text{‘to stir the fire’}
\end{align*}
\]
\[
\begin{align*}
\text{b.} & \quad \text{hambi} & \text{‘poison’} \\
& \quad \text{ʃUNGA} & \text{‘ten’} \\
& \quad \text{indi} & \text{‘sun’}
\end{align*}
\]

The forms in (21) indicate that this contrast is limited to stem-internal context; in case of an intervening morpheme boundary, a stop following a nasal surfaces predictably as voiced:

\[
\begin{align*}
\text{(21) a.} & \quad \text{wasi-ta} & \text{‘the others-OBJ’} \\
& \quad \text{sink-pa} & \text{‘porcupine-GEN’} \\
& \quad \text{satʃa-pi} & \text{‘jungle-LOC’}
\end{align*}
\]
\[
\begin{align*}
\text{b.} & \quad \text{wakin-da} & \text{‘the house-OBJ’} \\
& \quad \text{kam-ba} & \text{‘you-GEN’} \\
& \quad \text{hatum-bi} & \text{‘big one-LOC’}
\end{align*}
\]
Hence, the process which voices suffix-initial stops after nasals applies in derived environments only.

In an account in which nasals, as sonorants, are redundantly specified for [voice], the redundancy rule that fills in [voice] must be viewed as being lexical, given that it must distinguish between derived and non-derived contexts. According to Rice, this leads to a scenario where the point at which redundant feature specification applies must be stipulated for each language. This, Rice observes, is problematic, since it is contrary to the basic motivation of the redundancy rule approach, i.e. to provide a universal constraint which limits the power of a theory of underspecification.

Rice proposes an alternative analysis of the Puyo-Pongo Quechua facts in which nasals are specified for an SV-node, which identifies nasals as sonorants. Postnasal voicing can then be formalized in terms of spreading of this node to a following stop, given the appropriate morphological context. This is represented in (22), where N denotes a nasal and C a stop:

(22) $N)_{\text{STEM}} \rightarrow sfx(C)_{\text{SV}}$

For present purposes, the important observation is that in this analysis the derived voiced stops are interpreted as sonorants, even though there is no indication that these stops are phonetically any different from the voiced stops of, say, Dutch, which are never the result of postnasal voicing.

There is evidence to suggest that the notion of sonorant obstruents can be extended to underlying forms. Rice observes that Bear Lake Slavey, in common with many other Athapaskan languages, displays a number of morphologically conditioned alternations between voiced stops and nasals. Some examples are given in (23):

(23) a. sedá 'my eye' (se '1-SG-POSS' + da 'eye' + high tone 'POSS')
    natú 'my tear' (na 'eye' + tu 'water' + high tone 'POSS')

b. -de 'win-IMPERF'
    -nô 'win-PERF'
    -be 'swim-IMPERF'
    -mî 'swim-PERF'

32 Rice cites additional evidence from Japanese and Kikuyu which suggests that the redundancy rule that fills in [voice] is a late lexical rule (as in Japanese) or an early postlexical rule (as in Kikuyu).

33 In Dutch, voicing in stops is either underlyingly present or the result of spreading from an adjacent voiced obstruent; sonorants never trigger voicing. I return to this issue in §2.2.5.
In the forms in (23a), the alternation between voiced stops and nasals depends on whether the morpheme in question functions as the morphological head of the word. If it does, as in [sɛdâ] ‘my eye’, we find a voiced stop; if it does not, as in [nɑtʊ] ‘tear’, we find a nasal. In the forms in (23b), the alternation signals the distinction between the perfective and the imperfective.

Rice argues that these alternating consonants are sonorants underlyingly. Evidence for this view comes from the existence of a second, non-alternating class of consonants. As is shown in (24), these surface as voiced stops regardless of morphological context:

(24)  a.  sɛ-da ‘my chin’ (sɛ ‘1-SG-POSS’ + da ‘chin’)
        da-ɣɔ ‘my beard’ (da ‘chin’ + ɣɔ ‘hair’ + high tone ‘POSS’)
  b.  -da  ‘move-IMPERF’
       -ɗɔ  ‘move-PERF’
  c.  dɔ  ‘animal food storage place’
       dɔ  ‘four’

In (24a), unlike (23a), we find [d] irrespective of whether the morpheme in which it is contained functions as the morphological head. In (24b), the perfective is signalled by nasalization of the vowel, but, unlike (23b), vowel nasalization does not condition the presence of a preceding nasal. Finally, the forms in (24c) show that some instances of [d] can cooccur with a following nasalized vowel in monomorphemic forms.

The differences between (23) and (24) lead Rice to conclude that the stops in (23) are sonorants, and as such specified for SV, while the stops in (24) are obstruents, and as such specified for [voice]. This contrast is illustrated in (25) for the initial consonants of the imperfective forms of ‘win’ and ‘move’:

(25)  a.  d       b.  d
       |       |       
       SV    LAR
       |       |       [voice]

The sonorant stop in (25a) is realized as a nasal through spreading of [nasal] from a following vowel or, given the appropriate morphological context, through application of a default rule which fills in [nasal]. Thus, the fact that only some instances of voiced stops alternate with nasals is formalized by making [nasal] structurally dependent on the SV-node.

I return to the SV approach in §4.3.1, where I focus on the phonological interaction between sonorants, nasals, and voiced stops. However, one general

---

34 The change in vowel quality is due to ablaut, and not germane to the discussion here; vowel nasalization signals the perfective morpheme.
problem is worth noting here: in order to account for the interaction between these segment types, no fewer than three features—SV, [nasal], and [voice]—are required. This makes the SV approach considerably less restrictive than the Element-based Dependency approach, where the interaction between sonorants, nasals, and voiced stops can be expressed in terms of one and the same element, i.e. [L].

So far I have examined some evidence which suggests that the internal structure of a segment depends on its phonological behaviour, and not on its phonetic realization. By the same token, I further assume that an elemental configuration does not necessarily have a unique phonetic interpretation. The observation that languages differ with respect to the phonetic realization of segments is of course trivial, and not all of this variation is phonologically relevant. However, one type of variation that I do take to be relevant to phonology concerns prosodically conditioned lenition. Consider as an illustration the following facts from Fore, a Papuan language of New Guinea. Fore has the consonant inventory in (26) (cf. Scott 1978:6):

\[
\begin{array}{cccc}
p & t & k & ? \\
^n p & n t & n k & s \\
m & n \\
w & j \\
\end{array}
\]

Scott (1978:11) notes that /p t k/ have the following positional variants:

\[
\begin{array}{cccc}
\text{Word-initial} & \text{Postglottalic} & \text{Intervocalic} \\
/t/ & [5-t] & [5-t] & [l-r] \\
/k/ & [k-x] & [k-k\times] & [g\sim\gamma\sim g^\times\sim\gamma^\times] \\
\end{array}
\]

In (27), two lenition processes can be observed: in word-initial position /p/ and /k/ undergo optional spirantization, while in intervocalic position /p t k/ surface as voiced, with optional variation in terms of continuancy. I focus here on the type of lenition found in intervocalic context.

Intervocalic lenition in Fore is allophonic, and hence it is legitimate to ask whether it should be accounted for by the phonology. The answer to this depends to some extent on one’s theoretical assumptions, although according to the criteria laid out in Keating (1988) Fore lenition qualifies as phonological: the changes involved are categorial, they produce static effects, and they affect discrete segments.\(^\text{35}\)

\[^{35}\text{Phonetic processes, on the other hand, are typically gradient and non-static, and may affect only part of a segment (cf. Keating 1988); see Cohn (1990) for a discussion of these issues in relation to nasalization.}\]
Consider next how the various changes affecting intervocalic stops can be accounted for in terms of an element-based approach. The problem here is that the phonetic variants of /p t k/ are quite distinct from their underlying counterparts, differing from these in terms of voicing, and optionally in terms of continuancy, sonorancy, and laterality. I assume that these realizations represent different phonetic choices rather than phonologically distinct entities. Given that the constant factor concerns a change in voicing, the following representation of the process is, for phonological purposes at least, sufficient:

\[(28) \quad \text{Underlying} \rightarrow \text{Lenited}\]

\[
\begin{array}{c|c|c}
\text{?} & \text{?} & \text{\L} \\
\end{array}
\]

(28) is the Element-based Dependency representation of Fore lenition. Note that the process is interpreted as involving the insertion of \([\L]\) to the manner structure of the lenited stop, where it is dominated by \([?]\). Making \([\L]\) part of the head, rather than a branching dependent, signals that the lenition process is prosodically conditioned. That is, on the assumption that manner is visible to prosodic structure, the lenition of the stop can be related directly to its prosodic position. (28) further conveys that the phonetic result of the lenited output involves a combination of amplitude drop (as expressed by \([?]\)) and periodicity (as expressed by \([\L]\)), which in Fore is phonetically interpreted as a voiced consonant with variable continuancy. My claim is that this variability, while potentially linguistically significant, is not something that should be accounted for by the phonology.36

1.4 Summary

In this chapter, I have advanced a number of general arguments in favour of Element-based Dependency, a theory that combines insights from Dependency Phonology and Element Theory. Element-based Dependency assumes a restricted set of single-valued elements. These elements are a subset of those proposed in Harris & Lindsey (1995). The use of a reduced number of elements implies a loss of phonetic concreteness of phonological representations. This loss is in a sense counterbalanced by the assumption that elements have a different, but phonetically related, interpretation, depending on their structural position. A context-sensitivity interpretation of elements requires formally

36 It could be the case that the outcome of lenition is conditioned by factors such as age, sex, speech rate, or stylistic register; however, I have been unable to find any information bearing on this issue.
rigorous representations. To this end, it is assumed that phonological structures in Element-based Dependency are maximally binary-branching, and consist of head-dependency relations.
2 Element-based Dependency

In this chapter I outline the important aspects of the Element-based Dependency framework. First, in §2.1, I introduce the elements \( \mathcal{P}, \mathcal{H}, \) and \( \mathcal{L} \), and consider their interpretation in what I will refer to as “simplex manner types”. Next, in §2.2, I examine the ways in which \( \mathcal{P}, \mathcal{H}, \) and \( \mathcal{L} \) may combine to form “complex manner types”, discussing each complex manner type in turn. In §2.3, I focus on the representation of nasal manner, which, I argue, consists of a structure in which \( \mathcal{L} \) dominates \( \mathcal{P} \). In §§2.4 and 2.5, I outline my assumptions regarding the representation of phonation and place. Finally, in §2.6, I consider the status of branching manner structures, and examine to what extent these structures reflect traditional notions such as “segment” and “cluster”. The section ends with a brief outline of my assumptions regarding syllable structure.

2.1 Simplex manner types

I begin the Element-based Dependency interpretation of \( \mathcal{P}, \mathcal{H}, \) and \( \mathcal{L} \) against the backdrop of some familiar assumptions regarding manner of articulation. In traditional articulatory phonetics, speech sounds are classified into four manner types, i.e. stops, fricatives, approximants, and nasals. Of these, three types are distinguished from each other in terms of the degree of oral stricture: complete closure (stops), close approximation (fricatives), and open approximation (approximants). The fourth manner type, nasality, cannot be defined in terms of degree of oral stricture, since nasals are in this respect equivalent to stops. In fact, the position taken here is that the interpretation of nasality as a basic manner type must be rejected.

Given these observations, let us suppose that the basic distinction regarding manner is in terms of degree of oral stricture. Suppose further that \( \mathcal{P}, \mathcal{H}, \) and \( \mathcal{L} \) each correspond to a particular manner distinction, as in (1):

\[
\begin{align*}
\mathcal{P} & : \text{complete closure} \\
\mathcal{H} & : \text{close approximation} \\
\mathcal{L} & : \text{open approximation}
\end{align*}
\]

Thus, \( \mathcal{P}, \mathcal{H}, \) and \( \mathcal{L} \) can be considered “manner primitives”, in the sense that they function as building blocks with which finer-grained manner distinctions can be made.
Degree of oral stricture is an articulatory property. In view of the problems associated with a strictly articulatory interpretation of elements (see §1.1), I assume that \( ? \), \( H \), and \( L \) have complementary acoustic interpretations, given in (2):

\[
\begin{align*}
? & : \text{amplitude drop} \\
H & : \text{aperiodicity} \\
L & : \text{periodicity}
\end{align*}
\]

According to this interpretation, amplitude drop, aperiodicity, and periodicity are the invariant acoustic cues associated with \( ? \), \( H \), and \( L \).

In line with the autonomous interpretation hypothesis, I assume that in isolation \( ? \), \( H \), and \( L \) are interpreted as the prototypical segment types that are associated with the acoustic and articulatory properties described above. In this sense, stops, sibilants, and vowels form what might be termed “simplex manner types”:

\[
\begin{align*}
? & : \text{plosive (} = \text{prototypical stop)} \\
H & : \text{sibilant (} = \text{prototypical fricative)} \\
L & : \text{vowel (} = \text{prototypical sonorant)}
\end{align*}
\]

What is prototypical is determined by considerations of markedness, typology, and phonological behaviour. In the following subsections, I discuss these in turn for stops, sibilants, and vowels.

### 2.1.1 Stops

There are a number of arguments for treating stops as being the unmarked consonantal manner type. First, the consonant inventory of a given language minimally includes a series of stops (cf. Maddieson 1984). Second, stops are the first consonant type to emerge in language acquisition. Third, stops tend to display the greatest range of place and laryngeal contrasts. Moreover, the presence of a particular laryngeal modification in a manner type other than stop manner almost always implies the presence of the same modification in stops (cf. Maddieson 1984). We will see in §5.1 that this is a (near-) universal implication as far as laryngeally modified nasals are concerned.

The unmarked status of stops is reflected in their relatively simple representation, which consists of a manner component that is specified for \( ? \) only. In the absence of a place specification \( ? \) is interpreted as /\( R \)/, as is shown in (4a). The combination of \( ? \) with \( [U] \), \( [l] \), and \( [A] \) yields the basic stop series /p t k/, as is shown in (4b-d):\(^1\)

\(^1\) In consonants \([U] \), \([l] \), and \([A] \) represent labial, coronal, and velar place of articulation, respectively. Unless stated otherwise, I assume that consonants are dominated by an onset position.
Additional contrasts in terms of phonation and place are discussed in §§2.4 and 2.5.

### 2.1.2 Sibilants

Sibilants, in common with other fricatives, are characterized by a constriction which involves close approximation. As is observed by Ladefoged & Maddieson (1996:145), sibilants differ from other fricatives in the following respect:

> [I]n sibilants the principal source of the sound is the turbulent airstream produced when the jet of air created by the dental or alveolar constriction strikes the teeth, which form an obstacle downstream from the constriction itself.

Note that implicit in this description is the observation that sibilants are limited to coronal articulations.

Since non-sibilant fricatives lack the principal noise source characteristic of sibilants, sibilants display a spectrum with virtually no damping whereas non-sibilants display energy reduction in various frequency bands. As such sibilants are noisier than other fricatives; in perceptual terms they can therefore be regarded as the optimal fricative articulation. In traditional feature theory, the difference between sibilants and other fricatives is expressed by specifying sibilants as being \[(+)\text{strident}\] (see Jakobson et al. 1951, SPE). The problem with this view is that there are phonological grounds to take sibilants as the unmarked type of fricative. This cannot be expressed in terms of \[(+)\text{strident}\], since, if anything, this feature makes sibilant fricatives more marked than non-sibilant fricatives.

The unmarked status of sibilants suggests that their representation is relatively simple, and specifically less complex than that of other fricatives. For this reason I assume that |H|, when combined with head coronal place, is interpreted as a sibilant:

\[
\begin{array}{cccccc}
\text{a.} & \text{O} & \text{b.} & \text{O} & \text{c.} & \text{O} & \text{d.} & \text{O} \\
U & I & A & /\text{f}/ & /\text{p}/ & /\text{t}/ & /\text{k}/
\end{array}
\]
(5a) represents the unmarked sibilant /s/, which consists of [H] and [I] only. (5b) is the representation of palato-alveolar /ʃ/, which involves a complex place specification consisting of head [I] and dependent [A].

In isolation, [H] is interpreted as /h/. Support for a phonological relation between /s/ and /h/ comes for instance from debuccalization phenomena such as /s/ \rightarrow [h] in some dialects of Spanish (see also §1.1), and from the diachronic development *s \rightarrow h, which is attested in among others Welsh, Ancient Greek, and Hawaiian.

(6)

A strong argument for a structural relation between /s/ and /h/ is offered in §5.2.3, where we will see that *s is frequently the historical source of aspiration in aspirated nasals. This observation can be accounted for if aspiration is represented in terms of dependent [H]. On this assumption, the change from /s/ to aspiration can be expressed in terms of the deletion of the place component of the sibilant.

Sibilants are distinguished from non-sibilant fricatives in terms of structural complexity: whereas non-sibilant fricatives have a complex manner structure, sibilants have a simple manner structure, consisting of [H] only. This captures the relative markedness of non-sibilant fricatives as compared to sibilants. A structural distinction between sibilants and other fricatives is also assumed in some versions of Dependency Phonology (see Anderson & Ewen 1987, Smith 2000). There are a number of arguments for such a distinction.

First, as is noted by Anderson & Ewen and Smith, there are typological reasons for taking sibilants, particularly /s/, to be the unmarked fricative. Inspection of the UPSID database reveals that there are approximately twice as many languages which have the most frequent sibilant, i.e. /s/, as languages which have the most frequent non-sibilant fricative, i.e. /ʃ/ (cf. Maddieson 1984). In addition, there is the universal implication that if a language has a fricative, then this fricative is a sibilant (cf. Maddieson 1984).

Second, distributional restrictions on sibilants are generally less severe than those on other fricatives. Consider for instance the distribution of /s/-consonant
clusters in Germanic, or the distribution of /s/ in English.\footnote{2} Or consider Hausa, where codas are limited to glides, liquids, homorganic nasals, and /s/ (cf. Goldsmith 1990).

Third, there is evidence to suggest that distributional restrictions on other manner types parallel those of sibilants. For instance, Smith (2000) observes that the range of place contrasts in affricates and laterals is restricted to those found in sibilants. Like Smith, I interpret this relation to mean that affricates and laterals contain a sibilant manner component, although my representation of affricates and laterals is different from that of Smith. Observe that the relation between sibilants, affricates, and laterals cannot be captured in traditional feature theory, since here sibilants (and affricates) are specified as \([(+)\text{strident}]\) to the exclusion of other segment types.\footnote{3}

A fourth argument for treating sibilants as the unmarked fricative type concerns the observation that of the class of fricatives, sibilants are best suited to be combined with a laryngeal modification other than voice. UPSID contains 34 fricatives with a laryngeal modification other than voice; of these, no fewer than 25 are sibilants.\footnote{4} This asymmetry gains significance when we take into account the number of laryngeally modified fricatives in relation to the number of languages in which they occur. In 13 of the 19 languages with laryngeally modified fricatives, these fricatives are sibilants. In all but one of the remaining 6 languages, the presence of a laryngeally modified non-sibilant implies the presence of a laryngeally modified sibilant:\footnote{5}

\begin{itemize}
  \item Tlingit \(s', l', x', x'w', x', x''w'\)
  \item Yuchi \(\phi', s', j', l'\)
  \item Dakota \(s', j', x'\)
  \item Kabardian \(f', j'\)
  \item Southern Nambiquara \(s', 6\)
  \item Sui \(7\)
\end{itemize}

Observe here the lack of aspirated fricatives; the UPSID sample does not contain any examples of aspirated non-sibilant fricatives. Such segments are very rare

\footnote{2}{It has also been proposed that, in some languages at least, /s/-stop clusters are complex segments rather than clusters (see e.g. Van de Weijer 1996). According to this interpretation, /s/ would be unmarked because it combines with following stops, unlike other fricatives.}

\footnote{3}{Note that it has been proposed that /l/ (but not /l/) functions as \([+\text{strident}]\) (see e.g. Blevins 1994).}

\footnote{4}{Following Blevins (1994), I treat /l/ as a sibilant (see also n.3).}

\footnote{5}{In Element-based Dependency, Southern Nambiquara /6/ can be classified as a “non-buccal sibilant”. The only laryngeally modified non-sibilant in (7) would then be Sui /7/. Contrary to Maddieson, Li (1948) describes this sound as being preglottalized. I will argue in §2.4.1 that /7/ is an inherently voiced fricative with dependent glottalization. This effectively means that /7/ functions as a sonorant phonologically.}
indeed, and I know of no clear examples where they could be argued to be underlying.\textsuperscript{6} It seems plausible to assume that, within the class of fricatives, the preferential relation between sibilants and laryngeal modifications is functionally motivated, in the sense that the greater noisiness of sibilants exerts a positive effect on the perceptual cues of aspiration and glottalization.

The above observations lead me to conclude that there is sufficient phonetic and phonological evidence for analyzing sibilants as the unmarked fricative type. This then motivates a structural contrast between sibilant and non-sibilant fricatives.

\textbf{2.1.3 Vowels}

As was observed in §2.1, |L| is characterized in articulatory terms by open approximation, and in acoustic terms by periodicity (or "spontaneous voicing"). Given these characteristics, I assume that the presence of |L| in the manner structure of a segment identifies that segment as a sonorant. It follows, then, that |L| in isolation denotes vocalic manner, vowels being the unmarked type of sonorant. The unmarked status of vowels is among other things supported by the fact that they are the first sonorant segment type to emerge in language acquisition.

In the absence of place, the interpretation of |L| is a matter of language-specific phonetic implementation. The cross-linguistically unmarked realization of placeless |L| is schwa, although other realizations are also possible, for instance [i] in Korean (see e.g. Rhee 2002). The combination of |L| with |U|, |I|, and |A| yields the peripheral vowels /u i a/, as is illustrated in (8b-c). Note here that the vocalic interpretation of |L| is guaranteed by association to a nucleus constituent.

\begin{equation}
\begin{array}{cccccc}
\text{a. N} & \text{b. N} & \text{c. N} & \text{d. N} \\
| & | & | & | \\
L & L & L & L \\
| & | & | & | \\
U & I & A \\
\end{array}
\end{equation}

\begin{align*}
[\text{a}] & /u/ \\
[\text{i}] & /i/ \\
[\text{a}] & /a/
\end{align*}

The representation of sonorants, including vowels, in terms of |L| makes it possible to express natural class behaviour of sonorants. This option is not available in Element Theory, where vowels are assumed to consist of place elements only.

\textsuperscript{6} De Reuse (1981) reconstructs Ofo, an extinct Siouan language, as containing a series of aspirated fricatives.
In case the manner structures in (8b-d) are associated to an onset position, they are interpreted as non-syllabic vowels, i.e. /\N\ddot{a}/, or as approximants, such as /w v r j u/. Regarding the latter, I assume that segments which can be classified as approximants on phonetic grounds have a variable phonological representation. This representation may consist of a single [L] or of a complex manner structure in which [L] is dominated by [H] or [\?], the choice depending on the phonological behaviour of the segment. If, for instance, an approximant displays vowel-gliding alternations, a representation in terms of [L] is appropriate. If, on the other hand, an approximant displays behaviour which is typical of voiced fricatives, a complex manner representation in terms of [H] and [L] is in order. There are grounds for analyzing the Dutch labiodental approximant /\ldash/ in these terms, since it can appear as the leftmost member in the onset /\ldash/ as in a word like *wreed* /\ldash/ 'cruel'. A feasible representation of this onset cluster is given in (9), where I assume that /t/ is an underlyingly placeless rhotic:

\[
\begin{array}{c}
\text{(9)} \\
\text{O} \\
\text{H} \quad \text{L} \\
\text{L} \quad \text{H} \\
\text{U} \\
/\ldash/
\end{array}
\]

In (9), the obstruent-like characteristics which are associated with the prosodic position of /\ldash/ are reflected by the the headedness of the obstruent-like manner element [H].

Another possible representation of approximants is in terms of a manner structure in which [L] dominates [\?]. We will see in §3.2.2 that this representation is appropriate in those languages in which approximants alternate with nasals.

## 2.2 Complex manner types

In this section, I consider the interpretation of combinations of [\?], [H], and [L]. I refer to such combinations as “complex manner types”. In order to restrict the number of possible combinations, I assume that a given manner element may

---

7 This segment is realized as bilabial [\?] in southern varieties of Dutch, and as [w] in Surinam Dutch. Note that many Dutch speakers neutralize /\ldash/ to either [v] or [f] before /t/.

8 According to Van der Torre (2003:191), the relative distributional freedom of /\ldash/ is due to it being specified for the “consonantal” place element [U]. I consider this interpretation in more detail in chapter 7.
not occur more than once in the representation of a manner structure. I attribute this to an instantiation of the OCP. This yields a total of \(3! = 6\) possible representations. Below, I will be mostly concerned with complex manner structures that are restricted to a maximum of two manner elements. Tripartite manner structures represent more marked options; such structures may in some cases be necessary to express language-particular contrasts, or to capture language-particular cases of natural class behaviour (see §2.2.3).

Given that the absent element in bipartite manner structures is predictable, a total of six structures are predicted. Consider first of all the complex manner structures which involve a combination of \(|/|\) and \(|H|\):

\[
\begin{array}{cc}
(10) & \text{a.} & ? & \text{b.} & H \\
\end{array}
\]

\(10a\) consists of head \(|?|\) and dependent \(|H|\). I interpret this to mean that the manner type functions as a stop as regards its prosodic interpretation and as a fricative—more specifically, as a sibilant—as regards its selection of place. Hence, the unmarked interpretation of \(10a\) is that of an affricate. \(10b\) consists of head \(|H|\) and dependent \(|?|\). This means that the manner type functions as a fricative as regards its prosodic interpretation and as a stop as regards its selection of place. Thus, the unmarked interpretation of \(10b\) is that of a non-sibilant fricative.

Consider next those structures which consist of a combination of \(|H|\) and \(|L|\):

\[
\begin{array}{cc}
(11) & \text{a.} & H & \text{b.} & L \\
\end{array}
\]

\(11a\) consists of head \(|H|\) and dependent \(|L|\), so that the manner type functions as a fricative as regards its prosodic interpretation and as a sonorant as regards its selection of place. I will argue below that the phonetic realization of \(11a\) is variable, and may range from an approximant to a voiced fricative. \(11b\) consists of head \(|L|\) and dependent \(|H|\). Thus, the manner type functions as a sonorant as regards its prosodic interpretation and as a fricative—more specifically, as a sibilant—as regards its selection of place. I interpret this to mean that the unmarked interpretation of \(11b\) is that of a lateral approximant.

Consider finally those structures which involve a combination of \(|?|\) and \(|L|\):

\[
\begin{array}{cc}
(12) & \text{a.} & ? & \text{b.} & L \\
\end{array}
\]
(12a) consists of head \( \text{?} \) and dependent \( \text{L} \), so that the manner type functions as a stop as regards its prosodic interpretation and as a sonorant as regards its selection of place. As is the case for (11a), the phonetic realization of (12a) is variable. We will see below that it may range between a voiced stop, a nasal, and a tapped articulation. (12b) consists of head \( \text{L} \) and dependent \( \text{?} \). The manner type thus functions as a sonorant as regards its prosodic interpretation and as a stop as regards its selection of place. These characteristics are typical of nasals, as will become evident in §2.2.5.

A general comment is in order regarding the interpretation of complex manner types. In some cases, the interpretation of a head element appears to be fixed. For instance, a structure in which \( \text{?} \) is the only manner element present is a stop, and, similarly, all manner structures which are headed by \( \text{?} \) are also stop types. However, this is not the case for \( \text{H} \) and \( \text{L} \), the interpretation of which varies depending on whether they occur in isolation or with a dependent manner element. For instance, it is clear that the structure in (12b), which I claim represents nasal manner, is not a “stopped vowel”—if such a notion is meaningful at all. What this shows, then, is that the “is-a” relationship holds for some complex manner structures, but not for others. This is not necessarily problematic, and it should not be construed to mean that the interpretation of complex manner structures is arbitrary. In line with Dependency Phonology, the guiding principle in the interpretation of complex manner structures is primarily that of relative prominence. Thus, nasal manner involves a combination of vowel-like and stop-like properties, with the former being relatively prominent. This interpretation is supported by phonological evidence; as I will show in §2.3, the phonological behaviour of nasals is characteristic of vowels in some respects, and of stops in others.

In the following sections, I consider each of the complex manner types in (10-12) in more detail.

2.2.1 Affricates

A complex manner structure in which \( \text{?} \) dominates \( \text{H} \), as in (13), is interpreted as an affricate:

(13) \( \text{O}
\begin{array}{c}
\text{?} \\
\text{H}
\end{array}\) 

Phonetically, affricates consist of a stop phase followed by a homorganic release stage, resulting in sounds such as [\( \text{pF} \) ts k\( \text{x} \)]. The question is how such segments should be interpreted in phonological terms. In Kehrein (2002), the claim is advanced that the class of affricates has no phonological status. This accounts
for the observation that in languages with more than one affricate, these affricates never act as a natural class. Kehrein argues instead that the only type of affricate which is phonologically relevant is \([+\text{strident}]\). According to this interpretation, affricates are interpreted as strident stops.\(^9\)

Kehrein’s approach to affricates captures a number of pertinent observations. First, there is a considerable body of evidence which suggests that affricates and stops form a natural class. For instance, Steriade (1989) observes that Piro, an Arawakan language of Peru, exhibits a process of cluster simplification whereby the first fricative in a fricative-fricative cluster is deleted; however, no such simplification occurs in stop-fricative and affricate-fricative clusters. Similarly, there is abundant evidence that affricates and sibilants show natural class behaviour. Consider for instance English, where /\textipa{ʃ}\textipa{ʃ}/, parallel to /\textipa{ʃ}\textipa{ʃ}/, show epenthesis behaviour in plural formation, 3-SG verb inflection, and is-cliticization. Importantly, in both Piro and English, stops, sibilants, and affricates pattern together to the exclusion of fricatives. Indeed, Kehrein argues that class behaviour of affricates and fricatives is unattested universally.\(^10\)

A similar treatment of affricates can be found in Smith (2000), where affricates are represented as sibilants with a dependent stop component. This interpretation also captures the observation that phonologically relevant affricates are sibilant. I assume a similar representation here, with one important difference: in the present approach, sibilant manner dominates stop manner instead of the other way around, so that \(/\textipa{ʃ}/\) and \(/\textipa{ʃ}/\) are represented as follows:

\[
\begin{array}{c}
\text{(14) a. } & \text{O} & \text{b. } & \text{O} \\
\text{I} & \text{I} & \text{A} \\
\end{array}
\]

On the one hand, the representations in (14) express the fact that affricates, parallel to sibilants, are limited to coronal articulations; this is captured by making \([\text{H}]\) dominate place. On the other hand, they express the fact that affricates, by virtue of being \([\text{I}]\)-headed, have at their disposal the type of

\[^9\] On this view, other affricate types involve low-level phonetic affrication. It has also been argued that non-sibilant affricates such as those found in Zürich German involve a geminate-type structure (cf. Van Riemsdijk & Smith 1973).

\[^{10}\] Unless stops are included, in which case the natural class is that of obstruents.
laryngeal distinctions found in stops. Hence, affricates are like sibilants as regards place, and like stops as regards phonation.\footnote{The same observation is made in Van de Weijer (1996) and Hinskens & Van de Weijer (2003).}

An illustrative example of the range of laryngeal and place contrasts that are permitted by affricates comes from the Khoisan language !Xù. Consider the !Xù (non-clicked) stop, affricate, and sibilant inventory in (15):

\begin{itemize}
  \item \textit{Stops}\hspace{1cm} p \hspace{1cm} t \hspace{1cm} t^v \hspace{1cm} k
  \item \hspace{1cm} p^h \hspace{1cm} t^h \hspace{1cm} k^h
  \item \hspace{1cm} b \hspace{1cm} d \hspace{1cm} d^v \hspace{1cm} q
  \item \hspace{1cm} b^h \hspace{1cm} d^h \hspace{1cm} q^h
  \item \hspace{1cm} t' \hspace{1cm} k'
  \item \hspace{1cm} b' \hspace{1cm} d'
\end{itemize}

\begin{itemize}
  \item \textit{Affricates}\hspace{1cm} \tilde{t}s \hspace{1cm} \tilde{t}s^v \hspace{1cm} \tilde{t} \hspace{1cm} \tilde{t}^v
  \item \hspace{1cm} \tilde{t}s^h \hspace{1cm} \tilde{t}s^h \hspace{1cm} \tilde{t}^h \hspace{1cm} \tilde{t}^h
  \item \hspace{1cm} \tilde{d}z \hspace{1cm} \tilde{d}z^v \hspace{1cm} \tilde{d}z^v \hspace{1cm} \tilde{d}z^v
  \item \hspace{1cm} \tilde{d}z^h \hspace{1cm} \tilde{d}z^h \hspace{1cm} \tilde{d}z^h \hspace{1cm} \tilde{d}z^h
  \item \hspace{1cm} \tilde{d}z^h \hspace{1cm} \tilde{d}z^h
\end{itemize}

\begin{itemize}
  \item \textit{Sibilants}\hspace{1cm} s \hspace{1cm} f
  \item \hspace{1cm} z \hspace{1cm} \tilde{z}
\end{itemize}

In addition to plain stops, affricates, and sibilants, !Xù employs a five-way laryngeal contrast in terms of voice, aspiration, glottalization, breathy voice, and implosion in both stops and affricates; note, however, that sibilants contrast only in terms of voice. The distribution of affricates therefore parallels that of stops in terms of laryngeal modifications, and that of sibilants in terms of place. Observe further that there is no relation, neither in terms of place nor in terms of phonation, between affricates and non-sibilant fricatives; indeed, !Xù lacks non-sibilant fricatives altogether.

More generally, inspection of UPSID reveals that the presence of a laryngeal modification in affricates implies the presence of the same laryngeal modification in stops (cf. Maddieson 1984). This provides further support for the assumption that the dominating element in a manner structure determines the range of laryngeal contrasts, and thus further supports the view that affricates, like stops, are headed by \[
\text{\textit{[\iota]}\text{.}}\]
2.2.2 Non-sibilant fricatives

Non-sibilant fricatives—fricatives in short—consist of a complex manner type in which \(|H|\) dominates \(?\), as in (16):

\[
\begin{array}{c}
O \\
| \\
H \\
| \\
? \\
\end{array}
\]

In traditional feature theory, fricatives are distinguished from stops in terms of [(+)-continuant]. In Element-based Dependency this feature is reinterpreted as \(|H|\), which is present in the manner component of fricatives, but absent in that of stops. This captures the observation that fricatives are more marked than stops. Note, too, that fricatives contain \(?\). This expresses the fact that fricatives, like stops, involve energy reduction. In fricatives, \(?\) does not have the strong interpretation of complete closure which it has in stops, but the weaker interpretation of close approximation. This difference in interpretation is conveyed by the representation of fricatives, in which \(?\) is dominated by \(|H|\) and is therefore relatively less prominent.

There are further arguments for assigning fricatives the manner primitive \(?\). First, given that stops and fricatives frequently pattern together in phonological processes, it is reasonable to assume that they share some common structural ground. Consider for instance the fact that both stops and fricatives can be the first member of a complex onset in Dutch; this can be accounted for by the requirement that cluster-initial consonants be specified for \(?\). In addition, fricatives often result from diachronic lenition of stops. This type of lenition can be analyzed as involving the superimposition of \(|H|\) to the manner component of stops, yielding a homorganic fricative:

\[
\begin{array}{c}
? \\
> \\
H \\
| \\
? \\
\end{array}
\]

The combination of fricative manner with \(|U|, |I|, \) and \(|A|\) is interpreted as /\(\theta x/\), as is illustrated in (18):
In (18) labiodental /f/ is specified simply as [U], since in the unmarked case it patterns with labial /p/. The representation of labiodental fricatives in languages which contrast labiodental with labial place, such as Ewe, is discussed in §2.5.2.

As was the case for affricates, the representation of fricatives establishes a relation between the position of the manner elements of which fricatives are composed, and the type of laryngeal and place distinctions which fricatives permit. That is, fricatives permit the same type of laryngeal distinctions as sibilants, and are compatible with the same range of place distinctions as stops.

2.2.3 Liquids

I assume that the typical representation of liquids, i.e. laterals and rhotics, is in terms of a complex manner structure in which [L] dominates [H], as in (19):

(19) O
    | L
    | H

Of course, many languages have more than one liquid; this is true for 72.6% of the languages in UPSID. The typical pattern for a language is to have one lateral and one rhotic; this holds for 83.1% of the languages with two liquids (cf. Maddieson 1984). In any case, (19) is not sufficient in languages with more than one liquid. I will assume that in such languages liquids are distinguished from each other either in terms of manner or in terms of place. Before considering such distinctions, I first address some general characteristics of laterals and rhotics.

Taking laterals first, these are characterized by a lingual constriction along the mid-sagittal line of the vocal tract with the sides of the tongue lowered, so that air escapes over one or both sides of the tongue. Implicit in this characterization is that laterals are virtually always coronal phonetically. While velar liquids are found in a number of New Guinean languages, Blevins (1994) argues that these behave phonologically as coronals.
This suggests that laterals never contrast in terms of major place of articulation. Smith (2000) observes that place distinctions in laterals are instead of two types. First, laterals may contrast in terms of rounding, palatalization, or velarization, yielding the segments /l/ or /r/; following Smith, I assume that these contrasts are represented in terms of dependent vocalic manner dominating [U], [I], or [A], respectively. Second, laterals may contrast in terms of retraction and retroflexion, yielding palatal /k/ and retroflex /l/. As Smith observes, these distinctions parallel those that are found in sibilants. In terms of Element-based Dependency, this suggests that laterals, like sibilants (and like affricates), contain the element [H], which dominates [I]-headed place.

There is additional support for a phonological relation between laterals and sibilants. For instance, Blevins (1994) observes that the lateral fricatives /h/ can be classified as [+strident] on acoustic grounds. The sibilant nature of laterals is also supported by the existence of the lateral affricate /h/ in languages which have sibilant harmony, /h/, when present, are always included in the harmonic target range (cf. Shaw 1991). A further relation between laterals and sibilants is observed in diachronic developments. Consider for instance the observation that the Proto-Thai sibilants *s and *z have developed into /l/ in central Thai dialects (cf. Li 1977).

If, as has been assumed up to now, complex manner types are limited to at most two manner primitives, problems arise with respect to the representation of laterals. The range of place distinctions permitted by laterals suggests the presence of [H], while the sonorant status of laterals suggests the presence of [L]. The dominance relation between [L] and [H] in (19) captures the observation that laterals are like sibilants as regards place, and like sonorants as regards prosodic interpretation. It has been noted on a number of occasions, however, that laterals are phonologically non-continuant. Indeed, a standard assumption in feature theory is that the feature [+cont] distinguishes laterals from rhotics, such that laterals are [-cont] and rhotics [+cont] (see Clements 1987, Van de Weijer 1995). Evidence for the non-continuant status of laterals comes from natural class behaviour of stops, nasals, and /l/. For instance, in Basque stops are deleted before /l/, which, as Van de Weijer (1995:47) observes, “is a natural class of segments, on the assumption that /l/ is [-cont].” There is also distributional evidence for the non-continuant status of /l/. For instance, in Korean [r] and [l] are in complementary distribution, in such a way that [r] occurs between vowels and [l] elsewhere (see e.g. Rhee 2002). Word-final consonants in Korean are limited to [p t k l m n η]. This, too, is a natural class on the assumption that [l] is [-cont].

In Element-based Dependency the non-continuant status of /l/ must be expressed in terms of [l], an element that is also present in the manner structure of stops and nasals. More specifically, I assume that the manner structure of a non-continuant lateral has the representation in (20):
The structure in (20) retains the appropriate dependency relations regarding prosodic interpretation and place, while the “intermediate” specification [?] identifies the lateral as non-continuant.

It could be objected at this point that the representation of laterals in terms of three manner primitives results in unwarranted overgeneration, introducing as it does an additional six complex manner types. But, while the risk of overgeneration is indeed real, a number of points can be raised to lessen its impact. For instance, the possibility of tripartite manner structures does not imply that all such structures are necessarily present in the grammar. Consider this from the point of view of acquisition. In the unmarked case, the manner contrasts of a particular language can be expressed using simplex and complex manner types, where the latter do not exceed two elements. If a language requires more complex manner structures, it has the option of selecting a manner structure that consists of three elements, but this does not mean that the full range of three-way manner structures becomes available.

It is important to note that there are also languages in which laterals do pattern as continuants, such as Frisian (see e.g. Tiersma 1985, Van de Weijer 1996). As the forms in (21) illustrate, prefixation of /in/- and /oan/- to a stop-initial verb results in place assimilation of the nasal (and, in case of a nasal-initial stem, degemination):

(20) O
    L
    ?
    H

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(21) /in+pokə/ [impokə] ‘to wrap up’
    /in+qIan/ [inqIan] ‘to enter’
    /oan+nma/ [oanmə] ‘to accept’

No such assimilation is found in the forms of the kind in (22), where the prefix nasals are signalled by nasalization of the preceding vowel. The stem-initial consonants in (22) include fricatives, liquids (including /l/), and approximants. This is a natural class on the assumption that /l/ is [+continuant].

12 The prefix-final nasals can be analyzed as being unspecified for place underlyingly. Such an analysis is more efficient with respect to (22), since vowel nasalization then does not involve concomitant loss of the nasal’s place features. Note, however, that this account requires the default specification of [l] in case the stem is vowel-initial, as in [in-azəmA] ‘to breathe in’.
In traditional feature theory, these facts suggest that /l/ in Frisian must be specified as [+continuant]. The Element-based Dependency interpretation is different. Given that /l/ is already inherently continuant by virtue of [H], it does not need to be specified for [?]r; rather, whether or not /l/ has [?] is a language-particular option. In other words, since /l/ is by definition specified for [H], its continuant behaviour can be expressed regardless of whether /l/ is also specified for [?]r. Clearly, the more restrictive position is to regard /l/ as having [?]r only in case of positive phonological evidence.

It should be noted at this point that there are also languages where /l/ appears to lack [?]r. For instance, in a number of Bantu languages nasal prefixation to a liquid-initial stem results in hardening of the liquid to a stop. This hardening may affect both /l/ and /r/ as is for instance the case in Umbundu, Swahili, and Kihungan, where we find /N+/l, N+r/→[nd] (cf. Padgett 1995). There is also diachronic evidence that both /l/ and /r/ may pattern as continuants. For instance, the Welsh reflexes of Indo-European liquid-stop clusters suggest that in Welsh both /l/ and /r/ triggered spirantisation of a following stop. The Welsh diachronic developments can be summarized as follows (cf. Jones 1913:167):

   *ld, *lt > ld/lit, lit       *rt, *rd > rθ, rØ
   *lk, *lg > lχ              *rk, *rg > rx, rj, ra, rw

The facts considered show that the continuant status of laterals is a language-specific matter. In languages where both /l/ and /r/ behave as continuants, the structure in (19) may be appropriate for both, with the difference between /l/ and /r/ being represented in terms of place. Consider in this respect the Welsh data in (23), where we observe that coronal stops lenite after /r/ but not /l/. A possible interpretation of this asymmetry would be to specify /l/, but not /r/, for place. The retention of coronal stops after /l/ can then be attributed to their sharing the element [l], so that the absence of lenition in this context is an effect of partial geminate integrity.

Unlike laterals, rhotics do not have a unifying phonetic characteristic, either in articulatory or in acoustic terms. Nevertheless, there is abundant evidence that rhotics function as a phonological class (see e.g. Ladefoged & Maddieson 1996, Lindau 1978, 1985, Walsh-Dickey 1997). This makes rhotics a prime example
of a segment type that must be characterized in terms of a relatively abstract phonological specification.\footnote{The same point can be made regarding other types of approximants. As was argued in \S2.1.3, these have a variable representation, depending on their phonological behaviour.}

Like laterals, consonantal place in rhotics is non-distinctive. Unlike laterals, however, place in rhotics is not restricted to coronal articulations but runs the whole gamut of the vocal tract, from a labiodental approximant in certain variants of British English (cf. Foulkes & Docherty 2001) to a laryngeal creak in certain dialects of Belgian French (cf. Demolin 2001). Languages that contrast rhotics generally do so in terms of manner, e.g. fricative \textit{versus} sonorant, or in terms of vocalic place, e.g. retroflexion or palatalization.

As noted, I assume that in languages with more than one liquid, these liquids are distinguished from each other in terms of manner or place. Consider for instance German, where we find forms like \textit{Kerl} but not \textit{*Kelr}. This asymmetry is generally attributed to the fact that /r/ is more sonorous than /l/. A sonority difference could also be argued to be relevant in languages where /r/ and /l/ have an asymmetrical distribution in consonant clusters. A number of such cases are discussed by Van der Torre (2003), who argues that the place specification of rhotics is more vowel-like than that of laterals. In Element-based Dependency, this asymmetry can be expressed in a number of ways. One possibility is to represent rhotics as \textit{[L]-headed} and laterals as \textit{[H]-headed}. Another possibility is to represent rhotics as in (19), and to represent laterals with an additional \textit{[?] element}; this is motivated by the fact that the amplitude drop associated with \textit{[?] renders laterals less sonorous than rhotics. Note that the latter view implies that laterals pattern as non-continuants, which, as was observed above, should be determined on a language-specific basis.

It is important to note that there are also languages in which /r/ but not /l/ patterns with obstruents rather than with sonorants. An example of this type of class behaviour concerns Aitken’s Law in the history of Scots. Anderson & Ewen (1987:159) observe that Aitken’s Law consists of the two diachronic processes in (24):

\begin{equation}
\text{(24) \textit{Aitken’s Law}}
\end{equation}

\begin{enumerate}
\item All long vowels shorten everywhere except before /r v z ō #/.
\item All non-high short vowels lengthen before /r v z ō #/.
\end{enumerate}

Thus, in Aitken’s Law /r/ patterns as a voiced fricative rather than as a sonorant. Lass (1974:338-9) notes that this is supported by the observation that in some Scots dialects /r/, like obstruents, devoices in final position, and is realized phonetically as “a fricative and slightly retroflexed [θ].”

On the other hand, it has been proposed on a number of occasions that in at least some non-rhotic accents of English, such as RP English, /r/ functions phonologically as a low glide (see e.g. Giegerich 1999). This could be taken to
suggest that in such cases /ɾ/ is represented as a non-nuclear vowel dominating |A|. According to this approach, Scots /ɾ/ and RP English /ɾ/ can be represented as follows:

(25) a. Scots /ɾ/  b. RP English /ɾ/

\[
\begin{array}{c}
\text{H} \\
| \\
\text{L} \\
| \\
\text{L} \\
| \\
\text{A}
\end{array}
\]

It is clear that a lot more needs to be said about the representation of liquids than has been done here. Irrespective of the theory that is adopted, the fundamental insight regarding liquids is that this segment type, perhaps more so than other segment types, displays chameleonic behaviour. While liquids tend to pattern as a class, individual liquids may pattern with different classes of segments. In languages where such asymmetries are observed, rhotics typically pattern as continuants, whereas laterals may pattern either as continuants or as non-continuants.

2.2.4 Inherent voicing

I have so far proceeded on the assumption that sonorants, i.e. segments with voicing that is spontaneous and redundant, contain |L| as part of their manner specification, while voiced obstruents, i.e. segments with voicing that is optional and distinctive, have |L| as part of their laryngeal specification. This difference is shown in (26):

(26) a. Sonorant  b. Voiced obstruent

\[
\begin{array}{c}
\text{O} \\
| \\
\text{L} \\
\end{array}
\quad
\begin{array}{c}
\text{O} \\
\text{L} \\
\end{array}
\]

Note, however, that the existence of complex manner types implies that there are two positions within the manner structure where |L| may be located. The two possibilities are illustrated in (27):

(27) a.  b.  

\[
\begin{array}{c}
\text{O} \\
| \\
\text{L} \\
| \\
?/\text{H} \\
\end{array}
\quad
\begin{array}{c}
\text{O} \\
\text{L} \\
| \\
\text{?/H} \\
\end{array}
\]
I suggest that we are dealing here with a scenario of relative prominence. Dominance of [L], as in (27a), denotes a propensity of sonorancy, while dominance of [ʰ] or [H], as in (27b), denotes a propensity of obstruency. It follows, then, that [L], in its capacity of manner element, cannot be equated with the feature [(+sonorant)]. Rather, it is the location of [L] within the manner structure which determines the relative sonority of the segment involved. This shows that in Element-based Dependency relative sonority is derivable from the structural representation of segments.

In (28) I give the two complex manner types that have a manner structure in which [L] is the dominated element:

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

Given that these structures are headed by [ʰ] and [H], and given that voicing forms an integral part of the manner structure, I will refer to (28a) as an “inherently voiced stop” and to (28b) as an “inherently voiced fricative”. It is important to note, however, that the labels “stop” and “fricative” are rather unspecific in this context. Although inherently voiced stops involve complete closure and inherently voiced fricatives close approximation, their phonological behaviour is in some respects more characteristic of sonorants. On the one hand, the fact that they are headed by [ʰ] and [H] means that inherently voiced segments function as obstruents as regards prosodic interpretation. Thus, an inherently voiced fricative may for instance occur as the leftmost element in a complex onset constituent, as is the case for Dutch /v/ (see §2.1.3). On the other hand, inherently voiced segments function as sonorants with regard to the interpretation of dependent phonation. If, for instance, an inherently voiced segment is specified for dependent [L], then this [L] is interpreted as nasalization and not as voice, the point being that voicing is already inherent in the manner structure.

Given this scenario, I will assume that an inherently voiced stop that is specified for dependent element [L] is interpreted as a nasal contour:

---

14 Rice (1993) argues for the existence of a class of “sonorant obstruents”, i.e. segments which are realized as obstruents phonetically, but function as sonorants phonologically. This approach differs from the present proposal, where sonorancy is not a categorial but a gradient notion. Inherently voiced segments share some phonological characteristics with obstruents and some with sonorants, while phonetically their realization may vary between “sonorant” realizations such as taps, nasals, and approximants, and “obstruent” realizations such as voiced stops and voiced fricatives.
The phonological status of nasal contours differs from language to language. In some languages, such as Nambakaengö (Herbert 1986) and Tucano (Noske 1995), voiced oral stops are predictably realized as prenasalized. In such cases, nasalization does not need to be specified in the representation of these stops. In other languages, nasal contours emerge as the result of nasalization of stops, as in Maukakâ (Tourville 1991) and Sambú (Loewen 1963), or as the result of fusion of a nasal and a stop, as in Swahili (Polomé 1967). In such cases, too, there is no need to posit underlying nasal contours. Thus, only in those languages where nasal contours are demonstrably underlying do they have the representation in (29).

The Element-based Dependency approach to nasal contours predicts that these segments neither contrast in terms of voicing (e.g. */مب/ ~ */nb/) nor in terms of the order of the nasal and the oral parts (e.g. */Nb/ ~ */bN/). These predictions are borne out in the majority of languages that have underlying nasal contours, although some problematic cases can be noted. For instance, Babole, a Bantu language of Congo, is described as having a phonological contrast between a voiced and a voiceless series of prenasalized stops (cf. Leitch 1994), while Maddieson & Ladefoged (1993) note that Yeletnye, a Papuan language of New Guinea, contrasts a series of prenasalized and postnasalized stops in the same syllabic position. Such contrasts are also found in some Arandic languages, where a diachronic process of initial dropping (which resulted in the loss of word-initial consonant-vowel sequences) has conspired with a process of nasal prepllosion to produce a synchronic contrast between word-initial nasal-stop and stop-nasal sequences (see e.g. Koch 2001). A reasonable assumption is that at least some of these contrasts can be analyzed in terms of a contrast between a nasal-stop cluster and a nasal contour, but more research is required to determine this. A detailed examination of the status of nasal contours is beyond the scope of this dissertation (see e.g. Poser 1979, Herbert 1986, Van de Weijer 1996, and Downing 2003 for discussion of this issue).

As far as nasalized fricatives are concerned, this segment type is extremely rare underlyingly, but it has been reported to be contrastive in some languages, such as Waffa (Stringer & Holz 1973). I assume that distinctively nasalized fricatives involve both inherent voicing and dependent nasalization, as in (30):
Aside from Waffa, there are some languages, such as Inor and Umbundu, where voiced fricatives, parallel to sonorants, are targeted by nasalization (cf. Walker 1998). Consider in this respect the hypothesis that nasalization is restricted to sonorant segments, i.e. to segment types that have \(|L|\) as part of their manner component (see §1.2.1; see also §2.4.3). This hypothesis can be maintained if we distinguish between distinctively and inherently voiced segments. From the viewpoint of Element-based Dependency, the fricative targets of nasalization in Inor and Umbundu have inherent voicing; that is, they function as sonorants, not as obstruents. In the remainder of this section, I adduce some additional support for the notion of inherent voicing.

First, there is some evidence to suggest that \(/m/\), to the exclusion of other nasals, sometimes patterns with obstruents rather than with sonorants. One interpretation of this asymmetry, as is suggested in §7.1.4, is to represent \(/m/\) in terms of head \(|H|\) and dependent \(|L|\), and to assume the reverse dependency relation for other nasals.

Second, there are some languages, such as Turkish, in which devoicing targets voiced stops but leaves voiced fricatives unaffected. Some examples are given in (31) (cf. Rice 1993:332-3):

\[
\begin{array}{ll}
\text{(31)} & \\
\text{a.} & \text{jarap} \quad \text{‘wine-NOM-SG’} \\
\text{b.} & \text{az} \quad \text{‘few’} \\
\text{Turkish} & \text{jarabi} \quad \text{‘wine-ACC-SG’} \\
& \text{ev} \quad \text{‘house, home’} \\
& \text{jaraplar} \quad \text{‘wine-NOM-PL’}
\end{array}
\]

This asymmetry might be taken to suggest that in Turkish voiced stops have dependent voicing while voiced fricatives have inherent voicing. This difference is represented in (32) (note that the segments are dominated by a coda so as to indicate the context of the devoicing process):

\[
\begin{array}{ll}
\text{(32)} & \\
\text{a.} & \text{C} \\
\text{b.} & \text{C} \\
& \text{?} \\
& \text{L} \\
& \text{H} \\
& \text{L}
\end{array}
\]

\[\text{Voiced stop} \quad \text{Voiced fricative}\]

According to this interpretation, the devoicing process can be formalized as targeting dependent voicing only. Note, too, that in this analysis fricatives pattern together with sonorants, since neither is subject to devoicing. This is
straightforwardly accounted for if fricatives are analyzed as inherently voiced; according to this analysis, these fricatives are sonorants.

There is also typological support for a distinction between inherent and dependent voicing in fricatives. If voicing in fricatives is uniformly analyzed in terms of a laryngeal modification, then markedness considerations would lead us to expect that languages with voiced fricatives also have the corresponding voiceless fricative series. However, inspection of UPSID reveals that this implication is by no means universal. Maddieson (1984:48) notes for instance that

bilateral, dental and palatal non-sibilant fricatives are found to occur without a voiceless counterpart more often than with one.

This observation raises the question whether voiced fricatives always involve dependent voicing, or whether in some languages these segments are more appropriately analyzed as being inherently voiced. Either account will of course have to be substantiated by an analysis of the phonological system of the language concerned. A reasonable hypothesis is that in languages that have a voiced series of fricatives but lack a corresponding series of voiceless fricatives, the fricatives are the result of lenition of historically voiceless fricatives. Note that according to the interpretation of lenition that was suggested in §1.3.2, these fricatives would be represented as inherently voiced fricatives.

2.2.5 Nasals

Nasals are an extremely common segment type; so common, in fact, that Ferguson (1963:56) claims that “every language has at least one primary nasal consonant”. This position is too strong, however, given that there are some languages, such as Rotokas, Pirahã, and Lushootseed, which lack nasal consonants, at least at the level of underlying structure. In UPSID, 97% of the languages are described as having underlying nasals (cf. Maddieson 1984). This indicates that nasals, while not universally present, are cross-linguistically very frequent.

The cross-linguistic frequency of nasals is mirrored by the early stage at which nasals are acquired. As regards Dutch, Fikkert (1994) observes that nasals are acquired after stops, but before fricatives, liquids, and glides. The Dutch situation seems to be typical in this respect, and it supports a number of observations regarding the relation between stops and nasals. For instance, the early acquisition of stops and nasals shows that the obstruent-sonorant contrast is basic in language, and that the unmarked obstruent and sonorant consonants

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15 Ferguson’s term “primary nasal consonant” is equivalent to what I term “nasal” here: it includes segments such as /m n nj/, but excludes nasalized segments (e.g. /Ø Ñ/) and nasal contours (e.g. /b p/).
are stops and nasals. In addition, the order of acquisition indicates that the presence of a series of nasals in a language implies the presence of stops. More specifically, it supports the observation that the range of place contrasts found in nasals is a subset of the place contrasts found in stops, as we will see in §2.3.1.

The basic manner structure of nasals consists of a complex manner type in which $L$ dominates $\_$. Since this structure involves a combination of sonorancy and stopness, I will refer to it as a “sonorant stop”.

(33) $L$
    $|$  
    $\_?$

The phonetic realization of a sonorant stop is variable, and may range between a voiced oral consonant, either stopped or continuant, a nasal, and a nasal contour. This variability is in part a matter of free variation, and is in part dependent on the phonological system of the language concerned.

As an illustration, consider first of all the following facts from the Beijing dialect of Mandarin Chinese. As Li (1999) observes, in this dialect vowel-initial syllables of lexical words surface predictably with an initial consonant. This consonant is traditionally referred to as the “zero initial”. In the Beijing dialect, the zero initial is realized as a voiced velar, either $[\gamma]$, $[\upsilon]$, or $[\eta]$. Some examples are given in (34) (cf. Li 1999:97-8):

(34) $/\text{ba} + \text{an}/$  $[\text{ba}^{\gamma}\text{an} \sim \text{ba}^{\upsilon}\text{an} \sim \text{ba}^{\eta}\text{an}]$ ‘to return a favour’
    $/\text{te}^{\gamma}\text{ou} + \text{ou}/$  $[\text{te}^{\gamma}\text{ou}\text{an} \sim \text{te}^{\upsilon}\text{ou}\text{an} \sim \text{te}^{\eta}\text{ou}\text{an}]$ ‘proud’
    $/\text{me}^{\gamma}\text{en} + \text{ou}/$  $[\text{me}^{\gamma}\text{en}\text{an} \sim \text{me}^{\upsilon}\text{en}\text{an} \sim \text{me}^{\eta}\text{en}\text{an}]$ ‘winter coat’
    $/\text{en} + \text{ou}/$  $[\text{en}\text{ou}\text{an} \sim \text{en}\text{ou}\text{an} \sim \text{en}\text{ou}\text{an}]$ ‘lotus root’

The variable realization of the zero initial suggests that it consists of the sonorant stop structure in (35):

(35) $O$
    $|$  
    $L$
    $|$  
    $\_?$
    $|$  
    $A$
    $[\eta \sim \upsilon \sim \gamma]$

16 Another realization of the zero initial is glottal stop. According to Li, this variation is the result of dialect interference (though see Duanmu 1990 for a different interpretation).
Mandarin Chinese also has an underlying velar nasal which, in stem-final position, is in some morphological contexts realized as a nasalized version of a preceding vowel. This alternation suggests that such nasals are phonologically active, and are as such specified for a dependent element [L] (see (51) below). The nasal realization of the zero initial, on the other hand, is a matter of free variation, and hence no contrastive nasalization needs to be specified.

There are languages in which nasality in general represents a phonetic choice rather than a phonological category. Consider for instance the following facts from Rotokas, a Papuan language of New Guinea. In Firchow & Firchow (1969), Rotokas is described as having two dialects, which I will term “Rotokas A” and “Rotokas B”. These dialects differ in their underlying consonant inventories. Rotokas A displays a surface contrast between voiceless stops and nasals. Rotokas B displays a surface contrast between voiceless stops and a series of consonants that is realized as voiced, with variable continuancy and nasality. There does not appear to be a conditioning factor for this variation.

(36)  

\[
\begin{array}{llllll}
\text{Rotokas A} & \text{Rotokas B} \\
\{p\ t\ k\} & \{p\ t\ k\} \\
\{m\ n\ \eta\} & \{b\-\beta\-m\ d\-r\-l\-n\ g\-\gamma\-\eta\} \\
\end{array}
\]

As regards the nasal realizations in dialect B, Firchow & Firchow (1969:274) note that “they are rarely heard except when a native speaker is trying to imitate a foreigner’s attempt to speak Rotokas”.

Based on the description of Firchow & Firchow, Maddieson (1984) classifies Rotokas as lacking an underlying series of nasals. Following Rice (1993), I take the position that the phonetically variable consonants of Rotokas are sonorant stops. In Element-based Dependency terms, the labial series can be represented as in (37):

(37)  

\[
\begin{array}{llllll}
\text{Rotokas A} & \text{Rotokas B} \\
\{O\} & \{O\} \\
\{L\} & \{L\} \\
\{?\} & \{?\} \\
\{U\} & \{U\} \\
\{[m]\} & \{[b\-\beta\-m]\} \\
\end{array}
\]

The variable realization of the sonorant stops in Rotokas B is a matter of phonetic implementation. That is, the different realizations represent different phonetic choices but do not form distinct phonological entities.
The status of nasality in Pirahã, an Amazonian language of Brazil, is similar to that in Rotokas. According to Everett (1986), Pirahã has the following consonant inventory:17

\[(38)\]

\[
\begin{array}{llll}
\text{Obstruent stop} & \text{Sonorant stop} \\
\text{p} & \text{t} & \text{(k)} & \text{h} \\
\text{b} & \text{g} & & \\
\text{s} & & & \\
\end{array}
\]

Everett (1986:316) observes that \(/b\) are optionally realized as \([m f]\) in word-initial position after a pause, while \(/b/\) is optionally realized as a “bilabial vibrant” before \(/o/\). Like Rotokas, Pirahã therefore displays a type of allophonic variation which cuts across the obstruent-sonorant distinction, without there being a clear conditioning factor for this variation. Following Rice’s interpretation of Rotokas, I take the basic distinction in the Pirahã consonant system to involve an underlying contrast between obstruent and sonorant stops. This contrast can be represented as follows:

\[(39)\]

\[
\begin{array}{llll}
\text{Obstruent stop} & \text{Sonorant stop} \\
\text{O} & \text{O} \\
\text{?} & \text{L} \\
\text{?} & \\
\end{array}
\]

The interpretation of the voiced stops of Rotokas and Pirahã provides an important insight into the cross-linguistic frequency of nasals. While a small number of languages apparently lacks a series of underlying nasals, there appear to be no languages that lack an underlying contrast between obstruents and sonorants. Given the frequency of nasals, we may therefore conclude that nasals are the unmarked type of sonorant. In terms of Element-based Dependency, this observation can be interpreted to mean that the vast majority of languages have an underlying series of sonorant stops.18 In most of these languages, these sonorant stops are realized as nasals, while in some languages, such as Rotokas and Pirahã, these stops are realized as voiced oral stops. Thus, the contrast between obstruents and sonorants, a universal characteristic of consonant systems, indirectly accounts for the cross-linguistic frequency of nasals.

In a number of languages, the interpretation of sonorant stop structures is determined by the phonological system of the language involved. This is for

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17 In (38) I have placed /k/ in parentheses, since Everett notes that it could be analyzed as an allophone of the underlying sequence /h/.  
18 There are very few languages which appear to lack sonorant stops altogether. The only potential examples that I know of concern a number of Salish languages that have undergone denasalization, such as Twana and Lushootseed. I discuss this issue in §4.3.1.
instance the case in languages in which nasals are in complementary distribution with a series of voiced oral consonants. An example of such a language is Kpelle, a Mande language of Liberia and Guinea. According to the description in Welmers (1962), root-initial nasals in Kpelle occur before nasalized vowels, as in (40a), while voiced oral consonants occur before oral vowels, as in (40b):

(40) a. mpré ‘where’ (*mí) bála ‘sheep’ (*bíla)
    nFi ‘person’ (*núu) leyi ‘pot’ (*lëyi)
    ñfána ‘bitter’ (*ñána) wála ‘strong’ (*wíla)

Another example of this type of complementary distribution can be found in Tuyuca, an Amazonian language of Brazil. As is observed by Barnes (1996), nasality in Tuyuca is a property of entire morphemes, in such a way that nasals are found in nasal morphemes, as in (41a), while voiced stops are found in oral morphemes, as in (41b):

(41) a. Nasal morphemes b. Oral morphemes
    [míp] ‘badger’ (*[mip]) [bipl] ‘swollen’ (*[bipl])
    [níb] ‘lose’ (*[nitl]) [ditl] ‘coal’ (*[ditl])
    [tño] ‘follow’ (*[tno]) [sigé] ‘Yapara rapids’ (*[s9jU])

I interpret the surface alternation in Kpelle and Tuyuca to mean that the consonants involved are underlyingly represented as “bare” sonorant stops. In those environments in which these stops are realized as nasals, their nasality results from association with dependent |L|. The relevant nasalization process can be expressed as in (42):

(42) \[ \begin{array}{c}
O \\
\downarrow \\
L & L \\
\downarrow \\
? \end{array} \]

I will argue in §3.2.2 that in Kpelle and Tuyuca nasalization is a property of the syllable. Within nasalized syllables, all nasalizable segments, including sonorant stops, surface predictably as nasalized.

The preceding discussion demonstrates that sonorant stops are a prime example of the assumption, made in §1.3.2, that an elemental configuration does not have a unique phonetic realization. As regards the interpretation of bare and nasalized sonorant stops, I propose that the following implicational relation holds: if a language has both types of sonorant stops, then the bare sonorant stops will be realized as oral consonants, and the nasalized sonorant stops as
nasal consonants. If, on the other hand, a language has bare sonorant stops only, these will in most cases be realized as nasals. Rotokas A is an example of a language where this is the case. Another example of such a language is Dutch, as we will see shortly. Languages such as Rotokas B, where bare sonorant stops are realized as non-nasal consonants, are extremely rare. We may conclude from this that the unmarked realization of a sonorant stop is a nasal. This accounts for the cross-linguistic frequency of nasals, and it also shows that the obstruent-sonorant distinction in consonants is in all likelihood universal.

In those languages where bare sonorant stops are realized as nasals, the combination of a sonorant stop structure with |U|, |I|, and |A| is interpreted as /ŋ/, as in (43):

(43) a. O b. O c. O
   | L | L | L
   | ? | ? | ?
   | U | I | A

/m/ /n/ /ŋ/

Disregarding the difference in segmental content, this representation of nasal manner is similar to that of Anderson & Ewen (1987), in the sense that both involve a vocalic element dominating a consonantal element.

Nasals that consist of a sonorant stop structure only are "phonologically inert". Such nasals are neither involved in nasalization processes, nor do they trigger voicing of an adjacent obstruent. Note that this underscores the basic assumption, made in §1.3.2, that the representation of a particular segment type depends on its phonological behaviour.

An example of a language in which nasals are phonologically inert is Standard Dutch. In Standard Dutch, there is no indication that the nasalizing effect of nasals on neighbouring vowels is phonologically relevant.20 In addition, there is no indication that the voicing of nasals interacts with that of obstruents. This is evidenced for instance by the fact that Dutch stops in nasal-stop clusters contrast in voicing, as is illustrated in (44):

| L | L | L
| ? | ? | ?
| U | I | A

/m/ /n/ /ŋ/

---

19 We will see in §3.2 that in some languages bare sonorant stops are phonetically realized as nasal contours. I will argue there that this nasalization is phonologically irrelevant.

20 Some other dialects of Dutch, such as the dialect of West Brabant, display nasal effacement in preconsonantal context, creating surface minimal pairs like [lâp] ‘lamp’ ~ [lær] ‘rag’ (cf. Stroop 1994); observe here that the vowels also differ in terms of length, so that the underlying size of the vowel-nasal sequence is retained in the surface form. This suggests that in West Brabant Dutch nasals are phonologically active, and must hence be specified for dependent [L].
Matters are complicated when we consider the distribution of voiced obstruents in past-tense forms. Note first of all that Dutch has a process of final devoicing which targets voiced obstruents, but leaves sonorants unaffected. One environment in which devoicing can be found is in the PRES-1SG form of verbs:

I assume that the context in which devoicing occurs is that of the syllable coda. Consider next the pattern of allomorphy displayed by the past-tense suffix. The forms in (46) show that the past-tense morpheme surfaces as [–tə] after underlingly voiceless obstruents, and as [–də] elsewhere:

This could be taken to suggest that the underlying shape of the suffix is /-tə/, with the /t/ surfacing as voiced following a voiced segment. This interpretation is similar to that of Booij (1995). Booij views the suffix consonant as being underlingly underspecified for the binary-valued feature [+voice], the voicing specification being supplied by the spreading of [+voice] or [–voice] from the preceding stem-final segment. This analysis therefore implies that both voiced
obstruents and sonorants can trigger voicing, and thus that the nasals of Dutch are phonologically active.  

There are a number of problems with this account. Firstly, the fact that it relies on a binary-valued feature [+voice] fails to express the markedness of the voiced obstruent series. Secondly, the redundancy rule which inserts [+voice] on sonorants must be crucially ordered before past-tense suffixation and after final devoicing. Such ordering is against the spirit of the redundancy rule approach. What is more, the redundancy rule does little more than account for the occurrence of [-da] after sonorant-final stems. The phonology of Dutch does not provide any additional support for the relevance of sonorant voicing, nor of any other context in which progressive voicing assimilation takes place.

In view of these problems, an alternative interpretation of the Dutch facts is required. Suppose first of all that the voicing contrast in obstruents is privative. This can be achieved if voiceless obstruents consist of an obstruent manner component only, while voiced obstruents consist of an obstruent manner component with a dependent element [L]. This results in the representations of /p/ and /b/ as in (47) (note that the stops are dominated by a coda position, so as to indicate the context in which devoicing applies):

(47) C C
    |   |
    ?   ?  L
    |   |
    U   U

/p/   /b/

This interpretation captures the fact that voiced obstruents are marked, and permits a natural interpretation of final devoicing in terms of the deletion of dependent [L].

Suppose next that the underlying shape of the past tense suffix is /-da/. On this assumption, the fact that we find the allomorph [-da] after stem-final sonorants can be readily explained: the suffix is added to the stem, and no

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21 Booij (1995:12) argues that sonorants are underspecified for [+voice] but observes that the redundancy rule that fills in [+voice] cannot be relegated to the postlexical phonology, since “[t]here is also a lexical rule that spreads the feature [+voice] of sonorants to the initial consonant of the past-tense suffix”.

22 This presupposes that voicing is interpreted in privative terms. In a binary-valued approach to voicing, all instances of progressive voicing assimilation in Dutch involve spreading of [-voice]; this implies, then, that in a unary-valued approach there is no progressive voicing assimilation.

23 The fact that devoicing targets stops and fricatives is an argument for treating the voicing in these segments to be dependent rather than inherent.
further interaction between the stem sonorant and the suffix consonant takes place. This scenario is illustrated for the form /stem+da/ in (48):

(48) \[
\begin{array}{c|c|c|c|}
\text{C} & \text{O} & \text{C} & \text{O} \\
\hline
\text{L} & \text{?} & \text{L} & \text{?} \\
\hline
\text{?} & \text{I} & \text{?} & \text{I} \\
\hline
\text{U} & \text{U} & \text{U} & \text{U} \\
\end{array}
\]

/m+d/ \rightarrow [md]

Thus, the hypothesis that nasal manner consist of a bare sonorant stop structure can be maintained.

In case the stem ends in a voiced obstruent, as in, say, /krɔb+da/, the two voicing specifications are merged, and the result is a voiced obstruent cluster. The lack of final devoicing in this context can be attributed to the fact that dependent |L| is linked to both a coda and an onset.

(49) \[
\begin{array}{c|c|c|c|}
\text{C} & \text{O} & \text{C} & \text{O} \\
\hline
\text{?} & \text{L} & \text{?} & \text{L} \\
\hline
\text{U} & \text{I} & \text{U} & \text{I} \\
\end{array}
\]

/b+d/ \rightarrow [bd]

As regards such forms, Booij is forced to stipulate that rightward spreading of [+voice] precedes final devoicing. All that is required in the present account is the assumption that the two adjacent identical dependent |L| specifications are merged, which can be plausibly attributed to the OCP.

The final context that must be considered is that of a stem-final voiceless obstruent, as in a form like /stɔp+da/. The fact that the suffix consonant surfaces as voiceless in this environment can be expressed in terms of the deletion of dependent |L|, as is illustrated in (50):

24 Another way of putting this is to say that |L| is retained here by virtue of being “licensed” by an onset; see Lombardi (1991) for an approach along these lines.
The question, of course, is what motivates this deletion. The crucial insight here is that Dutch obstruents, when adjacent, must both be either voiced or voiceless. This implies that dependent [L] is tolerated only in case it is shared by both obstruents in a cluster. This sharing requirement accounts for the ill-formedness of [pd], but it leaves unaddressed the question why we do not find leftward spreading of [L] to the stem-final stop, resulting in the surface form *[std]. I suggest that leftward spreading of [L] is prohibited because it affects an unwarranted modification of the stem-internal obstruent. That is, the voicing specification of the suffix cannot affect the underlying specification in the stem.\(^{25}\) I conclude, then, that the pattern of allomorphy displayed in past-tense suffixation allows us to maintain the hypothesis that Dutch nasals are phonologically inert, and hence are represented as bare sonorant stop structures.

Phonologically inert nasals are structurally different from phonologically active nasals. The latter consist of a sonorant stop structure with a dependent element [L], as in (51):

(51) a. O b. O c. O

L L L L L

| ? | ? | ? |
U I A

/m/ /n/ /ŋ/

As I will argue in §2.4.3, dependent [L] is a property of distinctively voiced obstruents and distinctively nasalized sonorants. According to this interpretation, dependent [L] denotes either voicing or nasalization, depending on the manner type involved. The fact that nasals are sonorants thus implies that phonologically inert nasals are structurally different from phonologically active nasals. The latter consist of a sonorant stop structure with a dependent element [L], as in (51):

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| ? | ? | ? |
U I A

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| ? | ? | ? |
U I A

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L L L L L

| ? | ? | ? |
U I A

/m/ /n/ /ŋ/

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(51) a. O b. O c. O

L L L L L

| ? | ? | ? |
U I A

/m/ /n/ /ŋ/

As I will argue in §2.4.3, dependent [L] is a property of distinctively voiced obstruents and distinctively nasalized sonorants. According to this interpretation, dependent [L] denotes either voicing or nasalization, depending on the manner type involved. The fact that nasals are sonorants thus implies that phonologically inert nasals are structurally different from phonologically active nasals. The latter consist of a sonorant stop structure with a dependent element [L], as in (51):

(51) a. O b. O c. O

L L L L L

| ? | ? | ? |
U I A

/m/ /n/ /ŋ/

As I will argue in §2.4.3, dependent [L] is a property of distinctively voiced obstruents and distinctively nasalized sonorants. According to this interpretation, dependent [L] denotes either voicing or nasalization, depending on the manner type involved. The fact that nasals are sonorants thus implies that phonologically inert nasals are structurally different from phonologically active nasals. The latter consist of a sonorant stop structure with a dependent element [L], as in (51):

(51) a. O b. O c. O

L L L L L

| ? | ? | ? |
U I A

/m/ /n/ /ŋ/

As I will argue in §2.4.3, dependent [L] is a property of distinctively voiced obstruents and distinctively nasalized sonorants. According to this interpretation, dependent [L] denotes either voicing or nasalization, depending on the manner type involved. The fact that nasals are sonorants thus implies that phonologically inert nasals are structurally different from phonologically active nasals. The latter consist of a sonorant stop structure with a dependent element [L], as in (51):

(51) a. O b. O c. O

L L L L L

| ? | ? | ? |
U I A

/m/ /n/ /ŋ/
active nasals are equivalent in structural terms to nasalized sonorant stops. As we have seen, such structures can also be the output of nasalization processes of the type found in Kpelle and Tuyuca.

The voicing facts observed in Puyo-Pongo Quechua suggest that this language has phonologically active nasals. As was noted in §1.3.2, Puyo-Pongo Quechua displays a process of postnasal voicing which applies in derived environments only. The forms in (52) suggest that the underlying forms of the objective, genitive and locative suffixes are /-ta/, /-pa/, and /-pi/; these suffixes surface as [-da], [-ba], and [-bi] if the preceding stem ends in a nasal consonant:

(52) wasi-ta ‘the others-OBJ’  wakinda ‘the house-OBJ’
sink-pa ‘porcupine-GEN’  kam-ba ‘you-GEN’
saatja-pi ‘jungle-LOC’  hatum-bi ‘big one-LOC’

I interpret this allomorphy to mean that the nasals are specified for dependent [L], and that this [L] spreads to the dependent position of a following suffix-initial stop, where it is interpreted as voicing. This scenario is illustrated in (53):

(53)  

\[
\begin{array}{c}
  C \\
  O \\
  | \L \L \? \\
  | \\
  /N+\pm/ \rightarrow [N\emptyset]
\end{array}
\]

Note in (53) that the target of spreading is an obstruent. As a result, dependent [L] is realized phonetically as voicing.

Another example of phonologically active nasals can be found in the New Caledonian language Tinrin. Osumi (1995) notes that Tinrin has an underlying contrast between oral and nasalized vowels. Some (near-) minimal pairs are given in (54):

(54) be ‘to be dead’  bè ‘hand’
ho ‘to eat (meat)’  hô ‘to sing’
mu ‘gaiac (Lignum vitae)’  mû ‘be cold’

Tinrin also has a process of vowel nasalization whereby vowels surface as nasalized in case they are followed by a nasal or prenasalized consonant. Consider the forms in (55):

(55) /fâ+\de/  [fœ̃de] ‘hang something up’
/\de+nô/  [‘dênô] ‘hang down’
This process can be expressed in terms of spreading of dependent \(|L|\) from a nasal or prenasalized consonant to a preceding vowel, as is shown in (56) for the form \([\text{'dênô}]\); note in (56) that the triggering nasal is specified for dependent \(|L|\):

\[
\begin{array}{c}
N \quad O \\
| L \quad L \quad L \\
| I \quad A \quad ? \\
| \quad I \\
\end{array}
\]

/\text{e+n}/ \rightarrow [\text{ên}]

Given that the target of spreading in (56) is a sonorant, dependent \(|L|\) is realized as nasalization. This shows that dependent \(|L|\) has a variable interpretation, depending on the manner structure to which it is attached. I return to this issue in §2.4.3.

### 2.3 The internal structure of nasal manner

In this section, I provide phonological evidence for the hypothesis that nasals, whether they are phonologically active or inert, consist of a sonorant stop manner component. There are two kinds of support for this hypothesis. First, since sonorant stops consist of \(|?|\), nasals are expected to display phonological behaviour which is characteristic of stops. Second, given that sonorant stops are \(|L|\)-headed, nasals are expected to display phonological behaviour that is characteristic of sonorants. I consider both predictions in turn below.

#### 2.3.1 The consonantal component of nasal manner

The first piece of evidence for a structural relation between nasals and stops comes from the organization of nasal inventories. Inspection of UPSID reveals that the vast majority of languages either have /m/ and /n/ or a nasal series that is organized in terms of the basic labial, coronal, and velar places of articulation, as well as other possibilities that are paralleled in the stop system (see Maddieson 1984). An example of the first type of nasal system is found in Totonac. The Totonac consonant inventory has stops with labial, coronal, velar, and uvular place, while nasals are limited to labial and coronal place:
An example of the second type of nasal system is found in Aranda, a Pama-Nyungan language of Central Australia. Here we find labial, coronal, and velar stops, with a further contrast in terms of four coronal subtypes. Each place contrast in the stop series is matched by the same contrast in the nasal series:

(58) \textit{Aranda} \\
\begin{array}{cccccc}
\text{p} & 5 & t & \cdot & \emptyset & k \\
\text{m} & \text{f} & \text{n} & \eta & \eta
\end{array}

There is an implication to be captured here: as far as place of articulation is concerned, the number of nasals is a subset of the number of plain stops. As Maddieson (1984:69) observes:

The presence of a nasal at a given place of articulation implies the presence of an obstruent at the same place.

Thus, nasals are like stops as regards their compatibility with place. Note that this is expressed by making \$\emptyset\$, in both stops and nasals, dominate the place component.

At this point, a comment is in order regarding \$/\emptyset/\$, which, in common with other palatals, consists of a complex place component with head \$|\text{I}|\$ and dependent \$|\text{A}|\$. This is illustrated in (59):

(59) \\
\begin{array}{c}
\text{O} \\
\text{L} \\
\cdot \\
\eta \\
\text{I} \\
\text{A}
\end{array}

$/\emptyset$/

Of the 317 languages in UPSID, 107 have \$/\emptyset/\$, but only 41 have the palatal stop \$/\empty/$ (cf. Maddieson 1984). However, the subset relation between nasals and stops can be maintained if, as Maddieson (1984:65) argues, affricates are included in the set of stops:
A frequent discrepancy is that obstruents occur at palato-alveolar place but the closest nasal is palatal. This is close enough to be considered a matching place. This seems a reasonable enough suggestion, in particular because in the present model affricates are analyzed as a type of stop.

In many languages, the distributional restrictions on /p/ are more severe than those on other nasals. Consider for instance Tibeto-Burman, which has /m n p ŋ/ word-initially but only /m n ŋ/ word-finally (see e.g. Bradley 1979). The same situation is found in the Malayan family (cf. Adelaar 1985). This asymmetry can be attributed to a prohibition on complex, i.e. branching, place in final position. The advantage of such an account is that it brings the ban on final /p/ in line with other “coda effects” such as devoicing and deaspiration, which also target branching dependent structures.

The second piece of evidence for a phonological relation between nasals and stops comes from natural class behaviour of these two segment types. Such class behaviour can for instance be observed in phonotactic generalizations. Consider as an illustration the observation that in most Chinese, Kadai, and Austronesian languages, the set of coda consonants is restricted to stops and nasals.

Further evidence for a phonological relation between nasals and stops comes from processes in which nasals alternate with stops. One such process can be observed in the Taz dialect of Selkup, where we find free variation between nasals and stops in word-final position (cf. McNaughton 1976):

\[
\begin{align*}
\text{nom} & \sim \text{nop} & \text{‘heaven’} & \text{surɔm} & \sim \text{surɔp} & \text{‘beast’} \\
\text{man} & \sim \text{mat} & \text{‘I’} & \text{nætɛn} & \sim \text{nætɛt} & \text{‘of a girl, girls’} \\
\text{ɔŋ} & \sim \text{ɔk} & \text{‘mouth’} & \text{ɔtænɔŋ} & \sim \text{ɔtænɔk} & \text{‘reindeer-DAT-SG’}
\end{align*}
\]

Based on McNaughton’s description, there does not appear to be any evidence which suggests that the Taz Selkup nasals are phonologically active. If this is correct, then the alternation between stops and nasals can simply be expressed in terms of the presence versus the absence of [L]. This is illustrated in (61), where I assume that the alternating consonants occur in coda position:

\[
\begin{align*}
\text{nom} & \sim \text{nop} & \text{‘heaven’} & \text{surɔm} & \sim \text{surɔp} & \text{‘beast’} \\
\text{man} & \sim \text{mat} & \text{‘I’} & \text{nætɛn} & \sim \text{nætɛt} & \text{‘of a girl, girls’} \\
\text{ɔŋ} & \sim \text{ɔk} & \text{‘mouth’} & \text{ɔtænɔŋ} & \sim \text{ɔtænɔk} & \text{‘reindeer-DAT-SG’}
\end{align*}
\]

---

26 Maddieson appears to be referring to stops and affricates.

27 According to this position, only six languages remain that have /p/ but no corresponding stop. These are Ewe, Efik, Songhai, Javanese, Chamorra, and Aua. Note, however, that according to the description in Capo (1981), the phoneme inventory of Gbe (a Kwa dialect cluster which includes Ewe), does include /ɗ/ dy'.
This type of alternation supports a componential interpretation of nasal manner. More specifically, it supports the claim that stops and nasals share a common structural basis, interpreted here as the element \[|\].

The relation between nasals and stops is also supported by diachronic developments. Consider for instance South Island Maori, where /ŋ/ and /k/ have merged to /k/ (cf. Campbell 1998). This development can be characterized in terms of the loss of \[|\] from the manner structure of the nasal, yielding a homorganic stop. I refer to processes in which nasals are changed into stops as instances of “denasalization”.

Comparative evidence indicates that denasalization of final nasals to voiceless stops has occurred in a number of languages of South-East Asia and Indonesia. For instance, Blust (1997) observes that Roglai, an Austronesian language of the Chamic subgroup, has undergone a development in which the Proto-Chamic final nasals were changed into voiceless stops. This is illustrated by the forms in (62a); the forms in (62b) indicate that this development did not take place in case the final syllable contained a nasal:

(62)  
\begin{align*}
\text{Proto-Chamic} & \quad \text{Roglai} \\
\text{a.} & \quad \text{\textbullet masam} \quad \text{masap} \quad \text{‘sour’} \\
& \quad \text{\textbullet siam} \quad \text{siap} \quad \text{‘ant’} \\
& \quad \text{\textbullet maduan} \quad \text{maduat} \quad \text{‘old’} \\
& \quad \text{\textbullet ikan} \quad \text{\textbullet ika\v{c}} \quad \text{‘fish’} \\
& \quad \text{\textbullet b\=n} \quad \text{bak} \quad \text{‘door’} \\
& \quad \text{\textbullet d\=n} \quad \text{dak} \quad \text{‘hang up’} \\
\text{b.} & \quad \text{\textbullet gunan} \quad \text{gunam} \quad \text{‘cloud’} \\
& \quad \text{\textbullet ma\=n} \quad \text{ma\=n} \quad \text{‘to weave’} \\
& \quad \text{\textbullet a\=nan} \quad \text{a\=nan} \quad \text{‘name’} \\
& \quad \text{\textbullet kawam} \quad \text{kawam} \quad \text{‘nephew’} \\
& \quad \text{\textbullet lukan} \quad \text{lukan} \quad \text{‘tiger’} \\
& \quad \text{\textbullet t\=san} \quad \text{tsan} \quad \text{‘bed’}
\end{align*}

The development in (62a) suggests an analysis in terms of the deletion of \[|\] from the nasal manner structure. However, the comparative evidence presented by Blust shows that this process of denasalization plausibly involved an intermediate stage in which the final nasals were preploded, i.e. \*[N] > \*[N] > C. I consider this type of denasalization in more detail in §4.3.

The structural similarity between nasals and stops is also supported by conditioned alternations between these two segment types. For instance, in West
Greenlandic single word-final /p t k q/ are realized as /m n ŋ n/ when a vowel-initial clitic follows (cf. Fortescue 1984). A similar type of morphological conditioning can be observed in the Nilotic languages Dinka and Shilluck. The forms in (63) show that affixation of the determiner suffix in Dinka and Shilluck turns a stop into a homorganic nasal (cf. Tucker & Bryan 1966):

(63)  
<table>
<thead>
<tr>
<th>Dinka</th>
<th>Shilluck</th>
</tr>
</thead>
<tbody>
<tr>
<td>tɨk'b ‘woman’</td>
<td>&lt;ŋk ‘mouth’</td>
</tr>
<tr>
<td>ɣ̞ɪt ‘house’</td>
<td>ɣ̞ɪn ‘house’</td>
</tr>
<tr>
<td>‘woman-DET’</td>
<td>‘house-DEM’</td>
</tr>
<tr>
<td></td>
<td>‘stick-DEM’</td>
</tr>
</tbody>
</table>

In Dinka and Shilluck the alternation between stops and nasals is observed for all oral places of articulation.

In other languages, stops are realized as nasal under the influence of an adjacent nasal. Examples of such languages are Korean, Welsh, Sanskrit, and Chuckchee. With regard to Korean, Rhee (2002) observes that morpheme-final plain, aspirated, and tensed stops surface as nasals in case they are followed by a nasal. One environment in which stop nasalization applies is in suffixation of the interrogative marker /-ni/, as in (64):

(64)  
| /mək+ni/  | [məŋni] ‘to eat-INTER’ |
| /hop+ni/  | [nomni] ‘high-INTER’   |
| /k’ak’+ni/ | [k’aŋni] ‘to pick-INTER’ |

One way to account for this process is to analyze underlying nasals as being specified for dependent |L|. Stop nasalization can then be expressed in terms of spreading of dependent |L| to the manner structure of the preceding stop, thereby turning it into a nasal. This is illustrated for the form /mək+ni/ in (65), where I assume that the stop occupies the coda position:\footnote{This is done for illustrative purposes only. Rhee offers a number of arguments for treating Korean word-final consonants as onsets of empty-headed syllables.}

\footnote{This is done for illustrative purposes only. Rhee offers a number of arguments for treating Korean word-final consonants as onsets of empty-headed syllables.}
If the targeted stop is underlyingly specified for dependent $|H|$ or $|?|$, as is the case for aspirated stops and tensed stops, nasalization triggers deletion of the dependent laryngeal modification. This deletion can be attributed to structure preservation, given that Korean lacks laryngeally modified nasals. Note that an analysis of Korean nasals as having dependent $|L|$ is supported by the observation that Korean has a process of postnasal voicing, which turns underlyingly plain stops into voiced stops.\(^{29}\)

The analysis of stop nasalization in Korean is similar to the one which I propose for Welsh in §5.2.2. It should be observed, however, that a spreading operation of the kind is not unproblematic. The point is that many other conceivable spreading operations, which in structural terms are equivalent to (65), are unattested. For instance, there do not appear to be processes in which aspiration (as expressed by dependent $|H|$) spreads to the manner component of a neighbouring vowel, turning that vowel into an approximant. The absence of such processes casts doubt on the restrictiveness of Element-based Dependency. For this reason, a more appropriate approach might be one in which voiceless stop nasalization, as well as other assimilation processes which affect manner, are re-interpreted in terms of licensing conditions between adjacent subsyllabic positions; see Harris (1997) for an approach along these lines.\(^{30}\)

### 2.3.2 The vocalic component of nasal manner

In this section, I consider some evidence for analyzing nasals as being headed by the “vocalic” element $|L|$. The presence of $|L|$ in the manner component of nasals embodies the claim that nasals are sonorants. This claim is of course firmly established. The key evidence for the sonorant status of nasals comes from

---

\(^{29}\) It should be noted, however, that my analysis of the Korean facts sidesteps several complicating issues, such as postnasal tensification; see Rhee (2002) for discussion of this issue.

\(^{30}\) Voiceless stop nasalization is also problematic for other approaches, such as Feature Geometry, since it involves spreading of manner properties; that is, the assimilating segment is not only nasalized, but also changes from an obstruent to a sonorant. Processes of this kind are not very frequent.
natural class behaviour of nasals with other sonorants. Below, I briefly consider some examples.

First of all, nasals pattern as sonorants as regards their compatibility with distinctive laryngeal modifications. Like other sonorants, nasals are compatible with distinctive aspiration and distinctive glottalization, but are incompatible with distinctive voice, breathy voice, creaky voice. On a related, theory-internal point, nasals function as sonorants with regard to the interpretation of dependent [L], which in nasals, as in other sonorants, is phonetically interpreted as nasalization. In nasals, this nasalization produces what I referred to as a “nasalized sonorant stop” or “phonologically active nasal” above.

Another piece of evidence in favour of the sonorant status of nasals comes from their compatibility with tone. For instance, in most African tone languages the set of tone-bearing segments includes vowels and nasals. The same situation is observed in Thai. As in most South-East Asian tone languages, the range of tone contrasts in Thai depends on syllable type. Here the basic contrast is between syllables that end in a vowel or nasal, and syllables that end in an obstruent stop. Proto-Thai is for instance generally reconstructed as having four proto-tones, three of which occurred in vowel-final and nasal-final syllables, and only one of which occurred in stop-final syllables (cf. Li 1977). This illustrates both the distributional freedom of nasals as compared to other segment types in coda position, and the natural class behaviour of vowels and nasals. Both can be expressed by reference to the head element [L], which is a property of both vowels and nasals.

In addition, there is abundant cross-linguistic evidence which indicates that nasals pattern as sonorants in phonological processes. Consider as an illustration the pattern of diminutive allomorphy displayed by Dutch CVC-stems. If the stem-final consonant is an obstruent, as in (66a), the diminutive suffix surfaces as [−tj]. If, on the other hand, the stem-final consonant is a sonorant, as in (66b), the suffix surfaces as [−sj].

\[(66)\]

<table>
<thead>
<tr>
<th>STEM</th>
<th>STEM+DIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. /kat/</td>
<td>/katɔja/</td>
</tr>
<tr>
<td>/tas/</td>
<td>/tasɔja/</td>
</tr>
<tr>
<td>/slɛf/</td>
<td>/slɛfjɔ/</td>
</tr>
<tr>
<td>b. /kam/</td>
<td>/kamɔtjɔ/</td>
</tr>
<tr>
<td>/kan/</td>
<td>/kanɔtjɔ/</td>
</tr>
<tr>
<td>/tɔŋ/</td>
<td>/tɔŋtjɔ/</td>
</tr>
<tr>
<td>/bol/</td>
<td>/balɔtjɔ/</td>
</tr>
<tr>
<td>/stɛr/</td>
<td>/stɛrɔtjɔ/</td>
</tr>
</tbody>
</table>

31 The realization of <tj> varies between [tj], [tʃ], [tʃ], and [tʃ]; <sj> is usually realized as [ʃ].
Natural class behaviour of Dutch sonorants can also be observed in segment phonotactics. For instance, complex onsets with an initial obstruent stop predictably have a sonorant as their second member.\(^\text{32}\) The forms in (67) contain some examples involving /t\(\)l/:\(^\text{33}\)

\[
\begin{align*}
(67) & \text{ a. } /\text{pret}/ \quad \text{‘fun’} & \text{ b. } /\text{trap}/ \quad \text{‘stairs’} & \text{ c. } /\text{krat}/ \quad \text{‘crate’} \\
& /\text{plan}/ \quad \text{‘plan’} & & /\text{klsk}/ \quad \text{‘clock’} \\
& /\text{pnoeyma}/ \quad \text{‘pneuma’} & & /\text{knwp}/ \quad \text{‘button’}
\end{align*}
\]

Complex onsets of the kind in (67) are required to be heterorganic. This raises the question why /t\(\)r/ is permitted, but *tl/ is not; see Booij (1995) and Van der Torre (2003) for discussion of this issue. For present purposes, the point to note is that the [\(\)L]-headed status of nasals makes it possible to express sonorant class behaviour of the type displayed by Dutch.

The Dutch facts in (67) illustrate that a unifying property of sonorants is that they can occur in prosodic contexts which are often unavailable to obstruents. One such context is that of the coda position of the syllable.\(^\text{34}\) In this position, nasals in particular are unmarked. Languages in which codas are restricted to nasals include Pali, Japanese, and Axininca Campa, as well as those Bantu languages in which word-internal nasal-stop sequences cannot be plausibly analyzed as prenasalized stops (see Downing 2003 for a discussion of some of these cases). The observation that codas have a preference for nasals can be interpreted to mean that the coda is a “vocalic position”, i.e. a position in which [\(\)L]-headed material is preferred.

We may wonder at this point why it is that nasals, and not sonorants in general, are unmarked coda consonants. That is, if the coda is a vocalic position, the question arises why there do not seem to be languages in which, say, rhotics and laterals are permitted in codas but not nasals, especially since nasals are regarded as being less sonorous than rhotics and laterals. I suggest that the unmarkedness of coda nasals lies in the fact that in coda-onset sequences only one distinctive place specification is generally required for a nasal and a following consonant.\(^\text{35}\) According to this interpretation, nasals have, as it were,

---

\(^\text{32}\) Leaving aside a limited number of words of Greek origin that have stop-/s/ onsets, e.g. *psyche* /psix\(\)\(a/.

\(^\text{33}\) I ignore the approximants /\(\)\(\)\(\)\(\)\(\)\(\)/, whose distribution is more restricted than that of /t\(\)l/\(\)n/\(\). See Van der Torre (2003) for a in-depth discussion of distributional asymmetries involving Dutch sonorants.

\(^\text{34}\) I focus here on word-internal coda positions. Languages generally permit a greater range of consonantal distinctions in word-final context. In fact, the asymmetry between word-internal and word-final consonants is an argument against viewing the latter as codas; see Harris & Gussmann (1998) for a discussion of this issue.

\(^\text{35}\) See e.g. Ito (1986) and Yip (1991) for an interpretation of the relation between codas and place.
the best of both worlds. On the one hand, nasals are sufficiently vocalic to occur in coda position. On the other hand, nasals are sufficiently consonantal to permit the same range of place distinctions as stops, and so, unlike other sonorants, they can share their place specification with a following stop. The hybrid nature of nasals is reflected by their manner component, which consists of a combination of “vocalic” \([L]\) and “consonantal” \([?]\).

Evidence for the presence of a vocalic component in the manner structure of nasals also comes from processes in which vowels or glides develop into nasals and vice versa. I will consider a number of examples of alternations between nasal and oral sonorants in §3.2.2, where I focus on nasalization processes in which sonorants are phonetically realized as nasal(ized). The type of alternation considered here offers more direct evidence for the vocalic component of nasal manner. Consider the basic representation of nasal and vocalic manner in (68):

\[
\begin{array}{c|c|c|c}
\text{Nasal manner} & \text{Vocalic manner} \\
\hline
O & O/N \\
L & L \\
? & \end{array}
\]

The structural parallel between nasal and vocalic manner leads us to expect processes in which a nasal is changed to a vowel or a glide (by deletion of \([?]\)) as well as processes in which a vowel or a glide is changed to a nasal (by insertion of \([?]\)).

Processes of this kind are not very frequent, but they do not appear to be altogether absent. For instance, Li (1977) notes that in most modern dialects of Thai, Proto-Thai \(*g173\) has merged with \(*g106\). This merger can be expressed in terms of the deletion of \([?]\) from the manner structure of the nasal, yielding a homorganic glide:

\[
\begin{array}{c|c|c|c|c|c|c}
\text{O} & \text{O} \\
\hline
L > L \\
? & I & A \\
i & A \\
\end{array}
\]

\(*p > j\)

A more complex scenario is found in Cheyenne and Arapaho, where, as Picard (1984) notes, the Proto-Algonquian glides \(*w\) and \(*j\) have in some environments developed into /n/. Some representative developments are given in (70):
Consider first Cheyenne. The forms in (70d,e) suggest that in syllable-initial position Proto-Algonquian */g119* and */g106* underwent fortition to */g118*/ and */g116*/. Picard attributes the fact that no such fortition has occurred in (70a,b) to the presence of a preceding */g107*. In this context a process of glide neutralization occurred, whereby */w* merged with */j*. The preceding */k* was subsequently lost, after which */j* developed into */h/*. This raises the question how the presence of */h* in (70c) should be accounted for. Picard argues that this */h* is also a reflex of */j*, the latter having arisen through the palatalizing influence of */e* on the following */g107*. This suggests the development */g107/g101* > */g107/g106/g101* > */g106/g101* > */g110/g101*. According to this scenario, the final stage in this complex of changes is an example of “unconditioned” nasalization, changing syllable-initial */g106* to */g110*. This can be represented as in (71), where the vocalic manner component of the glide is augmented by */r* (note that I assume that */g106* is specified for */l* only):

(71)  

```
  O
 / |  /  
 L  >  L
 / |  
 I  ?
 /  |
 I
```

This process of nasalization can be viewed as an instance of fortition, since the addition of */r* implies a reduction of sonority.

The forms in (70d,e) show that glide nasalization also took place in Arapaho, where, as in Cheyenne, it occurred after glide neutralization. Arapaho differs from Cheyenne in that initial glides did not undergo fortition. A further difference between the two languages concerns the development of */kw* and */kj*. As is shown by (70f), */kw* has the reflex */j* in Arapaho, which indicates that after glide neutralization and loss of */k*, */j* did not nasalize to */n/*. Observe, too, that in case */kw* was preceded by a consonant, as in (70g), it disappeared altogether. For the purposes of glide nasalization, the crucial difference between Cheyenne and Arapaho is that it occurred before */k*-deletion in Arapaho, and after */k*-deletion in Cheyenne.
A process that arguably involved the diachronic change *V>N can be found in Makhuwa, a Bantu language of Mozambique. As Schadeberg (1999) notes, Makhuwa has developed aspirated stops in the context of high vowels and prenasalized stops. Schadeberg argues that these two contexts are not unrelated. One type of evidence for this view concerns the formation of perfectives, which involves the insertion of /n/ before a stem-final consonant (and the addition of the suffix /-e/). Historically, this /n/ derives from *-i-, which is itself a reflex of *-ile, the form that is still found in other Bantu languages. The Makhuwa development is illustrated in (72) (cf. Schadeberg 1999:385):

(72) | Makhuwa | Proto-Bantu |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-tenke-</td>
<td>&lt; -teɓe-</td>
<td>&lt; *-tek-ɓe</td>
</tr>
<tr>
<td>-linve-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-vinre-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to Schadeberg, the inserted nasal functions as an independent segment. This is supported by the fact that nasal contours, i.e. structures in which the nasal-stop sequence forms a single, complex structure, are realized as aspirated stops in Makhuwa. This is evidenced, for instance, by the effect of the Proto-Bantu class 9/10 prefix, which is generally reconstructed as *N-, i.e. an underlyingly placeless nasal (cf. Schadeberg 1999:384):

(73) | Proto-Bantu | Makhuwa |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>*-tatu-</td>
<td>&gt; raru</td>
<td>‘three’ cf. tharu ‘id.-CL10’</td>
</tr>
<tr>
<td>*-plit-</td>
<td>&gt; ovira</td>
<td>‘to pass’ cf. ephiro ‘path-CL9’</td>
</tr>
</tbody>
</table>

Aspiration of stops in the context of a preceding nasal prefix is also found in a number of other Bantu languages, including Swahili (see §6.2).

The Makhuwa change *É> n can be represented in terms of the insertion of [ʔ] into the manner component of the vowel, producing a homorganic nasal (in (74) I assume that the prosodic context is that of the coda, although the change may also have effected a change in syllabic status):

(74) | C | C |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>&gt;</td>
<td>L</td>
</tr>
<tr>
<td>I</td>
<td>?</td>
<td>I</td>
</tr>
</tbody>
</table>

*É> n
The fact that the Makhuwa change involves nasalization of a high close vowel may not be accidental. Interestingly, essentially the reverse process, i.e. a change from a high front vowel to a nasal, has occurred in Wambo, a Bantu subfamily of northern Namibia and southern Angola (see Baucom 1974). As is typical for Bantu in general, Wambo languages have a variety of reflexes of Proto-Bantu *N±, including N©, ~C, N±g, and ~. A special development is found in Evale, a Northern Wambo language, where *N has in all contexts developed into /i/:  

\[
\begin{align*}
\text{N+}p & > \text{i} & \text{N+}v & > \text{i} & \text{N+l} & > \text{i} & \text{N+V} & > \text{i} & \\
\text{N+t} & > \text{it} & \text{N+f} & > \text{i} & \text{N+j} & > \text{i} & \\
\text{N+k} & > \text{ik} & \text{N+w} & > \text{iw}
\end{align*}
\]

In representational terms, this suggests the development in (76); I assume in (76) that at the time of the change the nasal was syllabic, and had coronal place:36  

\[
\begin{align*}
\text{N} & \quad \text{N} \\
| & \quad | \\
L & \quad L \\
\text{?} & \quad I \\
I & \\
\end{align*}
\]

*\text{n} > \text{i}

According to Baucom, the change in (76) involved an intermediate stage in which the nasal was devoiced, i.e. *\text{N} > ~ > \text{i}. This account suggests that devoicing might have been initiated in the context of a following voiceless stop, since this is the context in which other Bantu languages, such as Shona, Pokomo, and Sukuma, have also developed voiceless (or aspirated) nasals. Note, too, that it suggests an interaction between high front vowels, devoicing (or aspiration), and nasality. More precisely, Baucom’s account raises the question whether high front vowels are perhaps more prone to devoice than other vowels.37 I will argue in §6.2 that in Swahili, another Bantu language, the Proto-Bantu prefix *ni- has developed into an underlyingly aspirated /n^h/-; this change could perhaps also be attributed to a historical process in which the high vowel was devoiced.

Another example of nasal vocalization can be observed in a number of Interior Salish languages, where this process is generally referred to as “nasal

36 The coronal place specification is supported by the observation that the *N- prefix ultimately derives from Proto-Bantu *ni-.

37 Since devoicing is typically associated with obstruent articulations, the Wambo facts could be argued to support Van der Hulst’s (1995) claim that high vowels contain a consonantal component as part of their structural make-up.
shift” (cf. Czaykowska-Higgins & Kinkade 1998). Nasal shift involves the replacement of nasals by the default vowel of the language involved. For instance, Czaykowska-Higgins & Kinkade (1998:13) note that in Spokane, /n/ surfaces as [i] or [j] in the environments C__s and (stressed) V__s. Two examples involving the verb stem /nɨʃ/- ‘cut’ are given in (77):

(77)  /nɨʃ]-n-t-es/  [nɨʃ]-is]  ‘he cut it’
     /nɨʃ]-nú-n-t-es/  [nɻ]-ɔnúʃ]  ‘he got it cut’

Like the vocalization of nasals in Wambo, nasal shift in Spokane can be expressed in terms of the deletion of [ɻ] from the nasal, resulting in a homorganic vowel or glide.

As a final illustration of nasal vocalization, consider the following facts from Usila Chinantec. As is noted by Skinner (1962), Usila Chinantec /m/ is optionally realized as [û]. The important difference between this process and the processes considered above is that in Usila Chinantec the vocalic variant surfaces as nasalized. I take this to mean that in Usila Chinantec nasalization is phonologically active, and hence that /m/ is specified for dependent [L]. This dependent [L] is a property of both the nasal and the vocalic variant; however, as far as the head manner component is concerned, we are dealing once more with a change from nasal to vocalic manner:

(78)  O  N
     /L L/  →  /L L/  
     |    |     |    |
     |    |     U
     U

/m/ → [û]

The change from a nasal manner component to a vocalic manner component can be regarded as an example of lenition, in the sense that loss of the consonantal component of the nasal produces a less constricted articulation. I consider a number of other processes of nasal lenition in §3.3.

2.3.3 Discussion

The data considered in §§2.3.1 and 2.3.2 strongly suggests that the nasal manner component consists of a combination of a stop-like element, e.g. [ɻ], and a vowel-like element, e.g. [L]. This is supported not only by the observation that nasals show both stop-like and vowel-like behaviour, but also by the observation that the constituent parts of nasal manner are individually manipulable.
The latter point is contested in Humbert (1995), where it is claimed that nasal manner consists of a single, complex manner structure. Consider to this effect the Dependency Phonology representations in (79a,b):

(79)  

\[
\begin{align*}
\text{(79a)} & \quad V \quad \mid \quad C \\
\text{(79b)} & \quad V \quad C
\end{align*}
\]

The representation of nasal manner in Anderson & Ewen (1987), as illustrated in (79a), consists of two separate components. By way of contrast, Humbert’s representation, as shown in (79b), has a single complex manner component. Humbert advances a number of arguments for this view. First, given that in (79a) \(|V|\) and \(|C|\) are individually accessible to phonological processing, Humbert observes that an approach in which \(|V|\) and \(|C|\) function as a single unit is the more restrictive one. The problem with this view, as we have seen, is that there is evidence to assume that the component parts of nasal manner are individually accessible. Second, Humbert argues that (79b) correctly accounts for the observation that nasality acts as a unit in debuccalization processes of the type in Malay (cf. Humbert 1995:88):

(80)  

\[
\begin{align*}
\text{(80a)} & \quad /i\text{kat}/ \quad [i\text{ka}?] \quad \text{‘to tie’} \\
\text{(80b)} & \quad /\text{lipas}/ \quad [\text{lipah}] \quad \text{‘cockroach’} \\
\text{(80c)} & \quad /\text{tawan}/ \quad [\text{taw\ø}] \quad \text{‘cloud’} \\
\text{(80d)} & \quad /\text{kenal}/ \quad [\text{kenal}] \quad \text{‘to know’}
\end{align*}
\]

According to Humbert, Malay has a process of syllable-final debuccalization that targets stops, sibilants, and nasals, but leaves laterals unaffected.38 Humbert notes that debuccalization affects obstruents and nasals in different ways: whereas debuccalized stops and sibilants retain their independent status as \(\theta\) and \(\text{[h]}\), debuccalized /\n/ is realized as nasalization of the preceding vowel.39 This leads Humbert (1995:88) to conclude that nasal manner functions as a unit:

---

38 It is unclear from which Malay dialect Humbert’s data are taken. In northern dialects of Malay, final /\n/ is realized as [i] (e.g. [kenal]), or is lost with compensatory lengthening of the preceding vowel (e.g. [kenal]) (cf. Teoh 1988). The description in Teoh suggests that those dialects with debuccalization of obstruents and nasals also exhibit either loss or vocalization of liquids.

39 Other interpretations of the Malay facts are possible. For one thing, it is arguable whether (80c) involves debuccalization, given that nasalization occurs in tandem with vowel raising. This raising can be accounted for in terms of place merger of the \(\text{[l]}\) element of the nasal and the \(\text{[A]}\) element of the vowel. Note, too, that nasalization occurs only in case the vowel is low; if the vowel is non-low, final /\n/ are realized as [n] or are lost altogether, the difference depending on dialect (cf. Teoh 1988).
If nasality was encoded in the |C| element of the manner component and manipulable on its own, instead of in the entire structure consisting of |V| with a |C| specification as a dependent component, nasalization of a preceding vowel would leave a single vowel component.

Note that Humbert rules out the possibility of a single debuccalized |V| component for theory-internal reasons.40 This aside, Humbert’s arguments for interpreting nasal manner as a single unit seem to rest on the assumption that in the representation in (79a) nasal manner is denoted by the |C| element. But this is incorrect: the position in Anderson & Ewen is not that |C| denotes nasal manner just in case it is dominated by |V|, but that the configuration of |V| dominating |C| denotes nasal manner.

Given this, and given the range of empirical evidence cited above, I conclude that the component parts of nasal manner are independently manipulable. Note in this respect that if they were not, as (79b) suggests, it would be unclear whether |V| and |C| can be regarded as component parts at all. Rather than restrictive, (79b) appears to introduce an additional component to the set of manner components. Thus, I conclude that an analysis of nasal manner in terms of two separate elements is more adequate.

2.4 Phonation

Following Smith (2000), I assume that the phonation component, which subsumes the various laryngeal modifications, is represented as a dependent manner component. Like head manner, dependent manner is specified by the elements |/@|, |H|, and |L|. This assumption keeps the number of manner elements restricted to three. The use of a single set of elements is supported by the fact that |/@|, |H|, and |L|, in their capacity as manner and phonation elements, share certain general articulatory and acoustic characteristics.41 In addition, there is phonological evidence, in particular from lenition and debuccalization processes, which points to a relation between manner and phonation. For instance, lenition processes in which voiceless stops are weakened to |/@| receive a straightforward interpretation if the output of such processes, i.e. |/@|, is already present in the structure of the affected segment (see Harris & Lindsey 1995 for discussion of this issue).

To restrict the number of possible dependent structures, I assume that the number of dependent elements is limited to one. We will see that this is

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40 This, according to Humbert, is also the reason why laterals fail to undergo debuccalization.

41 That these characteristics are general is underscored by the interpretation of |L| as nasalization, which, in phonetic terms, is not a laryngeal modification.
sufficient to express the various laryngeal modifications, at least from the viewpoint of phonological contrasts. Typical realizations of \( ? \), \( \text{H} \), and \( \text{L} \) as dependent manner are given in (81):

\[(81)\]

\[
\begin{align*}
? & : \text{glottalization, ejection, creaky voice, implosion} \\
\text{H} & : \text{aspiration, breathy voice, voicelessness} \\
\text{L} & : \text{voice, nasalization}
\end{align*}
\]

A comment is in order with respect to the interpretation of \( \text{H} \) and \( \text{L} \) as laryngeal elements. Note in (81) that dependent \( \text{H} \) involves a greater degree of glottal aperture than \( \text{L} \) while, in their capacity as heads, \( \text{L} \) involves a greater degree of supraglottal aperture than \( \text{H} \).\(^{42}\) This suggests, then, that the phonetic relation between head and dependent \( \text{H} \) and \( \text{L} \) is primarily acoustic.

The phonetic realization of dependent \( ? \), \( \text{H} \), and \( \text{L} \) is variable. This variability is due to two factors. First of all, languages differ in the way laryngeal distinctions are implemented. Consider for instance the realization of dependent \( \text{H} \) in English and Javanese. In English, fortis stops in foot-initial position are realized with a period of voicelessness after oral release and before the onset of voicing of a following vowel; for this reason, these stops are generally transcribed as aspirated \([p^h t^h k^h]\). The phonetic implementation of dependent \( \text{H} \) is quite different in Javanese. As is noted by Catford (1977), fortis stops in Javanese are realized with the larynx lowered, and with the vocal cords relaxed and opened at the cartilaginous part. This glottal configuration persists into a following vowel, which is produced with a lowered pitch and with breathy voicing. Catford transcribes the sounds in question as \([p^h s^h t^h s^h k^h]\), and refers to them as “heavy stops”.

Despite these phonetic differences, there is no reason to analyze the heavy stops of Javanese and the aspirated stops of English as different phonological entities. Although the two series of stops differ in terms of their realization and their effect on a following segment, neither Javanese nor English contrasts more than one type of fortis stop. Hence, both can be represented in terms of head stop manner with dependent \( \text{H} \). In Javanese, this \( \text{H} \) spreads to the dependent position of a following vowel, where it is phonetically interpreted as breathy voice. In English, on the other hand, no interaction between an aspirated consonant and a following vowel takes place; instead we find that the dependent \( \text{H} \) of the aspirated stop is realized on a following sonorant consonant, as in words like \textit{clue} \([k^h u^h]\) and \textit{cry} \([k^h a^h i^h]\) (see also §1.3).

Aside from differences in phonetic implementation, variability in the realization of laryngeal modifications may depend on the manner type to which dependent \( ? \), \( \text{H} \), and \( \text{L} \) are associated. Part of this variability is a matter of phonetic implementation. For instance, Sapir (1938) observes that in most languages of North America that have glottalized stops and sonorants, the stops

\[^{42}\text{I am grateful to Wolfgang Kehrein for raising this issue.}\]
are realized as postglottalized (or ejective) and the sonorants as preglottalized.\footnote{We will see in §5.3 that this difference is typical in prevocalic position.} Here, too, there is no reason to take this variation as phonologically relevant, since there do not appear to be any languages in which the ordering of laryngeal and supralaryngeal articulations is contrastive (see also §5.1).

What is phonologically relevant regarding the relation between manner and phonation concerns the observation that not all manner types are compatible with all phonation types. As regards this compatibility, segments fall into three classes:\footnote{In what follows, I ignore the relation between laryngeal segments and laryngeal modifications; this issue is discussed §6.3.} The first class comprises stops and affricates; these segment types are compatible with the maximum range of laryngeal contrasts. The second class comprises fricatives; this class permits only a subset of laryngeal modifications. The same holds for the third class, i.e. that of sonorants, although the range of laryngeal contrasts permitted by sonorants differs from that permitted by fricatives. Importantly, these three segment classes correspond exactly to the \[\mathcal{?}\], \[H\], and \[L\]-headed manner types distinguished in Element-based Dependency. The table in (82) summarizes the compatibility of manner and phonation types:\footnote{In (82) Voi denotes voice, Asp aspiration, Glott glottalization, BrVoi breathy voice (i.e. “voiced aspiration”), and Impl implosion (i.e. “voiced glottalization”).}

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|}
\hline
Segment type & Voi & Asp & Glott & BrVoi & Impl \\
\hline
\[\mathcal{?}\]-headed (stops) & ✓ & ✓ & ✓ & ✓ & ✓ \\
\[H\]-headed (fricatives) & ✓ & ✓ & ✓ & * & * \\
\[L\]-headed (sonorants) & * & ✓ & ✓ & * & * \\
\hline
\end{tabular}
\caption{(82) displays two asymmetries: breathy voice and implosion are compatible only with \[\mathcal{?}\]-headed segments, and voicing is restricted to \[\mathcal{?}\]-headed and \[L\]-headed segments. I will provide a principled account of both asymmetries below.}
\end{table}

\subsection*{2.4.1 Glottalization}

I assume that dependent \[?] is phonetically interpreted as glottalization, ejection, creaky voice, or implosion. Some examples of glottalized segment types are given in (83):

\begin{itemize}
\item
\end{itemize}
Note again the variable realization of structures that are specified for dependent \( \text{?} \). A segment such as /p\( ^\text{!}\)/ is in some languages realized as an ejective. Similarly, a segment like /a\( ^\text{!}\)/ is in some languages realized as a creaky voiced vowel, with optional pre- or postglottalization. These realizations simply reflect the combination of stop and vocalic manner with glottalization; phonologically, these segments are represented in terms of dependent \( \text{?} \). Below, I adopt the convention of transcribing all segments that contain dependent \( \text{?} \) with the glottalization diacritic /\( ^\text{!}\)/.

As was noted, contrastive implosion is compatible only with \( \text{?} \)-headed segments, i.e. stops and affricates. If we wish to maintain the hypothesis that dependent manner is limited to one element, the question is how these segment types must be represented. I suggest that in stops that involve both voicing and glottalization, voicing forms part of the manner component, as in (84a):

\[
\begin{array}{cccc}
\text{a.} & \text{O} & \text{b.} & \text{O} \\
\text{c.} & \text{O} & \text{d.} & \text{N} \\
\hline \\
? & ? & \text{H} & ? \\
\text{U} & \text{I} & \text{I} & \text{A} \\
/p\text{}/ & /\text{s}\text{}/ & /\text{j}\text{}/ & /\text{a}\text{}/
\end{array}
\]

(84a) is a bilabial glottalized sonorant stop, which is interpreted phonetically as an implosive [ɓ] or as a voiced glottalized stop, i.e. [b\( ^\text{!}\)] or [b\( ^\text{!}\)], with optional presence of voiced creak during oral closure. Thus, implosion is interpreted as a combination of inherent voicing and dependent \( \text{?} \). Note that this representation is required only in case implosive stops are contrastive, as in !Xu. In languages such as Thai and Swahili, in which voiced stops are phonetically realized as imploiled, glottalization does not serve a distinctive function, and hence can be left out of the underlying specification of these stops.\(^{46}\) In other languages, such

---

\(^{46}\) Since implosion involves lowering of the larynx, non-distinctive implosion can be viewed as a strategy to facilitate voicing in stops. Another such strategy is prenasalization, as we will see in §3.2.4.3.
as Kpelle, we find a phonetically implosive labial stop that functions phonologically as a sonorant stop.\footnote{In Gbe, we find a labial sonorant stop which in oral contexts is realized as \[b\] (see also §3.2.3); however, there is historical evidence that this stop derives from an earlier imploled \[b\] (cf. Smith & Haboo 2003).} In such cases, too, there is no need to represent these stops as underlyingly specified for dependent \[\?\]. I will consider the status and behaviour of Kpelle \(/b/\) in more detail in §3.2.4.1.

The structure in (84b) represents a contrastively implosed affricate. This segment type is very rare; the only language in UPSID which contains imploled affricates is !Xu. I assume that this segment type contains a tripartite manner structure, so as to accommodate the inherent voicing that is characteristic of distinctive implosion.

The fact that distinctive implosion involves inherent voicing raises the question how the structure in (84c) should be interpreted. As noted, a manner structure in which \[H\] dominates \[L\] represents an inherently voiced fricative or approximant, depending on the phonological system of the language. Since this configuration is not \[\?\]-headed, the resulting segment is not interpreted as being implosed but rather as being glottalized. Distinctively glottalized approximants are found in a number of South-East Asian and North American languages, such as Sedang, Montana Salish, and Klamath. A potentially problematic case is Sui, which according to Maddieson (1984) has a distinctive laryngealized voiced velar fricative \(/{/\}. I suggest that the sound in question functions phonologically as an inherently voiced fricative with dependent glottalization; that is, \(/{/\) has a manner component in which \[H\] dominates \[L\], and a dependent element \[\?\].

\subsection{2.4.2 Aspiration}

Dependent \[H\] is interpreted as aspiration, breathy voice or voicelessness. Some examples of segment types with dependent \[H\] are given in (85):

\begin{verbatim}
(85) a. O \ b. O \ c. N \ d. O
\ H \ H \ H \ L \ H \ L
\ L \ L \ H \ L \ H
\ T \ I \ A \ ?
\ |
\ /p^b/ \ /s^b/ \ /a^b/ \ /m^b/
\end{verbatim}

A comment is in order regarding the combination of sonorant manner and dependent \[H\]. Phonetically, such segments may or may not be characterized by a period of voicelessness, depending on the overlap of the articulatory gestures. As such, possible phonetic realizations of (85d) include \[\text{m}^h \text{m} \text{mf}\],\footnote{In Gbe, we find a labial sonorant stop which in oral contexts is realized as \[b\] (see also §3.2.3); however, there is historical evidence that this stop derives from an earlier imploled \[b\] (cf. Smith & Haboo 2003).}
so that the sounds can be labelled aspirated, breathy voiced, or voiceless. From a phonological perspective, however, the important point is that we are dealing with a single segment type, characterized by dependent \( \text{|H|} \). This is supported by the observation that we do not find languages with a phonological contrast between aspirated, breathy voiced, and voiceless sonorants (see also §5.2). Below, I transcribe all segments that contain dependent \( \text{|H|} \) in terms of the aspiration symbol \( `/h/`.

As was observed, only stops and affricates, i.e. \( \text{[/ʔ]-headed segments, are compatible with distinctive breathy voice. Similar to what I propose for distinctive implosion, I assign a componential interpretation to distinctive breathy voice, in the sense that breathy voice is represented by a combination of dominated \( \text{|L|} \) in the head manner component and dependent \( \text{|H|} \). Given this assumption, consider the representations in (86):

\[
\begin{align*}
\text{(86a)} & \text{ represents an inherently voiced bilabial stop with dependent } \text{|H|}, \text{ i.e. } /b^h/; \\
\text{(86b)} & \text{ is an inherently voiced affricate with dependent } \text{|H|}, \text{ i.e. } /\tilde{d}z^h/. \text{ Manner components that lack } \text{[/ʔ]} \text{ are incompatible with distinctive breathy voice. In such cases the phonetic interpretation may vary between aspiration, breathy voice and voicelessness. An example of such a segment type is the laryngeally modified lateral in (86c); I will discuss the interpretation of laryngeally modified nasals, including nasals with dependent } \text{|H|}, \text{ in more detail in chapter 5.}
\end{align*}
\]

### 2.4.3 Voice and nasalization

As can be seen in (82), one asymmetry in the compatibility of manner and phonation types is that distinctive voicing is compatible with \( \text{[/ʔ]-headed and } \text{|H|-headed manner types, but not with } \text{|L|-headed manner types. This asymmetry is repeated in (87):}
The assumption that voicing is represented in terms of dependent \( \text{[L]} \) suggests at first sight that it must be stipulated that voicing is incompatible with sonorants; we saw in §1.2 that this is the position taken in Humbert (1995). However, I argued in §1.2.1 that this stipulation can be circumvented if the element which specifies voice is assigned a more general interpretation. To this end, I propose that the interpretation of dependent \( \text{[L]} \) is not limited to voicing, but is extended to include nasalization. More specifically, my claim is that the interpretation of dependent \( \text{[L]} \) depends on the manner type of the segment to which it is associated. If the segment is a sonorant, then dependent \( \text{[L]} \) is interpreted as nasalization. If, on the other hand, the segment is an obstruent, then dependent \( \text{[L]} \) is interpreted as voicing.

Let us consider some consequences of this hypothesis. First of all, a context-sensitive interpretation of dependent \( \text{[L]} \) resolves the asymmetry in (87), as is shown in (88):

<table>
<thead>
<tr>
<th>Segment type</th>
<th>Voice</th>
<th>Nasalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{[?]}/ )-headed (stops)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>( \text{[H]}-/ )-headed (fricatives)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>( \text{[L]}-/ )-headed (sonorants)</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

An important proviso regarding (88) is that the complementary distribution of voice and nasalization pertains to supralaryngeal articulations. The status of dependent \( \text{[L]} \) in laryngeal articulations is different, as we will see in §6.1.

The dual interpretation of dependent \( \text{[L]} \) as voicing and nasalization makes two predictions. First, distinctively voiced sonorants have no phonological status. Second, obstruents never contrast in terms of nasalization. The first prediction is unproblematic, provided that a distinction is made between inherent and distinctive voicing. Sonorants are inherently voiced, as is expressed by the presence of \( \text{[L]} \) in their manner component. In those cases where sonorant voicing is phonologically relevant, it is by virtue of this \( \text{[L]} \). This implies that dependent \( \text{[L]} \) denotes distinctive voicing if the manner type to which it is linked does not itself contain \( \text{[L]} \), as is the case in structures of the kind in (89):
All structures in (89) have obstruent manner components, so that dependent \[\textit{L}\] is interpreted as distinctive voicing.

What about the second prediction? The overview of nasalized consonants in Cohn (1993) suggests that in those languages in which nasalized segments are distinctive, the segments involved are sonorants. This supports the claim that in those cases where a manner component contains \[\textit{L}\], dependent \[\textit{L}\] is interpreted as nasalization. Some representative manner structures are given in (90):


\[
\begin{array}{cccc}
\text{a.} & \text{b.} & \text{c.} & \text{d.} \\
/\textit{b}/ & /\textit{z}/ & /\textit{y}/ & /\textit{d}/ \\
\end{array}
\]

(90a) represents the nasalized vowel /\textit{û}/; (90b) is its non-nuclear counterpart, a typical realization of which is [\textit{U}]. Cohn (1993) observes that [\textit{U}] is contrastive in a number of languages, including Yakut, Koñagi, and Umbundu. (90c) is a voiced nasalized fricative /\textit{ʃ}/. This segment has been argued to be distinctive in Umbundu (Schadeberg 1982) and Igbo (Williamson 1969); from the perspective of Element-based Dependency, this implies that /\textit{ʃ}/ must be viewed as inherently voiced. Finally, (90d) represents a labial nasal contour, a typical realization of which is [\textit{b}]; the status of this segment type was discussed in §2.2.4.

Two remaining segment types that require discussion are that of nasalized sonorant stops and nasalized laryngeals. The former have the structure in (91):

\[
\begin{array}{cccc}
\text{a.} & \text{b.} & \text{c.} & \text{d.} \\
/\textit{w}/ & /\textit{ʊ}/ & /\textit{ʃ}/ & /\textit{b}/ \\
\end{array}
\]

48 Schadeberg and Williamson also posit a number of underlyingly \textit{voiceless} nasalized fricatives. Cohn argues that nasalization in these cases is more appropriately viewed as a property of the syllable. This interpretation is in line with the current approach to segment nasalization (see §3.2.5).
As was discussed in §2.2.5, this is the representation of a nasalized sonorant stop. Here the presence of dependent |L| serves a double function. On the one hand, dependent |L| identifies the structure as a whole as being nasalized. On the other hand, dependent |L| expresses the fact that the nasal to which it is attached is phonologically active, in the sense that it may trigger both voicing and nasalization.

Consider finally the representation of nasalized laryngeals. As is illustrated in (92), these consist of a placeless manner component that is specified for either |H| or |?|, and a dependent element |L|:

The status of nasalized laryngeals is not entirely uncontroversial. However, we will see in chapter 6 that there are strong arguments for recognizing nasalized laryngeals as a phonological class. For present purposes, the point to note is that the interpretation of dependent |L| as nasalization depends on two factors: the presence of |L| (in the case of nasalized sonorants) and the absence of place (in the case of nasalized laryngeals).

The fundamental claim of the Element-based Dependency approach to nasalization is that it is treated on a structural par with laryngeal modifications. While nasalization is not a phonation type in phonetic terms, there are a number of phonological parallels between the two. Consider for instance the observation that phonation and nasalization do not form an integral part of segments, but serve to modify these. From a representational viewpoint, this suggests that both function as dependent structures. It should also be noted that the dependent status of phonation is in line with the markedness observation that the presence of a laryngeally modified segment implies the presence of its non-laryngeally modified counterpart. The same markedness implication holds for nasalized segments. Most importantly, the dual interpretation of dependent |L| as voice and nasalization makes it possible to provide a natural account of processes
which involve phonological interaction between voiced and nasalized segments. I will consider a number of examples of such processes in chapter 4.

In terms of structure, the Element-based Dependency interpretation of dependent |L| makes it possible to maintain the hypothesis that dependent manner structures are limited to a maximum of one element. In addition, representing phonation and nasalization in terms of single elements permits a straightforward interpretation of their autosegmental behaviour. Compare in this respect Dependency Phonology approaches such as Humbert (1995) and Smith (2000), where nasalization consists of a degenerate nasal manner component consisting of |V| dominating |C|. The problem with this interpretation is that the autosegmental behaviour of nasality involves a combination of elements. The possibility of two elements spreading and delinking as a unit increases the number of possible operations in the grammar, and should therefore be approached with scepticism.

In terms of content, the basic assumption of the present approach is that nasality and voice are represented by one and the same element. An advantage of this interpretation is that it offers a principled explanation for why voicing is distinctive only in obstruents, and why nasalization is distinctive only in sonorants. The elemental make-up of nasal manner proposed here is similar to that in the “Revised” Element Theory of Ploch (1999), in that both consist of the elements |L|, |?| and a place specification. An important difference between the two approaches is that in Revised Element Theory segments lack an internal hierarchical organization: a nasal such as /m/ is represented as ([?·U·L]). An important difference between the two approaches is that in Revised Element Theory segments lack an internal hierarchical organization: a nasal such as /m/ is represented as ([?·U·L]). Ploch expresses the relation between nasals and voiced stops by assuming that the latter have the same elemental make-up as nasals, but differ from these in that in voiced stops |L| is headed. That is, a voiced stop such as /b/ is represented as ([?·U·L]).

While reasons of space preclude a detailed discussion of Revised Element Theory, a number of general problems are worth noting. First, the notion of headedness that is employed in Revised Element Theory does not involve a binary asymmetric relation, as is evidenced by the representation of voiced stops. As a result, these representations are rather unrestrictive: there is no principled way to restrict the number of elements within a segmental expression, nor to delimit the types of possible heads. This problem is exacerbated by Ploch’s (1999:163-4) assumption that

[there are two ways how [in Revised Element Theory] an H-head can be linked to an onset point: fused with the rest of the melodic material associated with that onset point or unfused with it.]

49 In Revised Element Theory, segmental expressions which contain more than one element involve “element fusion”. This is expressed in terms of the fusion symbol “.”.

50 I follow here the Revised Element Theory convention of indicating headedness in terms of underlining.
Given such assumptions, it is perhaps not surprising that Revised Element Theory overgenerates in a number of respects. For instance, Ploch must stipulate that \( |?| \) can be linked to onsets only, that \(|H|\) is the only element that can be “unfused”, and that combinations of \(|H|\) or \(|L|\) with \(|?|\) are possible only if \(|H|\) or \(|L|\) is head (cf. Ploch 1999:160-8).

The present proposal shares with Revised Element Theory the dual interpretation of \(|L|\) as nasality and voice. However, it differs from this framework in that it assigns a more general interpretation to \(|L|\) in terms of sonorant manner. This move has two advantages. First of all, it includes \(|L|\) in the set of autonomously interpretable elements, given that autonomous \(|L|\) is interpreted as vocalic manner. Second, the autonomous interpretation of \(|L|\) formalizes the primacy of manner properties in the segmental organization. Element-based Dependency differs in this respect from other element-based theories, as well as from Feature Geometry, where the manner properties of segments receive a “distributed” treatment.51

### 2.5 Place

I assume that place distinctions are expressed in terms of the elements \(|U|\), \(|I|\), and \(|A|\). These elements were originally proposed in early work in Dependency Phonology (see Anderson & Jones 1972). \(|U|\), \(|I|\), and \(|A|\) are used in a number of frameworks including Particle Theory (Schane 1984), Government Phonology (Kaye et al. 1985), and Element Theory (Harris & Lindsey 1995), although as vowel features only. Here I follow Smith (1988), Van der Hulst (1988a,b), Van der Hulst & Smith (1990), and Van de Weijer (1996), where \(|U|\), \(|I|\), and \(|A|\) specify place distinctions in both vowels and consonants. This view is not only restrictive, but it also permits a straightforward expression of place-related interaction between vowels and consonants.52

The phonetic interpretation of \(|U|\), \(|I|\), and \(|A|\) depends on whether they occur as heads or as dependents, and on whether they are associated to vowels or consonants. I outline my assumptions regarding vocalic and consonantal place in §§2.5.1 and 2.5.2.

#### 2.5.1 Vocalic place

As far as vocalic place is concerned, I follow the interpretation of \(|U|\), \(|I|\), and \(|A|\) as outlined in Smith (2000). In isolation \(|U|\), \(|I|\), and \(|A|\), when dominated by \(|L|\), have the following interpretation:

---

51 With the exception of the Feature Geometry model of Clements (1985), where the various manner features are subsumed under a single Manner node.

52 Recall for instance the process which rounds /i/ in Tulu (see §1.1).
It is also possible to view each element as imposing a partition of the vowel space into two regions. This is illustrated in (94):

Observe that there is no element which corresponds to the traditional feature [high]; instead, the absence of |A| will imply a high interpretation. In isolation |I| and |U| are interpreted as /i/ and /u/, on the assumption that the backness of |U| is typically enhanced by rounding. A vowel specified as |A| is interpreted as /a/.

Hence, the unmarked status of the peripheral vowels /u i a/ is reflected in their relatively simple representations, as is shown in (95) (recall that N in structural descriptions denotes the syllable nucleus):

Combinations of |U|, |I|, and |A| under a single manner element |L| result in a complex place specification and represent more marked vowel options. Consider for instance the combination of |I| and |A|. Here two structures are possible:

---

53 Smith (2000) argues that head |U| in vowels represents backness rather than roundness. This is motivated by the observation that back vowels are usually, but not invariably, round. As was observed in §1.1, a case in point is the |U|-specified vowel of Japanese, which is phonetically [u] rather than [u].
The vowels in (96) differ with respect to the dependency relation between |I| and |A|. Headedness of |I|, as in (96a), denotes a propensity of frontness and results in a high-mid interpretation, i.e. /e/. Headedness of |A|, as in (96b), denotes a propensity of lowness and results in a low-mid interpretation, i.e. /ɛ/.

With this in mind, consider the remaining place combinations in (97):

      |     |     |     |
      L   L   L   L
      |     |     |     |
      I   U   U   I   U   A   A   U
      /i/   /y/   /o/   /ɔ/

A comment is in order with respect to the combination of |U| and |I|. Since these elements refer to adjacent non-overlapping sectors of the vowel space, vowels denoted by a combination of |U| and |I| are located at the border of these sectors. Depending on the dependency relation involved, I take the relevant vowels to be /i/ and /y/ (see also Smith 2000).

I assume that complex place specifications which consist of identical place elements are prohibited in vowels. This can be attributed to an OCP condition on vocalic place. It should be noted, however, that there is no a priori reason to exclude such structures. In fact, we will see in §2.5.2 below that identical place specifications are permitted in consonants. This difference between vowels and consonants might be taken as another illustration of the fact that place is dependent on manner.

It is important to distinguish complex specifications of the kind in (97) from place specifications which are dominated by separate manner components, as in (98):

(98)  N
      |     |
manner    manner
      |     |
place    place
In (98) we observe a head manner component dominating a place component, and an additional dependent manner component dominating a second place component. I refer to the place component which is dominated by head manner as “primary place”, and to the place component which is dominated by dependent manner as “secondary place”. In their capacity as secondary place elements, [U], [I], and [A] have the interpretation in (99):

(99)  
U : (more) constricted labial cavity (=rounding)  
I : (more) constricted oral cavity (=ATR)  
A : (more) constricted pharyngeal cavity (=RTR)

Note that [U], [I], and [A] have this interpretation in case they are dominated by a dependent vocalic manner structure in the nucleus. I consider other types of branching manner structures in §2.6 below.

The distinction between primary and secondary place makes it possible to account for observed types of vowel harmony. The approach to vocalic place outlined here predicts six possible types of vowel harmony, all of which are attested.

(100)  
\[
\begin{array}{ll}
\text{Head} & \text{Dependent} \\
\text{U} & \text{back harmony} & \text{rounding harmony} \\
\text{I} & \text{front harmony} & \text{ATR harmony} \\
\text{A} & \text{low harmony} & \text{RTR harmony}
\end{array}
\]

Note that the approach to place that is outlined here predicts that there are no cases of [high] harmony. This prediction is not entirely uncontroversial, although it has been argued that reported cases of high harmony are amenable to alternative analyses (see e.g. Van der Hulst & Van de Weijer 1995a, Polgárdi 1998).

### 2.5.2 Consonantal place

The general organization of consonantal place is similar to that of vocalic place. In consonants the phonetic interpretation of [U], [I], and [A] corresponds to the three major places of articulation, i.e. labial, coronal, and dorsal (or velar):

(101)  
\[
\begin{array}{ll}
\text{U} & \text{labial constriction} \\
\text{I} & \text{coronal constriction} \\
\text{A} & \text{dorsal constriction}
\end{array}
\]

The interpretation of [U], [I], and [A] involves a number of related articulatory and acoustic properties. In this sense, it combines the acoustic interpretation of features in Jakobson et al. (1951) with the articulatory interpretation of features of SPE. Consider for instance [U], which is interpreted here as backness in
vowels and as labiality in consonants. In articulatory terms, these are two distinct properties: whereas back vowels involve a retracted tongue body and, normally, concomitant lip rounding, labial consonants involve a stricture made with the lips. In a framework in which features are based on concrete articulatory events, this difference implies that two distinct features, e.g. [round] and [labial], must be distinguished.

As was noted in §1.1, such an approach is at pains to express place-related interaction between vowels and consonants. Consider for instance the following accommodation process in the ancestor of present-day Sranan, an English-based creole of Surinam. As Smith (1988) observes, English CVC-stems with a non-low vowel are incorporated with an epithetic vowel, the quality of which is determined by the stem vowel. Some examples are given in (102); note that there is variation in case the stem vowel is /e/:

\[(102)\]

<table>
<thead>
<tr>
<th>English</th>
<th>Incorporated word</th>
<th>Sranan</th>
</tr>
</thead>
<tbody>
<tr>
<td>sick</td>
<td>/stɪk/</td>
<td>siki</td>
</tr>
<tr>
<td>beg</td>
<td>/bɛg/</td>
<td>begi</td>
</tr>
<tr>
<td>dead</td>
<td>/ded/</td>
<td>dede</td>
</tr>
<tr>
<td>soap</td>
<td>/səʊp/</td>
<td>sopo</td>
</tr>
<tr>
<td>loose</td>
<td>/lʊs/</td>
<td>lusu</td>
</tr>
</tbody>
</table>

The situation is different in case the stem vowel is /a/. In this case the quality of the epithetic vowel is determined by the place of the stem-final consonant:

\[(103)\]

<table>
<thead>
<tr>
<th>English</th>
<th>Incorporated word</th>
<th>Sranan</th>
</tr>
</thead>
<tbody>
<tr>
<td>grab</td>
<td>/ɡ्रæb/</td>
<td>grabu</td>
</tr>
<tr>
<td>hat</td>
<td>/hæt/</td>
<td>ati</td>
</tr>
<tr>
<td>crack</td>
<td>/kræk/</td>
<td>kraka</td>
</tr>
</tbody>
</table>

This regularity is difficult to express if the features which specify place in vowels are different from those which specify place in consonants. If, on the other hand, vowels and consonants are specified in terms of the same set of place elements, the process can be accounted for simply by spreading the place element of the final consonant to the epithetic vowel.

When it comes to the interpretation of |U|, |I|, and |A| as dependent elements in consonants, two complicating factors can be noted. First, association of place elements is determined in part by the manner type of consonants. Whereas manner types such as stops and fricatives allow the maximum number of place distinctions, other manner types are compatible with only a subset of place distinctions. In particular, sibilants, affricates and laterals are limited to head |I|. I suggest that this restriction is related to the presence of the manner element |H|. According to this view, the restriction can be attributed to the fact that manner, in the capacity of head, selects the range of possible place dependents. Of course, the fact that |H| can dominate |I| only is as much a stipulation as the fact
that features such as [strident] or [lateral] can only be combined with [coronal]. The merit of the present approach is that it accounts for the place restrictions on sibilants, affricates, and laterals in a uniform manner, i.e. by reference to a single dominating manner element.

Second, a distinction must again be made between complex place and secondary place. As for vowels, complex place in consonants involves segments that have two place elements which are dominated by a single manner component. The range of complex place specifications involving distinct elements is given in (104), where I restrict the attention to [ʔ]-headed consonants:

\[
(104) \quad \begin{array}{cccc}
\text{a. } & \text{O} & \text{b. } & \text{O} \\
\text{c. } & \text{O} & \text{d. } & \text{O} \\
\text{I} & \text{U} & \text{I} & \text{A} \\
\text{I} & \text{U} & \text{I} & \text{A} \\
\end{array}
\]

(104a) and (104b) involve a combination of labiality and coronality, which suggests that the structures are interpreted as /fp/p/. These segments are extremely rare and possibly non-existent underlyingly. Ladefoged & Maddieson (1996:344) observe that [fp] is an allophone of /kp/ in Dagbani; in Abkhaz and Lak it is, for some speakers at least, an allophone of /tʰ/. According to Ladefoged & Maddieson, the only language in which /fp/ might be phonemic is Yeletnye, a Papuan language of New Guinea, which arguably contrasts labio-alveolar, labio-postalveolar, and labio-velar stops, prenasals, and nasals. (104c) and (104d) involve a combination of labiality and velarity. Labio-velars are cross-linguistically much more frequent than labio-coronals. They are found in many West African languages, such as Dagbani, Kpelle, Ewe and Gã. As far as their phonological behaviour is concerned, Van de Weijer (1996) maintains that labio-velars sometimes pattern as labials and sometimes as velars. Hence, while there appear to be no languages which contain both (104c) and (104d), both structures could be argued to be phonologically relevant.54

I assumed in §2.5.1 that identical place specifications in vowels are banned. Here I would like to argue that such structures are possible in consonants. Consider (105):

---

54 Ohala & Ohala (1993:237) argue that labiovelar nasals tend to pattern with velars rather than with labials, and that labiovelar stops tend to pattern as velar when interacting with nasals. For instance, Yoruba /w̃ kp ŋb/ trigger merger of a following /b̃ ŋ/, parallel to /b f m/. However, assimilation of a nasal to /w/ yields [ŋ] and not [m].
A complex identical place specification involving |U| denotes labial as opposed to labiodental place, e.g. /ʃ/~/ʃ/. Guthrie (1967) reports contrastive labiodental stops in a number of Bantu languages of southern Africa, although Ladefoged & Maddieson (1996) note that their distinctive status is controversial. The contrast between bilabial and labiodental fricatives is well established, however, and is found in for instance Ewe and Tsonga. A complex identical place specification involving |I| is interpreted as dental place. This structure is found in languages which contrast a series of dental consonants with a series of alveolar consonants, e.g. /ʃ/~/ʃ/, as is the case for coronal stops in most Pama-Nyungan languages. In languages with a single coronal stop that is phonetically realized as dental, e.g. Finnish, a structure with a single specification for |I| is sufficient. A complex identical place involving |A| denotes pharyngeal place in languages that contrast dorsal and pharyngeal consonants, e.g. /x/~/x/. This type of contrast is attested in a number of Semitic and Cushitic languages including Arabic and Somali.

As for vowels, secondary place in consonants is dominated by a dependent vocalic manner component. In their capacity as secondary place elements in consonants, |U|, |I|, and |A| have the following interpretation:

(106) U : labialization
    I : palatalization
    A : velarization

Secondary articulations are viewed in terms of dependent vocalic manner structures. Consider as an illustration the representation of a palatalized labial stop in (107):

(107) O
    | L
    | U I

/pʃ/
secondary place and a consonant followed by a non-nuclear vowel, at least within the same subsyllabic position (see also Kehrein 2002). If this is correct, the prosodic approach to laryngeal features that was outlined in §1.2.2 can be extended to secondary place specifications. Note that in Element-based Dependency both types of modifications are expressed in terms of dependent manner.

The lack of a contrast such as /p~/pj/ is straightforwardly captured by the structure in (107), since here no distinction can be made between a single, complex segment and a cluster. If this distinction is phonologically irrelevant, this is an advantage rather than a liability. I return to this issue in §2.6.

### 2.6 The interpretation of branching manner structures

In this section, I focus in somewhat more detail on the interpretation of branching manner structures, i.e. those structures which involve a head manner component and a dependent manner component. First, in §2.6.1, I consider the interpretation of “bare” dependent manner, which, as we have seen, is used to represent laryngeal modifications. Next, in §2.6.2, I consider the interpretation of place-specified dependent manner. This type of structure is used to represent secondary articulations and, in traditional parlance, segmental clusters. Based on this discussion, I formulate a number of general well-formedness conditions on Element-based Dependency representations. Finally, in §2.6.3, I briefly set out my assumptions regarding syllable structure.

#### 2.6.1 Secondary manner

As was noted in §1.2.2, the hypothesis that manner and phonation are dominated by a subsyllabic constituent implies that Element-based Dependency does not recognize a level in the phonological organization which corresponds to that of the segment. This raises the question how branching manner structures must be interpreted. Consider in this respect the representation of a labial aspirated stop:

(108) $O$  
   \[ ? \quad H \]  
   \[ U \]

In terms of its constituent parts, the onset in (108) consists of a labial stop /p/ and a degenerate laryngeal /h/. Since both parts are capable of forming an onset on their own, (108) can, in principle at least, function as a single segment /p~/ or as a cluster /ph/. At issue here is the question whether this difference in
segmental status is something which Element-based Dependency should be able to account for.

As was already noted in relation to secondary articulations, the important observation is that there do not seem to be any languages which have a contrast between /pʰ/ and /ph/, at least not within the same subsyllabic position. From the perspective of phonological contrast, this suggests that a single representation /pʰh/ is sufficient. In this respect, Element-based Dependency is more restrictive than frameworks which recognize an independent segmental level. The question, then, is whether there are any persuasive arguments for a distinction between a single segment and a cluster interpretation of the type of structure in (108).

In those frameworks which recognize a level corresponding to the segment, a number of diagnostics are available which help us to determine the segmental status of laryngeally modified sequences. It is questionable, however, whether these diagnostics have any real value. To illustrate this, consider the “phoneme economy argument” that is sometimes advanced in support of a cluster interpretation: if a language has both /p/ and /h/, then an interpretation of /pʰh/ as a cluster implies that no segment /pʰ/ needs to be recognized. The advantage of this analysis would be that it yields a more economic phonemic inventory.

The phoneme economy argument is frequently in conflict with the “syllable economy argument” which is sometimes advanced for a single segment interpretation: if a language has /p/, /h/, and /pʰh/, and if this language allows no sequences other than /pʰh/, then a single segment interpretation of /pʰh/ permits the generalization that the language does not allow consonant clusters. The advantage of this analysis, then, would be that it yields a more economic syllable inventory.

The syllable economy argument has been used to support a single segment analysis of prenasalized stops, which, in many of the languages in which they occur, are the only permitted initial consonant sequences. However, it has been observed on a number of occasions that syllable economy does not provide any definitive evidence for the single segment status of prenasalized stops (see e.g. Poser 1979, Herbert 1986, and Van de Weijer 1996). As Van de Weijer notes, the possibility should be left open that nasal contours are the only exceptions to the distributional pattern in initial position.

In view of these observations, I propose that a sequence of a supralaryngeal and a laryngeal articulation functions as a cluster only if the two articulations belong to different subsyllabic constituents. Consider in this respect (109a-c), where each of the representations consists of a combination of /pʰh/, but only (109b,c), where /p/ and /h/ are not dominated by the same constituent, are clusters (note that “.” denotes a syllable boundary):

---

55 This argument is frequently found in language descriptions of the Summer Institute of Linguistics, under the influence of Pike (1947).
According to this approach, the question of segmental status is essentially reduced to a question of syllabification. I will return to this hypothesis in connection with laryngeally modified nasals in §5.4.2.

In some cases, there is more persuasive distributional evidence for a cluster analysis of laryngeally modified segments. Suppose for instance that a language has /p/, /l/, and /p+h/, and also permits some clusters other than /p+h/. This would suggest that both a cluster and a single segment analysis of /p+h/ are possible. Now, suppose further that the language concerned permits clusters which consist of a plain stop and a lateral, e.g. /pl/, but not of an aspirated stop and a lateral, e.g. */p+hl/. This could be interpreted to mean that aspirated stops function as clusters, since this permits the generalization that the language does not allow /CCC/-clusters.

It should be noted, however, that the distributional asymmetry between plain and aspirated stops can also be accounted for by other means. Consider to this effect the representations of /pl/ and /p+hl/ in (110):

(110) a. O b. O’

(110a) represents an onset constituent with a stop head and a sonorant dependent. The structure in (110b) also contains a stop head and a sonorant dependent, but here an additional laryngeal modification is present. Given that laryngeal contrasts have scope over the entire onset (see §1.2.2), I assume that branching manner structures with an additional laryngeal contrast involve projection of the onset constituent, and that the laryngeal modification is a
dependent of the projected onset. The projected onset is represented as $O'$. Projection of subsyllabic constituents offers an alternative interpretation of languages where (110a) is tolerated, but not (109b): in such languages, onset projection is prohibited. We will see in §5.4.2 that Sedang is an example of such a language.

### 2.6.2 Secondary place

The preceding discussion was centred on the observation that languages do not form underlying contrasts such as */pʰ~ph*/ and */p̩~pj/ within the same subsyllabic constituent. In this section, I take as my starting point the observation, made in §1.2.2, that languages also lack ordering contrasts such as */pʰ~pʰ/ and */p~p/ within the same subsyllabic constituent. In terms of Element-based Dependency, this implies that the relative order of branching manner structures is never contrastive.

At this point, a distinction must be made between bare dependent manner structures that represent laryngeal modifications and place-specified dependent manner structures. As regards the former, languages vary with respect to the realization of the ordering of supralaryngeal and laryngeal modifications; for instance, aspirated stops are realized as postaspirated in English, but as preaspirated in Ojibwa (cf. Maddieson 1984, Kehrein 2002). By way of contrast, languages do not appear to vary in the ordering of primary and secondary articulations; for instance, the combination of /p+h/ within an onset is universally realized as /p/ first and /h/ second. The fact that the order here is fixed can be attributed to the fact that /h/ is more sonorous—i.e. consists of more vocalic elements—than /p/. The combination /p+h/ is in this respect similar to a combination such as /f+l/ which, within the same subsyllabic constituent, is predictably realized as /f/ first and /l/ second.

These observations show that the order of branching manner structures is predictable if both are specified for place. In this sense, the place specifications can be said to function as “place holders”. Consider the representations in (111):

---

56 Note in this respect that a typical realization of (110b) is one in which the aspiration gesture is realized on the sonorant, i.e. [pʰ], as in English.

57 I assume that projection is possible only if the projected constituent has no phonetic content. This holds for subsyllabic constituents, but not for manner and place elements.
I will have little to say about the restrictions between place-specified branching manner structures. It is reasonable to analyze these as following from the inherent sonority of the manner components that are involved. Generally speaking, \( |p| \)-headed structures can precede \( |H| \)-headed and \( |L| \)-headed structures, and \( |H| \)-headed structures can precede \( |L| \)-headed structures, but not vice versa.

A final comment is in order regarding head-dependency relations within branching manner structures. I assume that dependent structure is permitted only in case head structure is present. This holds both for dependent place and dependent manner. The effect of this restriction is that representations of the kind in (112) are prohibited:

(112) a. \( *O \) b. \( *O \)

(112a) is illicit because it has a place-specified dependent, but lacks a place-specified head. (112b) is illicit because it has a manner-specified dependent, but lacks a manner-specified head. Note that the ill-formedness of (112a,b) cannot be attributed to the condition that heads be more complex—it.e. contain more elements—than dependents, since in structures such as /p+1/ as in (110a) the...

---

58 An alternative approach would be to derive the linear order of manner structures from their internal make-up. According to this view, (111a) is predictably realized as a stop followed by a glide, since in onsets place-specified \( |p| \)-headed structures are realized before place-specified \( |L| \)-headed ones. See Golston & Van der Hulst (1999) for an approach along these lines.

59 I ignore here the issue of sC-clusters. These can be accounted for by complicating the well-formedness conditions on onsets, positing extrametrical positions such as a “prependix” (see Fudge 1969) or an “extra-syllabic position” (see Fikkert 1994), or by analyzing such clusters as heterosyllabic (see e.g. Kaye et al. 1990).

60 Another reason why (112b) is prohibited is that it has a head place element which lacks a dominating manner element. This is impossible if, as is assumed here, place is dominated by manner.
dependent /l/ is more complex than the head /p/. Rather, for both manner and place the generalization is that the presence of dependent structure implies the presence of head structure.

2.6.3 Syllable structure

To conclude the discussion of branching structures, a few brief comments are in order concerning my assumptions with regard to syllable structure. I will take the position that syllable structure, like the segmental structure that it dominates, is maximally binary branching and consists of head-dependency relations. To this end, I follow in broad terms the theory of syllabic representation developed by Levin (1985). In this approach the head status of the nucleus is formalized by making the syllable a projection of the nucleus. More specifically, Levin’s assumption is that the coda functions as the complement of the nucleus, and is dominated by the first projection N'. This projection is therefore equivalent to the traditional notion of “rhyme”. The onset functions as the specifier of the nucleus, and is dominated by the second projection N". N", then, is equivalent to the unit of the syllable:

\[
\begin{array}{c}
N'' \\
| O \\
| N' \\
| \ldots N C \\
| \ldots \\
\end{array}
\]

The configuration in (113) represents the basic syllable-internal structure. Depending on the presence of contrastive laryngeal modifications in the onset, nucleus or coda, the levels of O, N, and C may themselves involve internal complexity. This was illustrated in (110b) in relation to a complex onset constituent such as /pl/.

Given that the level of the syllable involves the same structural principles as that of subsyllabic constituents, there is nothing which prohibits the association of contrastive laryngeal specifications to the level of the syllable itself. Consider as an illustration the representation of “syllable-level” nasalization in (114):

\[
\begin{array}{c}
N'''' \\
| N' \\
| L \\
| O \\
| N' \\
| \ldots \\
\end{array}
\]
As I will argue in §3.2.2, this type of representation is relevant in languages in which nasalization is as a property of entire syllables rather than of subsyllabic constituents. Observe that a concept such as syllable-level nasalization is entirely in accordance with the general approach to phonological contrasts that is advocated in Kehrein (2002): if nasalization is a property of the syllable, then dependent |L| should be assigned to the level of the syllable in the prosodic hierarchy.

2.7 Summary

In this chapter, I have outlined the main tenets of Element-based Dependency. In this theory, the manner and phonation properties of segments are expressed in terms of the elements |ʔ|, |H|, and |L|, and the place properties—both vocalic and consonantal—are expressed in terms of the elements |U|, |I|, and |A|. The internal structure of the manner component determines the range of dependent place and the phonetic interpretation of dependent phonation. This pertains in particular to dependent |L|, the realization of which—voice or nasalization—depends on the composition of the manner component to which it is associated. Phonetically non-homogeneous sequences, such as laryngeally modified structures and secondary articulations, are expressed in terms of branching manner structures. These structures are subject to a number of general well-formedness conditions. One such condition is that the presence of dependent structure implies the presence of head structure. A more specific condition is that cooccurrence restrictions between branching manner components apply in case both manner components are specified for place. In such cases, cooccurrence restrictions between different manner components follow from the relative sonority of the elements involved, where sonority is derivable from their elemental make-up.
Part II

Nasality
In the previous chapter I outlined the main tenets of Element-based Dependency, a theory of segment specification in which segmental manner is represented in terms of the elements \( |?| \), \( |H| \), and \( |L| \), and combinations of these. With this background, the present chapter examines the phonological status and behaviour of nasalized segments. As was argued in §2.4.3, nasalized segment types are characterized by the presence of a dependent element \(|L|\). Broadly speaking, two kinds of nasalized segment types can be distinguished: nasalized sonorants, as in (1a), and nasalized laryngeals, as in (1b):

\[(1) \quad \begin{align*}
\text{a.} & \quad \overbrace{\text{L}}^{|L|} \\
\text{b.} & \quad \overbrace{\text{H/}}^{|H|/}
\end{align*}\]

Nasalized sonorants consist of a manner component which contains \(|L|\), and which in turn dominates a place specification. Nasalized laryngeals consist of a manner component that contains either \(|H|\) or \(|?|\), and lack a place specification. In both types of structures in (1), dependent \(|L|\) is interpreted as nasalization; in other types of structures, dependent \(|L|\) is interpreted as voicing.

The present chapter is organized as follows. First, in §3.1, I put the interpretation of dependent \(|L|\) as nasalization on a concrete footing by examining some processes of vowel nasalization. Next, in §3.2, I shift the focus to nasal harmony, i.e. those processes in which nasalization is a property of a domain larger than the single segment. After a typological overview of nasal harmony processes, I examine a specific type of harmony in which nasalization is a property of syllables rather than of segments. The majority of languages which display this type of harmony also display complementary distribution between a series of nasals and a series of voiced oral stops. I interpret this to mean that the oral variants function as sonorant stops, which, given the appropriate context, are nasalized by association with dependent \(|L|\). As such, this type of harmony provides evidence for the notion of sonorant stop, and for an analysis of nasals as nasalized sonorant stops.
In §3.3, I offer further support for the interpretation of nasals as nasalized sonorant stops. The relevant evidence concerns what I will refer to as “nasal lenition”, a cover term for those phenomena in which nasals shed their consonantal properties and surface as nasalized approximants. The observation that the outcome of nasal lenition is a nasalized approximant suggests that lenition can be formalized in terms of the removal of \( [\tilde{r}] \) from the nasal manner component. As such, nasal lenition provides evidence for the presence of dependent \( [L] \) in nasals, and also supports the more general claim that lenition processes target segmental heads and leave dependent structure intact.

### 3.1 Vowel nasalization

As a prelude to the discussion of nasal harmony phenomena, this section considers the representation of nasalized vowels and examines some representative synchronic and diachronic origins of vowel nasalization.

As was argued in §2.1.3, the Element-based Dependency representation of vowels consists of a manner component \( [L] \) that is dominated by a nucleus. Given that vowels are sonorants, the association of dependent \( [L] \) to a vocalic manner structure yields a nasalized vowel. Consider the representations of oral /a/ and nasalized /\( \tilde{a} /\):

\[
\begin{array}{c}
a. \\
| L \\
| A \\
\end{array}
\]

\[
\begin{array}{c}
b. \\
| L | L \\
| A |
\end{array}
\]

In languages in which nasalized vowels are derived, these vowels are usually nasalized by a neighbouring nasal consonant.\(^1\) The existence of this process in a language implies that the triggering nasal has dependent \( [L] \).\(^2\) Vowel nasalization can then be expressed in terms of spreading of dependent \( [L] \) to the dependent position of the vowel. This is illustrated in (3) for the sequences /ma/ and /am/:

---

\(^1\) In §§6.1 and 6.2 I consider some processes in which vowel nasalization is triggered by a preceding laryngeal.

\(^2\) I am concerned here with phonological, not phonetic, vowel nasalization. Phonetic vowel nasalization is a universal coarticulatory phenomenon that is associated with the production of a vowel and a neighbouring nasal. Phonetically nasalized vowels are typically nasalized for only part of their duration. In addition, this nasalization always has a phonetically identifiable source. The phenomenon of nasal effacement, which I will discuss shortly, indicates that this is not always the case for phonological nasalization.
(3a) is an example of progressive vowel nasalization, since the triggering nasal precedes the vowel. (3b) is an example of regressive vowel nasalization, since the triggering nasal follows the vowel. Note that in both cases the nasal and the vowel are tautosyllabic; the cross-linguistic overview of vowel nasalization in Schourup (1973) suggests that this is the typical environment in which this process occurs.

Distinctively nasalized vowels are not infrequent. For instance, they occur in 22.4% of the languages in UPSID (cf. Maddieson 1984). In each of these languages, the number of nasalized vowels does not exceed that of oral vowels. This is expected not only from the perspective of markedness, but also from the fact that nasalized vowels are almost always historically derived from a sequence of an oral vowel and a neighbouring nasal. The typical diachronic scenario involves an initial stage in which a syllable-final nasal triggers regressive vowel nasalization. The second stage involves deletion of the manner component of the nasal, but not of the nasalization. Thus, the historical presence of the nasal can be deduced from the nasalization that is left behind on the preceding vowel. This scenario is referred to as “nasal effacement” by Foley (1975). The Element-based Dependency interpretation of nasal effacement is illustrated in (4) for the tautosyllabic sequence /am/:

3 I will not be concerned with the relation between nasalization and vowel place. Maddieson (1984:131) notes that peripheral /ɨ ū ţ/ are most frequent, and that “nasalized vowel frequency is generally correlated with the frequency of the oral equivalent”.
The first stage of nasal effacement involves regressive vowel nasalization, as expressed by the leftward spreading of dependent \[L\]. The second stage involves the loss of the nasal manner component, leaving behind a nasalized vowel.

According to the cross-linguistic overview of vowel nasalization in Schourup (1973), progressive vowel nasalization does not appear to be significantly less frequent than regressive vowel nasalization (see also Blust 1997). However, it is certainly the case that nasal effacement is far more typical for syllable-final nasals. It is reasonable to assume that this asymmetry is due to the fact that the syllable-final position is a weak position, and as such disfavours segmental complexity and the presence of consonantal material. Given that nasalized sonorant stops are both structurally complex (i.e. branching) and contain the consonantal manner element \[\tilde{r}\], their effacement in syllable-final context is unsurprising from the viewpoint of markedness.

Nasal effacement can be argued to be synchronically active in a language like French, which displays prosodically conditioned alternations of the kind in (5):

(5)  
- **a.** le petit ami  \[lɒpət\-ami\]  ‘the little friend’
  l’ami est petit  \[læmɪɛpɔti\]  ‘the friend is little’
  le petit cheval  \[lɒpɔt\-əval\]  ‘the little horse’
- **b.** le bon ami  \[læb\-ɔnami\]  ‘the good friend’
  l’ami est bon  \[læmɪe\-bð\]  ‘the friend is good’
  le bon cheval  \[læb\-əval\]  ‘the horse is good’

The forms in (5a) show that the final /\(U\)/ in *petit* is realized only if it can be syllabified as an onset. The forms in (5b) show that the same holds for the final /\(U\)/ of *bon*. If there is no available onset, as in *l’ami est bon*, nasal effacement applies, and underlying nasality is retained as nasalization of the preceding vowel.

Essentially the same alternation can be observed in morphologically related forms. Consider for instance the relation between masculine and feminine adjectives:

(6)  
- **bon**  \[b\-o\(n\) \~ \(b\-ð\)]  ‘good-MASC’
  bonne  \[b\-o\(n\) \~ \(b\-n\)\]  ‘good-FEM’
- **vain**  \[vɛ̃ \~ \(v\-\ɛ\)]  ‘vain-MASC’
  vaine  \[vɛ̃ \~ \(v\-ɛ\)\]  ‘vain-FEM’

The variation in the masculine forms is prosodically conditioned: a final nasal is realized in case there is an available onset position. The feminine forms are always realized with a final nasal. Since these forms are optionally realized with

---

4 Other examples include the relation between nouns like *ton* \(\text{[ton]}\) ‘tone’ and *tonalité* \(\text{[tonalite]}\) ‘tonality’, and between nouns and corresponding verbs, as in *son* \(\text{[sɔn]}\) ‘sound’ and *sonner* \(\text{[sɔne]}\) ‘to sound’. Nasal effacement can also be extended to word-internal nasalized vowels, as in *blanc* \(\text{[blɔ̃]}\) ‘white’ and *santé* \(\text{[sɛ̃te]}\) ‘health’.
a final schwa-like vowel (transcribed in (6) as [ə]), a reasonable assumption is that final nasals in feminine forms are syllabified as onsets. On this assumption, we can analyze the final nasals in feminine forms as underlyingly associated to an onset, and the final nasals in masculine forms as underlyingly unsyllabified.

Cross-linguistically, syllable-final nasal effacement is the typical origin of distinctively nasalized vowels. A case in point is observed in Bisoid, a dialect cluster which belongs to the Loloish branch of Tibeto-Burman, and which includes Bisu, Pyen, and Phunoi (cf. Bradley 1979, 1985a). Consider the following cognate sets (cf. Bradley 1985a:252-7):5

(7)  
\[
\begin{array}{lllll}
\text{Proto-Bisoid} & \text{Bisu} & \text{Pyen} & \text{Phunoi} \\
m\& & ?am\& & <\text{amawng}> & m_\text{s} & 'horse' \\
\text{hñ子弟} & \text{hñ子弟} & <\text{nakang}> & \text{\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t\t
\end{array}
\]

These cognate sets suggest that Phunoi, but not Bisu and Pyen, underwent syllable-final nasal effacement of /ŋ/, creating a series of distinctively nasalized vowels.

In other languages, the diachronic development of nasalized vowels is more complex. One such language is Lakkia, a Kadai language spoken in southern China. Haudricourt (1967) observes that Lakkia is the only Kadai language which has nasalized vowels. This is evidenced by the cognate sets in (8) (cf. Haudricourt 1967:172-4):6

(8)  
\[
\begin{array}{llllll}
\text{Lakkia} & \text{Thai} & \text{Sek} & \text{Sui} & \text{Kam} \\
\text{khjõp} & \text{phrom} & \text{phrom} & ?\gamma\text{um} & \text{wum} & '\text{slimmed}' \\
\text{kùi} & \text{mai} & \text{mi} & \ldots & \ldots & '\text{thread}' \\
\text{khù} & \text{mu} & \text{mu} & \text{hmù/hù} & \text{ŋu} & '\text{pork}' \\
\text{khwõ} & \text{ma} & \text{ma} & \text{hma} & \text{ŋwa} & '\text{dog}' \\
\text{kjë} & \text{na} & \text{na} & ?\text{na} & \text{na} & '\text{face}' \\
\text{kjùn} & \text{non} & \text{nol} & \ldots & \text{ nun} & '\text{worm}' \\
\text{tšiè} & \ldots & \ldots & ?\text{ja/nie} & \text{ija} & '\text{river}' \\
\text{phâ/hâ} & \text{ma} & \text{ma} & \text{ma} & \text{ma} & '\text{to return}'
\end{array}
\]

In Van de Weijer (1996), the origin of the nasalized vowels is analyzed as involving transfer of the feature [nasal] from a nasal to a neighbouring vowel. Van de Weijer (1996:216) represents this process as follows:

---

5 Bradley does not give a phonetic transcription of the Pyen forms. It is clear from his description, however, that <ng> represents /ŋ/.

6 Note that the Sui reflexes contain some instances of aspirated and glottalized nasals. Aspirated nasals can also be reconstructed for an earlier stage of Thai. I return to this issue in §5.2.3.1.
This scenario, Van der Weijer argues, supports the hypothesis that nasals consist of a stop component and a nasal component—a hypothesis which Element-based Dependency shares with Van de Weijer’s approach. Transfer of the nasal component leaves the stop component intact, so that the resulting segment is interpreted as a stop.

Although Van de Weijer observes that the triggering nasal either preceded or followed the vowel, his analysis appears to be based primarily on the correspondence /khɔp/ /phɔm/. The problem with this analysis is that there are no other forms that support regressive transfer of [nasal]. Inspection of the cognates in Haudricourt (1967) shows that nasal-final forms in Kadai generally correspond to nasal-final forms in Lakkia. Compare for instance the following correspondences between Lakkia and Thai:

(10) Lakkia Thai
    tam thom ‘lake’
    ɓˈen kin ‘to eat’
    liŋ liŋ ‘monkey’

This suggests that the source of vowel nasalization lies in the consonant preceding the vowel, as was in fact anticipated by Haudricourt (1976:176):

Cette série de correspondances explique … l’origine des voyelles nasales du Lakkia: c’est la consonne nasale du groupe initial qui en s’amusant a nasalisé la voyelle suivante.

In line with Haudricourt, I propose that the historical origin of the nasalized vowels is a preceding nasal consonant, which, presumably under the influence of a preceding stop, was lenited to a nasalized approximant. In Element-based Dependency this diachronic change can be expressed in terms of the removal of [?] from the nasal manner component.7

I further assume that a subsequent process of rightward transfer occurred in which dependent [L] was shifted from the approximant to the following vowel. This transfer of dependent [L] is a natural development, given the marked status of nasalized approximants. The transfer of dependent [L] is illustrated in (11) for

7 I will consider more examples of nasal lenition in §3.3. The diachronic development of Tai-Kadai nasals is discussed in §5.2.3.1.
Lakkia /kjɛ/, which, in line with the argumentation presented above, derives from Proto-Kadai *kne:

\[
\begin{array}{c|c}
\text{Stage 1: nasal lenition} & \text{Stage 2: rightward transfer} \\
\hline
\text{O} & \text{O} \\
\text{N} & \text{N} \\
\text{L} & \text{L} \\
\text{L} & \text{L} \\
\text{(?)} & \text{I} \\
\text{A} & \text{I} \\
\text{I} & \text{A} \\
\end{array}
\]

\[*\text{kne} > /kjɛ/\]

According to this interpretation, the development of nasalized vowels in Lakkia might be regarded as involving “partial” nasal effacement, in the sense that the original trigger, while no longer a nasal, has been retained.

Given the scenario in (11), a comment is in order regarding the rightward transfer of dependent [L] to the vowel. This, it was argued, produces a less marked structure. The representation in (11) demonstrates that this loss of markedness cannot be attributed to the manner type to which dependent [L] is associated, since approximants and vowels have the same manner specification. Rather, given the vocalic nature of [L], I assume that manner structures which are specified only for [L] are relatively unmarked in nuclei, but relatively marked in onsets. This captures the fact that nasalization (i.e. association of dependent [L]) is relatively unmarked for vowels, but relatively marked for approximants.

In this section, three general observations were made regarding vowel nasalization. First, the cross-linguistically typical scenario of vowel nasalization involves spreading of dependent [L] from a neighbouring nasal. Second, distinctively nasalized vowels result mostly from nasal effacement, a process in which a nasal that triggers nasalization is itself deleted. Nasalization and nasal effacement both support a representation of nasals in terms of dependent [L]. Third, in some languages nasalized vowels are the result of spreading or transfer of nasalization from a neighbouring nasalized approximant. In such cases, transfer of nasalization to the vowel involves a loss of markedness, in that it produces a structure in which a vocalic element (i.e. dependent [L]) is dominated by a vocalic position (i.e. a nucleus).

### 3.2 Nasal harmony

The processes of vowel nasalization considered in §3.1 are all local, in the sense that the nasalization trigger is adjacent to the target. However, not all nasalization is local, nor is the domain of nasalization always restricted to a
single nasalization target. Phenomena in which nasality surfaces as a property of not just one segment but a string of segments are generally referred to as “nasal harmony”.

In this section, I focus on two interrelated aspects of nasal harmony: the domains in which harmony is active, and the range of segmental nasalization targets within these domains. In §3.2.1, I provide a typological overview of nasal harmony processes. In §3.2.2, I offer a theoretical interpretation of a subtype of nasal harmony in which all sonorant targets within the harmonic domain are nasalized. One property of this type of harmony is that nasals are in complementary distribution with a series of voiced oral consonants. I will argue that the segment type concerned functions as a sonorant stop, which, depending on the presence of underlying nasalization, surfaces as either oral or nasal. A further property of this type of harmony is that nasalization functions as a property of syllables rather than of individual segments. Based on Piggott & Van der Hulst (1997), I offer an Element-based Dependency analysis of syllable nasalization in §3.2.3. This analysis is supported by a number of case studies, which are presented in §3.2.4. Finally, in §3.2.5, I briefly consider some general consequences of the proposed analysis.

3.2.1 Typological overview

Typological research on nasal harmony processes has shown that there are a number of parameters according to which language-specific harmony patterns may vary (see e.g. Court 1970, Schourup 1973, Anderson 1976, Van der Hulst & Smith 1982, Pulleyblank 1989, Piggott 1987, 1988, 1992, Piggott & Van der Hulst 1997, Walker 1998, and Ploch 1999). Pre-theoretically, the following five parameters can be distinguished:

(12) \textit{Parameters of nasal harmony}
   
   a. Domain of nasalization  
   b. Trigger of nasalization  
   c. Direction of nasalization  
   d. Target range of nasalization  
   e. Behaviour of non-targets

Parameters (a-c) are self-evident. In (d) “target range” refers to the range of segment types that is compatible with nasalization. In (e) “non-targets” are those segment types that are incompatible with nasalization; non-targets either block nasal harmony or are transparent to it. In the remainder of this section, I discuss the parameters in (12) in relation to a range of cross-linguistic data.

If we define nasal harmony as involving the association of nasalization in a domain larger than the single segment, then it follows that a standard case of vowel nasalization qualifies as the minimal example. Consider in this light Tinrin, where, according to Osumi (1995), vowels are nasalized before nasals
and prenasalized stops (see also §2.2.5). Or consider the Uma Juman dialect of Kayan, an Austronesian language of Sarawak, where we find forms of the kind in (13) (cf. Blust 1997):

\[(13)\]  
\[\begin{align*}
\text{a. } & \text{māṭaŋ} & \text{‘eye’} \\
& \text{himōh} & \text{‘to blow the nose’}
\end{align*}\]
\[\begin{align*}
\text{b. } & \text{ɡīhām} & \text{‘rapids’} \\
& \text{avin} & \text{‘because’}
\end{align*}\]

& \text{son} & \text{‘rice mortar’}

According to Blust (1997:151), this pattern is “fairly typical” of a number of languages of northern Sarawak. The forms in (13a) show that in Uma Juman vowels are nasalized after a syllable-initial nasal. The forms in (13b) show that there is no vowel nasalization in case a vowel is followed by a nasal. From this we may conclude that nasal harmony in Uma Juman is triggered by nasals, is progressive, targets vowels, and is blocked by all other segment types. Since only vowels are affected by nasalization, we can say that the domain of nasalization is that of an onset-nucleus sequence.

A minimally different harmony pattern is observed in Sundanese, an Austronesian language of western Java. Consider the forms in (14) (cf. Robins 1957, Cohn 1990):

\[(14)\]  
\[\begin{align*}
\text{a. } & \text{nāṭān} & \text{‘wet-_ACT’} \\
& \text{nāˈur} & \text{‘say-_ACT’} \\
& \text{kumāḥā} & \text{‘how?’} \\
& \text{biŋhār} & \text{‘be rich-_ACT’} \\
& \text{mīʔāsih} & \text{‘love-_ACT’}
\end{align*}\]
\[\begin{align*}
\text{b. } & \text{nājāk} & \text{‘sift-_ACT’} \\
& \text{nāwih} & \text{‘sing-_ACT’} \\
& \text{māro} & \text{‘halve-_ACT’} \\
& \text{mōloho} & \text{‘stare-_ACT’} \\
& \text{ɬātər} & \text{‘arrange-_ACT’}
\end{align*}\]

The forms in (14a) show that nasalization spreads rightwards from a nasal consonant, and targets vowels, and laryngeals. The forms in (14b) show that nasalization is blocked by any other segment type.\(^8\) Note that in both Sundanese and Uma Juman Kayan the direction of nasal harmony is progressive. According to Blust, this is the case in most Austronesian languages with nasal harmony (see also Court 1970).

The difference between Uma Juman Kayan and Sundanese is that the target range in Sundanese is extended to include the laryngeals /h?/. As to the phonetic

\[\text{\footnotesize{\(8\) A complication is that epenthetic [w] and infixed [l] do surface as nasalized. See Cohn (1990, 1993) and Benua (1997) for discussion of this issue.}}\]
realization of /h ?/, acoustic measurements reported by Ohala (1990) and Cohn (1990) indicate that in nasal contexts [h] is realized with nasal airflow. But what about [?] in nasal contexts? The fact that nasal airflow is incompatible with glottal closure should not be taken to imply that [?] induces raising of the velum. Indeed, velic closure is unexpected because of the following nasalized vowel. The point to note here is that while velic lowering has no perceptual effect, nothing rules out the combination of glottal closure and a lowered velum from an articulatory viewpoint. I discuss the issue of nasalized laryngeals in more detail in §6.1; there we will see that in some languages there are good grounds to posit *underlyingly* nasalized laryngeals.

Yet another minimal extension involves the inclusion of sonorant segment types into the harmonic target range. A case in point concerns the pattern of nasal harmony displayed in Warao, an isolate of Venezuela and Guyana (cf. Osborn 1966):

(15)  a. mõõûùiùi 'give it to him'
     inãûìûãûì 'summer'
     mõõûìûuõi 'give them to him'
     mõõûìõìûo 'shadow'
     b. tewêke 'kind of bird'
     te'rê 'it broke'
     ja 'sun'
     jã 'walking'
     c. iõ 'turtle'
     ôiõõõro 'kind of tree'

The forms in (15a) show that the harmony process is progressive, is initiated by nasals, targets vowels, laryngeals, and /w j/, and is blocked by other consonants. The forms in (15b) show that Warao also has *underlyingly* nasalized vowels. The forms in (15c) show that these, like nasals, trigger progressive nasalization.9

The pattern displayed in Warao is similar to that displayed in Capanahua, a Panoan language of Peru. The main difference is that Capanahua lacks underlyingly nasalized vowels and exhibits regressive harmony, as is shown in (16) (cf. Loos 1969:177-8):

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9 I have been unable to find any Warao forms with vowel sequences whose second, but not first, member is nasalized. According to Osborn’s description, such forms should be possible.
The forms in (16a) indicate that nasal harmony proceeds leftwards from a nasal, targets vowels, laryngeals, and /w j/, and is blocked by other consonants. The forms in (16b) indicate that triggering nasals, when in word-final position, are themselves deleted. This suggests that Capanahua exhibits a process of final nasal effacement, with nasalization being retained by spreading it leftwards. We may think of this nasalization as being compensatory, in the sense that it compensates for effacement of the nasal. As we will see in §3.3, nasal lenition may also give rise to this type of nasalization.

In fact, there is evidence to suggest that the pattern of nasal harmony in Capanahua is bidirectional. We saw in (16) that regressive nasalization is conditioned by nasals which, depending on the context, may or may not be realized themselves. In addition to this type of harmony, Capanahua also displays progressive nasalization. This second type of harmony is crucially conditioned by nasal effacement, as is indicated by the forms in (17) (cf. Loos 1969:180):

(17) /wiran-wi/ [wirã⁰] ‘push it over’
    /wiran-jaʔaʔn-wi/ [wirã⁰jaʔã¹] ‘push it over sometime’
    /hoʃiŋha-jaʔaʔn-wi/ [hoʃiHã¹jaʔã¹] ‘make it red sometime’

The forms in (17) show that nasal effacement also occurs in the context of a following laryngeal or approximant.\(^{10}\) In this environment, nasalization spreads bidirectionally from the effaced nasals until arrested by a non-target.

In the cases considered so far, the domain of nasal harmony essentially depends on the number of adjacent nasalizable segment types. In Warao, for instance, nasalization may be limited to a single segment, as in [tewéke], or it may be a property of an entire word, as in [mõaə]. In other languages, however, there is evidence to suggest that nasal harmony is bound by a prosodic unit, in particular that of the syllable.\(^{11}\) Consider as an illustration the following facts

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\(^{10}\) Loos notes that nasal effacement also occurs before fricatives, but does not provide any examples.

\(^{11}\) The syllable is not the only prosodic unit that can be argued to be relevant. For instance, a process of regressive vowel nasalization that is triggered by a following tautosyllabic nasal can be analyzed as being bound by the rhyme. In some languages with root-controlled nasal harmony, the domain of nasalization corresponds to the prosodic word, at least at the
from Secoya, a Western Tucanoan language of Ecuador (cf. Johnson & Peeke 1962; see also Ploch 1999):

(18)  
a. kumá³ ‘variety of tree’
  hamó³ ‘armadillo’
  mē³a ‘variety of ant’
  nā³so ‘crayfish’

b. ṭi³ko ‘she is weaving’
  jahi ‘sweet potato’
  ḍō ‘bread’

c. ū³ē ū³ē ‘variety of tree’
  ṭē³ ‘arm band’

The forms in (18a) show that Secoya, like Warao, displays a progressive nasal harmony which is initiated by nasals, targets vowels, laryngeals, and /w j/, and is blocked by all other consonants. Like Warao, Secoya has underlyingly nasalized vowels, as is shown by the forms in (18b). An important difference between Secoya and Warao is illustrated by the forms in (18c). These forms show that whenever a nasalized vowel is preceded by /w j/, /w j/ are also nasalized. This is unexpected, since the direction of nasalization in Secoya is generally progressive. The facts encountered thus suggest that two separate nasalization processes must be distinguished: a progressive harmony that is initiated by nasals and nasalized vowels, and a regressive, syllable-bound harmony that is initiated by nasalized vowels and targets preceding onset sonorants. Following Piggott & Van der Hulst (1997), I will refer to the second type of harmony as “syllable nasalization”.12

It is important to observe that the two nasalization processes displayed by Secoya operate independently of each other. This becomes evident when we consider the two processes from a cross-linguistic perspective. On the one hand, we saw that Warao has progressive harmony but lacks syllable nasalization. On the other hand, Yoruba, a Benue-Congo language of Nigeria, lacks progressive harmony but does display syllable nasalization. The Yoruba consonant inventory is given in (19) (cf. Dunstan 1964:163):13

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12 Ploch (1999) refers to this phenomenon as “nasal sharing”.

13 Note in (19) that [n] is not phonemic, but an allophone of /l/ before nasalized vowels.
Yoruba has an underlying contrast between oral and nasalized vowels. In case the non-nasal sonorants /l r j w/ precede a nasalized vowel, they are realized as [n Â”Ü ]. Other consonants do not show any allophonic variation in this context, which indicates that syllable nasalization in Yoruba targets sonorants only. Note that this pattern receives a natural interpretation in Element-based Dependency, where, at least as far as supralaryngeal articulations are concerned, nasalization is restricted to sonorant segment types.

Syllable nasalization plays a crucial role in one particular subtype of harmony. What unifies the harmony patterns considered above is that non-targets invariably block the spread of nasalization. However, there are also languages that have a harmony pattern in which non-targets are transparent to the spread of nasalization. This pattern can for instance be observed in Tuyuca, an Eastern Tucanoan language of Colombia, where we find forms of the kind in (20) (unless otherwise indicated, all Tuyuca data are taken from Walker 1998):

(20) a. Ūfã ‘to illuminate’
   Höl ‘there’
   êml ‘howler monkey’
   Ùínl ‘wind’

b. mîp ‘badger’
   nît ‘coal’
   tîsô ‘Yapara rapids’
   nôsî ‘bird’
   sîfl ‘to kill’

As (20a) shows, forms containing sonorants only are nasalized throughout. (20b) shows that nasalization is not always distributed across a continuous string of segments, since here the harmony process skips voiceless obstruents. This shows that we are dealing with a case of non-local nasalization: given a particular harmonic domain, nasalization is associated with all segment types within the target range, irrespective of the presence or the position of non-targets. This pattern of nasal harmony appears to be restricted to South America, where it can be observed in a number of Tucanoan, Tupi, Chibchan, and Maku languages.
Below, I refer to languages which display this pattern of harmony as “Tucano-type systems”.¹⁴

A number of generalizations can be made regarding Tucano-type systems. First, these systems display considerably less variation in the target range than harmony systems in which non-targets block nasalization. In Tucano-type systems, the only segment type that can be transparent to nasalization are voiceless obstruents. All other segment types are predictably included in the target range of nasal harmony.

Second, Tucano-type systems display complementary distribution between a series of voiced oral stops and a series of nasals. The former occur in what may be termed “oral words” and the latter in what may be termed “nasal words”. This is illustrated by the Tuyuca forms in (21a,b); note in (21) that voiceless obstruents occur in both oral and nasal words:

(21)  a. Oral words                   b. Nasal words
  bǐpí ‘swollen’                   mípó ‘badger’     (*mípí, *bípó, etc.)
  dílí ‘to lose’                   níló ‘coal’      (*nílí, *díló, etc.)
  sìqé ‘follow’                    tège ‘Yapara rapids’ (*sìqê, *tège, etc.)
  osó ‘bat’                        pósé ‘bird’
  peé ‘to bend’                    pêì ‘to prepare soup’
  sì ‘to tie’                      sì ‘to kill’

The complementary distribution of voiced oral stops and nasals suggests that the two segment types have a single underlying representation. This view receives support from processes of loanword accommodation. For instance, Campbell (1998) observes that in Tunebo, a Chibchan language with syllable nasalization, a Spanish loanword like *machete* is accommodated as /g98/g97/g120/g105/g116/g97/, since /g109/ in Tunebo can occur before nasalized vowels only. A similar accommodation process is observed in Desano, an Eastern Tucanoan language, as is illustrated by the following examples (cf. Kaye 1971:38):

(22)     Desano    Spanish/Portuguese
  a. [baria] Maria [maria] ‘Mary’
    [barateru] martelo [martelú] ‘hammer’
  b. [sabo] sabão [sabãû] ‘soap’

The realization of loans in Desano shows that syllable nasalization is active. Loanwords in which a nasal precedes an oral vowel are accommodated with the

¹⁴ A more precise term would be “Eastern Tucano-type harmony”, since some Western Tucanoan languages, such as Secoya, have syllable nasalization but no obstruent transparency. Tucano-type harmony is equivalent to what Piggott (1992) terms “type B harmony.”
nasal denasalized to a voiced stop, as in (22a). Note that vowel nasalization in
loans is retained in some forms, as in (22b), and lost in others, as in (22c). In
forms where vowel nasalization is retained, any sonorant which precedes the
nasalized vowel is also realized as nasalized.

Different interpretations of the complementary distribution between nasals
and voiced oral stops have been offered. According to one approach, Tucano-
type nasalization targets all voiced segment types, nasalizing sonorants and
turning voiced oral stops into nasals (see e.g. Pulleyblank 1989, Noske 1995,
Walker 1998). An alternative approach is to analyze Tucano-type harmony as
targeting sonorants only (see e.g. Piggott 1992, Rice 1993, Piggott & Van der
Hulst 1997); this implies that the voiced oral stops function as sonorants,
parallel to other nasalization targets. The latter view is also adopted here, since it
is in accordance with the Element-based Dependency claim that nasalization is
restricted to sonorant segment types. I return to this issue in §3.2.1.

A third property of Tucano-type systems is that in harmonic words it is
impossible to determine the direction of nasalization. For this reason, some
analyses of Tucano-type systems assume that nasalization is an underlying
property of entire morphemes (see e.g. Piggott 1992, Noske 1995). However,
not all Tucano-type systems have as their domain entire morphemes. In
Southern Barasano, a language closely related to Tucano, we find both nasal
words, as in (23a), and words that are only partly nasal, as in (23b). Piggott &
Van der Hulst refer to the latter type as “disharmonic roots”; note that in such
roots it is possible to determine the direction of nasalization:

(23) a. kãmõkã ‘rattle’
    mãsã ‘people’
    mõnõ ‘none’
    ûì ‘demon’

b. eonõ ‘mirror’
    rimä ‘poison’
    romõ ‘woman’
    hati-amì ‘he sneezes’
    hiâmãkõnõ ‘ten’

The form [hiâmãkõnõ] in (23b) shows that nasalization is lexically associated to
a vowel, from which it spreads rightwards, skipping any intervening obstruents.
Based on forms of this type, Piggott & Van der Hulst argue that the harmonic
domains in (22a,b) can be unified if it is assumed that Southern Barasano has
underlyingly nasalized vowels and syllable nasalization. The latter assumption is

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15 Pulleyblank assumes that nasalization is regulated by a “nasal/voicing condition”. This
condition sanctions the feature combination [+nasal,+voice] and rules out the feature
combination [+nasal,–voice].

16 Southern Barasano also has oral words, of course.
required to account for forms like [romɪ ŏ] (cf. (23a)) and [Ŭātɪ] (cf. (23b)): if nasalization spreads rightwards from the leftmost nasalized vowel, then syllable nasalization is necessary to account for the fact that any sonorant preceding the leftmost nasalized vowel is also nasalized. Tucano-type systems differ in this respect from the pattern displayed by Secoya; while syllable nasalization is optional in Secoya, it is required in Southern Barasano. I will examine the role of the syllable in nasal harmony systems in more detail in §3.2.3.

In this section, I have presented a typological overview of nasal harmony types, based on five parameters according to which language-particular manifestations of harmony may vary. First, languages differ in the harmonic domain, which ranges from a single vowel to an entire word. A subtype of nasal harmony, found in Secoya, Yoruba, and in Tucano-type systems, has as its domain the syllable. In this type of nasal harmony, all tautosyllabic sonorants are either oral or nasal, depending on the presence of underlying nasalization. Second, languages differ in the direction of nasal harmony. Nasalization can be regressive (as in Tinrin), progressive (as in Sundanese, Warao), or bidirectional (as in Capanahua). Third, languages differ in the trigger of nasal harmony. The trigger can be a nasal consonant (as in Sundanese), a nasalized vowel (as in Yoruba), or both (as in Warao); in addition, nasal harmony can be triggered by morpheme-level nasalization, as is the case in some Tucano-type systems. Fourth, languages differ in the harmonic target range. Nasalization target may range from vowels (as in Uma Juman Kayan) to all voiced—or, depending on one’s approach, sonorant—segments (as in Tuyuca, Southern Barasano). Fifth, languages differ in the behaviour of non-targets. If the non-target is a voiced obstruent or a sonorant, nasalization is invariably blocked. If, on the other hand, the non-target is a voiceless obstruent, languages vary as to whether non-targets block nasalization (as in Warao), or are transparent to it (as in Tuyuca, Southern Barasano).

In the following sections, I will provide an Element-based Dependency interpretation of three interrelated aspects that are observed in Tucano-type nasal harmony systems. First, in §3.2.2, I examine the target range of nasalization in Tucano-type harmony systems and, in connection with this, the complementary distribution between nasals and voiced oral consonants. In §3.2.3, I propose an Element-based Dependency interpretation of the notion of syllable nasalization.

### 3.2.2 Sonorant nasalization

One unifying property of Tucano-type nasal harmony systems is that the range of non-targets is restricted to voiceless obstruents. From this, two conclusions can be drawn: the range of nasalization targets is identified either in terms of voicing or in terms of sonorancy. The decision as to which of the two interpretations is appropriate lies in the status of voiced oral stops, which are in complementary distribution with nasals. While the phonetic realization of these
consonants might be argued to reflect their obstruent status, there are, as I will show, good grounds to analyze these stops as being sonorants phonologically.

First of all, according the voiced oral stops the status of sonorants permits a unified account of the nasalization process in Tucano-type systems. From the perspective of Element-based Dependency, we can then say that such systems contain an underlying series of “bare” sonorant stops, which, in case they form part of a nasal word, surface as nasals through association of dependent [L]. This scenario is illustrated in (24):

\[(24) \quad \begin{array}{c}
O \\
L \\
? 
\end{array} \quad \rightarrow \quad \begin{array}{c}
O \\
L \quad L \\
? 
\end{array}\]

On this interpretation, nasalization in Tucano-type systems can be interpreted as targeting all sonorant (and laryngeal) manner components within the harmonic domain. Observe in this respect that an analysis of the oral variants as voiced obstruents would imply that nasalization involves a change from obstruent to sonorant manner. The status of this type of process is dubious.

A second argument for interpreting the voiced oral stops in Tucano-type systems as sonorants is typological in nature. I noted in §2.2.5 that most—perhaps all—languages employ a contrast between a series of obstruent stops and a series of sonorant stops in their consonant inventory. In most languages, the sonorant stops are realized as nasals. In Tucano-type systems, on the other hand, nasals occur in the context of a following nasalized vowel only. This suggests that in these systems nasality is not an underlying property of sonorant stops, and hence it also suggests that the oral variants of sonorant stops should be regarded as being underlying. If, by way of contrast, the oral variants are analyzed as obstruents, then Tucano-type systems would lack an underlying contrast between obstruent and sonorant stops—a highly marked state of affairs.

Potential evidence against an analysis of voiced oral stops as sonorants comes from morphological alternations, and in particular from patterns of suffixation. In Tucanoan languages, two classes of suffixes can generally be distinguished. The first class consists of suffixes that are realized either as oral or as nasalized, depending on the presence of nasalization in the root. The second class of suffixes surfaces as either oral or nasalized, irrespective of the presence of nasalization in the root. Following Walker (1998), I refer to these two classes as “alternating” and “fixed” suffixes respectively, where the latter class consists of a set of “fixed oral” and a set of “fixed nasal” suffixes. Consider as an example the following data from Tuyuca (cf. Walker 1998:29-31; see also Barnes 1990:283-5):
(25)  a.  alternating suffix  :  /-ri/  ‘imperative of warning’
    after oral root  :  tuti-ri  ‘watch out or you will get scolded!’
    after nasal root  :  Hî-‘î  ‘watch out or you will get burned!’

b.  fixed oral suffix  :  /-da/  ‘classifier for round objects’
    after oral root  :  pia-dā  ‘two-CL-flexible’; ‘two strings’
    after nasal root  :  ðkU-da  ‘beads-CL-flexible’; ‘necklace’

c.  fixed nasal suffix  :  /-mā/  ‘imperative of permission’
    after oral root  :  koa-mā  ‘allow me to dig’
    after nasal root  :  ñī-mā  ‘allow me to come’

Some examples of alternating suffixes in Tuyuca are given in (26) (cf. Walker 1998:30):

(26)  Alternating suffixes
   a.  -a  animate plural
   b.  -ha  contrast
   c.  -ja  imperative
   d.  -wi  evidential
   e.  -wo  evidential
   f.  -ri  imperative of warning
   g.  -re  specifier
   h.  -ro  adverbializer
   i.  -ra  plural nominative

Some examples of fixed suffixes are given in (27) (cf. Walker 1998:30):

(27)  Fixed oral  Fixed nasal
   a.  -a  recent past  j.  -Hā  emphatic
   b.  -ja  evidential  k.  -Ü9  singularizer
   c.  -ri  inanimate-SG-NOM  l.  -‘î  time(s)
   d.  -ba  classifier  m.  -mā  classifier
   e.  -da  classifier  n.  -nā  at that instant
   f.  -ga  classifier  o.  -ŋā  diminutive
   g.  -pi  too much  p.  -pī  classifier
   h.  -to  classifier  q.  -tō  classifier
   i.  -sa  classifier  r.  -sā  continue action

The problem, as Walker (1998) observes, is that the set of alternating suffixes in Tuyuca does not contain any forms that have initial voiceless or voiced stops. Following Barnes (1996), Walker interprets this to mean that both voiceless and voiced stops function as obstruents, since this view permits the generalization that nasalization in suffixes targets sonorants only.
The Tuyuca facts are open to other interpretations, however. First, Walker notes that voiced velar stops, in contrast to other voiced stops, do occur in alternating suffixes. An example is the verbal suffix /-go/, which is realized as [go] after oral roots and as [ŋo] after nasal roots (cf. Walker 1998; see also Barnes 1996:35). In order to account for this asymmetry, Walker (1998:30) follows Trigo’s (1988) analysis of a similar phenomenon in Tucano:

[In] Tucano, which exhibits the same suffixal blocking effects, … the velar nasal alternant is actually a placeless nasal segment, and thus belongs to a separate class from the stops.

It is difficult to see, however, why the interpretation of the nasal alternant as placeless provides any evidence for the obstruent status of the oral alternant. Furthermore, the pattern of suffixation exhibited by Tucano appears to be different from that in Tuyuca. For instance, in Tucano we find alternating verbal suffixes of the kind in (28) (cf. West & Welch 1967; see also Piggott & Van der Hulst 1997:107):17

(28)  a. ?ôha'-ba ‘let me write’  ?î?ä-mâ ‘let me see’
    c. ‘ba?a-pi ‘I ate’  nî?ä-pi ‘I was’
    ?ôte-se ‘seeds’  ?î?û-se ‘pretty thing’

As can be seen in (28a), the stop-initial suffix /-ba/ (a cognate of Tuyuca /-mâ/; cf. (25c)) has a nasal and an oral allomorph, parallel to /-wi/ in (28b). This suggests that the initial consonant in (28a) is a sonorant stop which, like root-internal sonorant stops, surfaces as nasalized. Note, by way of contrast, that a suffix with an initial voiceless obstruent stop, as in (28c), is not targeted by nasal harmony.

In addition, Tucano has a number of gender and classifier suffixes that have oral and nasal variants, depending on the presence of nasalization in the root. Some examples are given in (29) (cf. Noske 1995:168ff.):18

(29)  [gi ~ ƞg] ‘animate-SG-MASC’
    [go ~ ƞg] ‘animate-SG-FEM’
    [gə ~ ƞə] ‘classifier-round objects’
    [gi ~ ƞg] ‘classifier-long/branching objects’

17 In Tucano, voiced stops in oral contexts are realized as prenasalized. There are good grounds to take this nasalization as phonologically irrelevant, as I will argue in §3.2.4.3.

18 Other Tucanoan languages with alternating stop-initial suffixes are Tatuyo (Gomez-Imbert 1980), Southern Barasano (Smith & Smith 1971) and Northern Barasano (Stolte & Stolte 1971).
Tucano is similar to Tuyuca in that most alternating stop-initial suffixes have an initial velar (but not all suffixes; cf. (28a) above). In Element-based Dependency, a number of interpretations of this asymmetry are possible. One is to analyze voiced velar stops as underlyingly placeless. Note, however, that this account requires an explanation as to why placeless segments are more prone to be nasalized than placeless segments. In view of this, it is perhaps more feasible to relate the propensity for velars to nasalize to the place element $|A|$. The fact that $|L|$ is a vocalic element might be taken to suggest a preferential relation between $|A|$ and relatively vocalic segment types.\(^{19}\) I consider this hypothesis in more detail in §7.2.

Let us next consider an alternative explanation of pattern of nasal harmony in Tuyuca suffixes. Following Piggott & Van der Hulst (1997), I argue that the asymmetry between roots and suffixes results from two distinct harmony systems.\(^{20}\) With regard to Tucano, Piggott & Van der Hulst maintain that root-internal nasalization is non-local: it targets sonorants and skips obstruents, the latter being transparent to the harmony. In suffixes, on the other hand, nasalization is local: it spreads rightwards from the root to the suffix until it is arrested by a non-nasalizable segment.

Now, as the forms in (28) indicate, in Tucano the range of non-nasalizable segment types in suffixes is coextensive with that in roots. However, given that we are dealing with two separate nasalization processes, there is nothing which prohibits the range of nasalization targets in roots to be the same as that in suffixes. This, I propose, is the key to the Tuyuca pattern. In Tuyuca, as in other Tucano-type harmony systems, root-internal harmony targets all sonorants. Within suffixes, however, the target range of nasalization in Tuyuca is more limited, in that it includes vowels and approximants, but not the relatively less sonorous sonorant stops. According to this account, the class behaviour of obstruent and sonorant stops can be attributed to the fact that they both have $|?|$ as part of their manner component.

I conclude that the pattern of suffixation in Tuyuca does not constitute compelling evidence against an analysis of voiced stops in Tucano-type systems as sonorants. The patterning of voiceless obstruents and voiced stops does not imply that the latter are obstruents, too. An alternative interpretation of the facts is that nasalization targets all sonorants within roots, but only a subset of

\(^{19}\) Walker speculates that the nasalization of $/g/$ may be due to the relative difficulty of maintaining voicing during a posterior oral closure. This interpretation is in line with Itô & Mester’s (1997) analysis of $[g~n]$ allophony in Tokyo Japanese.

\(^{20}\) Piggott & Van der Hulst do not discuss the complexities that arise in connection with stop-initial alternating suffixes. Note, incidentally, that Piggott (1992), on which much of Piggott & Van der Hulst’s analysis is based, maintains that the majority of fixed oral suffixes in Tucano begin with voiceless consonants. This is incorrect, both with respect to Tucano and Tucanoan languages in general (see also Noske 1995).
sonorants—i.e. those lacking /ŋ/—in suffixes. Observe that the latter interpretation is based on the assumption that the nasalization pattern in roots is different from that in suffixes. This distinction is needed in any case to account for the fact that initial voiceless stops in fixed suffixes, e.g. /-pi/ in (27g), are not transparent to the harmony process.

The analysis of Tucano-type voiced stops as sonorants is abstract to the extent that sounds like [b d g] function as obstruents in most languages. The fact that they function as sonorants in Tucano-type languages underscores two basic claims of Element-based Dependency, made in §1.3.2: a particular phonetic entity (e.g. a voiced stop) does not have a unique phonological representation, and a particular phonological entity (e.g. a sonorant stop) may have more than one phonetic realization.

The complementary distribution of nasals and voiced stops is a trait of Tucano-type systems. Other nasal harmony systems with syllable nasalization are also characterized by complementary distribution of nasals and voiced oral consonants, but here the oral variants are usually more readily identifiable as sonorants. A case in point is observed in Gbe, a Kwa language family of Ghana, Togo, and Benin. According to the description in Capo (1981), Gbe displays complementary distribution between a series of nasals and a series of voiced oral consonants, as is shown in (30). The oral series can be followed by oral vowels only; the nasal series can be followed by nasalized vowels only:

\[
\begin{align*}
\text{Oral series:} & \quad b, d, t, j, y, w, l, r, \eta \\
\text{Nasal series:} & \quad m, n, n^\prime, \eta, \eta^\prime, ð, ð, Đ
\end{align*}
\]

The complementary distribution of the oral and the nasal series suggests an analysis in which one series is underlying. The fact that the nasal series occurs before nasalized vowels and the fact that nasalized vowels can also cooccur with those oral consonants which are not included in (30) suggests that the oral series is underlying. Some examples of oral consonants which can be followed by both oral and nasalized vowels are given in (31) (cf. Capo 1981:14); note here that we find both voiceless and voiced consonants:

\[
\begin{align*}
\text{(31) a. } & fá ‘to be quiet’ & \quad \text{b. } & ffl ‘to embrace’ \\
& s+ ‘to hear’ & & sÜ ‘to worship’ \\
& sù ‘to be enough’ & & sfì ‘to plug’ \\
& -vi ‘small’ & & z Ü ‘lean against’
\end{align*}
\]

21 The assumption that the pattern of nasalization in suffixes is sensitive to sonority would be in line with the hierarchy of segment nasalizability proposed by Walker (1998) and Schourup (1973).

22 The observation that the constraints on segment nasalization are stricter in suffixes than in stems is cross-linguistically marked. A possible explanation for this state of affairs is that most of the Tuyuca suffixes appear to have been derived from lexical morphemes (see Barnes 1996 for discussion).
It is important to observe that the oral consonants in (30) are sonorants, whereas the oral consonants in (31) are obstruents. Given this, the complementary distribution of nasals and voiced oral consonants receives a straightforward interpretation on the assumption that the latter are sonorant stops, which surface as nasalized in the context of a preceding nasalized vowel.

Strong support for this interpretation of the Gbe facts, and for the unified treatment of voice and nasalization in general, comes from the organization of the Gbe consonant system. Inspection of the inventory in (32), based on Capo (1981:6), reveals that Gbe has a voicing contrast in obstruents and a nasalization contrast in sonorants. The table in (32) shows that both the obstruents and the sonorants can be further divided into a stop (i.e. non-continuant) series and a fricative (i.e. continuant) series. In each of these categories, the phonological contrast is between a plain and a complex series, with the latter specified for dependent [L]. Hence, the Element-based Dependency interpretation of voice and nasalization results in a nearly symmetrical consonant system (in (32) vcls and vcd are short for voiceless and voiced; nas is short for nasalized).

The Gbe system is not completely symmetrical, since it contains a gap where we would expect to find a voiced bilabial obstruent stop. Gbe does have a voiced bilabial stop, but this segment patterns as a sonorant rather than an obstruent. It is this observation that leads Capo to conclude that in the feature theories of Jakobson et al. (1951) and Chomsky & Halle (1968), there is no suitable feature available which characterizes the “alternating” oral series to the exclusion of the “non-alternating” oral consonants. Capo does observe that there are good grounds to view the oral series as having been derived historically from a series of lenis consonants. However, Capo (1981:30) goes on to note that a synchronic characterization of the oral series as being lenis is inadequate:

Note in (32) that there are no Gbe dialects which have both /ɸ/ β/ and /χʷ/ ηʷ/; some dialects, such as Ewe, have /ɸ/ β/ while other dialects, such as Fon, have /χʷ/ ηʷ/. Observe, too, that /p/ in Gbe is restricted to loans and ideophones; /p/ in the Gen dialect of Gbe corresponds to /χʷ/ in other Gbe dialects.

This leads Capo to analyze the alternating stops as being specified for the “set feature” [+paired].
Approximants are lenis. It is also true that, compared to Gbe laminal -d, the Gbe apical -q is lenis; but I do not find any articulatory basis nor any instrumental evidence to say that b in Modern Gbe dialects is lenis.

The term “lenis” has been employed to characterize those sounds that are realized with attenuated articulatory energy, relative to those sounds that are characterized as “fortis” (see e.g. Catford 1977, Ladefoged & Maddieson 1996). It is not entirely clear what Capo means by lenis; what is clear, however, is that lenis here cannot be equated simply with voice, since this fails to differentiate between the “alternating” oral consonants and, say, the “non-alternating” voiced fricatives.

Nevertheless, the fact that Capo is unable to find a shared phonetic property of the alternating oral series does not imply that such a property does not exist—as Capo (1981:31) himself is quick to acknowledge. Indeed, an instrumental study in Ladefoged & Maddieson (1996) indicates that Gbe [p] and [b] differ not only in terms of voicing, but also in what may be loosely termed “articulatory strength”. In their comparison of Gbe [p] and [b], Ladefoged & Maddieson (1996:96) observe that

[the closing movements of the upper and lower lips are markedly faster for p than they are for b, and the peak of the p is flatter, indicating more compression of the lips.

Following a recent suggestion by Clements & Osu (2002), we may interpret the voiced stops of Gbe as “explosives” and the voiceless stops as “non-explosives”. According to this interpretation, the non-explosive articulations, including /b/, involve a vocal tract configuration which does not inhibit voicing to such an extent that the resulting sounds are obstruents. From the perspective of Element-based Dependency, the phonetic characteristics of non-explosive stops can be interpreted to mean that these segments are sonorant stops.

A final argument for interpreting the nasal series as derived concerns the phonetically heterogeneous nature of the oral series. This argument is further supported by comparative evidence. Compare the following correspondences between a number of Gbe dialects (cf. Capo 1981:20):

(33) sfir[ê] (Waci) : súb% (Xxãoi) ‘worship’
    îp (Awlon) : ăjî (Fon) ‘earth’
    nqrô (Xxãoi) : ăqi (Waci) ‘to slip’
    qî (Gen) : w% (Ägbonô, Glexwê) ‘to detect’
    dî (Gen) : dà (Awlon) ‘snake’
    gbû (Gen) : gbê (Waci) ‘to breathe’
These correspondences suggest that the nasal series is historically derived from the oral series. Consider in this respect the phonetic variation that is observed in the oral series: where the nasal series consists of \{m n ñ ŋ\} (with \[n\] described as dental by Capo), the oral series includes a voiced bilabial stop, an apical retroflexed stop, and a palatal and labiovelar approximant. If the oral series was historically derived from the nasal series, we would expect a phonetically more homogeneous set, say, \{b d j ñ\}.

In this section, I have considered two interrelated properties that are displayed in a particular subtype of nasal harmony system: the complementary distribution of a series of nasals and a series of voiced oral consonants, and the sonorant target range of the nasalization process. These properties can be unified on the assumption that the voiced oral consonants function as sonorant stops, which, when nasalization is present, surface as nasalized by association of dependent \[L\]. The preceding discussion indicates that the realization of sonorant stops in oral spans is variable. In Tucano-type systems, they are realized as voiced stops.\(^{25}\) In other languages with sonorant nasalization, such as Gbe, the realization of sonorant stops is more diverse, and may range from approximant-like articulations to voiced, possibly “non-explosive” stops.

It would be interesting to see whether, in those languages where voiced oral stops (or a subset of these) alternate with nasals, there is some phonetic property which sets the alternating stops apart from other, non-alternating stops. At issue is the important question whether the participation of voiced stops in nasal harmony is phonetically motivated, or whether segment nasalizability is determined by more abstract, primarily phonological factors. With the exception of Clements & Osu (2002), where the issue of oral-nasal alternations is not discussed in any detail, I am unaware of any work that deals with this issue.

### 3.2.3 Syllable nasalization

In this section, I focus on the role of the syllable in nasal harmony. Of primary interest is the observation, made in §3.2.1, that Tucano-type harmony systems are characterized by obstruent transparency and syllable nasalization. Given that obstruent transparency implies syllable nasalization (but not vice versa), the challenge is to provide a theoretical interpretation of Tucano-type systems which relates both these characteristics in a non-stipulative fashion.

The first issue that must be considered is the question whether syllable nasalization implies the relevance of the unit of the syllable, or whether syllable nasalization is a side-effect of a more general process of nasalization. At first sight, there appear to be good grounds for taking the latter position. Given that the interpretation of dependent \[L\] as nasalization is determined by the phonological environment, it could be suggested that Tucano-type nasalization

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\(^{25}\) In a number of Tucano-type languages, voiced oral stops are realized as nasal contours. I discuss this issue in §3.2.4.3 below.
involves the association of dependent |L| to all |L|-headed manner types. According to this interpretation, a Southern Barasano word like \( \text{Üã} \) ‘demon’ (cf. (23a)) would have the following surface representation:

\[
\begin{array}{c}
\text{O} \\
\text{L} \\
\text{L} \\
\text{U} \\
\text{Ü} \\
\end{array}
\begin{array}{c}
\text{N} \\
\text{L} \\
\text{A} \\
\text{ã} \\
\end{array}
\begin{array}{c}
\text{O} \\
\text{L} \\
\text{I} \\
\text{î} \\
\end{array}
\]

According to this account, the fact that the first syllable of \( \text{Üã} \) surfaces as nasalized is epiphenomenal: it is the result of association of dependent |L| to |L|-headed manner types, and the first syllable happens to consist of |L|-headed manner types only.

The analysis of Southern Barasano nasalization in (33) is conceptually similar to the Feature Geometric account of Piggott (1992), where nasalization targets are identified by the presence of an SV-node, which provides the appropriate landing site for the feature [nasal]. In Piggott’s analysis, the form \( \text{Ñã}f \) involves the association of [nasal] to all SV-specified segments. This is shown in (34), where RT is short for Root Node:

\[
\begin{array}{c}
\text{Ü} \\
\text{ã} \\
\text{t} \\
\text{î} \\
\end{array}
\begin{array}{c}
\text{RT} \\
\text{RT} \\
\text{RT} \\
\text{RT} \\
\end{array}
\begin{array}{c}
\text{SV} \\
\text{SV} \\
\text{SV} \\
\text{[nasal]} \\
\end{array}
\]

Note that this analysis automatically accounts for obstruent transparency and that here, too, syllable nasalization is a consequence of sonorant nasalization.

While the above account is straightforward, closer inspection of Tucano-type systems reveals that it is problematic. As regards Southern Barasano, for

---

26 For reasons of convenience, I limit the present discussion to nasalized sonorants. The issue of nasalized laryngeals is discussed in §6.1.

27 Piggott (1992), for independent reasons, assumes a process of SV-fusion which merges all tautosyllabic SV-nodes. Given that SV dominates [nasal], SV-fusion thus implicitly recognizes nasalization at the level of the syllable. See Piggott (1992) for details of this analysis.
instance, the problem concerns the surface distribution of nasalization in disharmonic roots. Some examples of disharmonic roots are given in (35), repeated from (23b):

```
(35)  eonõ     ‘mirror’
     rimâ     ‘poison’
     romiõ     ‘woman’
     hâti-amî     ‘he sneezes’
     hiâmâkônõ     ‘ten’
```

These disharmonic roots bring to light two key properties of the Southern Barasano harmony pattern. First, they show that nasalization is progressive, and spreads from the nasalization trigger to the end of a word. Second, they show that nasalization originates in the leftmost nasalized vowel rather than in the leftmost nasalized segment. Observe that there are two reasons for identifying the leftmost nasalized vowel as the harmonic trigger: any sonorant preceding a nasalized vowel is predictably nasalized, as in [rimâ], and some disharmonic roots have a vowel-initial harmonic domain, as in [hiâmâkônõ].

The distribution of nasalization in disharmonic roots suggests two possible analyses of the Southern Barasano pattern. One possibility is to posit two separate nasalization processes, both triggered by the same nasalized vowel: the first proceeds rightwards, is unbounded, and targets all following nasalizable segment types; the second proceeds leftwards, is syllable-bound, and targets immediately preceding sonorants. The other possibility is to recognize only a rightward process of nasalization, and to attribute the leftward syllable-bound harmony to the effect of syllable nasalization. Inspection of the harmony pattern of Southern Barasano, and of Tucano-type nasal harmony in general, suggests that the latter approach is more appropriate.

A first, general reason for recognizing the relevance of the syllable is that it accounts for the fact that the scope of leftward harmony is limited to an immediately preceding target. This limited scope follows naturally from the assumption that leftward harmony is syllable-bound, but must be stipulated if the unit of the syllable does not play a role.

A second argument for syllable-based nasalization concerns the nature of rightward nasalization in Southern Barasano. We saw in §3.2.1 that Tucano-type nasal harmony is characterized by transparency of obstruents. As Piggott & Van der Hulst (1997) note, obstruent transparency in Tucano-type systems is similar to the more general consonant transparency that is found in most processes of vowel harmony. Given the fact that consonants are generally transparent, Piggott & Van der Hulst (1997:88) maintain that vowel harmony can be captured by the schema in (36). In (36), “σ” represents a syllable, “V” the syllable nucleus, “F”

---

28 Disharmonic roots are also found in other Tucanoan languages, such as Tucano (see e.g. Noske 1995).
the association of the harmonic feature F with the nucleus, and the arrow the
direction of harmony. The phonetic instantiation of F as a property of the
targeted vowels is represented by “f”; the fact that “f” results from association
with harmonic F is signalled by means of coindexation:

(36) F
[ | ]
( … V… )σ ( … V… )σ
| | 
f f

The key insight of this interpretation is that vowel harmony is defined at the
level of the syllable (or, more specifically, at the level of syllable heads). This,
Piggott & Van der Hulst (1997:97) note, expresses the fact that “[c]onsonant
transparency is an automatic consequence of vowel harmony as a relation
between syllable heads”.

Like vowel harmony, nasal harmony in Tucano-type languages involves
consonant transparency. Based on this similarity, Piggott & Van der Hulst go on
to propose that the harmony pattern of a language like Southern Barasano can
also be stated in terms of a relation between syllable heads. However, matters
are complicated by the fact that the range of consonant transparency in Tucano-
type harmony is more restricted than in vowel harmony, since nasalization
targets all sonorants, including sonorant consonants. Thus, the challenge for
Piggott & Van der Hulst’s approach is to provide a relation between syllable-to-
syllable harmony and syllable-internal harmony.

To account for syllable-internal nasal harmony, i.e. syllable nasalization,
Piggott & Van der Hulst (1997:102) suggest that making the feature [nasal] a
property of the nucleus automatically makes [nasal] a property of all nasalizable
segments within the syllable:

It is a fundamental principle of linguistic structure that the
properties of the head of a construction are simultaneously
the properties of the entire construction. Consequently, when [nasal] is
associated with the head or nucleus of the syllable, it is
automatically a feature of the syllable itself. It should, therefore, be
realized on all the segments in the syllable that can be nasal-
bearing.

Consider this hypothesis in relation to the Southern Barasano form [Ũātí]. As is
shown in (37), harmonic nasalization (as represented by “N”) is underlyingly
associated to the head of the first syllable. The arrow in (37) indicates rightward
spreading of nasalization at the level of the syllable. Nasalized segments are
identified by the presence of “n”, the phonetic instantiation of N:
However, this cannot be the complete story. Since Piggott & Van der Hulst allow for the possibility of nasalized obstruents, they need an explanation for the fact that the /t/ in (37) is not a suitable nasalization target. To this end, Piggott & Van der Hulst argue that [nasal] is located at a different structural position in sonorants and obstruents: in sonorants [nasal] is a head feature, while in obstruents [nasal] is a dependent feature. Piggott & Van der Hulst (1997:103) represent this difference as in (38):

(38)  a. Nasalized sonorant  b. Nasalized obstruent
     \( \begin{array}{c}
     \text{RT} \\
     \cdots \\
     [\text{nasal}] \\
     \cdots
     \end{array} \)  \( \begin{array}{c}
     \text{RT} \\
     \cdots \\
     [\text{nasal}] \\
     \cdots
     \end{array} \)

According to this view, syllable nasalization can be defined as the association of [nasal] to all segments in which [nasal] can occur as head. Piggott & Van der Hulst (1997:104) formalize this in terms of a principle that they refer to as “Consistency of Dependency Relations”:

(39) Consistency of Dependency Relations (CDR)

Every occurrence of an inherited feature must manifest the same dependency relation.

Thus, the combination of syllable nasalization and the principle in (39) accounts for obstruent transparency in Tucano-type nasal harmony systems.

Piggott & Van der Hulst do not discuss the internal structure of nasalized segments in any detail, nor do they discuss the relation between [nasal] and other features at any length. Nevertheless, the basic claim of their approach—Tucano-type nasal harmony is syllable-based—is attractive, and I will adopt it below. It should be noted, however, that the Element-based Dependency interpretation of Tucano-type systems differs from that of Piggott & Van der Hulst in some minor but important aspects.

In line with Piggott & Van der Hulst, I assume that in languages that display syllable nasalization, nasality is underlingly specified at the level of the syllable. More precisely, my assumption is that a syllable which is specified for
nasality has the general structure in (40). Observe in (40) that the level of the syllable is equivalent to the maximal projection of the syllable head N, i.e. N" (see §2.6.3); nasalization, as expressed by [\|L\|], is a dependent of this node:

\[
\begin{align*}
& N'' \quad | \quad N' \quad | \quad L \\
& \quad | \quad O \quad | \quad N \\
& \quad | \quad \ldots \quad | \quad \ldots 
\end{align*}
\]

(40) expresses the fact that in languages with syllable nasalization, nasality is never contrastive in a domain smaller than the syllable. This interpretation is therefore essentially an extension to Kehrein’s prosodic theory of laryngeal contrasts to the level of the syllable (see §1.2.2).

Given (40), consider next the interpretation of the nasal harmony pattern of Southern Barasano. As was observed, the pattern of nasalization in disharmonic roots shows that nasality in Southern Barasano is an underlying property of the leftmost syllable. From there, nasalization spreads rightwards to all following syllables within the root, as is illustrated in (41) for the form [rom\~0]:

\[
\begin{align*}
& N'' \quad N'' \quad N'' \\
& \quad | \quad N' \quad | \quad L_4 \quad | \quad N' \\
& \quad | \quad O \quad \quad | \quad O \quad \quad | \quad N \quad \quad | \quad N \\
& \quad | \quad H \quad \quad | \quad L \quad \quad | \quad L_4 \quad \quad | \quad L \quad \quad | \quad L_4 \\
& \quad | \quad L \quad \quad | \quad U \quad \quad | \quad A \quad \quad | \quad ? \quad \quad | \quad I \quad \quad | \quad U \quad \quad | \quad A \\
& \quad | \quad \quad | \quad I \quad \quad | \quad U \\
& \quad | \quad \quad | \quad r \quad \quad | \quad o \quad \quad | \quad m \quad \quad | \quad \checkmark \quad | \quad \checkmark 
\end{align*}
\]

Note in (41) that syllable-to-syllable harmony involves spreading of dependent [\|L\|] from the underlyingly nasalized syllable head to all syllable heads within the

29 I restrict my attention to CV syllables, the predominant syllable shape in Tucano-type systems. Examples of Tucano-type languages with word-final consonants are Kaingang (Wiesemann 1972) and Yuhup (Lopes & Parker 1999). With regard to Yuhup, I will argue in §3.2.4.3 that these consonants are best viewed as being onsets of empty-headed syllables.

30 For reasons of clarity, I assume in (40) that N is not itself a projection.
harmonic domain. Note also that each of the nasatization targets is specified for
dependent |L|; following Piggott & Van der Hulst, we can regard this |L| as the
phonetic instantiation of syllable-level nasality. This is expressed in (41) in
terms of coindexation.

This analysis can be extended to harmonic roots on the assumption that in
such roots the underlyingly nasalized syllable is root-initial, as is shown in (42)
for the form [Üäṭí]:

The form in (42) illustrates an important difference between the Piggott & Van
der Hulst’s analysis and the present approach. Piggott & Van der Hulst account
for the transparency of /gĩ/ by assuming that association of [nasal] to an obstruent
violates the CDR. The present approach is more restrictive, since there is onl y
one available “segmental” location for nasatization. This is a consequence of the
absence of a phonological category of nasalized obstruents.

However, it should be noted that the Element-based Dependency approach
to syllable nasatization does require an alternative explanation for obstruent
transparency. The point is that nothing rules out the structural combination of
obstruent manner and dependent |L|. Rather, what prohibits association of
dependent |L| is the fact that the phonetic result is a **voiced** and not a **nasalized**
segment. In view of this, I propose a modification of Piggott & van der Hulst’s
CDR. A revised and generalized version of this principle is given in (43):

\[(43) \text{Consistency of Dependency Relations (revised version)}\]

In a domain X⁰, where X⁰ is a projection of X⁰ and X⁰ is specified for Y,
Y is a property of all structures that are of the same type as X⁰.

With respect to syllable nasatization, “of the same type as X⁰” should be
interpreted as “being compatible with nasatization”. That is, (43) states that all
tautosyllabic manner types in which dependent |L| denotes nasatization—i.e. all
sonorant and laryngeal manner types—surface as nasalized.³¹ An important

---

³¹ As far as sonorants are concerned, “of the same type as X⁰” can be taken to mean “having
|L| as part of the manner component”. Note, however, that this interpretation fails to
prediction of (43) is that syllable nasalization can only trigger nasalization, and never both nasalization and voicing. This observation plays an important role in distinguishing segmental instantiations from syllabic instantiations of nasal harmony, as we will see in §3.2.4.

3.2.4 Case studies

In this section, I provide additional support for syllable nasalization by considering the patterns of nasal harmony in Kpelle, Zoque, and Yuhup. As regards Kpelle, an analysis of nasalization as a syllable-level property makes it possible to distinguish between nasal harmony in derived and non-derived environments. The pattern of Zoque is similar to that of Kpelle to the extent that nasal harmony is triggered in a derived environment. The theoretical challenge that is posed by the Zoque pattern is that nasals appear to be transparent to nasal harmony. I will argue that an interpretation of the harmony process as syllable-based provides a solution to this problem. Further support for the relevance of the syllable in nasal harmony comes from Yuhup. The pattern of nasal harmony displayed by Yuhup suggests that in this language syllable nasalization operates independently of the segmental targets that it dominates.

3.2.4.1 Kpelle

Tucano-type languages such as Southern Barasano bring to light two types of evidence for syllable nasalization: such languages show both syllable-to-syllable harmony and syllable-internal harmony. By way of contrast, a language such as Gbe brings to light just one type of evidence for syllable nasalization: the fact that the syllable is the domain in which nasalization is minimally constrastive.

Given that the evidence for syllable nasalization in Gbe-type languages is less strong, it might be proposed that in these languages nasalization is not a property of syllables but of vowels. According to this interpretation, syllable nasalization is a surface effect that results from leftward spreading of nasality from an underlyingly nasalized vowel to a preceding sonorant. This general scenario is illustrated in (44):
We may think of this approach as being a “dynamic” alternative to the “static” syllable-based approach. Nevertheless, there are a number of arguments against this alternative. To appreciate these, I consider the pattern of nasal harmony as displayed by Kpelle.

As is the case in Gbe, initial nasals in Kpelle morphemes invariably cooccur with a following nasalized vowel. This is evidenced by forms of the kind in (45) (all Kpelle data are taken from Welmers 1962):

(45)  
(46) A further parallel with Gbe is that Kpelle has a series of voiced oral consonants that is in complementary distribution with a series of nasals. Within morphemes, voiced oral consonants always cooccur with a following oral vowel. Some examples are provided in (46); note here, as in Gbe, the phonetically heterogeneous nature of the voiced oral consonants:

(47) A further complementary distribution suggests that we are dealing with a single series of underlying sonorant stops, which surface as nasalized in case they are followed by a nasalized vowel. Observe that an analysis of the vowel—or, alternatively, of the syllable—as the source of nasalization is supported by the fact that nasalized vowels are also found after non-nasalizable segment types, as is illustrated by the forms in (47):
From an output-oriented perspective, the facts considered so far can be accounted for by analyzing nasalization as being an underlying property of either vowels or entire syllables. In the former account, an output form such as [mə] involves sharing of dependent [L] by the onset sonorant and the vowel:

\[(48)\]

In the syllable-based approach, on the other hand, [mifikasi] has the structure in (49):

\[(49)\]

In non-derived environments, both approaches correctly account for the distribution of nasalization. However, the distribution of nasalization in derived environments suggests that the syllable-based approach is more adequate.

The description of Kpelle in Welmers suggests that the cooccurrence restriction on oral and nasalized segments does not remain in force when a definite marker is added to a root that begins with a voiced oral consonant. Consider the pattern of definite marking in (50):

\[(50)\]
The alternations in (50) indicate that the definite marker has three phonological effects on a root-initial consonant: the addition of a low tone if the consonant is a sonorant, the addition of voicing if the consonant is a voiceless obstruent, and the addition of nasalization and low tone if the initial consonant is a sonorant stop. For present purposes, the point to note is that the derived nasals in (50c) are followed by an oral vowel.

According to the description in Welmers, forms in which nasals precede oral vowels are invariably polymorphemic. This suggests that the nasalization in such forms is not a syllable-level property, but simply involves association of dependent \( |L| \) to the initial consonant of the root. If we disregard tone, this results in the following representation for the definite form of /\( \text{á} \)\( \) (cf. (50c)):

(51) \[
\begin{array}{c}
\text{N'} \\
\text{O} \\
\text{L} \\
\text{?} \\
\text{I} \\
/\text{DEF + \( \text{á} \)} / \rightarrow [\text{lá}] \\
\end{array}
\]

Association of dependent \( |L| \) to the sonorant stop, but not to the vowel, is difficult to account for if Kpelle nasal harmony involves a relation between segments. Such an approach requires an explanation for the fact that the prefixation of the definite marker produces a structure in which \( |L| \) is not shared by the sonorant and the following vowel. This problem does not arise if we distinguish between two distinct types of nasalization, one at the level of the syllable and one at the level of subsyllabic constituents. According to this approach, root-internal nasal harmony is the result of syllable nasalization. Note in this respect that the distribution of nasalization within roots displays two properties of syllable nasalization: the nasalization of all sonorants within the harmonic domain, and the absence of obstruent voicing. The latter property is a consequence of the revised CDR, as formulated in (43).
An important difference between root-internal and root-external nasalization is that the latter process triggers both nasalization and voicing, depending on the nature of the affected segment. If the affected segment is a sonorant, as in (51) above, association of [L] produces a nasal. If, on the other hand, the affected segment is an obstruct, as in (52), association of [L] produces a voiced allophone:

\[
(52)\quad \overset{N}{-\overset{O}{\overset{H}{\overset{I}{/\text{DEF + sen}/ \rightarrow [zen]}}}}{N'}
\]

The different effect of the definite marker on obstruents and sonorants supports the dual interpretation of dependent [L] as nasalization and voice.\(^\text{32}\) For present purposes, the point to note is that processes in which [L] is realized either as voicing or as nasalization indicate that [L] is a segmental, not a syllabic, property.

In my analysis of Kpelle nasal harmony, I have disregarded the low tone that is an underlying property of the definite marker. Note in (50) that the low tone surfaces as a property of initial sonorants only.\(^\text{33}\) Here its contrastive function is limited to signalling the distinction between toneless nasals, which are found in indefinites, and low-toned nasals, which are found in definites. Welmers (1962:71) observes that low-toned nasals “are more heavily voiced than nasals without tone”. A reasonable assumption is that tone is represented at some higher level in the prosodic organization; I leave the details of such an analysis for further research, however.\(^\text{34}\)

Summarizing, I have argued that Kpelle displays two distinct nasalization processes. One process operates on the segmental level and is instantiated by the

\(^{32}\) I will consider more processes of this type in §4.2.

\(^{33}\) Note, however, that the definite marker, when linked to a stop-initial root, conditions a lower allophone of the tone of the first vowel of the root, similar to what is observed in sonorant-initial roots (cf. Welmers 1962:71). This suggests that the tone of the definite marker is present at the surface level.

\(^{34}\) There is no indication in Welmer’s description that the tone-bearing nasals are syllabic. This would appear to suggest that tone is associated to onset constituents, which is a cross-linguistically marked state of affairs. Compare in this respect Yip’s (2002:74) observation that there appear to be no languages in which tone must crucially be associated to the level of the segment. Yip suggests that the smallest domain in which tone can be specified is therefore that of the mora. The Kpelle facts seem to indicate that this view is problematic.
definite marker. This process triggers nasalization of an initial oral sonorant and voicing of an initial obstruent. The second nasalization process operates on the syllabic level. This process affects all tautosyllabic sonorants and leaves obstruents unaffected. The transparency of obstruents is a consequence of the (revised) CDR principle, as formulated in (43).

In the following section, I will show that the patterns of voicing and nasalization found in Zoque suggest that in this language, too, dependent |L| is active at two levels in the prosodic organization.

3.2.4.2 Zoque

Zoque, a Mixe-Zoque language of Mexico, has a morphologically conditioned process of nasalization similar to that observed in Kpelle. Zoque differs from Kpelle in that it does not exhibit any root-internal nasalization. Zoque does display another kind of phonological activity involving nasals, however. As the forms in (53a,b) show, Zoque nasals condition the presence of a following voiced stop, both within and across morphemes. This suggests that we are dealing with a process of postnasal voicing (unless otherwise noted, all Zoque data are taken from Herrera 1995):

(53)  a. /tantan/ [tand] ‘mariposa’
     /sająka/ [są] ‘gordo’

     b. /tukun-tan/ [tukund] ‘arete-PL’
        /kižm-pa/ [kižm] ‘subir-IMPERF’
        /min-pa/ [minba] ‘viene’
        /są-kowı/ [sągowi] ‘muy sordo’

Postnasal voicing provides evidence for the presence of dependent |L| in nasals. The process can be analyzed as involving the spreading of dependent |L| to the dependent position of the stop, where it is phonetically interpreted as voicing. This is illustrated in (54) for the nasal-stop cluster in /min-pa/, where I assume that the nasal and the stop form a coda-onset sequence:

(54)  C     O
     |     |
     |     ?
     ?     U
     I

/n-p/ → [nb]
I examine this type of process in more detail in §4.1. Furthermore, we will see in §4.3.1 that the presence of dependent |L| in Zoque nasals is also supported by a process of denasalization, which turns nasals into voiced obstruent stops. Nasals in Zoque trigger voicing, but they do not trigger any nasalization. The latter process is triggered instead by prefixation of the 1/2-SG-POSS morpheme. The pattern of nasalization is illustrated by the forms in (55):

\[(55)\]

a. /N-waje/ \[\text{[}üä'ü\text{]}\] ‘mi masa’
   /N-wiškuį/ \[\text{[}Üũškuį\text{]}\] ‘mi peine’
   /N-juwi/ \[\text{[}OÜý\text{]}\] ‘mi rosadura’
   /N-johškuį/ \[\text{[}ɒhškuį\text{]}\] ‘mi trabajo’
   /N-haįja/ \[\text{[}hâ ʃö\text{]}\] ‘mi esposo’
   /N-heʔpe/ \[\text{[}hèʔpe\text{]}\] ‘mi ixtle’
   /N-weʔke/ \[\text{[}Üëʔke\text{]}\] ‘mi ceto’

b. /N-poki/ \[\text{[}mboki\text{]}\] ‘mi rodilla’
   /N-țihk/ \[\text{[}nđihk\text{]}\] ‘mi casa’
   /N-burco/ \[\text{[}mburco\text{]}\] ‘mi burro’
   /N-disko/ \[\text{[}ndisko\text{]}\] ‘mi disco’

The forms in (55a) show that nasalization is progressive, and proceeds from the initial segment of a root until it is arrested by a non-nasalizable segment type. The harmony process targets vowels, laryngeals, and glides, and is blocked by obstruents; if the obstruent is a root-initial stop, as in (55b), it surfaces as voiced and prenasalized. Based on the forms in (55), it seems plausible to analyze the underlying shape of the possessive morpheme as |L|.

At first blush, the facts encountered suggest that Zoque harmony is like the harmony pattern that is displayed in a language like Warao (see §3.2.1). However, as compared to Warao, the Zoque pattern has one complication. As the forms in (56) show, Zoque nasals are transparent to progressive nasalization:

\[(56)\]

a. /N-ʔane/ \[\text{[}ʔänê\text{]}\] ‘mi tortilla’
   /N-ʃamohk/ \[\text{[}ʃmõh 의사\text{]}\] ‘mi elote’
   /N-weʔni/ \[\text{[}Üęʔni\text{]}\] ‘mi avispa’
   /N-masha/ \[\text{[}mâša\text{]}\] ‘mi estrella’
   /N-ʃoʔot/ \[\text{[}ʃoʔõ\text{]}\] ‘mi suegro’
   /N-niwi/ \[\text{[}niÜï\text{]}\] ‘mi chile’
   /N-niįj/ \[\text{[}ni97\text{]}\] ‘mi nombre’

The observation that nasals do not block nasal spreading might initially suggest that nasals are underlingly unspecified for dependent |L| (i.e. are “bare” sonorant stops). According to this view, nasals would be targeted by harmonic |L|, parallel to other harmonic targets. This view would be corroborated by the fact that Zoque nasals do not trigger root-internal nasalization.
The problem with the above approach is the presence of postnasal voicing, which indicates that Zoque nasals must be underlingly specified for dependent |L|. We are therefore left with a puzzle: if nasals in Zoque have dependent |L|, and if nasals do not trigger nasalization, then how do we account for the fact that vowels following these nasals are a target for harmonic nasalization? Note that this specific question raises a more general typological problem. As was noted in §3.2.1, segmental transparency effects in nasal harmony processes appear to be universally restricted to obstruents. The Zoque facts, on the other hand, seem to suggest that nasals can also be included in the range of transparent segment types.

The solution that I would like to propose is that nasal harmony in Zoque is regulated by the syllable, similar to what we find in Tucano-type systems. However, the crucial difference between Tucano-type systems and Zoque is that in Zoque each tautosyllabic nasalizable manner type is required to surface with dependent |L|. To appreciate this point, consider the surface representation of the hypothetical form /N-wamaka/:

\[(57)\]

In (57), association of dependent |L| to the initial syllable results in nasalization of all segments within the syllable; hence the condition that each segment within the syllable must be realized as nasalized is satisfied. This condition is also satisfied in the second syllable, although here not all instantiations of nasalization have the same origin: while the vowel surfaces as nasalized as the result of syllable nasalization, the preceding nasal is already underlingly nasalized. This leaves us with the third syllable. Here the vowel is a potential nasalization target, but the preceding obstruent is not. Since the requirement in Zoque is that all segments within a syllable must be either oral or nasalized, no nasalization takes place. I assume that in such cases spreading of dependent |L| to the syllable head is blocked.

Another complication that is posed by the Zoque facts concerns the mixed behaviour of obstruents. In root-internal context, obstruents block nasalization. However, the forms in (55b) illustrate that root-initial obstruents are targeted by
the harmony process. The relevant forms are repeated in (58) below, together with some additional examples (data from Padgett 1995):

(58) a. /N-pama/ [mbama] ‘my clothing’
/N-tatah/ [ndatah] ‘my father’
/N-kaju/ [ngaju] ‘my horse’
/N-tsokoj/ [ndzokoj] ‘my heart’

b. /N-burco/ [mburco] ‘my donkey’
/N-disko/ [ndisko] ‘my phonograph record’
/N-gaju/ [ngaju] ‘my rooster’

The transcriptions in (58a,b), which are based on Herrera (1995), suggest that the prefix surfaces as a homorganic nasal in case the root is stop-initial. This is the interpretation in, for instance, Padgett (1995) and Ploch (1999). However, it is dubious whether this view is appropriate. The description in Herrera indicates that the nasal portion of these contours does not form an independent segment. This raises the question whether the nasality in such cases has the same status as that in harmonic forms of the kind in (56).

Following Iverson & Salmons (1996), who discuss the phonological status of nasal contours in a number of Mixtec dialects, I take the position that the prenasalization in the forms in (58a,b) does not reflect any phonologically relevant nasalization, but rather involves the phonetic manifestation of voice.36 According to this view, the voicing of the voiceless stops in (58a) can be attributed to the association of dependent |L|, as is illustrated in (59) for the initial consonant of /N-pama/:

(59)  
```
#   O
```
```
L   ?
```
```
U
```

/|L|+p /→ [b]

Essentially the same scenario can be proposed for the voiced stops in (58b), which, as Herrera notes, are found in Spanish loans only. I suggest that these stops function as inherently voiced stops (i.e. as manner structures in which [ʔ])

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35 Both Padgett and Ploch are concerned only with the pattern of prefixation that is displayed by obstruct-initial and liquid-initial roots. The facts considered show that the nature of this pattern becomes clear only when sonorant-initial roots are taken into account.

36 Iverson & Salmons refer to this type of voicing as “hypervoicing”. Other potential examples of this type of voicing can be found in a number of Tucanoan languages, where the series of voiced oral stops that occur in oral words are phonetically realized as nasal contours. I discuss this issue in relation to Yuhup in §3.2.4.3.
dominates [L]). As was argued in §2.2.4, the combination of such a stop and dependent [L] is phonetically interpreted as a voiced prenasal contour.37

The problem that is posed by roots with initial stops is that the phonetic realization of the possessive morpheme in such roots cannot be attributed to syllable nasalization. If syllable nasalization was active, we would predict to find nasalization, and not voicing. I would like to suggest that the answer to this problem lies in another requirement on the pattern of Zoque nasalization, i.e. the condition that the possessive morpheme must be left-aligned with the root to which it is attached. I assume that in roots with initial stops, the condition on left-alignment blocks application of syllable-based harmony.38

On a final point, a comment is in order with regard to roots with initial fricatives and liquids. The forms in (60), taken from Padgett (1995), show that prefixation of the 1/2-SG-POSS morpheme to such forms is not signalled at the surface level (note in (60b) that the liquids /ɾ/ occur in Spanish loans only):

(60) a. /N-sak/ [sak] ‘my beans’
    /N-japun/ [japun] ‘my soap’
    /N-faha/ [faha] ‘my belt’

b. /N-lawus/ [lawus] ‘my nail’
    /N-rantjo/ [rantjo] ‘my rancho’

With regard to such forms, Padgett (1995) accounts for the non-occurrence of nasality in terms of a constraint that prohibits the cooccurrence of the features [+nasal] and [+continuant]. From the point of view of the present approach, the question is rather what prohibits the occurrence of dependent [L] here. I suggest that the answer to this is that Zoque does not tolerate voiced fricatives and nasalized liquids. The combined effect of this restriction and the requirement of left-alignment is that the possessive morpheme is not phonetically realized.

To sum up, the facts encountered suggest that the basic nasalization pattern in Zoque is syllable-based. The assumption that spreading of nasalization applies at the level of the syllable permits a straightforward interpretation of the transparency of nasals. This transparency is difficult to account for if the harmony process applies at the segmental level, given that there is independent evidence that Zoque nasals are specified for dependent [L]. An additional argument for syllable nasalization is that, in root-internal contexts at least,

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37 This interpretation implies that Zoque has two structures which are both interpreted as nasal contours. Given the assumption, made in §1.3.2, that a phonological representation does not necessarily have a unique phonetic interpretation, I do not regard this as problematic.

38 The notion of alignment is familiar from Optimality Theory. In Optimality Theoretic terms, left-alignment of the possessive morpheme can be ensured by the alignment constraint ALIGN-LEFT(PFX,ROOT). This constraint would be undominated in the phonology of Zoque (and would be vacuously satisfied by the forms in (60) below).
dependent [L] is never associated to an obstruent manner type, as is predicted by the (revised) CDR. The only context in which syllable nasalization does not apply is in roots which have an initial obstruent. In such roots, syllable nasalization is overridden by the requirement that the possessive morpheme be left-aligned with the root. Left-alignment is possible if the root-initial segment is a sonorant or obstruent stop, but not if it is a fricative or liquid. In the latter case, the possessive morpheme is not realized; as was argued, this is due to a cooccurrence restriction on fricative and liquid manner and dependent [L].

3.2.4.3 Yuhup

To conclude this section, I consider another type of evidence for analyzing nasalization as a syllable-level property. The evidence in question comes from a nasalization process in Yuhup, a Maku language which displays Tucano-type harmony. Inspection of the Yuhup harmony pattern suggests that syllable nasalization may, under certain specific circumstances, operate independently from segmental nasalization targets.

As was noted, Tucano-type systems are characterized by a complementary distribution between a series of nasals and a series of voiced oral stops, with the former occurring in nasal words and the latter in oral words. An added complexity that I have ignored so far concerns the observation that, in a number of Tucano-type languages, voiced oral stops are phonetically realized as nasal contours. Consider for instance the following “oral words” from Southern Barasano (cf. Piggott & Van der Hulst 1997:95):

```
(61) "diro  ‘grasshopper’  (*diro)
     wa"ba ~ waba  ‘come!’  (*wā"ba)
     m"baqo ~ m"bago  ‘eater’  (*mābāqo)
     ta"boti ~ taboti  ‘grass’  (*tā"boti)
```

The forms in (61) show that voiced oral stops are phonetically realized as prenasalized stops; this prenasalization is required word-initially and optional word-internally. There are good grounds to interpret prenasalization as being phonologically irrelevant. Firstly, in word-internal position nasalization is not a required property of voiced stops.39 Second, and more importantly, prenasalized stops never trigger nasalization: a form like [wā"ba] is impossible in Southern Barasano.

Different interpretations of the nasalization of voiced stops have been offered. Noske (1995:153), for instance, observes that:

39 More generally, there are many languages with syllable nasalization in which voiced stops are realized as completely oral, such as Bear Lake Slavey (Rice 1993), Southern Min (Chung 1996) and Desano (Kaye 1971).
[in most Tucanoan languages] prenasalized stops occur only between a nasal and an oral vowel, and sometimes in word-initial position. Prenasalization is therefore predictable by rule, and should be accounted for by a spreading rule.

Piggott (1992:48) maintains that the variation between voiced stops and prenasals in languages like Southern Barasano must be treated as a phonetic effect (see Rice 1993 for a similar view):

The nasal property of … prenasalized stops is epiphenomenal; it is directly derivable from the articulatory adjustments required to realize spontaneous voicing.

Observe that both Noske and Piggott consider prenasalization to be predictable; the difference between the two views is that Noske accounts for their occurrence in terms of a (presumably postlexical) phonological process, whereas Piggott shifts the explanatory burden to phonetic implementation.

In all Tucano-type systems that I am familiar with, nasalization of voiced stops can be plausibly analyzed as being phonologically irrelevant. However, the nasal harmony pattern that is observed in Yuhup might at first sight seem to be a counterexample to this generalization. According to the description in Lopes & Parker (1999), Yuhup seems to display phonological prenasalization in contexts where other Tucano-type systems display phonetic prenasalization.41 Consider first the forms in (62), which illustrate that Yuhup exhibits sonorant nasalization and obstruent transparency:

(62)  a. Oral forms  b. Nasal forms
     pājḥ ‘rock, stone’ pā:‘H  ‘paternal uncle’
     wōxɔt ‘striped mullet’ ôHɔp  ‘to sleep’
     hɔd‘ ‘hole’ Hɔn  ‘to vomit’
     ‘dog’ ‘species of fruit’ nɔn  ‘grease, fat, oil’
     ʃjirib ‘foot’ kɔri:n  ‘large potato (Xanthosoma)’

The forms in (62) suggest that the harmonic domain is that of the morpheme. This is corroborated by the forms in (63), which show that Yuhup compounds freely combine oral and nasal morphemes:

40 According to Noske, these languages include Northern Barasano, Tuyuca, Siriono, Carapana, Cubeo, and Piratapuyo.

41 Unfortunately, the data in Lopes & Parker is limited owing to “the sensitive political issues which arise in conjunction with studying indigenous groups in Brazil” (cf. Lopes & Parker 1999:324). Additional Yuhup data can be found in Del Vigna & Lopes (1987), Del Vigna (1991), and Lopes (1995), but I have not been able to consult these sources.
So far Yuhup reveals the contours of a typical Tucano-type system. The target range of nasalization includes all sonorants and laryngeals, while the range of non-targets is limited to supralaryngeal obstruents, which are transparent to the harmonic process.42 Voiced oral stops, which are in complementary distribution with nasals, are realized as prenasalized in initial position and as postnasalized stops in final position.

As was noted, the standard interpretation of nasal contours in Tucano-type systems is to treat the nasalization of nasal contours as being phonologically irrelevant. But while this interpretation can be maintained in “standard” Tucano-type systems, it appears to be contradicted by Yuhup. This becomes apparent when we consider the pattern of allomorphy displayed by the progressive suffix /-ih/ (cf. Lopes & Parker 1999:333-4):

(64)  a. /bm-iʔ-ih/ ‘working’
     /dɔɾoːʔ-ih/ ‘getting married’
     /faːw-ih/ ‘shouting’
 b. /徂m-iH/ ‘killing’
     /pəːH-iH/ ‘hearing’
     /ˈoHɛp-iH/ ‘sleeping’
 c. /tɔɾd-iH/ ‘beating’

The forms in (64a,b) illustrate that /-ih/ is an alternating suffix: it surfaces as oral after oral forms, as in (64a), and as nasalized after nasal forms, as in (64b). Strikingly, /-ih/ also surfaces as nasalized when added to an oral form that ends in a postnasalized stop, as in (64c). This is unexpected if the nasalization of the nasal contour is phonologically irrelevant. However, if the nasalization in final postnasals is phonologically active, then the question is why in such forms nasality does not surface as a property of the word as a whole (i.e. *[t@n-iH]).

I would like to propose that the solution to the Yuhup conundrum lies in the syllabic status of stem-final consonants. Specifically, my claim is that these consonants occupy the onset position of an empty-headed syllable.43 This

42 Lopes & Parker maintain that /ʔ/ is included in the set of transparent segments, which suggests that they equate nasalization with the presence of nasal airflow. As was argued in §3.2.1, this is not the only possible interpretation; if nasalization is equated with a lowered velum, there are good grounds to include /ʔ/ in the target range. I discuss the issue of nasalized glottal stops in more detail in §6.1.

43 For general arguments in favour of this type of syllabification see, among others, Kaye et al. (1990), Harris (1994, 1997), and Harris & Gussmann (1998).
prosodic organization makes it possible to integrate the Yuhup facts on the basis of a shared trait of Tucano-type systems: syllable nasalization. According to this interpretation, I assume that the final syllable of [təxˈdə] has the following shape (in (65) I ignore place; "∅" denotes an empty position):

(65)

```
   N''
  / | 
 N'  / O  
   /   | 
    N     L   ∅
```

Being a Tucano-type system, nasalization in Yuhup is distinctive at the syllable level. As was argued in §3.2.3, allocating nasalization at the level of the syllable implies that nasalization is a property of the syllable head. Note, however, that the head in (65) is empty. As a consequence, nasalization cannot surface as a property of any of the other segments dominated by the syllable. It follows, then, that any sonorant which occupies the onset of an empty-headed syllable is phonologically oral. The consequence of this interpretation is that the realization of nasal contours can be relegated to the level of phonetic implementation, similar to other Tucano-type systems.

The question that remains is why suffixation of /-ih/ to /təxˈdə/ results in a nasalized allomorph. The answer that suggests itself is that /-ih/ is incorporated in the stem-final syllable. Given that this syllable now has a filled nucleus, nasalization is free to associate to all nasalization targets within its domain.44

Aside from nasalization, there is further support for analyzing word-final consonants in Yuhup as onsets of empty-headed syllables. According to the description in Lopes & Parker, Yuhup has the following canonical root shapes:

(66)

```
CV    /ke/    ‘wing’
CVC   /pɔp/   ‘larva of bot fly (Dermatobia hominis)’
VC    /ɔw/   ‘iguana lizard’
CVCC  /təjɔ/ ‘to kick’
VCC   /uŋɔ/ ‘species of bat (Desmodus rotundus)’
```

The root shapes in (66) lead Lopes & Parker to conclude that each Yuhup morpheme corresponds precisely to a syllable. Given that the penultimate

---

44 This interpretation raises the question why the stem-final consonant in [təxˈdə] ‘ih’ is apparently realized as a postnasalized stop rather than a plain nasal. More Yuhup data are required to check whether this is indeed the way such forms are realized.
segment of a morpheme which ends in two consonants is predictably /j/, this implies that the maximal syllable template in Yuhup is /CVjC/ (cf. Lopes & Parker 1999:326). There is reason to doubt this view, however. The reason lies in the distribution of long vowels, which occur in stressed syllables only. As Lopes & Parker (1999:331-2) observe:

Primary stress in Yuhup regularly falls on the final vowel/syllable of the word … The physical correlates of primary stress are greater amplitude, higher pitch, and lengthening of the vowel … [S]uffixes are treated as extrametrical since they are normally unstressed.

The forms in (67) illustrate this process of metrical vowel lengthening:

(67)  

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>/iːj/</td>
<td>[iːj:]</td>
<td>‘coati’</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>/jæp/</td>
<td>[jæp]</td>
<td>‘clothes’</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>/tɛ-tej/</td>
<td>[tɛtej]</td>
<td>‘species of snake’</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>/jo-joɡ/</td>
<td>[jojoɡ]</td>
<td>‘elbow’</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>/taɡt/</td>
<td>[taɡt]</td>
<td>‘to kick’</td>
<td></td>
</tr>
</tbody>
</table>

The forms in (67) suggest that metrical vowel lengthening takes place in three contexts: word-finally, as in (67a), before a single word-final consonant, as in (67b-d), and before a cluster of which the initial consonant is /j/, as in (67e). In Lopes & Parker’s model of syllable structure there is no shared property underlying these contexts. However, the contexts in which metrical lengthening occurs receive a unified treatment if we make two assumptions: firstly, that a word-final consonant occupies an onset position that is supported by an empty nucleus, and, secondly, that a preconsonantal glide /j/ occupies the dependent position of the nucleus.

There are a number of arguments that support this analysis. First of all, there seem to be no restrictions on the final consonant of Yuhup morphemes. This would be unexpected if this consonant occupies the coda position, since codas generally license only a subset of the contrasts that are licensed by onsets. Further support comes from the distribution of /j/. The available Yuhup data indicate that /j/ can cooccur with practically any kind of preceding vowel. Based on the forms given by Lopes & Parker, six of the nine Yuhup vowels can cooccur with a following /j/. The remaining three vowels are /i/, /ɪ/, and /o/. It is quite possible that the absence of a form containing [oj] is accidental, nor is it unthinkable that the absence of forms with [i] and [ɪ] is due to a cooccurrence restriction on a high unrounded vowel and a following palatal glide. I tentatively conclude, then, that apart from this constraint there are no cooccurrence restrictions on nuclei containing /j/. In this view, the Yuhup syllable template is restricted to CV(V). This analysis of Yuhup syllable structure makes it possible

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45 Yuhup has a nine-vowel system /i u e ɔ ə æ ə ɔ/.
to provide a unified account of the metrical lengthening process as targeting final stressed open syllables.

In Botma (2001) I propose a similar analysis in order to account for metrical lengthening in Icelandic. Since, in comparison with Yuhup, there is no shortage of Icelandic data, it is useful to briefly consider the Icelandic facts here. The metrical lengthening contexts of Icelandic are given in (68):

\[
\begin{align*}
(68) & \quad \text{a. } \text{bú} & [\text{pu:}] & \text{`estate'} \\
& \text{vé} & [\text{ve:}] & \text{`shrine'} \\
& \text{gulur} [\text{kvəlъ}] & \text{`yellow'} \\
& \text{slæmur} [\text{slaizmyъ}] & \text{`bad'} \\
& \text{b. } \text{is} & [\text{i:s}] & \text{`ice'} \\
& \text{lit} [\text{l̞i:tъ}] & \text{`colour'} \\
& \text{c. } \text{sötra} [\text{sø̂ta³ra}] & \text{`slurp'} \\
& \text{snupra} [\text{snupō³ra}] & \text{`rebuke'} \\
& \text{d. } \text{sötr} [\text{sø̂to³}] & \text{`slurping'} \\
& \text{snupr} [\text{snupō³}] & \text{`rebuking'} \\
& \text{e. } \text{is} [\text{i:s}] & \text{`estate'} \\
& \text{lit} [\text{li[tъ}] & \text{`shrine'} \\
\end{align*}
\]

Long vowels in Icelandic emerge in a number of contexts. They are found in stressed open syllables, as in (68a,b), before single word-final consonants, as in (68c), and before some word-medial and word-final consonant clusters, as in (68d). Crucial evidence in favour of a relation between vowel length and syllabification of word-final consonants comes from the forms in (68d,e). The clusters in (68e) cooccur with a preceding long vowel. As is shown by forms like sötra, it is precisely these clusters that are syllabified as onsets in word-internal position. An analysis of the final consonants in (68c) and of the clusters in (68e) as onsets of an empty-headed syllable permits a unified account of metrical lengthening as a process that targets initial open syllables. Essentially the same analysis can be advanced with respect to single word-final consonants in Yuhup.

The form [tæx̑d̥-H] is, unfortunately, the only example of a “phonologically active” postnasal that Lopes & Parker provide. However, there is some additional support for the exceptional status of Yuhup postnasals. The relevant evidence concerns the pattern of suffixation displayed by the locative suffix. Consider the forms in (69):

\[
\begin{align*}
(69) & \quad \text{STEM} & \text{STEM+LOC} \\
& \text{a. } \text{tiw} & \text{`path'} & \text{ti:w-wit} & \text{`on the path'} \\
& \text{b. } \text{ám} & \text{`village'} & \text{ám-máť} & \text{`in the village'} \\
& \text{c. } \text{jùd} & \text{`clothes'} & \text{jùd-máť} & \text{`on the clothes'} \\
\end{align*}
\]

\[\text{Specifically, before a cluster consisting of any obstruent stop or } /s/ \text{ and any of } /j \text{ v t/}.\]
Lopes & Parker take the underlying form of the locative suffix to be /CVu/, where the first consonant and the vowel are copied from the stem. Of importance is the form in (69c); this form indicates that in case the stem-final consonant is a postnasalized stop, the suffix-initial consonant is realized as a plain nasal. Again, this is unexpected if the nasality in the postnasal is merely a matter of phonetic implementation. Although here, too, data are very scant, one analysis suggests itself: the stem-final sonorant stop and its suffix-initial nasal variant form a single onset constituent which, being dominated by the second nasalized syllable, surfaces as nasalized.

The facts encountered, though fragmentary, initially suggest that Yuhup differs from other Tucano-type harmony systems in that in Yuhup postnasalized stops, which are in complementary distribution with nasals, display phonologically relevant nasalization. However, the nasalizing potential of these stops becomes less of a mystery when we analyze phonologically relevant nasalization as a property of the syllable in which these stops are contained. The advantage of this account is that the nasal portion of postnasalized stops can be regarded as phonologically irrelevant, parallel to what has been proposed for other Tucano-type systems.

3.2.5 Discussion

In the preceding sections, I have focused in some detail on two interrelated aspects of Tucano-type nasal harmony systems, i.e. the sonorant target range of nasalization and the syllable-level propagation of nasal harmony. Element-based Dependency accounts for both aspects in a straightforward fashion. As far as supralaryngeal articulations are concerned, nasalization targets are identified by the presence of |L| in their manner component. The transparency of obstruents is captured by formalizing the harmony process in terms of syllable-to-syllable spreading, while the association of dependent |L| within syllables is kept in bounds by the CDR principle. This principle ensures that dependent |L| is associated only to those segment types that are nasalizable. The approach developed in §3.2.2 therefore predicts that there are no Tucano-type languages which display simultaneous nasalization of sonorants and voicing of obstruents.

Additional support for the Element-based Dependency interpretation of Tucano-type nasal harmony comes from an inspection of glottal harmony in certain Salish languages, such as Spokane. As is noted by Carlson (1980), the repetitive morpheme in Spokane is signalled by the insertion of /e/ into a root, with concomitant glottalization of all root-internal sonorants. In Element-based Dependency, the harmonic element in this type of harmony process can be formalized as |?|, which is associated to the dependent position of all sonorants within the harmonic domain. A further similarity between the pattern of glottal harmony in Spokane and the pattern of nasal harmony in Tucano-type systems is

47 See Walker (2002) for an Optimality Theoretic analysis of this pattern.
that in both processes obstruents are transparent. It would seem, therefore, that syllable-based harmony is not restricted to \( |L| \), but may also involve \( |?| \).

The identification of the syllable as the level at which nasal harmony is active may also shed some light on those nasalization processes in which fricatives are reportedly included in the target range of nasalization. The database of nasal harmony systems in Walker (1998) contains a mere four languages for which this has been argued, Applecross Gaelic, Inor, Itsekiri, and Umbundu. The nasalizable fricatives in Inor, Itsekiri, and Umbundu are all voiced, which suggests that these segments can be viewed as inherently voiced fricatives (see also §2.2.4). The fact that inherent voicing involves the presence of \( |L| \) in the manner component makes these fricatives potential nasalization targets.

The Applecross dialect of Scottish Gaelic is the only language in Walker’s database where voiceless fricatives are described as being part of the target range of nasalization. Some examples of words containing nasalized fricatives are given in (70) (cf. Ternes 1973; see also Walker 1998):

\[
\begin{align*}
\text{frí+t a+e} & /\text{frí+t a+e}/ \quad [\text{frí+t a+e}] \quad \text{‘root’} \\
\text{k+hispaxk} & /\text{k+hispaxk}/ \quad [\text{k+hispaxk}] \quad \text{‘wasp’} \\
\text{strá+ry} & /\text{strá+ry}/ \quad [\text{strá+ry}] \quad \text{‘string’} \\
\text{t+husk} & /\text{t+husk}/ \quad [\text{t+husk}] \quad \text{‘senseless person, fool’} \\
\text{huc} & /\text{huc}/ \quad [\text{huc}] \quad \text{‘neck’}
\end{align*}
\]

The status of these nasalized fricatives is not uncontroversial, however. More recently, Ternes has concurred that acoustic measurements are required to substantiate that these sounds are indeed nasalized (Elmar Ternes, cited by Ohala & Ohala 1993). According to Ternes (1973), nasalization in Applecross Gaelic spreads bidirectionally from a stressed vowel. This leads Van der Hulst & Smith (1982) to equate the domain of nasalization with that of the foot. Given this domain, it is not unexpected that the realization of voiceless fricatives in nasalized feet involves some nasal airflow; but this should not be interpreted to mean that this nasalization is phonologically relevant. I conclude, then, that the pattern of nasal harmony displayed in Applecross Gaelic does not undermine the claim that there is no phonological category of nasalized obstruents.

---

48 I am unaware of any examples of languages in which \( |H| \) could be argued to be a syllable-level property. It might perhaps be suggested that this is the case in languages which contrast “ballistic” and “controlled” syllables, such as some Chinantec, Chatino, and Mazateco languages. Ballistic syllables are characterized by postvocalic aspiration and a raised pitch.

49 I propose a similar analysis for the nasalized fricative of Waffa in §3.3 below.
3.3 Nasal lenition

One of the basic claims of the Element-based Dependency approach to nasalization is that nasals, in those languages in which nasality is phonologically active, are represented as nasalized sonorant stops. Support for this analysis comes from processes in which nasals trigger nasalization (see §3.1) and from processes in which sonorant stops are themselves nasalized (see §3.2). Additional support comes from processes in which nasals trigger voicing of obstruents, as we will see in §§4.1 and 4.2. In this section, I will adduce another type of evidence for the representation of nasals in terms of sonorant stops. The evidence in question comes from an inspection of the phenomenon of nasal lenition, the cover term for processes in which nasals shed their consonantal properties and surface as nasalized approximants.

The unifying characteristic of lenition processes is that they involve a change towards a more open stricture of articulation. Given that nasals involve a complete closure of the oral cavity (and given that the degree of velic lowering does not play a linguistically significant role), lenition of nasals is expected to produce approximants. Inspection of diachronic processes of nasal lenition suggests that such approximants are, at least initially, nasalized, although subsequent developments have in many cases resulted in either loss or transfer of nasalization.

The hypothesis that nasal lenition produces a nasalized approximant receives a natural interpretation in Element-based Dependency, where it can be expressed in terms of the deletion of \(|g|\) from the nasal manner component. This scenario is illustrated in (71):

\[
\begin{array}{c}
\text{O} \\
\text{L} \\
\text{L} \\
\text{L} \\
\text{L} \\
\end{array} \quad \gg \quad \begin{array}{c}
\text{O} \\
\text{L} \\
\text{L} \\
\end{array}
\]

Hence, nasal lenition provides a theory-internal argument for treating nasals—the input to nasal lenition—as nasalized sonorant stops. On the assumption that lenition affects manner, and thus targets head rather than dependent structure, the process involves the stability of dependent \(|L|\).

Before turning to some illustrations of nasal lenition, consider first some typological facts. Distinctively nasalized approximants are cross-linguistically rare. For instance, the UPSID database contains only four examples of this segment type:
Distinctively nasalized approximants (cf. Maddieson 1984)

Breton \( \breve{U} \)

Kharia \( \ddot{m} \)

Yakut \( \ddot{m} \)

Japanese \( \div \)

It seems reasonable to relate the rarity of this segment type to the fact that nasalized approximants are perceptually not sufficiently distinct from both their oral and their fully nasal congeners.\(^{50}\) This might be the reason why in many of the languages with underlyingly nasalized approximants, these approximants trigger nasalization of surrounding segments. Such nasalization can be regarded as compensatory, in the sense that the lack of perceptual salience of the nasalized approximant is compensated for by spreading nasalization across a larger domain. We will see some examples of this type of nasalization below.

In her discussion of consonant nasalization, Cohn (1993) distinguishes between three types of nasalized continuants. One type invariably occurs in nasal spans, and is found in for instance Igbo and Umbundu. Cohn argues that in these languages the occurrence of nasalized continuants can be attributed to nasal harmony; as a result, nasalization is not underlyingly associated to these continuants, but is a property of a larger domain. In Umbundu, for instance, consonant nasalization is restricted to the final syllables of stems. Cohn observes that nasality can therefore be analyzed as a lexical property of stem-final syllables. Such an analysis is compatible with the Element-based Dependency approach to nasal harmony outlined in §3.2.

The second type of nasalized continuants are nasalized fricatives. Cohn mentions two languages that have been argued to possess such segments, Japanese and Waffa. In Japanese there are good grounds for treating the segment in question as being a derived nasalized approximant; in any case, there is no reason to assume that the sound is anything other than a sonorant. In Japanese, syllable-final nasals are homorganic with a following stop word-internally, as is illustrated by the forms in (73a). This suggests that syllable-final nasals do not license an independent place component. In word-final prepausal context, place-linking to a following stop is impossible, and the nasal surfaces as what may be termed a “nasal glide”. The description of this sound varies. Bloch (1950:102) terms it a “voiced frictionless nasalized mediovelar spirant” (which, as Yip 1991:69 points out, is a contradiction in terms). Maddieson (1984:246) calls it a “nasalized voiced velar approximant”. Yip (1991:69) observes that “prepausally, the nasal is unreleased, either uvular or velar, and oral closure may not be complete”. Finally, Trigo (1988), calls the sound a “nasal glide”; here I will refer to the sound as a “nasalized approximant”. For the sake of simplicity, I

---

\(^{50}\) This would hold *a fortiori* for nasalized fricatives, a segment type which I claim has no phonological status.
assume in (73b) that the realization of the segment in question varies between 
[ŋ] and [ŋ̊]:

m[o]ndai ‘problem’  ze[ŋ-M] ‘goodness’
da[ŋə]lo ‘dumpling’  a[ŋ-M] ‘idea’

In Botma & Van der Torre (2001), the realization of the nasals in (73b) is argued
to involve deletion of the consonantal component. This analysis is essentially
equivalent to what I interpret as nasal lenition here: in word-final prepausal
position, Japanese nasals lose the manner element [ŋ], which turns them into
nasalized approximants:

(74)

Support for this interpretation comes from the fact that all of the sources that I
have consulted transcribe vowels preceding such nasalized approximants as
nasalized; this suggests that the lenited nasals have dependent [L], which spreads
leftwards to the preceding vowel. In line with the argumentation presented
above, we may think of this vowel nasalization as being compensatory.

Waffa is described by Stringer & Holz (1973) as having a nasalized voiced
fricative /$/. This segment contrasts with its non-nasalized counterpart and with
/m/ and /n/ word-initially and word-medially, as is shown by the forms in (75):

(75) "búume ‘stamens’  ja"báa ‘banana’
βa′ni ‘close by’  ðoβo ‘type of yam’
$atá ‘ground’  jaasə ‘reed skirt’
mátee ‘now’  kamo ‘round taro’

Cohn observes that there is no clear evidence, neither phonetic nor phonological,
that /$/ is an obstruent. What is clear, however, is that the segment contrasts with
/m/, and is therefore in all likelihood not the result of nasal lenition. For this
reason, I suggest that /$/ constitutes what was termed an inherently voiced
fricative in §2.2.4. Consider the representation in (76):
CHAPTER 3

Since inherently voiced fricatives contain [L] as part of their manner component, they permit dependent nasalization.

The third type of nasalized continuant, nasalized approximants, is argued by Cohn to be the most frequent type. Cohn (1993:331-5) provides the following list of languages with distinctive nasalized approximants; following Cohn, I give the diachronic origin of each of these approximants:

<table>
<thead>
<tr>
<th>Nasalized approximant</th>
<th>Diachronic origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paya</td>
<td>Û</td>
</tr>
<tr>
<td>Lele</td>
<td>Û, ℮</td>
</tr>
<tr>
<td>Yakut</td>
<td>℮</td>
</tr>
<tr>
<td>Haitian Creole</td>
<td>℮</td>
</tr>
<tr>
<td>Lua</td>
<td>[Û~ŋ]</td>
</tr>
<tr>
<td>Ile de Groix Breton</td>
<td>[Û~ŋ]</td>
</tr>
</tbody>
</table>

The important observation is that each of the nasalized approximants in (77) appears to be the result of nasal lenition. This suggests that in those cases where nasalization is an underlying property of the approximant (and not the result of a nasalization process), the approximant is derived from a historical nasal. In the remainder of this section, I consider the status of a nasalized approximants in a number of languages not discussed by Cohn. We will see that in these languages, too, the available evidence suggests that these approximants are the result of synchronic or diachronic nasal lenition.

Consider first of all some examples of nasal lenition that can be observed in a process of morphologically conditioned consonant gradation, as found in a number of Mande and West Atlantic languages. The examples in (78) show that gradation involves the alternation of a labial stop, either oral or nasal, with nasalized or non-nasalized /w/:
On the assumption that the oral stops are sonorants, the change from the basic grade to the derived grade can be expressed in terms of the deletion of head /ʔ/. In the case of an oral stop, this yields an oral approximant, as in (79a); in the case of a nasal, this yields a nasalized approximant, as in (79b):

(79) a. Voiced stop lenition  

b. Nasal lenition

This interpretation of nasal lenition therefore supports a representation of nasals in terms of nasalized sonorant stops.

Nasal lenition can also be observed in the diachronic development of a number of North American languages. For instance, Taylor (1963:125) notes that Proto-Caddoan */ŋ/ has developed into /n/ in Wichita. Similarly, in the Uto-Aztecan language Shoshone /m n/ lenite to [ŋ] in intervocalic and final contexts (cf. Miller 1996:696). According to Miller, these lenited nasals are in some cases realized as devoiced; there seems to be no clear conditioning factor for this realization.

(80) Underlying: m  n
Lenited:  ŋ  ŋ

In those contexts where nasal lenition takes place, stops and affricates are spirantized. Spirantized stops and affricates are realized as either voiced or
voiceless fricatives; here, too, a clear conditioning factor for this variation appears to be lacking:

(81) Underlying: \[p \ t \ \theta \ k \ kw\]

Lenited: \[\phi \ \beta \ \xi \ \theta \ \delta \ x \ y \ x^w \ y^w\]

In feature-based theories, nasal lenition and stop spirantization can be given a unified account in terms of a change from \([-\text{continuant}]\) to \([+\text{continuant}]\). If we assume that Shoshone stops have a manner component consisting of both \[\|\] and \[\|H\|\], then a unified account is also available in Element-based Dependency in terms of the deletion of \[\|?\|\]. This is illustrated in (82):

(82) a. Nasal lenition

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

b. Stop spirantization

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

Lenition of intervocalic \[*m* \to Ū] can also be observed in the Bishop dialect of Monachi, another Uto-Aztecan language. As is noted by Norval Smith (p.c.), the lenited variant of /\(g109\)/ is \[\(g119\)\] in the North Fork dialect of Monachi:

(83) Bishop dialect North Fork dialect

mija\(\tilde{U}\)ai mijawai ‘will go’

ta\(\tilde{U}\)ijawai na tawijawai na ‘our future going’

In diachronic terms, this suggests that lenition occurred in both Monachi dialects, with a subsequent process of denasalization occurring in the North Fork dialect. The North Folk development is represented in (84):

(84) \[
\begin{array}{ccc}
O & O & O \\
\text{L} & \text{L} > & \text{L} \\
? & ? > & \text{U} \\
\end{array}
\]

\(/m/ \to /\tilde{U}/ \to /w/\)

As I observed in §3.1 in relation to Lakkia, the denasalization of nasalized approximants is unsurprising, given the markedness of this segment type.
Nasal lenition with subsequent denasalization has also occurred in the development from Sanskrit to Hindi and Panjabi, where intervocalic *m lenited to /ː/ or /ɻ/ (see Arun 1961). In Hindi, the nasalization was subsequently transferred to the preceding vowel, while in Panjabi the nasalized consonants underwent vocalization and, word-internally, denasalization. Some examples are given in (85):

(85)  

<table>
<thead>
<tr>
<th>Sanskrit</th>
<th>Hindi</th>
<th>Panjabi</th>
</tr>
</thead>
<tbody>
<tr>
<td>kānāla</td>
<td>kāl (&lt; kaul)</td>
<td>'lotus'</td>
</tr>
<tr>
<td>jānāla</td>
<td>sāla (&lt; saula)</td>
<td>'dark'</td>
</tr>
<tr>
<td>grāma</td>
<td>grâu (&lt; grāu)</td>
<td>'village'</td>
</tr>
<tr>
<td>nāma</td>
<td>nāː (&lt; nāu)</td>
<td>'name'</td>
</tr>
</tbody>
</table>

I propose that the lenited nasal is phonologically a nasalized labial approximant, i.e. a segment which consists of head [L] and dependent [L]. While it is possible that this segment was realized as [ʃ], it is not unlikely that other realizations included [ʃ], [ʃ], and perhaps [ɻ].

As can be observed in (85), the final stage of the development from Sanskrit to Hindi involved the transfer of nasality from the nasalized approximant to the vowel. This process can be represented as in (86):

(86)  

\[
\begin{array}{c}
N \\
O \\
L & L & L \\
\uparrow & \uparrow \\
A & U
\end{array}
\]

I assume that transfer of nasalization from an onset approximant to a nuclear vowel leads to a less marked structure. Observe once more that we can attribute this to the relative markedness of [L] in consonantal positions.

Denasalization and transfer are also observed in the history of the Goidelic languages (the various stages of Irish, Scottish Gaelic, and Manx). Goidelic exhibits the following synchronic lenition patterns (see e.g. Anderson 1975):

(87)  

m, mʲ \rightarrow v, vʲ  
N, Nʲ \rightarrow n, nʲ  
b, bʲ \rightarrow v, vʲ  
L, Lʲ \rightarrow l, lʲ  
p, pʲ \rightarrow f, fʲ  
R, Rʲ \rightarrow r, rʲ

---

Scottish Gaelic has only the non-palatalized labial nasal. The full set of coronal sonorants is not found in all dialects, at least not phonetically. In line with the tradition in Goidelic studies, the non-lenited sonorants are represented by capital letters; phonetically, these sonorants are distinguished from lenited sonorants in terms of their place of articulation and their geminate-like nature.
Note in (87) that the labial and coronal nasals display asymmetric behaviour. Whereas /N/ lenites to its lax counterpart [n] and retains its nasality, /m/ lenites to non-nasal /v/. The latter development becomes more natural when we take into account that /v/ derives from an earlier nasalized labial approximant. This approximant was obsolescent in certain dialects at the beginning of the 20th century. Consider for instance Sommerfelt’s (1922:153) description of the dialect of Torr County Donegal:

The nasalization [of /v/] is maintained in these cases with extreme fidelity by old people and it has seldom been troubled by analogy ... [For younger speakers] w, v and r are often nasalized, but as a general rule the nasalization has been displaced to the preceding or following vowel.

Some examples of this “displacement” are given in (88):

(88) /dːiːs/ [dːiːs ~ dːiːvːs] ‘disrespect’
/kːnːɔt/ [kːnːɔt ~ ɔkːvnːɔt] ‘mindful’

Like Hindi, Goidelic thus displays transfer of nasalization from an approximant to a neighbouring vowel. This is corroborated by Oftedal (1956:42), who, in his discussion of nasalized approximants in Scottish Gaelic, observes that

[p]honetically, the v may still be nasal [tʰːs:], but the phonemically relevant nasality has been shifted from the consonant to the vowel.

While the facts considered make the development from /m/ to /v/ more natural, the question remains why /m/ and /n/ display asymmetric behaviour in Goidelic lenition. I offer a tentative solution to this asymmetry in §7.2.

There is also evidence to suggest that in some languages nasalized approximants are underlingly present even though they are never realized phonetically. For instance, Bright (1957:39-40) posits /ˌv/ in Karok on the basis of the alternations in (89a):

(89) a. ʔâːm-tiːh ‘to be eating’ ʔâːv-ət ‘ate’
    vûŋ-tiːh ‘to be flowing’ vû-uniː ‘to flow downhill’

b. vaθiːv-tiːh ‘to be fighting’ vaθiːv ‘to fight’

The forms in (89) suggest that Karok, at some point in its history, underwent a process of intervocalic nasal lenition which changed *VmV into [VːV] and *VnV into [VːV]. These nasalized approximants subsequently disappeared from the surface level, but are still present underlingly. The fact that lenited /m/ is transcribed by Bright as /v/ could be interpreted to mean that the segment has obstruent status. This is unlikely, however. The form in (89b) shows that not all
instances of /v/ alternate with /m/. This suggests that the two types of /v/ differ in their underlying representation. I suggest that the alternating /v/ is a labial approximant. Support for this interpretation comes from the observation that Karok lacks a labial(-velar) approximant /v/ or /w/; hence, the alternating /v/ could be argued to fill this position in the consonant inventory.

It should further be noted that there is independent evidence for the presence of dependent [L] in Karok nasals. As Bright observes, /r/ surfaces as [n] in the context of preceding /m/ or /n/. This is shown by the forms in (90), where /-ri/ is the locative suffix:

(90) a. /ikxâram-ri/ [ikxâramni] ‘in a dark place’
     b. /îüdâram-ri/ [îüdâramnî] ‘among strangers’

This suggests that /r/ functions as a sonorant stop, and surfaces as nasalized after nasals as the result of spreading of dependent [L]. The alternation in (90a) can therefore be represented as follows:

(91) C O
    L L L L
    ? ? ? ?
    U I

/m-ri/ → [mn]

Summarizing, the Monachi, Hindi, Goidelic, and Karok facts illustrate the markedness of nasalized approximants. Unlike in Monachi, however, nasalization in Hindi, Goidelic, and Karok is not lost altogether, but is instead transferred to a neighbouring vowel, as in Hindi and some Goidelic languages, or remains underlingly present, as in Karok.

As was observed at the beginning of this section, the relative instability of nasalized approximants is likely to be due to the relative lack of perceptual salience of nasalization in these segments. It is therefore not surprising that the nasalization of these approximants is transferred to a position in which it is perceptually more salient. The examples of this strategy that we have seen so far all involved transfer to a neighbouring vowel. Another, more drastic, strategy to ensure the perceptual salience of nasalization is to spread it across a larger domain. To conclude this section, I consider two languages in which nasal lenition sets, or has set, in motion a process of nasal harmony.

52 Bright (1957:8) notes that apparently all instances of what he transcribes as /v/ are realized as unrounded bilabial spirants, i.e. a sound approximating [/>. 
Consider first a synchronic process of nasal lenition that is exhibited by Inor, a Semitic language of Ethiopia. Nasal lenition in Inor forms part of a more general process of lenition that affects stem-initial consonants in the context of a preceding prefix. Some examples involving nasals are given in (92); here the prefix that is involved is the imperfective marker /ji-/ (cf. Chamora & Hetzron 2000:16):

(92)   Perf   Imperf
a. natar   ʼ uproot’
   b. məsər   ʼ resemble’
   c. nətər   ʼ bore a hole’
   d. məkər   ʼ come out’
   e. daməd   ji-domd  ʼ put together’
   f. fənd   ji-fənd  ʼ cut in half’

(92) illustrates that prefixation of /ji-/ triggers lenition of /m n/ to [ $ *]. The lenited nasals trigger bidirectional nasalization of vowels, approximants, liquids, and /g/. The form in (92b) shows that a voiceless fricative blocks rightward nasalization. The forms in (92c,d) indicate that nasalization is also arrested by voiceless stops, although these, unlike voiceless fricatives, surface as voiced. Finally, the forms in (92e,f) show that nasal lenition targets stem-initial nasals, but not stem-internal nasals.

Another illustration of nasal harmony that is triggered by nasal lenition can be found in Urhobo, a Kwa language of Nigeria. Consider in (93) a number of cognates from Urhobo and the closely related Ora (cf. Kelly 1969):

(93)   Ora   Urhobo
      oome  ʼ tongue’
oimi  ʼ corpse’
uhumu  ʼ tail ’
emjami  ʼ sickness’
ihumu  ʼ medicine’
ipo  ʼ honeybee’
eami  ʼ animal’
omhe  ʼ sleep’

These correspondences suggest that lenition of /m/ has resulted in a nasalized bilabial approximant in Urhobo. The lenition context appears to be intervocalic,

---

53 Chamora & Hetzron transcribe lenited /m/ as [ŋ]; their description indicates that the sound is phonetically nasalized [β].

54 It is also possible to say that /n/ is included in the set of nasalizable segments, since there is nothing which prohibits the combination of glottal closure and velic lowering. I return to the relation between glottal stop and nasalization in §6.1.
as is suggested by forms like /emjami/, and targets /m/ only, as is shown by the form /ipo/. Nasal lenition triggers bidirectional harmony, which targets vowels and /r/. Observe that it appears to leave /r/ unaffected, which might be taken to suggest that this segment functions as an obstruent phonologically.

Interestingly, in both Inor and Urhobo lenited nasals trigger nasal harmony while non-lenited nasals do not. It is reasonable to relate this difference to the relative markedness of nasalization in both segment types. Dependent [L] as a property of an approximant is relatively marked, and triggers spreading of [L] across a larger domain. Dependent [L] as a property of a sonorant stop, on the other hand, is less marked, and does not trigger spreading of [L]. Thus, it appears to be the case that in both Inor and Urhobo the loss of perceptual salience of nasality that is caused by nasal lenition is compensated for by nasal harmony. This scenario might offer a plausible historical explanation for at least some types of nasal harmony processes.

The interpretation of nasal lenition that is proposed here provides a possible answer to a general problem that confronts a phonological characterization of nasality. According to traditional phonetics, consonants are classified into four manner types: stops, fricatives, approximants, and nasals. A complication here is that stops, fricatives, and approximants are typical manner classes, in the sense that they are distinguished from each other in terms of the degree of oral stricture. This cannot be said of nasals, since nasals, like stops, are characterized by complete oral closure of the oral cavity. An interpretation of nasals as being a separate manner type has unfortunate phonological repercussions. To illustrate this, consider a gradual process of consonant lenition in which the manner type of a stop is changed in the direction of a more open stricture. In (94), I give the changes that led from Pre-Old English āgan to Modern (RP) English own (cf. Ewen & Van der Hulst 2001:13).

(94)  Pre-OE  OE  eME  ME  eMdE  MdE
      *āgan  >  āyan  >  ɔːwɔn  >  oːn  >  oːn  >  oːn

The gradual vocalization of *g that is observed in (94) involves a step-by-step increase in sonority. This raises the question why in the development from *g to /w/ there is no intermediate stage at which the outcome is a nasal. The reason is, presumably, that lenition takes account of the oral stricture properties of consonants, and as far as oral stricture properties are concerned, nasals do not form a separate class. A theory of segment structure must provide a principled explanation of why nasals are absent in lenition trajectories. However, this is not a straightforward affair if, as the traditional view has it, nasals are treated on a par with segment types that differ in terms of their oral stricture properties.

---

55 In (94), OE is short for Old English, eME for early Middle English, ME for Middle English, eMdE for early Modern English, and MdE for Modern English.
The Element-based Dependency approach to nasality offers a potential explanation for the absence of nasals in lenition trajectories. In those languages in which nasality is phonologically active, nasal consonants consist of a combination of sonorant stop manner and dependent [L]. Hence, changes affecting manner—the key characteristic of lenition—can never have a nasal consonant as its output.

### 3.4 Summary

In this chapter, I have examined the interpretation of dependent [L] as nasalization. One of the fundamental claims of Element-based Dependency is that dependent [L] is interpreted as nasalization only in case [L] is associated to a sonorant or laryngeal manner component. In some languages nasalization is a property of a subsyllabic constituents, such as an onset or a nucleus. In other languages nasalization may surface as a property of larger domains, such as syllables and words; I have argued that in some of these languages, in particular those that display sonorant nasalization and obstruent transparency, nasalization is best analyzed as an underlying property of the syllable. On the assumption that such syllables are [L]-headed, dependent [L] surfaces as a property of all tautosyllabic [L]-headed segments while leaving other segment types unaffected. The distribution of dependent [L] within syllables is regulated by the (revised) CDR. This principle ensures that syllable-level [L] associates to nasalizable, i.e. [L]-headed—manner types only. The relevance of the syllable in nasal harmony is supported by a number of different manifestations of nasal harmony, such as those observed in Southern Barasano, Gbe, Kpelle, Zoque, and Yuhup.

A more specific focus of this chapter was the distinction between bare and nasalized sonorant stops. The latter segment type represents a phonologically active nasal. This interpretation of nasals is supported by processes of nasal effacement, by alternations between oral and nasal sonorants in nasal harmony processes, and by processes of nasal lenition.
One of the key claims of the Element-based Dependency approach is that dependent [L] is interpreted either as nasalization or as voice, depending on the structure of the manner component to which it is associated. An illustrative example of this approach was observed in the previous chapter, where we saw that the definite marker in Kpelle is realized as voicing in case of a root-initial obstruent, and as nasalization in case of a root-initial sonorant. In the previous chapter, the main focus was on the interpretation of dependent [L] as nasalization. The present chapter is concerned mainly with the interpretation of dependent [L] as voice.

As was argued in chapter 2, distinctively voiced obstruents—segment types which do not have [L] as part of their head manner component—are represented in terms of a dependent element [L]. Two examples of voiced obstruents are given in (1):

\[(1) \quad \begin{array}{c}
a. \quad O \\ \quad \mathbf{L} \\ \quad U \\ \quad /b/ \\
\hline
b. \quad O \\ \quad H \\ \quad I \\ \quad /z/ \\
\end{array} \]

Representations of the kind in (1) make it possible to characterize patterns of obstruent voicing assimilation such as that displayed by Dutch in terms of spreading and, where appropriate, delinking of dependent [L]. In addition, they provide a natural account of devoicing processes in terms of position-dependent deletion of dependent [L]; this captures the observation that devoicing involves a loss of markedness.

The aim of this chapter is to provide support for the interpretation of dependent [L] as voice by considering a number of phonological interactions between nasals and obstruents. The first type of support comes from postnasal voicing processes in which underlyingly voiceless stops surface as voiced under the influence of a preceding nasal. In §4.1, I will claim that the presence of postnasal voicing in a language implies that the triggering nasals are specified for dependent [L]; if a nasal precedes a voiceless stop, this [L] spreads to the dependent position of the stop, where it is phonetically interpreted as voicing.
In §4.2, I offer support for the dual interpretation of dependent $|L|$ as nasalization and voice by examining processes in which nasals trigger either nasalization or voicing, depending on whether the segment following the nasal is a sonorant or an obstruent. The existence of such processes suggests that nasalization and voice are characterized by one and the same element, e.g. $|L|$, for which the triggering nasal is specified.

The evidence for the dual interpretation of dependent $|L|$ that I adduce in §4.3 is less direct. In this section, the focus is on what I term “nasal fortition”, a cover term for phenomena in which nasals shed their vocalic properties and surface as stops, with complete or partial denasalization. An analysis of the targeted nasals as nasalized sonorant stops predicts that nasal fortition may produce either a voiced obstruent stop (through deletion of head $|L|$) or an inherently voiced sonorant stop (through deletion of dependent $|L|$). I will consider a number of examples of each type of fortition, and discuss a number of diagnostics that will help us to determine the status of the denasalized output. With regard to $|L|$, denasalization of a nasal to a voiced obstruent stop adds further support to the dual interpretation of dependent $|L|$.

### 4.1 Postnasal voicing

Postnasal voicing is a process whereby a voiceless obstruent—usually a stop—surfaces as voiced under the influence of a preceding nasal. The existence of postnasal voicing offers support for the dual interpretation of dependent $|L|$ as nasalization and voice. The process receives a natural interpretation in terms of the spreading of dependent $|L|$ from the nasal to the dependent position of a following stop. This is shown in (2), where I assume that the nasal and the stop form a coda-onset sequence:

\[
\begin{align*}
\text{(2)} \quad & C \quad O \\
& \text{L} \quad \text{L} \quad ? \\
& ? \\
& /\text{N}^\pm/ \rightarrow [\text{N}^\emptyset]
\end{align*}
\]

This interpretation of postnasal voicing implies that the triggering nasal is specified for dependent $|L|$, i.e. it is a nasalized sonorant stop. As such, (2) illustrates the dual interpretation of dependent $|L|$: $|L|$ denotes nasalization when linked to a sonorant manner component and voicing when linked to an obstruent manner component.

Cross-linguistically, postnasal voicing is quite common. The process can be observed in, for instance, Kpelle (Welmers 1962), Kikuyu (Herbert 1986), Ndele
(Herbert 1986), Korean (Rhee 2002), Yamato Japanese (Itô & Mester 1986), Greek (Newton 1972), Gaelic (Ofedal 1956), Zoque (Herrera 1995), Quechua (Rice 1993), Jicaque (Campbell & Oltrogge 1998), Mbiyom (Hale 1976), Oykagand (Sommer 1969), and Wembawemba (Hercus 1986). Consider for instance the following data from Zoque (cf. Herrera 1995) (some of these data were also considered in §3.2.4.2):

\[(3) \quad \begin{align*}
a. & \quad /\text{g}116/\text{g}97/\text{g}110/\text{g}116/\text{g}97/\text{g}110 [\text{g}116/\text{g}97/\text{g}110/\text{g}100/\text{g}97/\text{g}110] \quad \text{‘mariposa’} \\
& \quad /\text{g}116/\text{g}161/\text{g}115/\text{g}97/\text{g}78/\text{g}107/\text{g}97 [\text{g}116/\text{g}161/\text{g}115/\text{g}97/\text{g}78/\text{g}103/\text{g}97] \quad \text{‘gordo’} \\
b. & \quad /\text{g}116/\text{g}117/\text{g}107/\text{g}117/\text{g}110 [\text{g}116/\text{g}97/\text{g}110] \quad \text{‘arete-PL’} \\
& \quad /\text{g}107/\text{g}233/\text{g}47/\text{g}109 [\text{g}107/\text{g}233/\text{g}47/\text{g}109/\text{g}98/\text{g}97] \quad \text{‘subir-IMPERF’} \\
& \quad /\text{g}109/\text{g}105/\text{g}110 [\text{g}109/\text{g}105/\text{g}110/\text{g}98/\text{g}97] \quad \text{‘viene’} \\
& \quad /\text{g}115/\text{g}97/\text{g}78 [\text{g}115/\text{g}97/\text{g}78/\text{g}103/\text{g}111/\text{g}119/\text{g}105] \quad \text{‘muy sordo’} \\
c. & \quad /\text{g}116/\text{g}97/\text{g}110/\text{g}100/\text{g}97/\text{g}78 [\text{g}107/\text{g}101/\text{g}104/\text{g}107] [\text{g}116/\text{g}97/\text{g}110/\text{g}100/\text{g}97/\text{g}78/\text{g}103/\text{g}101/\text{g}104/\text{g}107/\text{g}112/\text{g}97] \quad \text{‘mariposa cae’}
\end{align*}\]

The forms in (3) show that postnasal voicing of voiceless stops and affricates in Zoque applies in an across-the-board fashion: it is found in morpheme-internal context, as in (3a), across a morpheme boundary, as in (3b), and across a word boundary, as in (3c). Note that postnasal voicing operates independently of place assimilation, since nasal-stop clusters in Zoque are not required to be homorganic.

From a general perspective, the voicing effect exerted by nasals is unsurprising. Nasals are voiced phonetically, and there is no a priori reason why this voicing should not be relevant phonologically. However, the problem is that nasals are generally the only sonorant segment type which triggers obstruent voicing. Consider in this light the following data from the Pama-Nyungan language Wembawemba (cf. Hercus 1986; see also Hayes 1995):

\[(4) \quad \begin{align*}
a. & \quad /\text{g}116/\text{g}97/\text{g}107/\text{g}97 [\text{g}116/\text{g}97/\text{g}107/\text{g}191] \quad \text{‘to hit’} \\
b. & \quad /\text{g}109/\text{g}105/\text{g}108/\text{g}112/\text{g}97 [\text{g}109/\text{g}105/\text{g}108/\text{g}112/\text{g}191] \quad \text{‘to twist’} \\
c. & \quad /\text{g}106/\text{g}97/\text{g}110/\text{g}116/\text{g}105/\text{g}110 [\text{g}106/\text{g}97/\text{g}110/\text{g}100/\text{g}105/\text{g}110] \quad \text{‘me’} \\
d. & \quad /\text{g}112/\text{g}97/\text{g}110/\text{g}112/\text{g}97/\text{g}114 [\text{g}112/\text{g}97/\text{g}110/\text{g}98/\text{g}97/\text{g}114] \quad \text{‘shovel’}
\end{align*}\]

Wembawemba is representative of the overwhelming majority of languages which have postnasal voicing: the process is triggered by nasals, and not by other sonorants.

This observation leads Hayes to suggest that postnasal voicing must be accounted for in specific phonetic terms. According to Hayes, there are two reasons why obstruents, and in particular obstruent stops, are prone to undergo voicing in postnasal context. First, the initial portion of a stop in postnasal context involves a brief period during which the passage to the nasal cavity is not sealed off completely. This “nasal leak” facilitates voicing. Second, the raising of the velum that is required for an oral stop continues for some time
after the nasal passage has been closed. This raising gesture expands the oral
cavity, and thus also facilitates voicing. Note that these characteristics are
specific to nasal-stop sequences; hence, they provide a phonetic explanation of
the fact that sonorant-induced voicing of obstruents is generally restricted to
nasals.

While I do not deny that postnasal voicing is phonetically motivated, it is
questionable whether a phonological interpretation of the process requires the
degree of phonetic detail that is suggested by Hayes. In Element-based
Dependency, postnasal voicing can be straightforwardly accounted for in terms
of spreading of dependent |L| from the nasal to the following stop. The fact that
postsonorant voicing is specific to nasals is due to the fact that phonologically
active nasals are nasalized sonorant stops, and hence are specified for dependent
|L|. Dependent |L| is absent in other sonorant segment types; if it were not, this
would incorrectly imply that the sonorants are nasalized. Consider the
representation of the medial consonant cluster of /milpa/ (cf. 4b)). In (5), I
assume that the manner component of /L/ consists of |L| dominating |H|:

(5) \[
\begin{array}{c|c|c}
\text{C} & \text{O} \\
\hline
\text{L} & ? \\
\hline
\text{H} & \text{U} \\
\hline
\text{I} \\
\end{array}
\]

/\text{l.p}/

Note the absence of dependent |L| in the representation of /L/; as a consequence,
no interaction between the sonorant and the stop takes place:

The approach to postnasal voicing that is advocated here raises the question
how other forms of postsonorant voicing of stops should be accounted for. A
reasonable assumption is that the voicing in these cases is not conditioned by the
segmental but by the prosodic context. To illustrate this, consider the following
correspondences between Jicaque and Tol, two closely related languages of
Honduras (cf. Campbell & Oltrogge 1980); in (6), my reconstruction of Proto-
Jicaque follows that of Campbell & Oltrogge:

(6)  
\begin{tabular}{l|l|l|l}
\text{Proto-Jicaque} & \text{Tol} & \text{Jicaque} \\
\hline
\text{a. kampa} & \text{kampa} & \text{kamba} & \text{‘far, long’} \\
\text{manti} & \text{manti} & \text{mandi} & \text{‘vulture’} \\
\text{m-pʰats’} & \text{m-pʰats’} & \text{m-bat} & \text{‘my ear’} \\
\hline
\text{b. alpa-} & \text{alpa-} & \text{arba-} & \text{‘above’} \\
\end{tabular}
The forms in (6a-c) show that the development from Proto-Jicaque to Jicaque involved voicing of postnasal, postliquid, and intervocalic stops. I suggest that what unifies these voicing contexts is the prosodic position of the targeted stop, which is that of the foot-internal onset. According to this interpretation, voicing in Jicaque is the result of prosodically conditioned lenition, similar to what I proposed for Fore in §1.3.2. Lenition involves the addition of |L| to the manner component of the affected stops. As was noted, this signals that the process is prosodically rather than segmentally conditioned.

An inspection of cross-linguistic obstruent voicing processes in postsonorant context suggest that the presence of postvocalic and postliquid voicing implies the presence of postnasal voicing, but not the other way around. Hayes (1995:2) observes that this is “a likely Greenbergian implicational universal”. Note that this supports the interpretation of postnasal voicing in terms of spreading of dependent |L|, at least in those languages in which voicing is triggered specifically by nasals.

An additional argument for treating postnasal voicing as primarily phonological is that many languages restrict postnasal voicing to specific domains. In Japanese, for instance, morpheme-internal nasal-obstruent clusters are required to be voiced only in the native, “Yamato” stratum of the lexicon (cf. Itô & Mester 1995). In other lexical strata, such as those containing Sino-Japanese and foreign words, NC sequences are tolerated:

(7) a. **Yamato**
   - tombo ‘dragonfly’ (*tompo)
   - kande ‘chewing’ (*kante)
   - jombori ‘lonely’ (*jompori)
   - unzari ‘disgusted’ (*unsari)

b. **Sino-Japanese**
   - sampo ‘walk’
   - hantai ‘opposite’
   - kankei ‘relation’
   - sensei ‘teacher’

c. **Foreign**
   - kompuutaa ‘computer’
   - santaakuroozu ‘Santa Claus’
   - konkurito ‘concrete’

---

1 Note the change *k > 7 in Tol in (6c). This development affected all instances of *k.
Another language in which postnasal voicing has a restricted domain of application is OshiKwanyama, a Bantu language of Angola. In OshiKwanyama, voiced and voiceless stops are in complementary distribution, with the former occurring in postnasal context only (cf. Pater 1997); this suggests a morpheme-internal process of postnasal voicing. Support for this view comes from the accommodation of loans with voiceless nasal-stop clusters. As Pater (1997:19) observes, such clusters are realized with the stop part voiced:

(8)  
\[
\begin{array}{l}
\text{OshiKwanyama} \quad \text{English} \\
\text{sitamba} \quad < \quad \text{stamp} \\
\text{pelenda} \quad < \quad \text{print} \\
\text{oinga} \quad < \quad \text{ink}
\end{array}
\]

However, voiceless nasal-stop clusters that are the result of prefixation do not display postnasal voicing. Instead, the nasal-final prefix surfaces with the place specification of the stem-initial stop, which is itself deleted (cf. Pater 1997:19):

(9)  
\[
\begin{array}{l}
/e:N+pati/ \quad [\text{emati}] \quad \text{‘ribs’} \\
/oN+pote/ \quad [\text{omote}] \quad \text{‘good-for-nothing’} \\
/oN+tana/ \quad [\text{onana}] \quad \text{‘calf’}
\end{array}
\]

Pater refers to this process as “nasal substitution”. In Element-based Dependency, it can be interpreted as involving the deletion of the manner component of the stem-initial stop, with the remaining place specification taken over by the nasal. This scenario is shown in (10) for the nasal-stop cluster in /e:N+pati/. Observe in (10) that the identification of the morphological context is crucial, since a stop following a nasal in morpheme-internal context is voiced, not deleted:\(^2\)

(10)  
\[
\begin{array}{l}
(PFX) \quad (STEM) \\
\text{C} \quad \text{O} \\
\text{L} \quad \text{L} \quad (\text{?}) \\
\text{?} \\
\text{U} \\
/N+p/ \rightarrow [m]
\end{array}
\]

\(^2\) I further assume that the nasal prefix is resyllabified as an onset; this has not been indicated in (10).
Another language in which voiceless nasal-stop clusters are subject to nasal substitution is Indonesian; see Pater (1997) for an account of this process.

As a final example of a language in which postnasal voicing applies under specific circumstances, consider Quechua. As was already noted in §1.3.2, postnasal voicing in the Puyo-Pongo dialect of Quechua is restricted to derived environments. Voicing of stops is contrastive in postnasal context morphology-externally, as in (11a,b); however, when there is a morpheme boundary involved, as in (11c), nasals can be followed by voiced stops only:

(11)  a. pampa Phoneme 'skirt'
       /in/ Phoneme 'soot'
       /ũ/nti Phoneme 'to stir the fire'
  b. hambi Phoneme 'poison'
       /i/ndi Phoneme 'sun'
       /ũ/nga Phoneme 'ten'
  c. kamba Phoneme 'you-GEN' (cf. sinik-PA 'porcupine-GEN')
       hatum-bi Phoneme 'big one-LOC' (cf. sat-PA-PI 'jungle-LOC')
       wakin-da Phoneme 'the house-OBJ' (cf. wasi-ta 'the others-OBJ')

In the languages discussed, postnasal voicing occurs only under specific, grammatically defined circumstances. This suggests that a purely phonetic account of the process, as is proposed by Hayes (1995), must in any case be augmented with phonological and morphological information. It would appear, therefore, that a theory in which postnasal voicing accounted for in strictly phonological terms is more restrictive.

To conclude this section, it should be noted that while most processes of postnasal voicing involve a nasal as trigger, there are also voicing processes that are conditioned by other nasalized segment types. Consider as an example the following forms from the Odienné dialect of Jula, a Manding language spoken in Guinea-Bissao and Ivory Coast (cf. Tourville 1991):

(12)  a. /dê/ Phoneme [dê] Phoneme 'child'
  b. /dê-te/ Phoneme [dê-dê] Phoneme 'it’s not a child'
  c. /dê-sawa/ Phoneme [dêzawa] Phoneme 'two children'

These data suggest that underlying vowel nasalization is signalled by prenasalization and voicing of stops, as in (12b), and by voicing of fricatives, as in (12c). The latter process can be represented as in (13):

---

3 Note that vowel nasalization is not realized in case a stop follows; see Tourville (1991) for discussion of this issue, and for a detailed examination of the status of nasality in Jula in general.
The Jula facts illustrate the dual interpretation of dependent [L]: if [L] surfaces as part of a sonorant it is realized as nasalization; if, on the other hand, [L] surfaces as part of an obstruent—either a stop or a fricative—it is realized as voicing. The facts further demonstrate that obstruent voicing can be triggered not only by nasalized stops but also by other nasalized segment types. Note that in Element-based Dependency the triggering contexts are unified in terms of dependent [L]. By way of contrast, it is not entirely clear how the phonetically motivated account of Hayes would account for the presence of obstruent voicing in the context of a following nasalized segment type.

### 4.2 Interactions involving nasalization and voice

In this section, I consider a number of processes in which nasalized segments trigger either nasalization or voicing, depending on whether the target of [L]-spreading is a sonorant or an obstruent. The existence of such processes offers strong support for the dual interpretation of dependent [L] as nasalization and voice.\(^4\)

Consider first of all the pattern of perfective formation in Navajo and Chipewyan. As Rice (1993:329) observes, perfectives in these languages are signalled by the voicing of stem-final fricatives, as in (14a), and by nasalization of stem-final vowels, as in (14b):

\[
\begin{array}{ccc}
\text{IMPERF} & \text{PERF} & \text{ Meaning} \\
\text{Navajo} & -ʔaal & -ʔaal & \text{‘chew, eat’} \\
& -ʔaaʃ & -ʔaaʃ & \text{‘few go’} \\
& -lʊðs & -lʊðz & \text{‘lead’} \\
\text{Chipewyan} & -ʔät & -ʔäl & \text{‘chew, eat’} \\
& -ʔås & -ʔåz & \text{‘few go’} \\
\text{Navajo} & -bí & -bí & \text{‘swim’} \\
& -ʔá & -ʔfl & \text{‘classificatory compact object’} \\
& -ka & -kā & \text{‘classificatory contained object’} \\
\end{array}
\]

\(^4\) Some examples of this type of process were already considered in §§3.2.4.1 and 3.2.4.2.
The two surface manifestations of the perfective receive a natural interpretation if the perfective morpheme is analyzed as consisting of [L] underlyingly. This [L] is linked to the dependent position of a stem-final segment and, depending on its manner type, is realized as nasalization or voice. The dual interpretation of the perfective is illustrated in (15), where I assume that stem-final fricatives occupy the syllable coda:

\[
\begin{array}{ccc}
\text{a.} & \text{N} & \text{b.} & \text{C} \\ \\
& \vert & \vert \\
\text{L} & \text{L} & \text{H} & \text{L} \\
\ldots & \ldots & \\
\end{array}
\]

\text{Nasalized vowel} \quad \text{Voiced fricative}

Whereas this account seems feasible for Chipewyan, there is a complication with regard to Navajo. Rice notes that after vowel-final stems, the Navajo perfective suffix surfaces as [n] in case a vowel-initial enclitic follows, as in the forms in (16):

\[
\begin{align*}
\text{a.} & \quad /i/110/g110/g105/g83/g241 & \rightarrow & \text{‘I am’} \\
& \quad ni\text{f}n\text{y}\text{ed} & \rightarrow & \text{‘when I was’ (enclitic: - ñed ‘past time’)} \\
\text{b.} & \quad /i/104/g97/g122/g47 & \rightarrow & \text{‘area is located’} \\
& \quad hnz\text{y}\text{ed} & \rightarrow & \text{‘law’ (enclitic: - ñ ‘relative’)} \\
\end{align*}
\]

While the hypothesis that the perfective morpheme in Chipewyan is dependent [L] can therefore be maintained, an alternative interpretation is required for Navajo. I suggest that in Navajo the perfective suffix consists of a (coronal) nasalized sonorant stop. This stop is phonetically realized if it is followed by a vowel-initial enclitic. This is illustrated in (17), where I assume that the perfective suffix forms an onset constituent:

\[
\begin{align*}
\text{a.} & \quad /i/110/g110/g105/g83/g241 & \rightarrow & \text{‘I am’} \\
& \quad ni\text{f}n\text{y}\text{ed} & \rightarrow & \text{‘when I was’ (enclitic: - ñed ‘past time’)} \\
\text{b.} & \quad /i/104/g97/g122/g47 & \rightarrow & \text{‘area is located’} \\
& \quad hnz\text{y}\text{ed} & \rightarrow & \text{‘law’ (enclitic: - ñ ‘relative’)} \\
\end{align*}
\]

5 In Chipewyan, nasalized vowels are generally retained before vowel-initial enclitics (cf. Rice 1993; see also Li 1946). Note, too, that in Sarcee, a language closely related to Chipewyan and Navajo, the perfective suffix is marked by /n/, which is licensed only if a bimoraic vowel follows. Unlike Chipewyan and Navajo, Sarcee does not tolerate derived nasalized vowels.

6 Rice suggests that the perfective in Chipewyan might consist of the feature SV, with a subsequent default rule filling in the feature [nasal]. I will discuss some problems with this approach in §4.3.1.

7 In (17) I ignore place, though—as noted—I assume that the perfective suffix is underlyingly coronal. Note, however, that an analysis in terms of default coronal place is also feasible.
The facts suggest that the distribution of the perfective suffix in Navajo is prosodically conditioned: the nasalized sonorant stop is licensed only when the onset by which it is dominated is followed by a nucleus. This is the case when the perfective is followed by a vowel-initial enclitic. If there is no following enclitic, the stop is effaced. In this case, dependent [L] is retained through association to the preceding stem-final vowel, as is illustrated in (18):

```
(18)   (STEM)  (PERF)  (ENCL)
       N       O       N
       L       L       L
       ?       I
```

Although more comparative data is required to substantiate this, a plausible assumption is that the Chipewyan pattern represents an innovation of the pattern found in Navajo. The facts considered suggest that in Chipewyan nasal effacement was at some point generalized to all contexts, which led to an eventual loss of the underlying nasal manner component.

The pattern of perfective suffixation in Navajo shares certain characteristics with that of Irish eclipsis. This concerns a morphologically conditioned process that turns stem-initial voiceless obstruents into voiced obstruents, and voiced obstruents into nasals; in case of vowel-initial stems, eclipsis triggers the insertion of an initial nasal consonant (see Ó Siadhail 1989, Rice 1993). The effects of eclipsis are summarized in (19):

```
(19)   (STEM)  (PERF)
       N       (O)
       L       (L)
       ?       (I)
```

---

8 The inserted nasal is the long (or tense) coronal nasal, represented here as “N”.

9 Ó Siadhail notes that /s/ eclipses to [z] in some dialects only. In (19) I ignore palatalization, which does not play a role in eclipsis.
The insertion of a nasal before vowel-initial stems suggests that eclipsis is triggered by an underlyingly nasalized sonorant stop rather than by |L| alone. This interpretation is consistent with diachronic evidence, which shows that the synchronic eclipsis trigger derives from a historical nasal, which occupied the final position of the word preceding the affected word.

The nasalization of voiced stops in (19) suggests that these function as sonorants in Irish, parallel to voiced stops in languages that display syllable nasalization (see §3.2.2). I interpret this to mean that the manner component of a segment such as /b/ consists of a bare sonorant structure. Eclipsis of /b/ involves association of dependent |L| with concomitant effacement of the manner component of the eclipsis trigger, resulting in [m]:

In traditional feature theories, the consonantal changes that are effected by Irish eclipsis can be accounted for in terms of an incremental increase in sonority. According to this interpretation, the least sonorous segment types, i.e. voiceless stops and fricatives, are targeted by the feature [voice]. The more sonorous voiced stops (which, depending on the feature model, are already specified for [voice] or [sonorant]) are targeted by [nasal]. The problem with this type of analysis is that the relation between [voice] and [nasal] is stipulative. In Element-based Dependency, on the other hand, the relation between voicing and nasalization is captured in a straightforward way, since both are represented in terms of one and the same element, i.e. |L|.

Processes in which voiceless stops are voiced and voiced stops are nasalized suggest that the former are obstruents and the latter function sonorants. Another such process can be found in Maukakã, a Manding language spoken in Guinea-Bissau and Ivory Coast. According to the description in Tourville (1991), Maukakã morphemes have four basic shapes. Evidence for this categorization comes among other things from the pattern of suffixation that is displayed by the definite marker /-o/ (cf. Tourville 1991:44-6):
In (21), two independent manifestations of nasality can be observed. The first concerns vowel nasalization, which, as the forms in (21a) and (21b) indicate, is contrastive. The second manifestation of nasality is prosodically conditioned; as the forms in (21c) and (21d) show, stem-final /ŋ/ is realized in case it is followed by a vowel-initial suffix and is deleted in word-final prepausal position. Note that both manifestations of nasality can occur independently, and that underlying vowel nasalization is always phonetically realized.

If a stem ending in /ŋ/ is followed by a consonant-initial morpheme, the underlying presence of /ŋ/ is always signalled in the surface form. The forms in (22) show the effect of /ŋ/ on a following consonant (cf. Tourville 1991:48,59):

(22) a. /səŋ+kawa/ [səŋgawa] ‘stone that surrounds fire’
b. /məŋ+di/ [məndi] ‘not pleasant’
c. /kʊŋ+jie/ [kʊŋjje] ‘head hair’
d. /ɡeŋ+mʊbo/ [ɡɛmʊbo] ‘species of cricket’

Given these surface realizations, the challenge is to determine the precise underlying shape of the stem-final nasal. The fact that it surfaces as [ŋ] when followed by a vowel suggests that it has the following underlying structure:\footnote{I assume that the place specification |A| is underlyingly present, although an analysis in terms of default velar place is also feasible.}

(23) O
   / L   L
   / ?  
   / A

The underlying presence of dependent |L| is important for two reasons. First, it establishes a contrast between a series of voiced oral consonants, /b d ɹ j w h/, and a series of nasals, /m n ŋ n̥/, both of which are distinctive in the language. Second, it permits an elegant interpretation of the nasalization of the oral series after stem-final /ŋ/ in terms of spreading of dependent |L| and concomitant nasal effacement. This is illustrated in (24) for the labial sonorant stop /b/:
The combination of /ŋ/ and a following sonorant stop produces a single nasal that has the place specification of the underlyingly oral consonant. Similar to the nasalization of voiced oral stops in Tucano-type systems, this involves association of dependent [L] to a sonorant stop structure. The difference between the two types of nasalization is that in Tucano-type systems nasalization is a property of the syllable, while in Maukakã it is a property of nasal consonants.

The forms in (22) further indicate that stem-final /ŋ/ triggers voicing of a following voiceless obstruent. In this context, no nasal effacement takes place. The realization of a combination like /ŋ+k/ therefore simply involves spreading of dependent [L] from the nasal to the following stop, as is shown in (25):¹¹

The different effect of /ŋ/ on obstruents and sonorants thus provides support for the dual interpretation of dependent [L] as nasalization and voice.

Further support for a unified treatment of nasalization and voice comes from the inspection of a number of stop assimilation patterns in Sambú, a Chocó language of northern Colombia. Sambú contrasts three types of stops which Loewen (1963), from which all Sambú data below are taken, interprets as fortis, lenis, and voiced. In word-initial position fortis stops are realized as voiceless aspirated, lenis stops as voiceless unaspirated, and voiced stops as voiced. The three stop series show different behaviour when preceded by a nasalized vowel. Here the fortis series is realized with, as Loewen (1963:358) puts it, “the sharp onset and the following release … greatly attenuated”. In the same context the

¹¹ I assume in (24) that the two velar place elements are merged. Observe that other nasal-obstruent combinations involve place assimilation, as is illustrated by the form in (22c).
lenis stops surface as voiced, and the voiced series as nasals. The different realizations of the Sambú stops are summarized in (26):12

(26) \[
\begin{array}{lcccc}
\text{Stop type} & \# & \bar{o} & \bar{\bar{o}} \\
\text{fortis} & [C^\emptyset] & [C\ldots C^0] \\
\text{lenis} & [\pm] & [\bar{\bar{\emptyset}}] \\
\text{voiced} & [\bar{\bar{\emptyset}}] & [N] \\
\end{array}
\]

Since the lenis stops are phonetically voiceless in initial position, it seems appropriate to analyze these as plain stops phonologically; I will refer to this series as “plain” below.

Loewen further notes that a sequence of a nasalized vowel and a following fortis or plain stop is realized with an “epenthetic nasal continuant”. Some examples involving fortis stops are provided in (27) (cf. Loewen 1963:368):

(27) /nɛpʰono/ [nɛmpʰono] ‘flower, blossom’
/âpʰara/ [ãmpʰara] ‘fish sábalo’
/âɐʰi/ [ãɐʰi] ‘up, above’
/ʋə-lɐea/ [wəlɐea] ‘in order to go’
/âkʰau/ [ãkʰau] ‘bench’
/kʰãkʰãi/ [kʰãkʰãi] ‘star, firefly’

Some examples involving plain stops are given in (28) (cf. Loewen 1963:368):

(28) /kʰɛpi/ [kʰɛmbi] ‘nose’
/ hãpa/ [ hãmba] ‘canoe’
/kûra/ [kûndra] ‘youth’
/ jñtra/ [ jôndra] ‘old woman’
/nâku/ [nâŋgu] ‘wind’
/ãkosɔ/ [ãŋgoso] ‘vulture’

It seems reasonable to interpret the emergence of homorganic nasals as a coarticulatory effect rather than as a phonological process of nasal epenthesis. However, according to Loewen it is the phenomenon of nasal epenthesis that indirectly accounts for the nasalization of voiced stops. Some examples of voiced stop nasalization are given in (29); Loewen observes that most examples of this process involve suffixation of the present tense auxiliary /-bi/ to verb stems ending in a nasalized vowel (although he does not provide any examples of such forms):

---

12 This allophonic variation is characteristic of northern Chocó languages and in particular of Northern Epera, the dialect cluster that includes Sambú. Loewen notes that in southern Chocó languages assimilation of stops to nasalized vowels is generally absent.
(29) /hâbâra/ [hâmara] ‘basket’
/îbama/ [îmama] ‘lion’

Loewen (1963:362) offers the following explanation for voiced stop nasalization:

The b=m, d=n and g~[ŋ] variation involves the assimilation of voiced stops to the epenthetic nasal continuant. The result, when completely assimilated, actualizes as a long consonant, or a cluster of identical consonants; however this cluster is often reduced to one mora of length.

This interpretation provides a unified account of the effect of vowel nasalization on a following stop, but it does so at a considerable cost. For instance, Loewen’s account relies on three processes (nasal insertion, stop assimilation, and length reduction), which must be crucially ordered. Moreover, it is doubtful whether Loewen’s nasal epenthesis must be considered a phonological process, rather than a coarticulatory effect. Note in this respect that that the epenthetic nasal that Loewen postulates never occurs on the phonetic surface, and that an account in terms of nasal epenthesis implies an additional process of length reduction. There is no independent evidence for either process.

If, on the other hand, voicing and nasalization are expressed in terms of a single element, e.g. dependent [L], then the Sambú stop alternations can be accounted for in a straightforward fashion. The phonetic characteristics and the phonological behaviour of the Sambú stops suggest that they have the following representations:

(30) a. Fortis b. Plain c. Voiced

On the assumption that nasalized vowels have dependent [L], spreading of this [L] to the dependent position of a plain stop, as in (31a), results in a voiced stop. Spreading of [L] to the dependent position of a sonorant stop, as in (31b), results in a nasal.
The lack of assimilation of fortis stops can be attributed to the fact that these stops have dependent |H|, the presence of which implies that there is no available landing site for dependent |L|.

In this section, I have considered a number of processes in which dependent |L| is realized either as voicing or nasalization, depending on the manner type of the segment to which it is associated. The existence of such processes provides compelling support for the dual interpretation of dependent |L| as voice and nasalization. Note, too, that all processes considered in this section apply at the level of subsegmental constituents, and not at the level of syllables. This is in accordance with the CDR principle as formulated in §3.2.3, which states that dependent |L| has a fixed interpretation of nasalization when it is underlingly associated to a syllable.

### 4.3 Nasal fortition

In this section, I consider a less direct type of support for the dual interpretation of dependent |L| as nasalization and voice. The relevant evidence comes from processes of nasal fortition, the cover term for those phenomena in which nasals shed their vocalic properties and surface as stops, with either complete denasalization (i.e. N > ©) or partial denasalization (i.e. N > NC or N > C©).

To appreciate the support adduced from nasal fortition processes, recall first of all the scenario of nasal lenition that was proposed in §3.3, and is repeated in (32) below:

\[
\text{(32)} \quad \begin{array}{c}
\text{N} \\
\text{O} \\
\text{L} \\
\text{L} \\
\text{?}
\end{array} \quad \begin{array}{c}
\text{N} \\
\text{O} \\
\text{L} \\
\text{L} \\
\text{L} \\
\text{?}
\end{array}
\]

The point to note is that the outcome of nasal lenition is, initially at least, a nasalized approximant. The fact that nasal lenition shows stability of nasalization thus supports a characterization of the process in which the lenition input is specified for dependent |L|. 
According to this line of reasoning, nasal fortition can be interpreted as involving the removal of the element |L| from the nasal manner component, resulting in a voiced obstruent stop. This scenario is illustrated in (33):

(33) \[ \begin{array}{c} \text{O} \\
| \text{L} \text{L} \rangle > ? \text{L} \\
\text{L} \end{array} \]

Two observations can be made regarding (33). First, nasal fortition, like nasal lenition, shows stability of dependent |L|. Second, given that we are dealing with change from a nasalized to a voiced segment type, nasal fortition supports the dual interpretation of dependent |L| as nasalization and voice.

It is important to observe at this point that the Element-based Dependency representation of nasals predicts that (33) is not the only possible type of nasal fortition. Another way in which nasals may shed a vocalic property is through the loss of dependent rather than head |L|. This scenario is illustrated in (34):

(34) \[ \begin{array}{c} \text{O} \\
| \text{L} \text{L} \rangle > \text{L} \\
\text{L} \end{array} \]

(34) involves a change from a nasalized sonorant stop to a plain sonorant stop. As such, this process is effectively the reverse of the process of sonorant nasalization that was discussed in §3.2.2.

In addition, it could be claimed that another type of nasal fortition involves a switch in the dependency relation between the head manner elements |L| and |\text{?}|, changing a nasal into a nasal contour (i.e. N > ^N\text{C} or N > \text{C}^N). This type of nasal fortition is shown in (35):

(35) \[ \begin{array}{c} \text{O} \\
| \text{L} \text{L} \rangle > ? \text{L} \\
\text{L} \end{array} \]

Since the change in (35) involves the promotion of |\text{?}| to dominating manner element, and therefore produces a more consonantal articulation, it qualifies as a type of nasal fortition.

The challenge facing Element-based Dependency is to determine whether the output of a particular nasal fortition process is a voiced obstruent stop, an
inherently voiced sonorant stop, or a nasal contour. Here the problem is that there is no straightforward one-to-one relationship between the phonetic result of nasal fortition and a particular Element-based Dependency representation. For instance, we observed in §3.2.2 that a phonetic entity such as [d] may function as an obstruent in some languages and as a sonorant in others. Similarly, we saw in §3.2.4.3 that the nasal part of a sound such as [d] may or may not be phonologically relevant. Hence, there is more than one way in which the outcome of fortition processes like /g110 > /g100/ and /g110 > /g100/ can be represented.

Below, I consider a number of examples of nasal fortition processes and discuss a number of diagnostics that will help us to determine the status of the denasalized outcome. These include the phonological behaviour of denasalized stops, the phonetic realization of such stops, and typological considerations regarding the organization of consonant inventories. First, in §4.3.1, I consider the status of denasalized segments in languages where nasal fortition has produced a completely nasal-less inventory. Next, in §4.3.2, I discuss some processes of nasal fortition which affect only a subset of nasals. In §4.3.3, I consider some instances of nasal fortition which have resulted in nasal contours.

### 4.3.1 Complete denasalization

In this section, I consider a number of examples of “complete” denasalization, i.e. denasalization processes which have as their outcome completely oral stops. In some languages, a diachronic process of complete denasalization has led to a completely nasal-less inventory. In other languages, complete denasalization has affected—or is affecting—nasals in particular contexts only. Examples of both types of processes will be discussed below.

Consider first the status of denasalized stops in languages which, due to a historical process of denasalization, lack an underlying series of nasals. To put the discussion on a concrete footing, it is useful to reiterate some typological observations regarding nasals. As was noted in §2.2.5, 3% of the languages in UPSID lack phonemic nasals (cf. Maddieson 1984). This concerns just ten languages: Quileute, Puget Sound, Hakka, Apinayé, Barasano, Siriono, Tucano, Kpelle, Rotokas, and Mura (Pirahã). Of these, Apinayé, Barasano, Siriono, Tucano, and Kpelle display complementary distribution between nasals and a series of voiced oral consonants. As was argued in §3.2.2, these languages have a single series of underlying sonorant stops, which surface as nasals if harmonic nasalization is present. According to the argumentation presented in §2.2.5, Rotokas and Pirahã also have a series of underlying sonorant stops. We saw that these stops are generally realized as oral, although they may in some cases surface as nasals. This leaves us with Hakka, Quileute, and Puget Sound.

Maddieson describes Hakka, a Sinitic language, as having an underlying series of prenasalized stops rather than nasals. It is doubtful, however, whether this is correct. According to Hashimoto (1973), Maddieson’s source, syllable-initial nasals in Hakka are realized as slightly denasalized, so that the resulting
sounds can be termed prenasalized stops or, perhaps more appropriately, poststopped nasals. Hashimoto (1973:88) notes that “these parasitic explosive noises … are phonologically non-distinctive”. Syllable-finally, Hakka displays surface variation between prestopped and plain nasals that is conditioned by tone: prestopped nasals occur after short staccato tones and plain nasals after long legato tones. As regards this alternation, Hashimoto (1973:94) observes that

the occlusion between the velum and the pharyngeal wall [i.e. the stop part of prestopped nasals] constitutes the most natural and most economical way of producing short syllables or, in our interpretation, of realizing a staccato (nonlegato) tone, while keeping the point of articulation unchanged.

One possible account of this variation would be to treat syllable-final prestopped nasals as clusters of a nasal and a stop, so that a syllable with a short vowel followed by a stop-nasal cluster would have the same weight as a syllable with a long vowel followed by a nasal. In any case, there appears to be no reason to analyze Hakka as lacking underlying nasals. Indeed, a strong argument in favour of underlying nasals concerns the fact that Hakka has two syllabic nasals, [Ø], the realization of which never contains a stop phase (cf. Hashimoto 1973).

Quileute and Puget Sound, languages which belong to the Salish family, are described by Maddieson as lacking nasality altogether. Quileute and Puget Sound are spoken on the northwest coast of America, where the lack of nasals is an areal feature (see Hockett 1955, Thompson & Thompson 1972). Comparative evidence indicates that the lack of nasals is due to a historical process of denasalization which turned nasals into voiced stops. With respect to Southern Puget Sound for instance, Snyder (1968:10) notes that “[t]he nasal stops [m] and [n] occur in surrounding Salishan dialects and are regularly replaced in this dialect with the stops [b] and [d]”. More generally, a number of Salish languages display evidence of diachronic changes in which sonorants, both nasals and approximants, developed into voiced stops (cf. Thompson & Thompson 1972:448-50).

Denasalization of nasals to voiced stops is a feature of the region stretching from the Washington-British Columbia border area, where it is observed in, for instance, Puget Sound, Quileute, and Twana, to the San Joaquin valley in northern California, where it is observed in the northernmost dialects of Yokuts

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13 Denasalization is typical of a number of Chinese dialects. Partial denasalization is found in southwestern dialects of Mandarin as well as in some dialects of Cantonese. Complete denasalization is found in some Southern Min dialects; here the oral variant of /n/ is often /l/ (cf. Hyman 1975).

14 Tonal conditioning of oral-nasal allophones is also observed in other languages of South-East Asia, such as Ong-Be (cf. Hashimoto 1985).
(see Whistler & Golla 1986, Smith 2002). Smith also notes that some Yokuts dialects exhibit occasional correspondences between nasals and voiceless stops. These stops generally occur in word-final position, where devoicing affects both obstruents and sonorants. Denasalization typically, and in most languages exclusively, produces voiced oral stops.

The effect of denasalization is illustrated in (36), which contains some representative cognate sets from a number of different language families of northwest America (SPu denotes Southern Puget Sound, NPu denotes Northern Puget Sound, and PA denotes Proto-Algonquian):

<table>
<thead>
<tr>
<th>(36) a. Salishan (Newman 1977)</th>
<th>Proto-Salish</th>
<th>Lilloet</th>
<th>SPu</th>
<th>NPu</th>
<th>Twana</th>
</tr>
</thead>
<tbody>
<tr>
<td>*tsaniɬ</td>
<td>s-nil</td>
<td>ìšådel</td>
<td>ìšadíl</td>
<td>ìšadíl</td>
<td>‘he’</td>
</tr>
<tr>
<td>*nimaḷ</td>
<td>s-nimaḷ</td>
<td>dëböl</td>
<td>dëböl</td>
<td>dëböl</td>
<td>‘we’</td>
</tr>
<tr>
<td>b. Chemakuan (Andrade 1953)</td>
<td>Chemakum</td>
<td>Quileute</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>miʔis</td>
<td>baʔjas</td>
<td>‘four’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hamaʔa</td>
<td>habaʔaʔ</td>
<td>‘tree’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hina</td>
<td>hidaʔ</td>
<td>‘father’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Wakashan (Haas 1972)</td>
<td>Nootka</td>
<td>Nitinat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>niq-</td>
<td>dîq-</td>
<td>‘to sew’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mitxʷ-</td>
<td>bitxʷ-</td>
<td>‘to turn around’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>q’imatq-</td>
<td>q’ibitq-</td>
<td>‘whirlpool’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Algonquian (Proulx 1984)</td>
<td>PA</td>
<td>Yokuts</td>
<td>Wiyot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*njiiʃw-</td>
<td>niʔiʃ-</td>
<td>dî-</td>
<td>‘two’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*neeqɬ-</td>
<td>nahks-</td>
<td>dîkh-</td>
<td>‘three’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*mikehsa</td>
<td>mekwət</td>
<td>bukt</td>
<td>‘snail’</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In each of these languages, denasalization has turned nasals into voiced stops.

In terms of Element-based Dependency, there are two conceivable ways in which the above denasalization processes can be represented. The first option, illustrated in (37a), involves the deletion of dependent [L], producing a sonorant stop. The second option, illustrated in (37b), involves the deletion of head [L] producing an obstruent stop:
The decision as to which of these options is appropriate is not always a straightforward affair. As was observed before, the main problem is in this respect that a phonetically voiced oral stop may function as an obstruent or as a sonorant.

From a typological perspective, it is plausible to interpret the denasalized outputs as sonorants in those languages where denasalization has produced a nasal-less consonant system. The reason is that the overwhelming majority of languages has an underlying series of sonorant stops (which is in most cases realized phonetically as nasal). As was argued in §2.2.5, this observation is a strong argument for regarding the voiced stops of Rotokas and Pirahã as sonorants. If these stops were obstruents, then these languages would lack sonorant consonants altogether—this is a typologically highly marked, and presumably universally unattested state of affairs.

Typological considerations might be argued to have a weaker impact in the languages of northwest America that display denasalization. Although denasalization has in some cases led to nasal-less systems, these languages have retained other sonorant segments such as /w/. Indeed, in some Salish languages in which denasalization has occurred, e.g. Lushootseed, there are good grounds to view the denasalized stops as obstruents.

A strong piece of evidence for treating the denasalized stops of Lushootseed as being obstruents comes from glottalization. A number of Salish languages have reduplicative morphology that operates in tandem with glottalization of sonorants. This glottalization may signal the diminutive, as in Shuswap, Squamish, and Twana, the affective, as in Thompson, or the distributive, as in Coeur d’Alene and Lushootseed (see Czaykowska-Higgins & Kinkade 1993). Given that glottalization targets sonorants, it is interesting to find out whether in those languages that have undergone denasalization, the denasalized stops are glottalization targets. Evidence from Lushootseed suggests that this is not the case. As is observed by Hess & Hilbert (1978), the distributive in Lushootseed is signalled by reduplication of the first three segments of the stem. The forms in (38a) show that if the final segment of the reduplicant is /w/, it surfaces as

\[\text{(37) a. } \begin{array}{cc}
L & L > L \\
? & ?
\end{array} \quad \begin{array}{cc}
L & L > ? \\
? & ?
\end{array}\]

15 This is the case in, for instance, Puget Sound and Quileute.

16 Following McCarthy & Prince (1986), it seems more appropriate to define the size of the reduplicant in prosodic terms, e.g. as a bimoraic foot. This accounts for the fact that the reduplicant in /sul’sul’ak/ consists of four segments; if the reduplicant is defined as a bimoraic foot, then the size of the onset is irrelevant.
glottalized. The forms in (38b) show that other segments, including denasalized /b d/, are unaffected:

*(38)*

<table>
<thead>
<tr>
<th>STEM</th>
<th>STEM-DIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>sal?</td>
</tr>
<tr>
<td></td>
<td>stulokw</td>
</tr>
<tr>
<td>b.</td>
<td>saq”</td>
</tr>
<tr>
<td></td>
<td>g”ødil</td>
</tr>
<tr>
<td></td>
<td>jubil</td>
</tr>
</tbody>
</table>

The fact that /b d/ pattern together with obstruents suggests that they are obstruents themselves, and thus have the manner structure in (39):

*(39)*

```
O
↑   L
```

This account provides a straightforward answer to the question why glottalization does not target denasalized stops: the denasalized stops cannot be targets, since the landing site for glottalization is occupied by dependent |L|. With regard to denasalization, the behaviour of denasalized stops suggests therefore that nasal fortition in Lushootseed involved the deletion of head [L] from the nasal manner component, thereby changing the nasal to a voiced obstruent stop.

Another argument for interpreting denasalized stops as obstruents comes from their participation in devoicing phenomena. The fact that a denasalized voiced stop, parallel to obstruents, is subject to devoicing suggests that the stop is itself an obstruent. In this case, the scenario in (40) is appropriate, where stage 1 involves a diachronic process of denasalization to a voiced obstruent stop, and stage 2 a synchronic process in which the voiced stop is devoiced:

*(40)*

```
O   O   O
↑   ↑   |
L   L   >    ?   L   >    ?
↑   |
?   |
```

*Stage 1: denasalization  Stage 2: devoicing*

Observe, however, that the following development is, in principle at least, also possible:
Stage 1: denasalization  Stage 2: devoicing

It is reasonable to suggest, however, that the former development is more appropriate if the denasalized stops pattern together with obstruents in the devoicing process, since in this case the target of devoicing can be formalized in terms of an obstruent manner component.

An example of a Salish language in which denasalized stops are subject to devoicing is the Snoqualmie-Duwamish dialect of Puget Sound. Tweddel (1950:11) notes that in this dialect “a word-final voiced stop may become voiceless when utterance-medial”, and gives the example in (42a). Tweddel further observes that “a word-medial voiced stop may become voiceless in rapid speech”, which he illustrates with the form in (42b) (note here the elision of /ə/):

(42)  a. /xələb-tʃɪl/ [xəlaptʃɪl] ‘we are like (him)’
    b. /tulədəb[ʃɪxʷ]/ [tulapdəptʃɪxʷ] ‘you were seen’

These facts suggest that the denasalized stops in Snoqualmie-Duwamish Puget Sound function as obstruents, and thus consist of stop manner with dependent [L]. General support for an interpretation of the denasalized stops of Salish as being obstruents comes from their phonetic characteristics. Thompson & Thompson (1972:445) observe that

these elements [i.e. the denasalized stops], incidentally, are very much like their English counterparts—lenis, and fully voiced in voiced surroundings, but beginning or ending unvoiced adjacent to voiceless sequences.

Note, finally, that obstruentization of sonorants in Salish is not limited to nasals, but also affects other types of sonorants. For instance, Thompson & Thompson (1972:442) note that the Straits languages, spoken just north of Puget Sound, have undergone a diachronic change in which Proto-Salish *w and *j developed into voiced /ʍ/ and /nı/, which subsequently devoiced to /kʷ/ and /ɾ/. The same type of devoicing can be observed in other Salish languages, such as Coeur d’Alene, Tillamook, and Chemakum.

In other languages of North America which have been affected by denasalization there is evidence to assume that the denasalized stops are still functioning as sonorants. This is the case in most—and perhaps all—Athapaskan languages. As is observed by Krauss & Leer (1981), the Proto-Athapaskan stem-initial nasals *m and *n have been retained in all daughter
languages in case *m and *n were followed by a vowel which was in turn followed by a nasal. However, when *m and *n were followed by a vowel which was in turn followed by an obstruent, the nasals have in some languages developed into voiced or prenasalized stops.\footnote{Examples of Athapaskan languages in which denasalization resulted in voiced stops include Galice, Hare, Tahltan, and Bear Lake Slavey. Languages in which denasalization resulted in prenasalized stops include Han, Southern Slavey, Western Apache, Upper Tanana, and Tanacross (see Krauss & Leer 1981, Rice 1993).}

In those Athapaskan languages which display denasalization to voiced stops, we find a merger of historical nasals with voiced stops on the phonetic level. However, in some of these languages there is evidence that the two types of voiced stops maintain distinct underlying representations. Rice (1993) discusses an illustrative case from Bear Lake Slavey (see also §1.2.2). Bear Lake Slavey has a number of morphologically conditioned processes in which some—but not all—voiced stops alternate with nasals. One such context is found in perfective formation. Two near-minimal pairs are provided in (43). In the forms in (43a) the perfective is signalled by nasalization of the stem vowel and the preceding stop. In the forms in (43b), on the other hand, the perfective is signalled by nasalization of the stem vowel only (cf. Rice 1993:322-3):

\begin{itemize}
  \item (43a) -de ‘win-IMPERF’ -nô ‘win-PERF’
  \item (43b) -da ‘move-IMPERF’ -dô ‘move-PERF’
\end{itemize}

The difference between (43a) and (43b) reflects a difference in the phonological status of the two types of stops. According to Rice, the non-alternating stops are voiced obstruents while the alternating stops, which are historically derived from nasals, are sonorants. This analysis is conceptually similar to the Element-based Dependency interpretation of the Slavey facts. In this account, the perfective morpheme consists of a single element [L], which is linked to the dependent position of a stem vowel and, when present, to a preceding sonorant stop. This is illustrated for the perfective form of /-de/ in (44) (in (44) I ignore place):\footnote{As in §1.2.2, I ignore the change in vowel quality that is triggered by affixation of the perfective morpheme.}

\begin{itemize}
  \item (44) \[
  \begin{array}{c}
  O \\
  | \\
  N \\
  | \\
  L \\
  | \\
  L \\
  | \\
  L \\
  | \\
  \end{array}
  \]
\end{itemize}
The non-alternating stops function as distinctively voiced obstruent stops, and as such are represented in terms of a head manner element [?] and a dependent element [L]. As a consequence, these stops cannot undergo nasalization, so that the perfected marker surfaces as part of the stem vowel only. This scenario is illustrated in (45) (in (45) I ignore place):

(45)  

\[ -/\text{da}/ \rightarrow [\text{dō}] \]

The phonological behaviour of denasalized stops in Bear Lake Slavey strongly suggests that these segments function as sonorants. This suggests in turn that nasal fortition in this language involved the loss of dependent [L], changing nasals into sonorant stops.

The present approach to the Bear Lake Slavey facts is conceptually similar to the SV-based approach proposed by Rice (1993), which I briefly discussed in §1.3.2. According to Rice, the non-alternating instances of /\text{d}/ in Bear Lake Slavey are obstruents and are represented as in (46a). The alternating instances of /\text{d}/ are sonorants and are represented as in (46b):

(46)  

a.  \emph{Obstruent stop}  
\[ \text{RT} \text{stop} \text{RT} \text{place} \]

b.  \emph{Sonorant stop}  
\[ \text{RT} \text{SV} \text{RT} \text{place} \]

On the assumption that the feature [nasal] is a dependent of the SV-node, the nasal-oral alternation can be expressed by spreading of [nasal] from a following nasalized vowel:

(47)  

\[ \text{RT} \text{place} \text{SV} \text{RT} \text{place} \]

\[ [\text{nasal}] \]

Thus, the absence of nasalization in case of a preceding obstruent stop is explained by the absence of an SV-node in the structural description of obstruents.

As compared to the present account, the general problem of the SV-account is that it requires three features—SV, [nasal], and [voice]—while Element-based Dependency requires only one, i.e. [L]. In addition, the SV-account has another weakness, which lies in the relation that is assumed between SV and [nasal].
According to Rice, nasals are normally underspecified for [nasal]; underlyingly, nasals consist of a bare SV-node, which identifies them as sonorants (cf. also Rice & Avery 1989, 1991b). When not otherwise specified in the course of the phonological derivation (for instance by association of [nasal] as the result of nasalization, or by spreading of [lateral]), a universal default rule applies that fills in the feature [nasal]. Rice (1993:313) represents this rule as follows:

(48) \[ SV \]
\[ [\text{nasal}] \]

According to Rice, this rule accounts for the cross-linguistic frequency of nasals; the vast majority of languages have an underlying series of sonorant stops, and in most of these languages these stops will surface as nasals through the application of the nasal default rule.

It should be observed, however, that in languages like Bear Lake Slavey, as well as in Tucano-type systems, it must be stipulated whether the nasal default rule applies. In a language like Southern Barasano the nasal default rule does not apply, since otherwise sonorant stops in oral contexts would surface as nasalized (cf. *[sinè]; see §3.2.2). In Bear Lake Slavey, on the other hand, the default rule does apply, since here some sonorant stops are underlyingly unmarked for the oral-nasal alternation while others surface as nasalized regardless of the context. Examples of the latter type include [dah-n( n)¯] ‘hill, plateau’ and [nàt( n)] ‘(s)he goes’ (cf. Rice 1993:322-3). It would appear, then, that neither the presence nor the behaviour of nasality in a system makes the application of the nasal default rule predictable. This indeterminacy seems unwarranted, and it suggests that the present approach, which assigns a phonetic interpretation to sonorant stops without recourse to a default rule, is more appropriate.

Another language in which phonological diagnostics are available to determine the status of denasalized stops is Zoque. As was noted in §4.1, the existence of a process of postnasal voicing suggests that nasals in Zoque have dependent |L| (see also §3.2.4.2). According to Herrera (1995), Zoque displays a process in which nasals are denasalized to voiceless oral stops word-finally, as in (49a), and to voiced oral stops before voiceless stops, as in (49b). For our purposes, the crucial observation in (49b) is that a voiceless stop following a denasalized stop surfaces as voiced:

(49) a. /kom/ [kop] ‘horcón’ (cf. /kom-omo/ [komomo] ‘en el horcón’)
   /win/ [wit] ‘punta’ (cf. /win-ij-u/ [winiju] ‘tuvo punta’)
   /kañ/ [kak] ‘tigre’ (cf. /kañ-ah-u/ [kañahu] ‘se volvió tigre’)

Herrera observes that this process is not entirely regular, and notes that denasalization can be considered a change in progress.
Taking the devoicing process first, this can be most appropriately stated in terms of the deletion of dependent $|L|$. On the assumption that the targeted stop occupies the coda position, we may interpret devoicing as involving a loss of markedness, in the sense that it produces a non-branching structure. This interpretation implies that denasalization involves the deletion of head $|L|$ from the underlying nasal consonant. This two-step process is illustrated in (50) for the final nasal in /kany/ ‘tigre’:

(50)

\[
\begin{array}{c|c|c}
\text{O} & \text{O} & \text{O} \\
\hline
L & L & ? \\
\hline
? & A & A \\
\hline
A \\
\end{array}
\]

\textit{Stage 1: denasalization} \hspace{1cm} \textit{Stage 2: devoicing}

An analysis of denasalized stops as obstruents is supported by the observation that voiceless stops following denasalized stops are realized as voiced. The fact that voicing in Zoque is triggered by both nasals and denasalized stops suggests that both are specified for dependent $|L|$, and hence that denasalization involves the deletion of head $|L|$. The combination of denasalization and voicing is illustrated in (51) for the nasal-stop cluster in /kaŋ-tam/ ‘tigres’:

(51)

\[
\begin{array}{c|c|c}
\text{C} & \text{O} & \text{O} \\
\hline
(L) & L & ? \\
\hline
? & I & ? \\
\hline
A \\
\end{array}
\]

\[/ŋ-t/ \rightarrow [gd]\]

\footnote{For the purpose of clarity, I have represented denasalization and devoicing as ordered processes; however, I am not claiming that the two processes are ordered in derivational terms.}
Thus, the fact that denasalized stops remain phonologically active, in the sense that they trigger voicing of a following stop, suggests that denasalization in Zoque produces a voiced obstruent stop.

Another diagnostic that can be used to determine the status of a denasalized stop is its phonetic realization. Consider in this light the following facts from Wiyot, an extinct Algic language of northern California. According to Proulx (1984:177), Wiyot displays a surface alternation between nasals and voiced stops, in such a way that “[n] and [n] are found after the first vowel of a word [and] b and d elsewhere”. That denasalization lies at the heart of this alternation becomes evident when we take into account comparative evidence from Proto-Algonquian and Yurok, which represent other branches of the Algic family (the data in (52) are taken from Proulx):

(52) a.  

<table>
<thead>
<tr>
<th>Proto-Algonquian</th>
<th>Wiyot</th>
<th>Yurok</th>
</tr>
</thead>
<tbody>
<tr>
<td>*meseni</td>
<td>b’sad</td>
<td>‘breast’</td>
</tr>
<tr>
<td>*ahîsam</td>
<td>*tsâb</td>
<td>‘give (food) to’</td>
</tr>
<tr>
<td>*mêtî</td>
<td>bɒ̞l</td>
<td>mɒ̞l</td>
</tr>
<tr>
<td>*w’elkanî</td>
<td>wɔtkëd(ât)</td>
<td>‘bone’</td>
</tr>
<tr>
<td>*wètempi</td>
<td>wɔtb(∗t)</td>
<td>‘head’</td>
</tr>
</tbody>
</table>

b. *këmtîl        | k*mar-    | kemol-    | ‘steal’ |
| *pëgëmi:pi       | pûmipəl   | pûmipəl   | ‘stone knife’ |

c. *me’ìsêni,    *me’ìsani | -e’san  | mesen     | ‘breast’ |
| *metkanfsega     | b’tkən    |           | ‘fingermale’ |

d. *pe’mëjei      | pû’m      | pemej     | ‘grease’ |
| *e’mî’i:ka       | a’mîk     | e’mî’i    | ‘pidgeon’ |
| *i’mëli, *i’ëmeri |  i’məl    | imer      | ‘below’  |
| *tî’ëma:ri       | tî’mâ     | tâ’amo    | ‘elderberry’ |
|                   | tî’malat  |           | ‘elderberry bush’ |

The cognate sets in (52a) suggest that Wiyot has undergone denasalization, although as compared with, say, Puget Sound, the process has not resulted in a nasal-less system. As shown in (52b), most instances of Wiyot nasals occur after an initial vowel; however, the forms in (52c) indicate that denasalization has apparently left some nasals unaffected. A reasonable explanation for these exceptions is that at the time the Wiyot data were recorded, denasalization was a change in progress. The forms in (52d) show that regular exceptions to denasalization are those forms in which /m/ is preceded by /?/. Note, however, that we can account for (52b,d) by stating that nasals are found in the onset of the second syllable of a word.21

21 The absence of #ïm and #ïn suggests that these sequences do not form glottalized nasals, but must instead be analyzed as heterosyllabic. Note in this respect that the Wiyot reflexes
The description of Wiyot in Teeter (1964) supports the distributional observations regarding nasals made above. Noting the occurrence of certain “sporadic nasalizations”, Teeter (1964:24,n.2) points out that there are three contexts in which nasalization seems to be regular. First, [m n] are found when “in the formation of verb complexes, stems beginning with /b/ or /d/ … occur directly after a preverb ending in /ə/” (cf. Teeter 1964:24). Some examples are given in (53a). Teeter further observes that suffixation to a stem ending in /d/ triggers nasalization, as is illustrated by the form in (53b); no such nasalization is reported in case of stem-final /b/.

\[(53) \]

\(\begin{align*}
\text{a.} & \quad \text{bāšad} \quad \text{it is dry} & \quad \text{kō mašad} \quad \text{it is not dry} \\
& \quad \text{dākw} \quad \text{it happens} & \quad \text{kō nakw} \quad \text{it doesn’t happen} \\
\text{b.} & \quad \text{tōd} \quad \text{‘father’} & \quad \text{tōnaiʔ} \quad \text{‘his father’}
\end{align*}\)

The lack of relevant data makes it difficult to establish a conditioning factor for this alternation, but it is certainly striking that in each of the forms in (53) the nasal occurs after the first vowel. This may be taken to suggest that /kō-/ which Teeter analyzes as a proclitic, functions as part of the word for the purposes of the nasal-stop alternation.

Teeter observes that the third context in which nasals are found is after a glottal stop. As was noted, this is also what is suggested by the forms in (52c). Teeter provides some additional data which involve prefixation of a [ʔ]-final prefix, as in the forms in (54a,b), and infixation of [ʔ], as in the forms in (54c,d):

\[(54) \]

\(\begin{align*}
\text{a.} & \quad \text{bēl} \quad \text{‘axe’} & \quad \text{dūʔ-mēl} \quad \text{‘my axe’} \\
\text{b.} & \quad \text{dōpl} \quad \text{‘snag’} & \quad \text{kʰuʔ-nōpl} \quad \text{‘your snag’} \\
\text{c.} & \quad \text{tōlīb} \quad \text{‘it lies there’} & \quad \text{tōlīʔn} \quad \text{‘what lies there’} \\
\text{d.} & \quad \text{tōwikəd} \quad \text{‘one seeks it’} & \quad \text{tōwikən} \quad \text{‘what one seeks’}
\end{align*}\)

According to the generalization stated above, the occurrence of the nasals in (54a,b) is expected. However, it is unclear how the emergence of the nasals in (54c), and especially (54d), must be accounted for. Apparently, [ʔ] conditions the presence of a following nasal, regardless of the position in the word.

The alternation that is observed in postglottal context might be taken to suggest that the voiced oral consonants stops are underlying, or that Wiyot has underlying nasals that are retained when following [ʔ]. In either case, it is unclear why [ʔ] should have this effect. Perhaps the presence of nasals in

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22 I have not been able to find any examples of suffixed forms with stem-final /b/ in Teeter’s data, however.

of Proto-Algic glottalized stops have merged with both aspirated and plain stop series (see Proulx 1984). The conditioning factor for these mergers is not entirely clear.
postglottal environment requires an explanation in terms of rhinoglottophilia.\textsuperscript{23} Equally unclear is the question whether the oral stops or the nasals must be considered as underlying in the onset position of the second syllable. If, as the data in (52) appears to indicate, denasalization was a change in progress, then the second onset of words might be regarded as the last context in which nasals occurred regularly. This might in turn suggest that nasals are still underlying synchronically, and that they denasalize to voiced stops in all other contexts.

Given the absence of a clear conditioning context, the most compelling diagnostic to determine the status of the voiced consonants is their phonetic realization. As is noted by Teeter, [b] is realized as a voiced bilabial fricative with weak frication and [d] as an apico-alveolar voiced flap. Teeter (1964:14) further observes that

\[
\text{[i]Initially the former is in free alternation with } /m/, \text{ and in this position the phonetic realization varies over the whole gamut between the two sounds.}
\]

I take this to mean that the phonetic realization varies between \[m\, w\, Û\, β\, $\, ^{m}b\] and, presumably, [b]. Each of these realizations is a plausible interpretation of a labial sonorant stop:

\begin{equation}
\begin{array}{c}
\text{O} \\
\text{L} \\
? \\
\text{U}
\end{array}
\end{equation}

\[\text{[m-w-Û-β-$^{m}$b-b]}\]

According to this interpretation, the various realizations of (55) share the property of spontaneous voicing, as is expressed by the dominating element [L]. The presence of dominated [?] implies a reduction of periodicity. This reduction is effected by a closer labial constriction, but the extent of this constriction is not such that the segment loses its sonorant status. According to the tentative scenario suggested above, sonorant stops are synchronically derived from nasals. This implies that nasals are specified in terms of a sonorant stop with a dependent element [L]. Denasalization can then be formalized in terms of the deletion of this [L], a process that occurs in all contexts apart from the second onset position of words, and following [?].

\textsuperscript{23} According to this interpretation, the nasalizing influence that is exerted by [?] would condition a following nasal allophone. I consider some processes of this type in §6.2.
To conclude this section, I consider a process of denasalization that is displayed by Acehnese, an Austronesian language of northern Sumatra. Durie (1985:19) gives the following underlying consonant inventory for Acehnese:24

\[
\begin{array}{cccccc}
\text{p} & \text{t} & \text{c} & \text{k} & \text{ʔ} \\
\text{b} & \text{d} & \text{ɡ} & \text{ɡ} \\
\text{m} & \text{n} & \text{ɲ} & \text{ɲ} \\
\text{m} & \text{n} & \text{ɲ} & \text{ɲ} \\
\text{w} & \text{j} \\
\end{array}
\]

What makes Acehnese typologically interesting is that it has a series of nasals in addition to a plain nasal series. The status of these nasals, transcribed as /m^b n^d ɲ/ in (56), is a matter of some controversy. Durie, who terms them “funny” nasals, notes that these nasals are characterized by a longer duration and a lesser rate of airflow. This last aspect has led Catford (1977) to suggest that the “funny” nasals involve a lesser degree of velopharyngeal opening than plain nasals. If correct, Acehnese provides evidence for a phonological distinction between two degrees of nasalization, or, in Catford’s terms, between “light” and “heavy” nasals. Essentially the same contrast in nasals can be found in Rejang, an Austronesian language of southern Sumatra (cf. Coady & McGinn 1982; see also McGinn 1979).

This interpretation is challenged by Ladefoged & Maddieson (1996:104-6). They note that, apart from a longer duration, the “funny” nasals involve raising of the velum during the oral closure phase. Velic raising results in a decline of nasal airflow and, concomitant with this, an increase in intra-oral air pressure. Given that there is no appreciable nasal airflow at the time of oral release, Ladefoged & Maddieson term the “funny” nasals “orally released nasals”, and transcribe these in terms of a nasal followed by a superscript homorganic stop, i.e. [n^C]. I adopt this convention here.

The phonetic difference between plain and “funny” nasals is mirrored by a difference in their phonological behaviour. Durie (1985:22) observes that when the initial consonant of a penultimate syllable is a plain nasal, nasalization spreads through following vowels, laryngeals, glides, and liquids in case there is

24 The segments which Durie transcribes as palatal stops appear to be coronal affricates phonetically. This can be surmised from Durie’s (1985:22) remark that “the palatal stop /c/ patterns as homo-organic with the dental nasal [n]”.

no intervening morpheme boundary. Some examples of this process are given in (57a); the forms in (57b) show that funny nasals do not trigger nasalization:

(57)  a.  maŋû ‘rose’   b.  mûñ ‘dew’  
mû ñ ‘expensive’  ñram ‘angry’

The same contrast can be observed in the near-minimal pair provided by Ladefoged & Maddieson (1996:104-5). Their acoustic measurements show that the final vowel in the form in (58a) is nasalized while the final vowel in the form in (58b) is oral:

(58)  a.  tcam ‘sea-mew’  b.  ham’a ‘servant’

The nasalizing effect of plain nasals suggests that these consist of a nasalized sonorant stop structure with dependent |L|; given the appropriate context, this dependent |L| spreads rightwards, nasalizing following vowels, laryngeals, glides, and liquids. But how should the “funny” nasals be represented? Since these do not trigger nasalization, a reasonable hypothesis is that these nasals consist of a bare sonorant stop structure:

(59)  a.  Plain nasals  “Funny” nasals

There are a number of problems with this approach, however. First of all, the “funny” nasals of Acehnese are typologically highly marked. This fact is not reflected in their representation, which is less complex than that of the typologically unmarked plain nasals. Second, and more specifically, there is language-internal evidence against (59b). Durie observes that some Acehnese dialects have an optional process of denasalization which turns underlyingly plain nasals into voiced stops. This process is conditioned by the presence of a plain nasal within the same syllable. Some examples are given in (60):

(60)  /mandrêt ~ bandrêt/  ‘type of spicy drink’  
    /punjampoh ~ puñampoh/  ‘broom’  
    /lan ~ nan/  ‘clitic relative clause marker’

25 Ladefoged & Maddieson’s transcription [ʨ] (a voiceless alveo-palatal affricate) appears to be the phonetic realization of what Durie analyzes as the phoneme /t/ (see also n.24).
According to Durie, it is not always possible to tell whether the nasal or the oral form is underlying synchronically, although diachronic evidence generally shows that the nasal form is basic. For this reason, the process can be interpreted as denasalization.

Durie transcribes the denasalized forms in (60) as containing an oral stop followed by an oral vowel, which suggests that denasalization also removes the nasalization of the following vowel. This suggests that the denasalized form lacks dependent [L], which in the corresponding nasal form is shared by the initial nasal and the following vowel. This is illustrated in (61) for the initial two segments of /mandrët ~ bandrët/:

\[
\begin{array}{c|c}
\text{Nasal form} & \text{Denasalized form} \\
\hline
\text{O} & \text{O} \\
\text{N} & \text{N} \\
\text{L} & \text{L} \\
\text{L} & \text{L} \\
\text{?} & \text{?} \\
\text{A} & \text{A} \\
\text{U} & \text{U} \\
\text{m} & \text{ā} \\
\text{ã} & \text{b} \\
\text{a} & \text{a} \\
\end{array}
\]

Thus, denasalization in Acehnese receives a straightforward interpretation in terms of delinking of dependent [L] from a sonorant stop structure. Note, however, that this account implies that an alternative interpretation is required for the “funny” nasals. In view of this, I suggest that a representation of these nasals in terms of a dependent element [ʔ] is more appropriate:

\[
\begin{array}{c}
\text{“Funny” nasals} \\
\text{O} \\
\text{L} \\
\text{?} \\
\end{array}
\]

There are a number of arguments in favour of this representation. First, it captures the observation that “funny” nasals do not trigger nasalization. Second, it is in line with the poststopped character of the nasals involved; we may think of dependent [ʔ] as being interpreted as a brief homorganic oral stop that coincides with the nasal’s oral release.\textsuperscript{26} The third argument for (62) is historical

\textsuperscript{26} In chapter 5 we will see that another interpretation of (62) is that of a glottalized nasal. This freedom of interpretation is warranted since there are, as far as I am aware at least, no languages which contrast a series of “funny” nasals with a series of glottalized nasals. It is
in nature. Comparative evidence suggests that the “funny” nasals of Acehnese derive historically from NC-clusters (see Durie 1985; cf. also Coady & McGinn 1982 with regard to Rejang). Note that the diachronic history of the “funny” nasals is still visible in their internal structure, in the sense that (62) consists of a sonorant stop with dependent stop manner. A final, and general, argument in favour of (62) is that it offers an account of the “funny” nasals that is not based on the rate of nasal airflow. It thus supports the claim, made by Ladefoged & Maddieson (1996:106), that “no linguistically distinctive use is made of nasals which differ in manner of articulation of the velum”.

In this section, I have examined a number of denasalization processes. The facts that were encountered suggest that in those cases in which the outcome of denasalization is a voiced oral stop, languages may differ as to whether these stops function as sonorants or as obstruents. A number of diagnostics can be used to determine the phonological status of the denasalized outcome. These include typological considerations, phonetic evidence, and, most importantly, the phonological behaviour of the denasalized stop. If a denasalized stop shows class behaviour with obstruents, for instance because, like obstruents, it fails to undergo glottalization, denasalization involves the loss of [L] from the nasal manner component. This is the case in Lushootseed. In other languages, the behaviour of denasalized stops is characteristic of sonorants. Examples of such languages include Bear Lake Slavey and Acehnese, where denasalized stops still display alternations with the nasals from which they are historically derived. This suggests that denasalization in these languages involved deletion of dependent [L], thereby changing the nasals into inherently voiced sonorant stops.

### 4.3.2 Partial denasalization

In this section, I consider a number of examples of processes in which nasals are denasalized to nasal contours. Given that the outcome of denasalization in these cases still contains a nasal part, we can refer to this type of process as “partial” denasalization. Examples of partial denasalization can be observed in a number of language families, including Austronesian, Austro-Asiatic, Pama-Nyungan, and Macro-Cie (see Blust 1997 for an overview). Here I briefly focus on the pattern of partial denasalization that is found in a number of Austronesian and

---

27 The change from an NC-cluster to a “funny” nasal therefore included, among other things, transfer of the stop’s place specification to the preceding nasal, and incorporation of the stop’s manner component into the dependent component of the nasal.
Australian languages, and which is referred to by Blust as nasal “prestopping”. Nasal prestopping is a process in which a nasal develops a brief homorganic stop phase which precedes the nasal phase, i.e. $N \rightarrow ^{\prime} N$. Blust observes that languages may differ as to whether this stop phase is voiced or voiceless.

Prestopping is a trait of a number of Pama-Nyungan languages. It can be observed, for instance, in some languages of Central Australia, particularly Arandic (see e.g. Koch 2001), as well as in a number of Cape York languages such as Oykagand, a Kunjen dialect (see Sommer 1969). Comparative evidence shows that denasalization affected historically intervocalic nasals that followed an oral consonant in the preceding syllable. Consider the following forms from Oykagand, together with their reconstructed Proto-Paman roots (cf. Sommer 1969:54-5):

\[
\begin{align*}
(63) & \\
\text{Oykagand} & \quad \text{Proto-Paman} \\
\text{abm} & \rightarrow *pama \quad \text{‘person’} \\
\text{ubman} & \rightarrow *kuman \quad \text{‘thigh’} \\
\text{ugŋ} & \rightarrow *puŋa \quad \text{‘sun’} \\
\text{eŋŋal} & \rightarrow *waŋal \quad \text{‘boomerang’} \\
\text{udna-} & \rightarrow *wuna \quad \text{‘lie down’}
\end{align*}
\]

Prestopping is crucially conditioned by the presence of a preceding word-initial non-nasal consonant. The forms in (64) indicate that intervocalic nasals that follow a historically word-initial nasal are generally retained.\(^{28}\)

\[
\begin{align*}
(64) & \\
\text{Oykagand} & \quad \text{Proto-Paman} \\
\text{amâŋ̂ŋ̂} & \rightarrow *ŋ̂a/m/u \quad \text{‘mother’} \\
\text{anur} & \rightarrow *ŋ̂a/amur \quad \text{‘armpit’} \\
\text{anen} & \rightarrow *ŋ̂a/ani/a \quad \text{‘what’}
\end{align*}
\]

Observe in (64) the loss of Proto-Paman vowel length and the loss of the initial consonant. The latter process is part of a more general process of “initial dropping”, which has affected different Paman languages in different degrees.

I interpret the Oykagand forms in (64) to mean that Proto-Paman displayed a process of progressive nasalization which was initiated by initial nasals. The nasalizing effect of these nasals “protected” a following nasal from undergoing prestopping. This protection can be formalized on the assumption that the surface representation of a word such as *ŋ̂ama/u involved multiple-linking of dependent $L$, as shown in (65):

\[
\text{\ldots}
\]

\[^{28}\text{Note the qualification “generally”; the Oykangand data in Sommer (1969) contain some instances of nasals that were apparently preceded by a nasal in Proto-Paman.}\]
The scenario in (65) suggests that Proto-Paman nasals were specified for dependent |L|. Given this scenario, I suggest that nasal prestopping involved the removal of dependent |L|, as is shown in (66). The outcome of this process is a sonorant stop, which is phonetically interpreted as a prestopped nasal:

(66)  
```
  O
  L  L > L
  ?   ?
  *N > [C^N]
```

Nasal prestopping applied to nasals in intervocalic context, presumably because such nasals occupy a weak prosodic position in which segmental complexity—as formalized in terms of a branching structure—was disfavoured. The only nasals which escaped partial denasalization were those which were preceded by a word-initial nasal. These word-initial nasals did not occur in a prestopping context, and thus retained dependent |L|. The rightward spreading of this |L| ensured that a following intervocalic nasal, although in prestopping context, failed to undergo partial denasalization.

While prestopping of intervocalic nasals appears to be fairly regular; the situation is less clear regarding nasals in nasal-stop clusters. While the forms in (67a,b) show the expected pattern, the forms in (67c) show that not all nasals underwent prestopping in prestopping contexts (cf. Sommer 1969:55):

(67)  
<table>
<thead>
<tr>
<th>Okagand</th>
<th>Proto-Paman</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ambul</td>
<td>*ŋampul ‘we-INCL-ERG’</td>
</tr>
<tr>
<td>ungul</td>
<td>*ŋunjku ‘there’</td>
</tr>
<tr>
<td>b. udng</td>
<td>*kunka ‘alive’</td>
</tr>
<tr>
<td>egŋgare</td>
<td>*tunjkar ‘laugh’</td>
</tr>
</tbody>
</table>

29 The relevant position can be equated with that of the foot-internal onset. Harris (1997) discusses a number of processes which suggest that this position permits only a subset of the segmental contrasts that are permitted by the foot-initial onset position.
The prestopping context in the forms in (67c) can be identified as the coda position; note, however, that prestopping occurred in some forms, but not in others. Perhaps the irregular occurrence of prestopping in this context is the result of the loss of the conditioning factor due to the process of initial dropping. This would suggest that initial dropping and nasal prestopping were partly overlapping sound changes.

The nasal prestopping context in Austronesian is similar to that observed in Pama-Nyungan. Nasal prestopping in Austronesian generally affects word-final nasals which are preceded by non-nasal(ized) consonant in the same syllable. Prestopping of final nasals is characteristic of a number of languages of Borneo, including Selako, Bonggi, and Kelabit (cf. Blust 1997, Adelaar 1992). Consider in (68) a number of cognates from Malay and Selako, together with their reconstructed Proto-Malayic forms (cf. Adelaar 1992:386-7):

(68)  

<table>
<thead>
<tr>
<th>Proto-Malayic</th>
<th>Malay</th>
<th>Salako</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. hasam</td>
<td>(m)-jasam</td>
<td>asâpm ‘acid (Malay), sour fruit’</td>
</tr>
<tr>
<td>jalan</td>
<td>jalan</td>
<td>ba-jåâtn ‘go, walk, road (Malay)’</td>
</tr>
<tr>
<td>b. anâm</td>
<td>anam</td>
<td>anâm ‘six’</td>
</tr>
<tr>
<td>anîn</td>
<td>anîn</td>
<td>anîn ‘wind’</td>
</tr>
<tr>
<td>känîn</td>
<td>känîn</td>
<td>känîn ‘forehead, eyebrow (Malay)’</td>
</tr>
</tbody>
</table>

The forms in (68a) illustrate that nasal-final forms in Malay correspond to prestopped nasals in Salako. The Proto-Malayic forms suggest that this is an innovation of Salako. The forms in (68b) show that Salako has retained the final nasals of Proto-Malayic in case they are preceded by another nasal.

As Blust observes, nasal prestopping of the kind in (68a) is sometimes accounted for in “teleological” terms, in the sense that the nasal develops a homorganic stop to protect the orality of the preceding vowel. This scenario is rather questionable, however. First, it begs the question why prestopping only occurs in word-final context. Second, it is unclear why prestopping of a final nasal would protect the orality of the preceding vowel, since nasalization in Austronesian is generally progressive.

As an alternative, I suggest that the prestopping of nasals in Austronesian is prosodically conditioned, similar to what I proposed with regard to Oykagand. The fact that all Austronesian languages with nasal prestopping also appear to display progressive nasalization may be taken to suggest that nasals in such languages are specified for dependent [L]. On this assumption, nasal prestopping can be expressed in terms of the deletion of dependent [L]:

\[
\begin{align*}
\text{c. } \text{aŋk} & \quad < \quad ^*\text{kaŋk} \quad \text{‘leaf’} \\
\text{uŋk} & \quad < \quad ^*\text{muŋk} \quad \text{‘cook’}
\end{align*}
\]
As in Oykagand, the resulting structure—a “bare” sonorant stop—is realized phonetically as a prestopped nasal. The context in which prestopping takes place is that of a word-final consonant. This context can be considered a prosodically weak position, which can be formalized by equating it with a coda, or with an onset of a final empty-headed syllable. Compare in this light prestopping in Salako with other “coda effects” such as devoicing in Dutch and deaspiration in Icelandic. What unifies these processes is that they can all be analyzed in terms of the deletion of a dependent manner component, resulting in a less marked structure.

On a final point, it should be observed that some Austronesian languages for which historical prestopped nasals can be reconstructed have undergone a subsequent change in which the prestopped nasals developed to voiceless stops (i.e. \( \overset{[-N]}{CN} \)). As we saw in §2.5.2, Roglai is an example of such a language. Consider once more some examples of Roglai forms, together with their reconstructed Proto-Chamic forms:

(70)  

<table>
<thead>
<tr>
<th>Proto-Chamic</th>
<th>Roglai</th>
</tr>
</thead>
<tbody>
<tr>
<td>*masam</td>
<td>masap</td>
</tr>
<tr>
<td>*siaːm</td>
<td>siaːp</td>
</tr>
<tr>
<td>*maduɔn</td>
<td>maduat</td>
</tr>
<tr>
<td>*ikaŋ</td>
<td>?ikaːt</td>
</tr>
<tr>
<td>*baŋ</td>
<td>bak</td>
</tr>
<tr>
<td>*daŋ</td>
<td>dak</td>
</tr>
</tbody>
</table>

I suggest that the development from Proto-Chamic to Roglai involved two changes. The first change involved prestopping of nasals in the context of a preceding non-nasal consonant, similar to what I suggested for Salako above. The result of this development was a sonorant stop, which was phonetically realized as a prestopped nasal. The second change involved devoicing of the sonorant stop. This change can be expressed in terms of the loss of the manner element \([L]\), thus changing the sonorant stop to a voiceless obstruent.

The cases of partial denasalization that I have considered so far do not provide any evidence for the retention of dependent \([L]\) in the derived contours. Evidence for the retention of dependent \([L]\) would come, for instance, from a language in which these contours would trigger progressive nasalization. To the best of my knowledge, there are no examples of Pama-Nyungan or Austronesian languages in which denasalized nasals trigger nasalization, however. This
observation may suggest that all instances of partial denasalization involve the removal of dependent \( [L] \). There is, however, evidence of another kind that suggests that at least some processes of partial denasalization require another interpretation.

As is observed by Campbell (1998), Nootka and Nitinat, two Wakashan languages of northwestern Canada, have undergone a denasalization process in which nasals were changed into voiced oral stops. In addition, Nootka and Nitinat underwent a parallel development in which glottalized nasals developed into voiced glottalized oral stops. Given the assumption that glottalized nasals consist of a sonorant stop with dependent \( /[\text{g}]\) (see §5.3), the latter development can be interpreted in terms of a switch in the dominance relation between \( [L] \) and \( /[\text{g}]\). This scenario is illustrated in (71):

\[
(71)
\begin{array}{c}
O \\
\downarrow [L] \quad > \\
\downarrow [\text{g}] \\
U
\end{array}
\begin{array}{c}
O \\
\downarrow [\text{g}] \\
\downarrow L \\
U
\end{array}
\]

Note that this type of denasalization can only be expressed in terms of a switch in the dominance relation between \( [L] \) and \( /[\text{g}]\), since the presence of glottalization (as expressed in terms of dependent \( /[\text{g}]\)) occupies the dependent position.

### 4.4 Summary

In this chapter, I have examined the dual interpretation of dependent \( [L] \) as voice and nasalization. Support for this dual interpretation comes from a number of related types of processes. First of all, inspection of postnasal voicing processes suggests that the triggering nasals function as nasalized sonorant stops; these nasals spread nasalization, as expressed by dependent \( [L] \), to a following stop, where it is interpreted as voice. Second, processes in which obstruents are voiced and sonorants are nasalized suggest that voicing and nasalization are represented in terms of a single element, formalized as dependent \( [L] \). The third type of support for the dual interpretation of dependent \( [L] \) comes from processes of nasal fortition. The fact that the outcome of such processes is either a distinctively voiced obstruent stop or a spontaneously voiced sonorant stop supports an interpretation of the targeted nasals as nasalized sonorant stops, i.e. as sonorant stops with a dependent element \( [L] \).
5 Laryngeally modified nasals

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.\footnote{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%.

UPSID distinguishes three types of laryngeally modified nasals: voiceless, laryngealized, and breathy voiced nasals. Based on this categorization, (1)
provides an overview of languages that have distinctive laryngeally modified nasals (data from Maddieson 1984 and Ladefoged & Maddieson 1996):²

(1)  

<table>
<thead>
<tr>
<th>Language</th>
<th>Vcd</th>
<th>Vcls</th>
<th>Lar</th>
<th>BrVoil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sui</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Sedang</td>
<td>✓</td>
<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>!Xû</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>
</tr>
<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>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<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) Vcd denotes “voiced”, Vcls “voiceless”, Lar “laryngealized”, and BrVoil “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 !Xû. 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, !Xû 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):

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

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. \([?], [H]\), 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 \([?], [H]\), 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).
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:

\[
\begin{array}{|c|c|c|c|c|c|c|}
\hline
\text{Segment type} & \text{Glott} & \text{Impl} & \text{Asp} & \text{BrVoi} & \text{Voi} & \text{Nas} \\
\hline
|\text{[-]-headed} (\text{stops}) & \checkmark & \checkmark & \checkmark & \checkmark & \checkmark & * \\
|\text{[H]-headed} (\text{fricatives}) & \checkmark & * & \checkmark & * & \checkmark & * \\
|\text{[L]-headed} (\text{sonorants}) & \checkmark & * & \checkmark & * & \checkmark & \checkmark \\
\hline
\end{array}
\]

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):

\[
\begin{array}{ccc}
\text{(5a) } & \text{(5b) } & \text{(5c) } & \text{(5d) }\\
\text{[L]} & \text{[L]} & \text{[L]} & \text{[L]} \\
\text{?} & \text{?} & \text{?} & \text{?} \\
\text{U} & \text{U} & \text{U} & \text{U} \\
/m/ & /m/ & /m'/ & /m'/ \\
\end{array}
\]

(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. A labial nasal with a dependent element |H|, as in (5d), denotes an

---

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

---

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].\(^7\) As regards this feature, Halle & Stevens (1971:201-2) observe that

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

Thus, segments that are realized with vocal fold abduction may or may not be voiceless. This suggests that a specification in terms of [–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 ([|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 [H].\(^8\) Consider once more the Element-based Dependency representation of a labial aspirated nasal /m\(\text{b}^1\)/, together with some possible phonetic realizations:

\begin{equation}
(6)
\begin{array}{c}
\text{O} \\
\text{L} \\
\text{?} \\
\text{U}
\end{array}
\begin{array}{c}
\text{H}
\end{array}
\end{equation}

[\text{[\&m, m\&E, hm, mh, mf, 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

\(^7\) Halle & Stevens consider only vowels and glides; however, their observations appear to be equally amenable to other types of sonorants.

\(^8\) Given the range of phonetic variation of (6), the term “[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.
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.9

(7)  
\[ \begin{array}{c|c|c|c|c|c|c} 
O & O & \rightarrow & ? & \rightarrow & U \\
\hline 
\end{array} \]

/N/ → [±]

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.10 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

---

9 Essentially the same point is made by Humbert (1995:92).
10 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.
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) Kawa Samtao
    hm órg Æh orphan ‘hear’
    hnam Æhám ‘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 [bʰ]. 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”:

(9)

<table>
<thead>
<tr>
<th></th>
<th>Miao A</th>
<th>Miao B</th>
<th>Miao C</th>
</tr>
</thead>
<tbody>
<tr>
<td>m</td>
<td>/Eh</td>
<td>m</td>
<td>m</td>
</tr>
<tr>
<td>mj, mz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>Øh</td>
<td>n</td>
<td>n</td>
</tr>
<tr>
<td>η</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nη</td>
<td>!h</td>
<td>n !h</td>
<td>!h</td>
</tr>
<tr>
<td>η</td>
<td></td>
<td>η</td>
<td>η</td>
</tr>
<tr>
<td>ηw</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 n/. 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 [mη] with a nasal that is realized as [E], 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):

(10)

<table>
<thead>
<tr>
<th></th>
<th>Onset</th>
<th>Coda</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comaltepec Chinantec</td>
<td>/mʰ/</td>
<td>[Æm]</td>
</tr>
<tr>
<td>Klamath</td>
<td>/mʰ/</td>
<td>[vÆ]</td>
</tr>
</tbody>
</table>

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. /mʰ/.

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. */Æ~/~`). 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 intervocically:

(11)

<table>
<thead>
<tr>
<th>Modal voice</th>
<th>Breathy voice</th>
</tr>
</thead>
<tbody>
<tr>
<td>kumar ‘boy’</td>
<td>ku’ar ‘potter’</td>
</tr>
<tr>
<td>sunar ‘goldsmith’</td>
<td>ɗ intéressant auai ‘moonlight’</td>
</tr>
</tbody>
</table>

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 /l/; whether or not /r/ 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 /ɗ intéressant auai/ is obsolete and has become /ɗ getIntérêt auai/ 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

\[
\begin{align*}
\text{(12)} & \quad \text{a. Modal voice} & \text{b. “Breathy voice”} \\
& \text{O} & \text{O} \\
& \text{L} & \text{L H} \\
& ? & ? \\
& \text{U} & \text{U} \\
\text{/m/} & \text{/m\textsuperscript{b}/}
\end{align*}
\]

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:

\[
\begin{align*}
\text{(13)} & \quad \text{plain} & \text{voiced} & \text{aspirated} & \text{breathy voiced} \\
& /p\text{al}/ & /b\text{al}/ & /p\text{h\textsuperscript{al}}/ & /b\text{h\textsuperscript{al}}/ \\
& \text{“take care of”} & \text{“hair”} & \text{“knife blade”} & \text{“forehead”}
\end{align*}
\]

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 |L|; the voiceless aspirated stop in (14c) has dependent |H|; the breathy voiced stop in (14d) also has dependent |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 obstruent 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 obstruent 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.\footnote{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.}

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...
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):

\[
\begin{array}{llll}
\text{Proto-Aleut} & \text{Atkan Aleut} & \text{Attuan Aleut} \\
*ag̮asix & ag̮asix & hamasix & \text{‘to ask’} \\
*ag̮ik & ag̮ik & hanis̱ & \text{‘lake’} \\
*g̮uli: & g̮uli: & huji: & \text{‘his sister’} \\
\end{array}
\]

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:

\[
\begin{array}{ll}
a. \ [k̄a:jik \sim hɔk̄a:jik] & \text{‘moon’} \\
\ [īt̄a:w \sim hɔt̄a:w] & \text{‘gourd’} \\
\end{array}
\]

\[
\begin{array}{ll}
b. \ [Ēap \sim hɔm̄ap] & \text{‘throw (away from speaker)’} \\
\ [āya \sim hɔl̄aːya] & \text{‘reed, cane’} \\
\end{array}
\]

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 Pilieni, a language of the Solomon Islands. According to the description in Naess (2000), Pilieni 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:

(17) /tama-ana/ [tamana ~ m[^a]ana] ‘his/her father’
     /ma-na/ [mana] ‘for him/her’

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

(18)

<table>
<thead>
<tr>
<th></th>
<th>DUAL</th>
<th>PLURAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tokelauan</td>
<td>Pilieni</td>
</tr>
<tr>
<td></td>
<td>Tokelauan</td>
<td>Pilieni</td>
</tr>
<tr>
<td>1ST-INCL</td>
<td>ki taua</td>
<td>t[^a]aua</td>
</tr>
<tr>
<td></td>
<td>ki tautou</td>
<td>t[^a]tou</td>
</tr>
<tr>
<td>1ST-EXCL</td>
<td>ki maua</td>
<td>m[^a]aua</td>
</tr>
<tr>
<td></td>
<td>ki matou</td>
<td>m[^a]tou</td>
</tr>
<tr>
<td>2ND</td>
<td>ki koula</td>
<td>k[^o]oulua</td>
</tr>
<tr>
<td></td>
<td>ki koutou</td>
<td>k[^o]tou</td>
</tr>
<tr>
<td>3RD</td>
<td>ki laua</td>
<td>l[^a]ua</td>
</tr>
<tr>
<td></td>
<td>ki latou</td>
<td>l[^a]tou</td>
</tr>
</tbody>
</table>

In both Tokelauan and Pilieni, dual and plural possessive pronouns have the same form as personal pronouns. In Tokelauan, possessive pronouns occur without ki; in Pilieni, 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 Pilieni, in the pronoun system at least, aspiration is underlingly 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 Except the 2ND-POSS personal pronouns, which in their possessive forms lack the initial velar stop.

19 Burmese also has initial voiced stops, but these are generally restricted to nouns.
(19)  

<table>
<thead>
<tr>
<th>Simplex forms</th>
<th>Causative forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>/pau/ ‘be pierced’</td>
<td>/pʰau/ ‘pierce’</td>
</tr>
<tr>
<td>/cɛʔ/ ‘be cooked’</td>
<td>/cʰɛʔ/ ‘cook’</td>
</tr>
<tr>
<td>/kwâ/ ‘peel off’</td>
<td>/kʰwâ/ ‘separate’</td>
</tr>
<tr>
<td>/mjí/ ‘be floating’</td>
<td>/Ejí/ ‘set afloat’</td>
</tr>
<tr>
<td>/n̥u/ ‘be awake’</td>
<td>/ʔu/ ‘waken’</td>
</tr>
<tr>
<td>/l̥ʔ/ ‘be bare’</td>
<td>/’ʔʔ/ ‘uncover’</td>
</tr>
</tbody>
</table>

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-POS 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 [m ŋ ŋ]. Some examples of nasal mutation are given in (20) (cf. Jones 1984:41):

(20)  

| a.  | /an + bərn/   | /əm mərn/ | ‘my opinion’          |
|     | /an + dəm/   | /ən nərn/ | ‘my price’            |
|     | /an + gair/  | /ən ɲəir/ | ‘my word’             |
| b.  | /an + pʰən/  | /ən ɛn/   | ‘my head’             |
|     | /an + tʰəd/  | /ən ʔəd/  | ‘my father’           |
|     | /an + kʰət/  | /ən l ət/ | ‘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 [kˈjuː] and cry [kˈri] (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:

\[(22)\quad \begin{array}{cccccccc}
\text{O'} & \text{O} & \text{H} \\
\text{U} & \text{L} & \text{I} \\
\end{array}\]

\[
no_{(+)} \rightarrow [\text{NN}_{h}]
\]
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>Plosive</th>
<th>Plain</th>
<th>Aspirated</th>
</tr>
</thead>
<tbody>
<tr>
<td>banna [pʰanːa]</td>
<td>‘to forbid’</td>
<td>panna [pʰaːna] ‘pan’</td>
</tr>
<tr>
<td>dala [taːla]</td>
<td>‘valley-GEN-PL’</td>
<td>tala [tʰaːla] ‘to talk’</td>
</tr>
<tr>
<td>gala [kaːla]</td>
<td>‘crow’</td>
<td>kala [kʰaːla] ‘to freeze’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sonorant</th>
<th>Plain</th>
<th>Aspirated</th>
</tr>
</thead>
<tbody>
<tr>
<td>né [nːeː]</td>
<td>‘either’</td>
<td>hné [ʊːː] ‘knee’</td>
</tr>
<tr>
<td>ljóð [ljoʊːð]</td>
<td>‘poem’</td>
<td>hljóð [ʰjoʊːð] ‘sound’</td>
</tr>
<tr>
<td>rós [rouːs]</td>
<td>‘rose’</td>
<td>hrós [ʰouːs] ‘praise’</td>
</tr>
<tr>
<td>jól [jœlj]</td>
<td>‘Christmas’</td>
<td>hjól [Qœlj] ‘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 /tʰþi/</td>
<td>[tʰþi]</td>
<td>[þi] ‘depth’</td>
</tr>
<tr>
<td>b. sök /sʰkʰ/</td>
<td>[sʰkʰ]</td>
<td>[sʰk] ‘fault’</td>
</tr>
<tr>
<td>c. nepja /nepʰja/</td>
<td>[nepʰja]</td>
<td>[neːpa] ‘cold weather’</td>
</tr>
<tr>
<td>vökva /vðkʰva/</td>
<td>[vðkʰva]</td>
<td>[vðkva] ‘to water’</td>
</tr>
<tr>
<td>depra /teþpra/</td>
<td>[teþpra]</td>
<td>[teþpra] ‘sadness’</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 <nlrj> 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 underlyingly aspirated stop is realized as deaspirated. Some morpheme-internal examples of sonorant devoicing are given in (25):

(25) /lampʰt/  [lampʰt ~ laEpi] ‘lamp’
/mjoulkʰa/  [mjoulkʰa ~ 'miou'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) /φym+tʰ̊/  [φymt ~ φyt] ‘miserable-NEUT’
/kraint+tʰ̊/  [kraintʰ ~ kraift] ‘green-NEUT’
/sail+tʰ̊/    [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)  

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 underlyingly 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 /k/. In this case, too, the aspirated stop is itself deaspirated:

(28) maþkur /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 /eplʰi/ [eplí] ‘apple’
lækñir /lækʰnir/ [lækknír] ‘physician’
b. tappi /tʰapʰpʰi/ [tʰahpi] ‘cork’
nátt /nautʰi/ [nauhti] ‘night’
c. feitt /feiðtʰ-þ/ [feiðtí] ‘fat-NEUT-SG’
mætti /mætʰtʰi/ [mætítri] ‘meet-INF’
d. rekñet /rekʰ-ñtʰ/ [rekʰntʰi] ‘drift net’
hluttaka /hlutʰ-aka/ [hlutʰaka] ‘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.

The facts considered so far show that there are a number of contexts in Icelandic in which dependent \( \text{H} \) 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 \( \text{H} \) is shared by a coda and an onset is illicit; this is expressed by the representation in (30):

\[
\begin{array}{c}
\ast C \\
\text{…} \\
\text{H} \\
\text{…}
\end{array}
\]

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):

\[
\begin{array}{l}
\text{hefti} \ /\text{hefti}/ \ [\text{hefti}] \quad \text{‘notebook’} \quad (\ast [\text{hefti}]) \\
\text{aftur} \ /\text{aftri}/ \ [\text{aftri}] \quad \text{‘after’} \quad (\ast [\text{aftri}]) \\
\text{skóta} \ /\text{skóta}/ \ [\text{skóta}] \quad \text{‘to harm’} \quad (\ast [\text{skóta}]) \\
\text{flaska} \ /\text{flasksa}/ \ [\text{flaska}] \quad \text{‘bottle’} \quad (\ast [\text{flasksa}]) \\
\text{akta} \ /\text{akta}/ \ [\text{akta}] \quad \text{‘to respect’} \quad (\ast [\text{akta}]) \\
\text{október} \ /\text{oktober}/ \ [\text{oktober}] \quad \text{‘October’} \quad (\ast [\text{oktober}])
\end{array}
\]

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 \( \text{H} \), 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 \( \text{H} \) 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 \([\text{Af}]\) 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):

\[
\begin{array}{l}
\text{hefti} \ /\text{hefti}/ \\
\text{aftur} \ /\text{aftri}/ \\
\text{skóta} \ /\text{skóta}/ \\
\text{flaska} \ /\text{flasksa}/ \\
\text{akta} \ /\text{akta}/ \\
\text{október} \ /\text{oktober}/
\end{array}
\]

\(^{25}\) More generally, Huffman & Hinnebusch (1998:5) observe that they have found no convincing cases of double-linking of the feature \(+\text{spread glottis}\).
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

(33) (p) t ñs k q
   m n ñ
   mʰ nʰ ñʰ

Bergsland (1997:17) observes that of the stop series, /t k/ are “unaspirated or weakly aspirated” while /ñs 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 ñs/ 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 Dha, 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):28

\[(34) \quad \text{PEA} \quad \rightarrow \quad \text{Aleut}\]

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

\[\ast \text{VpV} \rightarrow \text{Vm}^3\text{V}\]

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:

\[(35) \quad \text{Russian} \quad \rightarrow \quad \text{Aleut}\]

\[
\begin{array}{l|l}
\text{pila} & \text{Æila}农户 - \text{mil}农户 \quad \text{‘file’} \\
\text{lopatka} & \text{luÆa}农户ka农户 \quad \text{‘shovel’} \\
\text{tabak} & \text{taÆa}农户ka农户 - \text{tama}农户ka农户 \quad \text{‘tobacco’} \\
\end{array}
\]

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.29 However, this is not the only possible explanation. An alternative, perhaps more plausible, reason might be that /p/ was accommodated as /m\textsuperscript{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 \text{ 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 \S 1.3.2.}\]

\[29 \text{ Bergsland places the first Aleut-Russian contact at the beginning of 19th century. Fortescue et al. estimate that Proto-Eskimo-Aleut was spoken some 4,000 years ago.}\]
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 underlingly 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):

(36)  

\[
\begin{array}{ll}
\text{Proto-Algonquian} & \text{Cree, Menomini} \\
*mp & hp \\
*nt & ht \\
*nk (=n[k]) & hk \\
*n\tilde{t} & h\tilde{t} \\
*ns & hs \\
*n\tilde{s} & h\tilde{s} \\

\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

30 These are Breton, Farsi, Osmanli, Mongolian, Ewe, Akan, Gâ, 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 /sniz/ as [ˈʃɪt] and [ˈʃɪd]. 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):

(37) O O
     H L > L H
     |   |
     I ? ?
     |   |
     U U

*sm > 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:
[T]o 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 underlyingly 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):

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

\[(kn)^h > n^h > n\]

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

(39)

```
Kadai
  |   Kam-Tai
  |   Hlai (Li)
  |   Geyang
  |   Gelao
  |   Lachi
  
  Kam-Sui
  |   (Ong-)Be
  |   Thai
  |   Biao
  |   Lakkia
  |   Biao
  |   Sui
  |   Then
  |   Mak
  |
  |   Southwest
  |   Central
  |   Northern
  |
  |   Thai, Lao
  |   Nung
  |   Saek
  |
  |   Shan, Ahom
  |   S. Zhuang
  |   N. Zhuang
  |
  |   Black Thai
  |   Tày (Thô)
  |   Yay
```

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

---

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></th>
<th>Sui</th>
<th>Kam</th>
<th>Lakkia</th>
<th>SW Thai</th>
</tr>
</thead>
<tbody>
<tr>
<td>m³a¹</td>
<td>ɲwa¹</td>
<td>kʰwó¹</td>
<td>maa¹</td>
<td>‘dog’</td>
</tr>
<tr>
<td>m³u⁵</td>
<td>ɲu⁵</td>
<td>kʰţi¹</td>
<td>muu¹</td>
<td>‘pig’</td>
</tr>
<tr>
<td>m¹i¹</td>
<td>me¹</td>
<td>kūui¹</td>
<td>mii¹</td>
<td>‘bear’</td>
</tr>
<tr>
<td>m³o³</td>
<td>no³</td>
<td>kiui³</td>
<td>nuu¹</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 /ŋ/. 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 *m and a palatal glide as the reflex of historical *n.35

The correspondences in (40) suggest that Proto-Kadai had two initial velar stops, *k and *kʰ, which were retained in Lakkia and which, in some cases at least, were nasalized to /ŋ/ 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>*k-mV</td>
<td>m¹V</td>
</tr>
<tr>
<td>*kʰ-mV</td>
<td>m³V</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

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):

\[
\begin{align*}
(42) &
\begin{array}{c}
\text{O'} \\
\text{O} & \text{H} \\
(?) & \text{L} \\
(A) & ? \\
\text{U}
\end{array}
\end{align*}
\]
* ( km ) > \text{m} 

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):

\[
\begin{align*}
(43) &
\begin{array}{cccccccc}
\text{Li-Ngam} & \text{Jungchiang} & \text{Pyo} & \text{Mak} & \text{Then} & \text{Kam} \\
\text{a. Plain nasals} & \\
\text{m} & \text{m} & \text{m} & \text{m} & \text{m} & \text{m} \\
\text{n} & \text{n} & \text{n} & \text{n} & \text{n} & \text{n} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{b. Glottalized nasals} & \\
\text{m'} & \text{m'} & \text{m'} & \text{m'} & \text{m'} & \text{m'} \\
\text{n'} & \text{n'} & \text{n'} & \text{n'} & \text{n'} & \text{n'} \\
\text{ŋ'} & \text{ŋ'} & \text{ŋ'} & \text{ŋ'} & \text{ŋ'} & \text{ŋ'} \\
\text{ŋ'} & \text{ŋ'} & \text{ŋ'} & \text{ŋ'} & \text{ŋ'} & \text{ŋ'} \\
\text{c. Aspirated nasals} & \\
\text{m} & \text{m} & \text{m} & \text{m} & \text{m} & \text{m} \\
\text{n} & \text{n} & \text{n} & \text{n} & \text{n} & \text{n} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} & \text{ŋ} \\
\end{array}
\end{align*}
\]

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):

(44) $\begin{array}{c|c|c}
\text{PT} & \text{MT} \\
\hline
*m & m \\
*m^h & m \\
*n & n \\
*n^h & n \\
\end{array} \quad \begin{array}{c|c|c}
\text{PT} & \text{MT} \\
\hline
*n & n, j \\
*n^h & n, j \\
\end{array}$

In most present-day Thai dialects, $*n$ has merged with $*j$, although $*n$ 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 $*n^h$ and $*n$. Nasal deaspiration receives a straightforward interpretation in terms of deletion of the dependent manner structure, as is shown in (45):

(45) $\begin{array}{c}
O \\
\bigg| \\
L \\
\bigg| \\
? \\
\bigg| \\
*N^h > N \\
\end{array}$

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:

(46) \[
\begin{array}{c}
O \\
\downarrow \\
L \\
| \\
? \\
| \\
A \\
\end{array}
\]

\[^*\eta^h > h\]

Brown (1965) observes that in some southern dialects of Thai, both *\eta^- and *\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 *\eta^m^h, *\eta^h^- *\eta^h^- *\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 *\eta^h^- differ from those affecting other aspirated nasals. Compare for instance the development of *\eta^h^- and *\eta^m^- (in (47) A, B, and C refer to the Mal dialects examined by Filbeck):

(47) \[
\begin{array}{ccc}
\text{Proto-Mal} & A & B & C \\
*\eta^h^- \text{ (series 1)} & > & h & \eta & \eta \\
*\eta^h^- \text{ (series 2)} & > & \eta^h^- & \eta & \eta \\
*\eta^m^- \text{ (series 1)} & > & m^h^- & m^h & h \\
*\eta^m^- \text{ (series 2)} & > & m^h^- & m & m \\
\end{array}
\]

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^- /\eta^- 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
   |   |   ?  ?
   /ŋ/  /ŋʰ/

The relative markedness of /ŋʰ/ can then be interpreted to mean that it is marked for a placeless structure to have a laryngeal modification.³⁶ 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 /ŋ/. Consider once more the Algonquian languages Menomini and Cree, where the nasals of Proto-Algonquian nasal-consonant clusters have developed into /ŋ/.

The relevant developments are repeated in (49) (see also §5.2.2):

(49)  Proto-Algonquian  Cree, Menomini
     *mp   hp
     *nt   ht
     *nk (=ηk)  hk
     *nʃ  hʃ
     *ns   hs
     *nʃ  hʃ

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 /ŋ/ 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 \( \eta \) 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 \(*\eta-\) and \(*\eta\-\), which, when added to a nasal-initial stem, yielded \(*\eta\m\) and \(*\eta\-\) 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:

(50)  

<table>
<thead>
<tr>
<th>Language</th>
<th>( \eta )</th>
<th>( \eta-)</th>
<th>( \eta-)</th>
<th>( \eta-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burmese</td>
<td>m</td>
<td>m</td>
<td>hm</td>
<td>m</td>
</tr>
<tr>
<td>Phunoi, Bisu</td>
<td>m</td>
<td>b</td>
<td>hm</td>
<td>hm</td>
</tr>
<tr>
<td>Yi</td>
<td>m</td>
<td>m</td>
<td>( \emptyset )</td>
<td>( \emptyset )</td>
</tr>
<tr>
<td>Lisu, Akha, Lahu, Mpi</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
</tr>
</tbody>
</table>

Note that Bradley distinguishes between \( /hm/ \) and \( /\emptyset/ \). 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 *?m as reconstructed for Proto-Burmese-Loloish has a synchronic reflex.\footnote{In Maru, a Burmese (but not a Loloish) language, *sm and *?m have developed into laryngealized nasals with creaky voice in the following vowel (see also §5.3.2).}

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 \cite{Bradley1979} (see also Bradley 1985). Whereas Bisu has generally retained Proto-Loloish *-\textit{g109}, *-\textit{g110}, *-\textit{g78}, in Phunoi *-\textit{g78} has merged with a preceding vowel to produce a nasalized vowel. It is the development of Proto-Bisoid *-\textit{g78} 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):

\begin{table}[h]
\centering
\begin{tabular}{llll}
\hline
\textbf{PL} & \textbf{PB} & \textbf{Phunoi} & \textbf{Bisu} \\
\hline
a. 17 mi & \textit{m4n} & m\textordmasculine} & \textit{\textordmasculine}ame\textordmasculine} & ‘cat’ \\
321 mo & m\textordmasculine}n/b\textordmasculine}n\textordmasculine} & m\textordmasculine}th\textordmasculine} & m\textordmasculine} & ‘sky’ \\
\hline
b. 84 s-mo & h\textordmasculine}n\textordmasculine} & h\textordmasculine} & h\textordmasculine} & ‘mushroom’ \\
152 s-nap & h\textordmasculine}p & h\textordmasculine}p & h\textordmasculine} & ‘mucus’ \\
113 s-\textordmasculine}n & l\textordmasculine} & l\textordmasculine} & l\textordmasculine} & ‘finger’ \\
\hline
c. 257 \textordmasculine}m(a) & h\textordmasculine} & h\textordmasculine} & h\textordmasculine} & ‘knife’ \\
85 \textordmasculine}nwe & h\textordmasculine} & h\textordmasculine} & h\textordmasculine} & ‘feathers, fur’ \\
323 \textordmasculine}tre nsa & h\textordmasculine} & h\textordmasculine} & h\textordmasculine} & ‘earth’ \\
461 \textordmasculine}n-ne & h\textordmasculine} & h\textordmasculine} & h\textordmasculine} & ‘day’ \\
526 \textordmasculine}n-nak & h\textordmasculine} & h\textordmasculine} & h\textordmasculine} & ‘deep’ \\
\end{tabular}
\end{table}

Note first of all that Proto-Loloish rhymes consisting of a nasal and a following vowel have the reflex /-V\textordmasculine}/ in Bisu and /-ö/ in Phunoi, as is shown in (51a).\footnote{In (51a) some Bisoid forms are preceded by /\textordmasculine}/ in Phunoi, and as shown in (51a).}

The forms in (51b,c) show that we find the same scenario in case such rhymes are preceded by *\textordmasculine}- or *?\textordmasculine}- in Proto-Loloish. Here the additional development is that the merger of these prefixes with a root-initial nasal has resulted in aspirated nasals. Note also that, with the exception of /s-\textordmasculine}/, (51b) and (51c) do not contain any forms with an initial *\textordmasculine}- or *?\textordmasculine}. Inspection of Bradley’s wordlist reveals that the Bisoid reflexes of such stems have in most cases lost the nasal. The loss of *\textordmasculine}-, *?\textordmasculine}, but not *\textordmasculine}-, *\textordmasculine}, is unsurprising from the viewpoint of the markedness relation between phonation and nasal place, as was observed in relation to Kadai in §5.2.3.1.

\footnote{In (51a) some Bisoid forms are preceded by /\textordmasculine}/. This concerns a prefix which derives from Proto-Tibeto-Burman *\textordmasculine}. The semantic contribution of this prefix is unclear \cite{Matisoff1975}. Note that this prefix shows the same variation in terms of nasalization as nasal-initial stems, which suggests that initial /\textordmasculine}/, 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 *-Vη for Proto-Bisoid. Implicit in this reconstruction is that the subsequent development *Vη > ð is is specific to Phunoi, and that the development of Proto-Loloish to Proto-Bisoid involved the excrescence of final -η.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 *-Vη > ð applied prior to excrescence of /-η/. According to this interpretation, Proto-Loloish *-Vη would have the Proto-Bisoid reflex *-ð; these nasalized vowels would then be retained in Phunoi, and develop into /-Vη/ sequences in Bisu.

While Bradley does not discuss the order of excrescence of /-η/ and vowel nasalization, his reconstructions support Proto-Bisoid *-Vη rather than *-ð. The evidence for Proto-Bisoid *-Vη comes from the development of Bisoid 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, *-η. These rhymes have the following reflexes in Phunoi and Bisu (cf. Bradley 1979:188):

(52) PL Phunoi Bisu
    a. *-im -um -um
       *-um -um -um
       *-am -am -am
    b. *-in -in -en
       *-un -an -en
       *-an -án -en
    c. *-iη -iŋ -umŋ
       *-oŋ -ð -oŋ
       *-aŋ -ã -aŋ

For present purposes, the crucial development is *-iŋ > -iŋ, 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 [ŋ] 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 /ɲ/; form 461 is perhaps another example of this type of change.

(54)

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

*ɪŋ > ɪɲ

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 /ɲ/ 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).

(55)

<table>
<thead>
<tr>
<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 (thɔ)</td>
<td>bi</td>
</tr>
<tr>
<td>598b</td>
<td>(C)-ni</td>
<td>dɔŋ(ŋ)/nɔŋ</td>
<td>ni</td>
</tr>
<tr>
<td>675</td>
<td>m-(b)u</td>
<td>bɔŋ ŋ</td>
<td>...</td>
</tr>
<tr>
<td>767</td>
<td>(C)-no</td>
<td>dʊŋ/nɔŋ</td>
<td>nɔnã</td>
</tr>
</tbody>
</table>
The forms in (55) show the typical development of Proto-Loloish nasals preceded by a consonant prefix other than *s- or *?--. 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)  PL       PB₁      PB₂        Phunoi Nō
      *NV ———*Nŋ ———*NVŋ

Bisu NVŋ ~ ©Vŋ

Proto-Bisoid₁ is of course a hypothetical stage. All that can be said for certain is that nonasal vowels were tolerated in Proto-Bisoid₂. 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)  PL      PB      Phunoi      Bisu
a. 17  mi  meŋ m>  ?ameŋ  'cat'
    321 mo  múŋ/bûŋ mú tha múŋ  'sky'

b. 84  s-mo  hmûŋ  hmû  hmûŋ  'mushroom'
   152  s-nap  hûp  hûp  hûw  'mucus'
   113  s-no  là  hûŋ  là  hûŋ  'finger'

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.-⁴¹

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:

\[
\begin{array}{cccccc}
| & | & | & | & | & | \\
H & L & L & > & H & L & L & L \\
I & ? & place & <\text{i}> & ? & place \\
| & place & place \\
\end{array}
\]

\[\ast s-NV > N^{\#}\]

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 \(\ast ?\)- only affected root-initial nasals when vowel nasalization was no longer active, or the merger of \(\ast ?\)- 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>Ø²n¹ 'outside'</td>
<td>n²ŋ² 'sit'</td>
<td>Ø²n¹ 'face'</td>
<td>m¹ŋ² 'housefly'</td>
</tr>
<tr>
<td>a³ 'after'</td>
<td>l¹ŋ³ 'monkey'</td>
<td>a³ 'bow'</td>
<td>n³m² 'leaf'</td>
</tr>
<tr>
<td>£ a:⁵ 'quick'</td>
<td>w:a:n² 'day'</td>
<td>o¹ 'big'</td>
<td>l³ 'look for'</td>
</tr>
<tr>
<td>Q:a³ 'dry'</td>
<td>ja² 'ear'</td>
<td>a:⁵ 'moon'</td>
<td>l³w:e:⁶ 'lazy'</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. hm²n² Ø³h²n² 'hear'
   hn³m² Ø³h³m² 'blood'
   hl³a? 'h³a? 'leaf'
b. m)² m³a? 'mother'
   n³k² n³k² 'neck'
   l³n² l³n² '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
     ?

/N³hV/ → [N³h₄ ]

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*}
(62) & \quad \text{high tone} \quad \text{já} \quad \text{‘tree’} \\
& \quad \text{aspiration} \quad \text{jÅ} \quad \text{‘he wears’} \\
& \quad \text{high tone + aspiration} \quad \text{nd/} \quad \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 F0 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|‘hõasi !Xã, 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. 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:

(64) Combinations

a. 1, 2, 3, 4 ~ 5       White Thai, Black Thai, Lungchow, Wu-ming
b. 1, 2, 3 ~ 4 ~ 5     Chiangmai, Chiangrai, T’ien-chow, Yay, Po-ai
c. 1, 2 ~ 3, 4 ~ 5      Siamese, Songkhla, Krabi, Hua Sai
d. 2, 3 ~ 1, 3 ~ 4 ~ 5   T’ien-pao

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>
</tr>
</thead>
<tbody>
<tr>
<td>*kʰ</td>
<td>kʰaau 24</td>
<td>kʰaau 33</td>
<td>haau 24</td>
</tr>
<tr>
<td>*f</td>
<td>fon 24</td>
<td>pʰin 33</td>
<td>hin 24</td>
</tr>
<tr>
<td>*mʰ</td>
<td>maa 24</td>
<td>maa 33</td>
<td>maa 24</td>
</tr>
<tr>
<td>*lʰ</td>
<td>laan 24</td>
<td>laan 33</td>
<td>laan 24</td>
</tr>
</tbody>
</table>

b. **Class 3**

<table>
<thead>
<tr>
<th>PT</th>
<th>Siamese</th>
<th>Lungchow</th>
<th>Po-ai</th>
</tr>
</thead>
<tbody>
<tr>
<td>*p</td>
<td>pai 33</td>
<td>pai 33</td>
<td>pai 24</td>
</tr>
<tr>
<td>*t</td>
<td>taa 33</td>
<td>taa 33</td>
<td>taa 24</td>
</tr>
<tr>
<td>*k</td>
<td>kin 33</td>
<td>kin 33</td>
<td>kin 24</td>
</tr>
</tbody>
</table>

c. **Class 4, 5**

<table>
<thead>
<tr>
<th>PT</th>
<th>Siamese</th>
<th>Lungchow</th>
<th>Po-ai</th>
</tr>
</thead>
<tbody>
<tr>
<td>*(?)b</td>
<td>bin 33</td>
<td>bin 33</td>
<td>min 31</td>
</tr>
<tr>
<td>*(?)d</td>
<td>dii 33</td>
<td>dai 33</td>
<td>nii 31</td>
</tr>
<tr>
<td>*ʔ</td>
<td>?au 33</td>
<td>?au 33</td>
<td>?au 31</td>
</tr>
</tbody>
</table>

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.
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 ($a_1$, $b_1$) or glottalized segments ($a_2$, $b_2$). Observe that in these languages aspirated sonorants always pattern together with aspirated stops. The only exception to this is type $b_3$, 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):

(66) **Tone splitting: two-way splits**

<table>
<thead>
<tr>
<th></th>
<th>Tone elevators</th>
<th>Tone depressors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obstruent stop</strong></td>
<td>$p, p^h, b$</td>
<td>$b$</td>
</tr>
<tr>
<td><strong>Prenasalized stop</strong></td>
<td>$m^p$</td>
<td>$m^b$</td>
</tr>
<tr>
<td><strong>Fricative</strong></td>
<td>$f$</td>
<td>$v$</td>
</tr>
<tr>
<td><strong>Nasal</strong></td>
<td>$m^b, m'$</td>
<td>$m$</td>
</tr>
<tr>
<td><strong>Approximant</strong></td>
<td>$w^h, w'$</td>
<td>$w$</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 \([+\text{constricted glottis}]\). This feature is also characteristic of glottalized stops, the realization of which includes tensed, ejective, and implosive articulations. Regarding \([+\text{constricted glottis}]\), Halle & Stevens (1971:202) observe that

> 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 \([\text{ejection}]\) while glottalized sonorants are specified in terms of the feature \([\text{creak}]\). 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:

\[
\begin{align*}
/g106/g97/g104/g109/g111/g116+ /g47/ & \rightarrow [\text{jahmot}'] \quad \text{‘it’s a cougar’} \\
/\text{i}[^\text{i}]\text{fakan}+ /g47/ & \rightarrow [\text{i}[^\text{i}]\text{fkan}'] \quad \text{‘it’s pretty’}
\end{align*}
\]

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:

\[
\begin{align*}
\text{O} \\
\text{L} \\
\text{?} \\
\text{?} \\
\text{U}
\end{align*}
\]

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

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. [\text{m}]), 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.

\footnote{Buckley analyzes the morpheme as a floating [constricted glottis] feature. In Element-based Dependency, the morpheme can be analyzed as a single, dependent element |?|.}
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) __#V __C __#
    Yawelmani [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):

\[(71)\]

\[
\begin{array}{cccccc}
\text{(PFX)} & O & N & O & N \\
\text{ʔ} & L & L & \Rightarrow & \text{ʔ} & L & L \\
\text{ʔ} & ? & ? \\
\end{array}
\]

\[\text{ʔ}+\text{NV} > \text{N’V}\]

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):

\[(72)\]

\[
\begin{array}{lll}
\text{Proto-Kadai} & \text{Proto-Kam-Sui/Tai} \\
*k\text{-mV} & > & *m’V \\
\end{array}
\]
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)  

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)  

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.50

(75)  
Stage 1  Stage 2  Stage 3  Stage 4
a. pun > p, n > p, fn > pui? ‘four’  
b. patam > patam > patam > patao? ~ pata? ‘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)  
C
  +  
L  ?
  \ |  
|  ?
  \ |  place
*V’ > ?

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 [vɪʔ~vɪʔ], [vɪʔ~vɪʔ], and [vɪʔ~vɪʔ]. 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) a. O
    H
    L
    ?
    U

(77b) 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) a. O
    L
    ?
    U

(78b), 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 i å/ 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.\textsuperscript{51}

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.\textsuperscript{52} 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 \([a]\) or \([e]\), as in the forms in (79b):

\begin{align*}
\text{(79) }& \ a. /t’\text{upm}/ \quad [\dddot{t}’\text{\textvar{UP}}] \quad \text{‘to twist’} \\
& \quad /\text{ntes}/ \quad [\dddot{t}’\text{\textvar{TS}}] \quad \text{‘he places it’} \\
& \quad \text{b. } /t’\text{upns}/ \quad [\dddot{t}’\text{\textvar{UN}}] \quad \text{‘he twisted it’} \\
& \quad /\text{ntes}/ \quad [\textvar{KNT}\text{\textvar{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*}
\text{(80) }& \ a. /\text{pln’tes}/ \quad [\textvar{PL\textvar{T}}\text{\textvar{ES}}] \quad \text{‘he puts rocks in the sweathouse’} \\
& \quad /\text{txwx’pm}/ \quad [\textvar{TXW}\text{\textvar{P}}] \quad \text{‘I trim its tail’} \\
& \quad /\text{lxw-us-tn’}/ \quad [\textvar{LX}\text{\textvar{U}}\text{\textvar{T}}] \quad \text{‘globe of kerosene lamp’} \\
& \quad \text{b. } /t’\text{q”eq”jm’x}/ \quad [\dddot{t}’\text{\textvar{Q”E”J}}\text{\textvar{M}}\text{\textvar{X}}] \quad \text{‘red pigment’} \\
& \quad /\text{swekmn’s}/ \quad [\textvar{SW}\text{\textvar{KMN}\textvar{S}}] \quad \text{‘lightning’} \\
& \quad /\text{pn’sq’xe’}/ \quad [\textvar{POn\textvar{SQ}’\textvar{XE}’}] \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

\textsuperscript{51} I am grateful to Edward Flemming for bringing these facts to my attention.

\textsuperscript{52} 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.
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 \[\pm\text{ATR}\] rather than in terms of a laryngeal contrast (see also Gregerson 1976).53

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).54

\[(81) \quad \text{Modal voice} \quad \text{Creaky voice} \quad \text{Breathy voice} \]
\[
j\acute{a} \quad \text{‘tree’} \quad j\grave{e} \quad \text{‘he carries’} \quad j\ddot{a} \quad \text{‘he wears’} \\
nt^{\text{b}} \quad \text{‘seed’} \quad nd^{\text{d}} \quad \text{‘arse’} \quad nd^{\text{v}} \quad \text{‘horse’} \\
\]

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)  a. **Aspiration**  **Breathy voice**

<table>
<thead>
<tr>
<th>Consonant</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>/h3i/</td>
<td>‘fish’</td>
</tr>
<tr>
<td>/h3a/</td>
<td>‘stubble’</td>
</tr>
<tr>
<td>/h3g/</td>
<td>‘bad smelling’</td>
</tr>
</tbody>
</table>

b. **Glottalization**  **Creaky voice**

<table>
<thead>
<tr>
<th>Consonant</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>/h47/</td>
<td>‘hook’</td>
</tr>
<tr>
<td>/h66/</td>
<td>‘I hit’</td>
</tr>
<tr>
<td>/h47/</td>
<td>‘rainbow’</td>
</tr>
<tr>
<td>/h106/</td>
<td>‘I carry’</td>
</tr>
</tbody>
</table>

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)  a.  b.  c.

```
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>A</td>
<td>/a/</td>
</tr>
<tr>
<td>L</td>
<td>A</td>
<td>/a/</td>
</tr>
<tr>
<td>L</td>
<td>A</td>
<td>/a/</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

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 [ʔ]) 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.

---

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 \(|g47|\) or \(|H|\)). This holds a fortiori for syllabic laryngeally modified nasals, which contain \(|g47|\) 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 /mʰh/ is sufficient.\(^5\) 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 underlyingly aspirated stop to a preceding sonorant. This is not the only environment in which aspirated sonorants are found, however. Aspirated sonorants also occur word-initially, where they are reflected in the orthography as <n₁ r j> preceded by <h>. The (near-) minimal pairs in (85) show that aspiration is distinctive in word-initial sonorants:

\[
\begin{align*}
(85) & \quad \text{hnota} \ [\overset{\text{Ø}}{\text{Ø}} \text{a}] \quad \text{‘nut’} \quad \text{cf.} \quad \text{nota} \ [\overset{\text{Ø}}{\text{Ø}} \text{a}] \quad \text{‘to use’} \\
& \quad \text{hné} \ [\overset{\text{Ø}}{\text{e}:}] \quad \text{‘knee’} \quad \text{cf.} \quad \text{né} \ [\overset{\text{Ø}}{\text{e}:}] \quad \text{‘either’} \\
& \quad \text{hljóh} \ [\overset{\text{Ø}}{\text{jou:θj}}] \quad \text{‘sound’} \quad \text{cf.} \quad \text{ljóh} \ [\overset{\text{Ø}}{\text{jou:θj}}] \quad \text{‘poem’} \\
& \quad \text{hrópur} \ [\overset{\text{Ø}}{\text{ou:θj}]} \quad \text{‘fame’} \quad \text{cf.} \quad \text{rópur} \ [\overset{\text{Ø}}{\text{ou:θj}]} \quad \text{‘row’} \\
& \quad \text{hrós} \ [\overset{\text{Ø}}{\text{ou:s}]} \quad \text{‘praise’} \quad \text{cf.} \quad \text{rós} \ [\overset{\text{Ø}}{\text{ou:s}]} \quad \text{‘rose’} \\
& \quad \text{hjól} \ [\overset{\text{Ø}}{\text{ou:θj}}] \quad \text{‘wheel’} \quad \text{cf.} \quad \text{jól} \ [\overset{\text{Ø}}{\text{ou:θj}}] \quad \text{‘Christmas’} \\
& \quad \text{hjarta} \ [\overset{\text{Ø}}{\text{θ:ta}]} \quad \text{‘heart’} \quad \text{cf.} \quad \text{jarma} \ [\overset{\text{Ø}}{\text{θ:ma}]} \quad \text{‘to bleat’}
\end{align*}
\]

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

\(^5\) 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:

\[
\begin{array}{c}
\sigma \\
O \\
L & H
\end{array}
\]

(86) expresses the fact that sonorants, i.e. structures that contain |L| as part of their manner component, are compatible with dependent |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):

\[
\begin{array}{cccc}
p & t & ì & k \\
b & d & ìj & g \\
s & ì & h \\
m & n & ñ & ñ \\
v & l & r
\end{array}
\]

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 /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 /h/ 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.\footnote{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).} 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 n\(^{p}/\).\footnote{The only exception concerns a sequence which is transcribed by Smith (1973a:55) as /hnr/, phonetically presumably \[\text{ỊNr}\]; Smith notes that this sequence occurs in only two lexical items.} 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\(^{b}\) m\(^{b}/\), but not /l(pl)\(^{b}\) (ml)\(^{b}/\), suggests that onsets which contain O’ are illicit.

This is illustrated in (88) for */(ml)\(^{b}/\):

\begin{center}
\begin{tabular}{c|c|c|c|c}
   & O & H & L & H \\
\hline
   & ? & L & U & I \\
   \hline
\end{tabular}
\end{center}

(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
marginal occurrences of /r/ and /l/.

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. The restrictions can also be stated in terms of a prohibition on branching manner structures in specific prosodic environments.

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):

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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 /h/ to occupy the final position.

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

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 syllable 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. /t̚h̚k̚i/ [t̚h̚k̚i] ‘throw (toward speaker)’
    b. /t̚hm̚i/ [t̚hm̚i] ‘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) STEM + DECL.
    a. /ka-ta/ [kata] ‘to go’
       /nar-ta/ [nulta] ‘to fly’
    b. /m̚k-ta/ [m̚k’ta] ‘to eat’
       /m̚k’-ta/ [m̚k’ta] ‘to tie’
       /t̚p̚-ta/ [t̚p̚t’a] ‘to cover’
    c. /nam-ta/ [namt’a] ‘to remain’
       /an-ta/ [ant’a] ‘to hug’
    d. /n̚h-ta/ [n̚h’ta] ‘set free’
       /m̚nh-ta/ [m̚nh’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:

\[(92)\]

\[C \quad O \quad O \]
\[\quad \quad ? \quad \quad ? \quad H \]
\[I \quad I \]

/h-t/ \[\rightarrow \] [tʰ]

The syllabic affiliation of [tʰ] 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):

\[(93)\]

\[\text{STEM+DUR}\]
\[a. \quad \tilde{\text{saw}}+ʔa/ \quad [\tilde{\text{saw}′a}] \quad \text{‘shout’}\]
\[\quad /\text{nin}+ʔa/ \quad [\text{nin}′a] \quad \text{‘quieter’}\]
\[b. \quad /\text{el}k+ʔa/ \quad [\text{el}k′a] \quad \text{‘sing’}\]
\[\quad /\text{mojn}+ʔa/ \quad [\text{moj}′a] \quad \text{‘get tired’}\]
\[c. \quad /\text{jawl}+ʔa/ \quad [\text{jawl}′a] \quad \text{‘follow’}\]
\[\quad /\text{hogn}+ʔa/ \quad [\text{hogn}′a] \quad \text{‘make’}\]
\[\quad /\text{agj}+ʔa/ \quad [\text{agj}′a] \quad \text{‘pull’}\]

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 [i-r]; [r] occurs intervocally, [i] 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 *'[hoqn′a]'.
that glottalization does not skip across the vowel, as this would yield an illicit word-initial glottalized sonorant:

(94)  STEM+DUR
  a. /max+ʔʔa:/ [maxʔʔa]  ‘procure’
  b. /doš+ʔʔa:/ [došʔʔa:]  ‘report’
  c. /hot’+ʔʔa:/ [hotʔʔa:]  ‘build a fire’

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)  STEM+DUR
  a. /ɡ47/ɡ105/ɡ201/ɡ108/ɡ107/  
     /ɡ47/ɡ97/ɡ201/  
     /ɡ47/ɡ101/ɡ108/ɡ39/ɡ107/ɡ97/ɡ201/  ‘sing’  (cf. (93b))
  b. /ɡ109/ɡ97/ɡ201/ɡ120/  
     /ɡ47/ɡ97/ɡ201/  
     /ɡ109/ɡ97/ɡ120/ɡ47/ɡ97/ɡ201/  ‘procure’  (cf. (94a))

In (95a), vowel shortening serves to incorporate the combination /ɡ108 ɡ47/, which suggests that the resulting glottalized sonorant is tautosyllabic. In (95b), vowel shortening serves to incorporate /ɡ/ into the initial syllable. Observe here that Yawelmani does not permit the combination of a fricative and a glottal stop in the same onset.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 /ʔ/. Blevins (1993) observes that /ʔ/ surfaces in prevocalic context, as in the forms in (96a). In word-final and preconsonantal context, /ʔ/ is deleted with compensatory lengthening of the preceding vowel, as in the forms in (96b):66

(96)  a. /sleʔʔa:/  
     /sʔetw/  
     /sʔeto:/  ‘sees’
  b. /hes-sleʔ/  
     /hesleʔ/  ‘come to see, show!’
     /sleʔʔiʔʔa:/  /sleʔʔiʔʔahi/  ‘goes to see’
     /sleʔʔiki/  /sleʔʔiki/  ‘comes to see’

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

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

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

(97)  a. /juuːʔ/ ‘buffalo’ /juuʔaːk/ ‘DIST-buffalos-DIM’
    b. /ʔankuʔ/ ‘stick’ /ʔaʔankəʔaːk/ ‘DIST-sticks-DIM’
    c. /pʰetʔaʔ/ ‘foot’ /pepʔaʔaːk/ ‘DIST-feet-DIM’

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

(98)  a. /ʔuʔl/ ‘star’
    b. [ʔuʔlʔaːk] ‘DIST-stars-DIM’
    c. [ʔuʔlʔam] ‘star-GEN’

(98a) is the morpheme for ‘star’. In (98b), suffixation of /ʔaːk/ (or /ʔaʔaːk/) produces a glottalized [l], while in (98c) suffixation of /ʔm/ (or /ʔm/) results in a sonorant-[ʔ] 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 [ʔuʔlʔaːk] forms a single, branching onset structure. At the same time, it suggests that the sonorant-[ʔ] sequence in [ʔuʔlʔam] 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 [ʔuʔlʔam].

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

67 Following Blevins, I assume here that [a] is epenthetic.
CHAPTER 5

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):

\[
(99) \quad \underline{\_\_V} \quad \underline{\_C} \quad \underline{\_\#}
\]

<table>
<thead>
<tr>
<th></th>
<th>Yawelmani</th>
<th></th>
<th>Klamath</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>[ʔm]</td>
<td>[mʔ]</td>
<td>[mʔ]</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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. In Maddieson (1984), Hindi is described as having the breathy voiced nasals / ฏ/ . By way of contrast, Ohala (1983) interprets these nasals as clusters, i.e. /mh 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.

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 [m̩ fi] and [n̩yi]. 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 /-m₁h₁/- and /-nd₁h₁/-, 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-
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.\(^{72}\)

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 /\(\mathcal{H}\)/. 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 [\(\mathcal{H}\)], 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 [\(\mathcal{H}\)], and distinctive glottalization, i.e. with dependent [\(\mathfrak{g}\)]. 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 [\(\mathcal{H}\)] and [\(\mathfrak{g}\)]. 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.

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\(^{72}\) According to the description in Kelkar (1968), breathy voiced nasals may also result from optional vowel deletion in words like [m\(\mathfrak{a}ra\)\(\mathfrak{s}\)] ~ [m\(\mathfrak{n}\)ara\(\mathfrak{s}\)]. However, as Godard Schokker (p.c.) notes, vowel deletion in such forms is impossible.
Part III  Further issues
In the previous chapter I examined the issue of laryngeal modifications in the class of nasals. In the present chapter, I consider the issue of nasal modifications in the class of laryngeals. Thus, the resulting segment type is that of “nasalized laryngeals”. Processes in which nasalized laryngeals are involved include nasalization processes which target laryngeals, processes in which laryngeals trigger vowel nasalization, alternations between nasals and laryngeals, and diachronic changes in which laryngeals develop into nasals or vice versa.

In this chapter, I will be concerned mainly with the role of laryngeals in nasalization processes. In §6.1, I discuss a number of examples of distinctively and non-distinctively nasalized laryngeals, and consider some cases of “spontaneous nasalization” of vowels by laryngeals. In §6.2, I briefly consider a number of other phenomena that involve a phonological interaction between nasality and laryngeal articulations, and examine to what extent these phenomena involve spontaneous nasalization. In §6.3, I discuss some general repercussions that the recognition of a class of nasalized laryngeals has on the Element-based Dependency representation of segmental contrasts.

### 6.1 Derived and distinctive nasalized laryngeals

In the Element-based Dependency approach to nasalization in chapter 3, the discussion of nasalized segment types was limited to nasalized sonorants. In this section, I consider the phonological status of nasalized laryngeals, i.e. placeless manner structures with dependent [L]. This concerns the two structures in (1):

\[
\begin{align*}
(1) & \quad \text{a. } O & \text{b. } O \\
& \quad \text{[?]} & \quad \text{[H]} \\
& \quad \text{L} & \quad \text{L} \\
& \quad /?/ & \quad /H/
\end{align*}
\]

Support for the representations in (1) comes from the existence of nasalization processes which target laryngeals and from the existence of processes in which nasalization is triggered by laryngeals.

Nasalized laryngeals involve the combination of a lowered velum and a constriction behind the uvula. Note that in case of complete glottal closure, as in
[?] a lowered velum does not result in any audible nasalization. However, it is important to note that there is nothing which prohibits the combination of glottal closure and velic lowering from an articulatory viewpoint. Moreover, it should be noted that the release phase of a glottal stop can be accompanied by audible nasalization. For instance, Harris (1972) reports that in Standard Thai utterance-final voiceless stops, including [ʔ], are typically realized with a slight nasal release, so that they can be transcribed as [pʰ tʰ kʰ ʔʰ]. The same allophonic realization is found in Vietnamese (cf. Ladefoged & Maddieson 1996:129).

Most instances of nasalized laryngeals are the result of nasal harmony processes in which laryngeals are included in the target range of nasalization. According to the nasal harmony database in Walker (1998), laryngeals are in fact the consonant type that is most prone to undergo nasalization. Walker argues that segment nasalizability in nasal harmony involves the implicational hierarchy in (2):

(2) vowels > laryngeals > glides > liquids > fricatives > stops

The hierarchy in (2) reflects the fact that vowels are the most likely segment type to undergo nasalization. It is implicational in the sense that it expresses the fact that if in a language a particular segment type is a nasalization target, then all segment types which are more prone to be nasalized are also targets. Thus, (2) predicts for instance that if in a language liquids are nasalized, then glides, laryngeals, and vowels will also be nasalized. The hierarchy also predicts that there are languages in which nasalization targets vowels and laryngeals only. As was noted in §3.2.1, one such language is Sundanese. Consider the forms in (3):

(3) nājak ‘sift-ACT’
    nāwih ‘sing-ACT’
    māro ‘halve-ACT’
    mōlokok ‘stare-ACT’
    nātur ‘arrange-ACT’
    nāfān ‘wet-ACT’
    nāūr ‘say-ACT’
    kumāḥā ‘how?’
    biŋhūr ‘be rich-ACT’
    mī?āsīh ‘love-ACT’

The forms in (3) show that nasalization spreads rightward from a nasal, targets vowels and laryngeals, and is blocked by stops, fricatives, liquids, and glides. Of the laryngeals, /h/ is underlying and [ʔ] occurs between identical vowels and at certain morphological boundaries (cf. Cohn 1990).

---

1 Recall that epenthetic [w] and infixed [l] are included in the target range of nasalization.
As far as the nasalized laryngeals of Sundanese are concerned, acoustic measurements indicate that in nasal contexts /h/ is realized with nasal airflow (cf. Ohala 1990, see also Cohn 1990). There are also good grounds to consider [ʔ] in nasal contexts as nasalized. As was observed in §3.2.1, the incompatibility of nasal airflow and glottal closure does not imply that [ʔ] induces raising of the velum; indeed, velic raising is unexpected because the vowel following [ʔ] is nasalized. Hence, the interpretation of [ʔ] as nasalized in this context is essentially a matter of interpretation. If nasality is defined primarily in terms of nasal airflow, as Cohn assumes, [ʔ] is oral. If, on the other hand, nasality is defined by a lowered velum, [ʔ] can be interpreted as nasalized. This is the position taken in Walker & Pullum (1999). An argument for the latter view is that [ʔ], in Sundanese as well as in most other languages that I know, does not block nasalization. This means that an analysis which regards nasalization as being incompatible with glottal closure must explain why this incompatibility leads to transparency, while the incompatibility of obstruents, liquids, and glides leads to blocking of nasal spread.

Walker’s hierarchy seems on the whole to be descriptively adequate, although there appear to be some counterexamples involving laryngeals. However, in most of these cases there are arguments for analyzing the segments concerned as being supralaryngeal obstruents underlingly.2

Consider for instance the following facts from Terena (Tereno), an Arawakan language of Brazil (cf. Bendor-Samuel 1960; see also Ohala & Ohala 1993 and Walker & Pullum 1999). In Terena, nasalization functions as a morpheme indicating first person inflection. Nasalization spreads rightwards from the beginning of a word until it encounters a voiceless stop or fricative, which block nasalization and surface as prenasalized and voiced:

(4)  a. ajo ‘his brother’  b. ã⁢â³ ‘my brother’
owoku ‘his house’  õÕõ⁢⁡⁡ ‘my house’
emoʔu ‘his word’  êmõ⁡ ‘my word’
isu ‘he hoed’  ñ”zo ‘I hoed’
ab/aʔaʃo ‘he desires’  â⁢â⁢aʔaʃo ‘I desire’
iha ‘his name’  ñ”za ‘my name’

The forms in (4) show that nasalization spreads across [ʔ], but not across [h] and [h‘]. With regard to this asymmetry, Ohala & Ohala (1993:231) maintain that the [h] (and perhaps the [h‘]) derives from an earlier apical obstruent /t/, which plausibly passed through an intermediate stage of /s/ before becoming Terena /h/ in non-nasal environments.

2 A “true” counterexample to the nasalizability hierarchy appears to be Rejang, where /t/ blocks nasalization but glides do not (cf. McGinn 1979; see also Walker 1998).
Support for this diachronic scenario comes from the observation that in the synchronic grammar of Terena [h h̩] pattern with fricatives rather than with [ʔ]. This can be seen in (4), where we find the surface alternations [h,s~z] and [h̩, ,~z]. As Ohala & Ohala note, this means that nasalization of [h h̩] cannot be reduced to coarticulation with an adjacent nasalized vowel, but must be viewed as being part of the phonology of Terena. More specifically, it suggests that the segments which in oral forms are realized as laryngeals function as supralaryngeal obstruents underlingly. According to this interpretation, Terena does not constitute a counterexample to Walker’s nasalizability hierarchy.

Other apparent counterexamples involving blocking of nasalization by laryngeals are found in Inor and Bonggi. In Inor, nasal harmony appears to be blocked by [h], but this [h] can be analyzed as a surface realization of /x/ (Jean-François Prunet, p.c.). In Bonggi, an Austronesian language, word-final nasals have developed into prestopped nasals in case the word-final syllable did not begin with a nasal.\(^3\) Consider the examples in (5) (cf. Blust 1997:156):\(^4\)

\[(5)\]
\[
\begin{align*}
\text{fud} & \mathrel{<} \ *\text{puʔun} \quad \text{‘tree’} \\
\text{buit} & \mathrel{<} \ *\text{bulan} \quad \text{‘moon’} \\
\text{torig} & \mathrel{<} \ *\text{teriŋ} \quad \text{‘species of bamboo’}
\end{align*}
\]

Blust notes that there is one prestopping context which, in synchronic terms at least, is unexpected. This concerns words which in present-day Bonggi have [h] as the onset of the final syllable. The important observation here is that [h] in this context is historically derived from */k/. As Blust (1997:156) notes:

In a word such as mokon [m^^\text{o}h\text{'}d^n] ‘to eat’, nasal preplossilion almost certainly occurred before the change of */k* to [h], since \(h\) is transparent to nasal harmony virtually everywhere in island South-East Asia where we have sufficiently good descriptions to determine the point.

One interpretation of the Bonggi facts, as suggested by Blust, is to regard the variation between plain and prestopped nasals as no longer allophonic. According to this view, prestopped nasals can also occur in nasalizing contexts. While this seems reasonable, it should be observed that Blust does not transcribe the second vowel in [m^^\text{o}h\text{'}d^n] as nasalized. If this vowel is indeed oral, and if, as Blust appears to suggest, Bonggi [h] is transparent to nasalization, then we

---

\(^3\) This phenomenon was discussed in relation to nasal fortition in §4.3.2.

\(^4\) Blust does not give any examples of Bonggi forms in which the nasal has been retained; Blust’s description (and his discussion of prestopping in related languages) makes clear that these derive from words which have the shape */CVNVN* (or */NVNVN*).
may also interpret [h] as being derived from underlying /k/\(^5\). It is clear that more
data is required to substantiate either analysis.

The preceding discussion shows that laryngeals are among the segment
types that are most prone to undergo nasalization. It is therefore surprising that a
number of feature-based theories do not allow for the possibility of nasalized
laryngeals. For instance, in some versions of Feature Geometry the feature
[nasal] is analyzed as a dependent of the Supralaryngeal node, which is a
property of all buccal segments (cf. Trigo 1993; see also Sagey 1986, Halle
1992). This organization predicts that /h/\(^7\) cannot be phonologically nasalized.
Another feature-based proposal that denies the phonological relevance of
nasalized laryngeals is the SV-hypothesis (see Rice & Avery 1989, Piggott
1992, Rice 1993). As was observed in §3.2.2, the SV-hypothesis accounts for
Tucano-type nasal harmony in terms of spreading of [nasal] to all SV-nodes
within the harmonic domain. While this correctly accounts for the fact that the
target range in Tucano-type systems includes all sonorants, it fails to account for
the fact that in such systems laryngeals are also invariably included in the target
range.\(^6\)

Proponents of these feature theories could maintain that the nasalization of
laryngeals is phonologically irrelevant. However, there are good reasons for
taking this view to be untenable. First, if the nasalization of laryngeals is simply
irrelevant, then an explanation is required for the fact that in many languages
with nasal harmony, such as Sundanese and Warao, supralaryngeal obstruents
block nasalization while [?] is transparent to it.

A more serious problem concerns the observation that there are languages in
which nasalization in laryngeals is underlyingly contrastive. As McCarthy
(1988:92) notes, such a contrast is highly implausible on perceptual grounds:

> An underlying phonological distinction in [nasal] for h and ? is
> perceptually unlikely or impossible. ? cannot be perceptually
> distinctive for [nasal], since glottal closure is obviously
> incompatible with nasal airflow. With h, even when voiced, the
> lack of resistance in the oral vocal tract would significantly reduce
> nasal airflow, rendering nasality essentially inaudible.

Nevertheless, there is evidence that, in /h/ at least, an underlying contrast in
terms of nasality is possible. In the remainder of this section, I discuss a number
of examples of languages which can be argued to have underlyingly nasalized

\(^5\) Blust appears to use the term “transparent” in the sense of “nasalizable” and not—as is
usually the case—in the sense of “being invisible to the nasal harmony process”.

\(^6\) According to Piggott (1992:39), a nasalized glottal stop is “an impossible phonetic entity”.
Piggott attributes this impossibility to a cooccurrence restriction on [nasal] and [constricted
glottis]. Piggott does not discuss the status of nasalized [h] in Tucano-type harmony
systems.
Most of the data that will be discussed are also considered in Walker & Pullum (1999).

Consider first the following facts from Seimat, an Austronesian language of the Admiralty Islands. In common with most Austronesian languages with nasal harmony, Seimat vowels surface as nasalized in the context of a preceding nasal. However, as Blust (1998) observes, Seimat also has some instances of /ŋ/ that condition the presence of a following nasalized vowel. Some examples of this “nasalizing” /ŋ/ are provided in (6a); (6b) contains some examples of “non-nasalizing” /ŋ/:

(6)  a. ūŋ ‘to hear’  b. han ‘to climb’
     hūhūa/hūohū ‘two’     hil ‘how much/how many?’
     mati(hū)- ‘to sleep’   hon ‘sea turtle’
     wah(ā) ‘root’         utuhi ‘to draw water’

Based on the forms in (6), it would be possible to maintain that Seimat has underlying nasalized vowels. However, compelling evidence for an underlying distinction between nasalizing and non-nasalizing /ŋ/ comes from morphological alternations involving the transitive suffix /-i/. Blust notes that this suffix surfaces as nasalized after nasals and some instances of /ŋ/, as in (7a), and as oral after oral consonants and other instances of /ŋ/, as in (7b):

(7)  a. aum-i ‘embrace someone’  b. utuh-i ‘to draw water’
     tih-i ‘pour something’     salek-i ‘boil something in a pot’
     hatuh-i ‘make something stand’ taputu-i ‘hit something with a fist’

This alternation strongly suggests an underlying distinction in /ŋ/ in terms of nasality, since otherwise it would be impossible to account for the [i–i] allomorphy.

Another candidate for an underlying distinction between an oral and a nasalized /ŋ/ is Kwangali, a Southern Bantu language of Namibia. According to the description in Ladefoged & Maddieson (1996), nasalized vowels in Kwangali are found after some instances of /ŋ/ but not others.\footnote{Ladefoged & Maddieson (1996:133) note that nasalized vowels are also found in “the context of nasals”. Unfortunately, they do not indicate whether the nasalization in such cases is progressive, regressive, or both.} Instrumental evidence shows that an /ŋ/ preceding a nasalized vowel is realized with nasal airflow. Ladefoged & Maddieson (1996:132) provide the following near-minimal pairs:
The point to note regarding the forms in (8a) is that an analysis in terms of underlying vowel nasalization or syllable nasalization seems to be inappropriate. According to such an analysis, we would expect to find nasalized vowels in word-initial position as well as after, say, voiceless stops. Based on the description by Ladefoged & Maddieson, such forms are impossible in Kwangali. Hence, a more appropriate interpretation is to posit an underlyingly nasalized /H/, which contrasts with oral /h/.

Walker & Pullum discuss two examples of Amazonian languages with underlying /H/ that are more controversial. Arabela, a Zaparoan language of Peru, displays rightward nasal harmony that targets vowels, glides, and, presumably, /ɾ/, which occurs predictably in word-final position following an open syllable. The forms in (9a) show that nasalization is triggered by nasals; the forms in (9b) indicate that nasalization is also triggered by /h/, which is invariably realized as nasalized phonetically (the Arabela data are taken from Rich 1963:234):

(9)  a. mõnû? ‘to kill’  b. Hûû? ‘a yellow bird’
    mõñû? ‘swallow’  Hêêq? ‘termites’
    kironi? ‘deep’  Hîõ? ‘old woman’

In contrast to the languages considered so far, Arabela lacks oral /h/. This is unexpected from a markedness perspective. Indeed, there is some support for an alternative interpretation of the Arabela facts. According to Rich, Arabela has the nasals /m n H/, which might be taken to suggest that /H/ is derived from historical *η. The fact that this change affected *η and not *m and *n is unsurprising, since in voiced segment types velar place is relatively unstable as compared to labial and coronal place. In Element-based Dependency the change from *η to /H/ can be interpreted as involving the loss of both velar place and the stop component /ɾ/, as is illustrated in (10):

---

8 This type of asymmetry is discussed in more detail in §7.2.1 (see also §5.2.3.1).
If this diachronic scenario is correct, then we are dealing synchronically with a placeless nasalized glide rather than with a nasalized laryngeal.

More direct evidence for a relation between [ŋ] and [H] can be found in Aguaruna, a Jivoroan language of Peru (cf. Payne 1974; see also Walker & Pullum 1999). According to Payne, [H] triggers bidirectional nasalization that targets vowels and glides, and is blocked by other consonants. This is illustrated by the forms in (11):

(11)  aHûm  ‘later’
      tsûH  ‘fish’
      sûHk  ‘beads’
      kûHû  ‘porcupine’
      sakâHû  ‘skeleton’

An analysis of Aguaruna in terms of underlying /H/ does not seem warranted since, as Payne notes, [H] is in complementary distribution with [ŋ]: the former is found in onsets and the latter in codas. It is therefore reasonable to suggest, as Payne does, that [H] is derived through debuccalization of /ŋ/ (see also Trigo 1988). In Element-based Dependency, this process can be accounted for in terms of the removal of the elements [ŋ] and [A] from the nasal, as is represented in (10) above. Note, again, that this analysis implies that [H] is a sonorant rather than a laryngeal phonologically.

The data considered in this section show that there are good grounds for recognizing the possibility of nasalized laryngeals, both at the level of surface and underlying structure. However, it should be observed that all examples of underlyingly nasalized laryngeals considered so far involve /h/. This begs the question whether there are any languages that have underlyingly nasalized /ʔ/ and, should this not be the case, whether there is any principled explanation for the absence of this segment type.

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9 It is intriguing that [h] and [ŋ] are in complementary distribution in a language like English. This observation has been used to argue that complementary distribution alone is not sufficient to conclude that two sounds are derived from a single phoneme (see e.g. Pike 1947). The Aguaruna facts suggest that [h] and [ŋ] might have more in common than is traditionally assumed. See Matisoff (1975) for some speculation on this issue.
As was observed in relation to Sundanese above, the recognition of nasalized [?] as a possible segment type depends on one’s definition of nasality. If nasality is defined in terms of nasal airflow, as in Cohn (1990), then [?] cannot be nasalized. If, on the other hand, nasality is defined in terms of velic lowering, as in Walker & Pullum (1999), then there is no a priori reason why /?/ should not be potentially contrastive. Like McCarthy, Walker & Pullum observe that an argument against recognizing contrastively nasalized /?/ is that this segment is perceptually non-distinct from oral /?/. But, as Walker & Pullum (1999:776) point out, perceptual distinctness is not the only prerequisite for an underlying contrast:

Sounds can be detected not only through their acoustic properties but also via the acoustic consequences of their effects on neighbouring segments. A child in the language acquisition phase could easily discover that a glottal stop was nasal: all that would be necessary is an identifiable spreading process in the language.

Note that this observation ties in with the spreading of nasalization that is typically observed in the case of nasalized approximants (see §3.3). The fact that such segments are perceptually similar to their oral and fully nasal congeners makes them marked as an underlying segment type, but this is in some sense compensated for by spreading the contrastive property across a larger domain. This point holds a fortiori for nasalized glottal stops, which, in perceptual terms, are not similar but identical to their oral congeners.

Like Walker & Pullum, I do not know of any clear examples of languages which have an underlying contrast between oral and nasalized glottal stop. However, I would like to propose that at least some cases of “spontaneous nasalization” qualify as evidence for the existence of underlyingly nasalized /?/.

I consider this type of nasalization in more detail in §6.1.1.

6.1.1 Spontaneous nasalization

The laryngeal-induced nasalization processes discussed above all involve nasalization by underlying /H/, which, in each of the languages considered, contrasts with /h/.10 Aside from such processes, there are also processes of vowel nasalization that are triggered by laryngeals which do not contrast in terms of nasalization. These processes involve what is sometimes referred to as “spontaneous nasalization” (cf. Grierson 1922, Ohala 1972, 1975, Ohala & Ohala 1993). Spontaneous nasalization forms part of the complex of naso-laryngeal interactions that Matisoff (1975:265) terms “rhinoglottophilia”, i.e. “the mysterious connection between nasality and glottality”. In this section, I

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10 The exception is Arabela, which has /H/ but not /h/; recall, however, that there are grounds for analyzing /H/ as a placeless sonorant.
briefly discuss some instances of spontaneous nasalization. As we will see, this type of nasalization typically applies in a rather erratic and irregular manner. However, at least some of the cases that will be considered provide evidence for underlyingly nasalized laryngeals, including nasalized glottal stop.

Consider first of all the following facts from Thai. As Matisoff (1975:266) observes, in northeastern dialects of Thai vowels are allophonically nasalized after nasals and after /ŋ/ (see also Noss 1964, Harris 1972). Some examples are given in (12):

(12) /məa/ [mā] ‘come’
/heː/ [hē] ‘parade’
/ʔɔ̠ɔk/ [ʔōk] ‘leave, depart’

Matisoff notes that in central dialects of Thai, including the Bangkok dialect, only the mid and low vowels /e a ɔ/ are affected. This situation is similar to that in Mal, a Mon-Khmer language of northern Thailand, where /e a ɔ/ are nasalized after /ŋ/, and /h/ after /h/ (cf. Purnell 1972). With regard to Thai, Harris (1972:18) observes that some speakers always realize /ŋ/ as nasalized, and that this [ŋ] always conditions the presence of a following nasalized vowel. This suggests that, for some speakers at least, underlying /H/ must be recognized. Matisoff’s description of Thai suggests that the same point can be made with regard to /ŋ/.

In some southern dialects of Thai, nasalized /h/ can be traced back to an earlier nasal consonant. According to Li (1977), modern Thai dialects have both /ŋ/ and /ŋ/- as reflexes of Proto-Thai *ŋ- (see also §5.2.3.1). Li (1977:206) observes that these “dialects are not consistent in having either /ŋ/ or /ŋ/- throughout”. Consider as an illustration some reflexes of *ŋ- in a number of modern Thai dialects:

(13) Proto-Thai Siamese Lungchow Po-ai
  *ŋŋ- ŋaai haaï haaï  ‘moonlight’
  *ŋŋ- haau - ŋaau ‘to yawn’
  *ŋŋ- ɲɪk hīk ɲiik ‘gum, palate’

Li further notes that dialects which have h- as a reflex of both *ŋ- and *ŋŋ- are much more restricted. The survey of dialects in Brown (1965) contains eight such dialects, Krabi, Nakhon, Thung Song, Trang, Khuan Khanun, Hua Sai, Songkhla and Ranot, all spoken in southern Thailand. In three of these, i.e. Krabi, Songkhla, and Hua Sai, the present-day reflex is transcribed by Brown as /H/, i.e. a nasalized laryngeal fricative which contrasts with oral /h/-. As regards these laryngeals, Brown (1965:61) notes that:
A phonetically, /hur/ and /Hr/ are [húr] and [hₜuᵲ], but it is out of the question to consider nasalized vowels as phonemic since they occur only after [h].

In the remaining five dialects we find /h-/ rather than /H-. It seems reasonable to suggest that here *hn- has merged with *h-, possibly via intermediate /H-/. These developments are summarized in (14), where I take Songkhla and Nakhon as exemplars of southern dialects, and Siamese as an exemplar of a central dialect:

\[
\text{Proto-Thai} \quad \text{Siamese} \quad \text{Songkhla} \quad \text{Nakhon}
\]

\[
\begin{array}{cccc}
*\eta- & /\eta/-h-/ & /\eta/- & /h-/ (< /H-/) \\
*hn- & /\eta/- & /H- & /h-/ (< /H-/) \\
*h- & /h- & /h- & /h-/ \\
\end{array}
\]

Hence, in southern dialects of Thai such as Songkhla, nasalized /h/ is historically derived from a velar nasal.

Essentially the same diachronic scenario is observed in Sui, a language related to Thai, where the aspirated nasals in southern dialects of Sui correspond to /H/ in northern dialects of Sui (cf. Haudricourt 1967). On the assumption that aspirated nasals consist of nasal manner and dependent |H| (see §5.2), we can interpret this development as having involved the loss of both the manner element |n| and the place component of the nasal, with a concomitant shift in the dependency relation between |L| and |H|:

\[
\text{(15)} \quad \begin{array}{cccc}
O & O & O \\
L & H & < & H & L \\
\eta & < & H \\
A & \end{array}
\]

Haudricourt observes that nasalized vowels in northern dialects of Sui occur only in the context of a preceding /h/ or /ʔ/, and notes that the same situation is found in a number of Austro-Asiatic languages, e.g. Sedang, Jeh, and Halang, as well as in the Semai and Sekai dialects of Malay.

While nasalized /h/ in Thai and Sui derives from a historical nasal consonant, there are also languages in which /h/, and sometimes also /ʔ/, have independently acquired nasalization. This is the case in for instance Lisu, Lahu, 11

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11 The diachronic origin of aspirated nasals in Tai-Kadai, the language family of which both Thai and Sui are members, was discussed in §5.2.3.1.
Phunoi, and Bisu, Burmese-Loloish languages that are spoken in the border area of China, Burma, and Thailand.

With regard to Lisu, both the context and conditioning factor of vowel nasalization are not entirely clear. According to the description of Fraser (1922), initial onsetless syllables are realized with a nasalized vowel. However, as Matisoff (1975) points out, such vowels begin with [?] phonetically, which might be interpreted to mean that vowel nasalization is triggered by glottal stop. Fraser further notes that syllables beginning with nasalized /h/ are realized as nasalized throughout. According to the description in Bradley (1979), however, some Lisu speakers report that [H] and [?] do not contrast with each other in native words. Finally, Hope (1976) states that Lisu /h/ is realized as [H] before high vowels and is in free variation with [h] before non-high vowels. Hope (1976:134) gives the examples [H] ‘house’ and [he] (~ [Hê]) ‘yet’, noting that [H] always cooccurs with a following nasalized vowel. Hope’s description suggests that nasalization is more general after /m n ŋ/ and [?], where all vowels surface as nasalized.

With regard to Lahu, Matisoff (1973b, 1975) notes that distinctively nasalized vowels occur in Shan, Burmese, and Thai loanwords only. According to the description in Matisoff (1973b), vowel nasalization in native Lahu words is conditioned by a preceding nasal; compare for instance Matisoff’s (1973b:20) transcription of the diminutive markers /mu/ and /mwe/ as [m uy ] and [m uy ê]. Confusingly, Matisoff (1975:267) maintains that in Lahu “nasal consonants do not have any noticeable effect on the following vowel”. The nasalizing effect of /h/, on the other hand, is unmistakable: Matisoff (1973b:20-1) notes that Lahu has “optional vowel nasalization that occurs (even in native syllables) with the vowels -a or -o, where the initial consonant is h- or zero”. Consider the examples in (16), where I omit tonal specifications:

(16)

<table>
<thead>
<tr>
<th></th>
<th>‘four’</th>
<th>‘elephant’</th>
<th>‘to coil’</th>
<th>‘water buffalo’</th>
<th>‘spirit’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[ô ~ ɔ]</td>
<td>[hô ~ hɔ]</td>
<td>[hôʔ ~ hɔʔ]</td>
<td>[ôqa ~ ɔqa]</td>
<td>[ôhâ ~ ɔha]</td>
</tr>
<tr>
<td></td>
<td>‘four’</td>
<td>‘elephant’</td>
<td>‘to coil’</td>
<td>‘water buffalo’</td>
<td>‘spirit’</td>
</tr>
</tbody>
</table>

Note that the nasalization of word-initial vowels does not seem to be due to the effect of a preceding laryngeal, given that Matisoff (1975:267) observes that Lahu does not have a phonetic glottal stop in this context. It is also impossible to attribute nasalization in this environment to an [h]-like on-glide, given that the forms in (16) show that the presence of /h/ is contrastive with its absence. If this kind of nasalization is indeed regular, as Matisoff suggests, then how should we account for it? One interpretation would be to assume that initial vowels are preceded by a nasalized vowel-like on-glide, which consists of a placeless vocalic manner component and a dependent element \( [L] \). This \( [L] \) would then spread rightwards to the following vowel:
It should be emphasized that this account is extremely speculative. Part of the problem is that it is unclear just how regular word-initial vowel nasalization is, and whether it occurs in any languages other than Lahu.

The origin of vowel nasalization in Phunoi and Bisu was discussed in §5.2.3.2. There the focus was primarily on the diachronic relation between nasalized vowels and aspirated nasals, although I noted that some occurrences of nasality in Phunoi and Bisu were due to an independent process of nasalization that was triggered by glottal stops. Some examples are given in (18), repeated from (51) in §5.2.3.2:

(18)  
<table>
<thead>
<tr>
<th>Proto-Loloish</th>
<th>Proto-Bisoid</th>
<th>Phunoi</th>
<th>Bisu</th>
</tr>
</thead>
<tbody>
<tr>
<td>mi</td>
<td>men</td>
<td>m'</td>
<td>?amen</td>
</tr>
<tr>
<td>?-mwe</td>
<td>hmu(t)</td>
<td>?â</td>
<td>?an hmnu</td>
</tr>
<tr>
<td>?-nak</td>
<td>hna</td>
<td>?â</td>
<td>?an hna</td>
</tr>
</tbody>
</table>

As was noted, this nasalization is observed in the prefix /?â∼/?an/, which derives from Proto-Tibeto-Burman *?o-. The different reflexes in Phunoi and Bisoid suggest that the prefix had the form *?â- in Proto-Bisoid, with a subsequent change to /?an/ in Bisu. We can think of this development as having involved the “unpacking” of vowel nasalization (see Paradis & Prunet 2000).

The difference between languages like Thai and Sui and languages like Lisu and Lahu is that in the latter two nasalization in laryngeals does not have a diachronic source. The reconstruction of Proto-Loloish in Bradley (1979) suggests that /H developed from a variety of Proto-Loloish sounds, including oral sonorants and *x. The velar fricative has merged with *f in all Loloish languages except Lisu, where its reflexes are /x/ and /Ĥ/. (cf. Bradley 1979:153).

To sum up, the preceding discussion shows that descriptions of spontaneous nasalization phenomena are often vague and inconclusive. Nevertheless, some of these descriptions suggest that in a number of languages, such as Lahu, Sui, and in some southern dialects of Thai, spontaneous nasalization is sufficiently regular to warrant underlyingly nasalized laryngeals. In other languages, such as Lisu, more data is required to shed light on the generality of spontaneous nasalization.

Inspection of spontaneous nasalization in other languages suggests that the process is not as regular as nasal-induced vowel nasalization. While the latter type of nasalization usually applies in an across-the-board fashion, spontaneous nasalization typically applies in a more erratic manner. Moreover, the available
descriptions of languages that display spontaneous nasalization do not always indicate whether this nasalization is obligatory or optional, whether it targets all or only some vowels, and whether it affects all or only some words. Examples of languages in which spontaneous nasalization appears to have a restricted distribution include Arakanese (Bradley 1985b), Kuy (Johnston 1976), Phlong (Cooke et al. 1976), Kisi (Childs 1991), and perhaps Gourmantché (Dell 1993). With regard to Kisi, Childs notes that spontaneous nasalization is restricted to ideophones.

The haphazard nature of spontaneous nasalization can also be observed in languages in which there is evidence for a diachronic process of spontaneous nasalization. For instance, Hetzron (1969) notes that some languages of the Gurage branch of Semitic have nasals in contexts where other Semitic languages have a laryngeal or guttural consonant. Some representative correspondences are given in (19):

(19) Semitic      Gurage
    a. *str       : antārā (Zway)    ‘pea’
    b. *ḥjk       : enke (Ṣālt‘i)    ‘to chew’
    c. *ḥqf       : enqāfā (Ṣālt‘i, Wālāne) ‘embrace’
    d. *ṣwf       : ūf (Zway, Sal’ti, Wālāne) ‘bird’

According to Hetzron, the non-etymological nasals in (19a-c) result from a complex of sound changes in which the gutturals developed into laryngeals, which in turn triggered progressive vowel nasalization. In some Gurage forms the resulting nasalized vowels were subsequently unpacked into sequences of an oral vowel and a following nasal consonant. Presumably, the latter process took place only in case the nasalized vowel was followed by a stop, as in the forms in (19a-c). However, there is reason to believe that spontaneous nasalization did not apply whenever the structural context was met. Leslau (1970) cites several Gurage forms where spontaneous nasalization apparently did not take place, and lists a number of forms which contain non-etymological nasals that cannot be attributed to the presence of a historical guttural.

The effect of spontaneous nasalization in Hindi yields a similar picture. In Hindi, as in all languages with distinctive vowel nasalization, most instances of synchronic nasalized vowels derive from earlier sequences of an oral vowel and a following nasal. However, not all nasalized vowels in Hindi are derived from such sequences. The forms in (20), taken from Ohala (1983:77-90), appear to be the result of spontaneous nasalization:

12 This type of alternation is also observed in other languages. For instance, Polish displays a complementary distribution between nasalized vowels and sequences of an oral vowel and a following nasal, with the former occurring before fricatives and the latter before stops (cf. Van de Weijer 1996).
Regarding these forms, Ohala & Ohala (1993:240) conclude that spontaneous nasalization in Hindi is found in the vicinity of segments that are “characterized by high airflow, including any voiceless fricative, especially [h], aspirated stops, and affricates”.

Arun (1961:73) gives some additional examples of spontaneous nasalization in Hindi and Panjabi, a related Indo-Aryan language. Consider the examples in (20) (OIA denotes Old Indo-Aryan, as reconstructed by Arun):

(20)  
\[
\begin{array}{llll}
\text{[p@û\text{̀}]} & \text{‘attain’ (< Sanskrit /prâghuṝṇa/)} \\
\text{[h@li]} & \text{‘collar bone’} \\
\text{[h@rjà]} & \text{‘sickle’} \\
\text{[h@i]} & \text{‘laughter’ (< Sanskrit /hâśja/)} \\
\text{[P\text{̀}as]} & \text{‘be entangled-IMP’} \\
\text{[d\text{̀}G]} & \text{‘be stuck-IMP’} \\
\text{[sâp]} & \text{‘snake’ (< Sanskrit /sarpa/)} \\
\text{[sâs]} & \text{‘breath’ (< Sanskrit /vâsə/)} \\
\text{[âsui]} & \text{‘tear’ (< Sanskrit /aʃru/)} \\
\text{[e\text{̀}G]} & \text{‘bite-IMP (used only for snake bites’)} \\
\end{array}
\]

The developments in (21a) show that in Hindi and Panjabi spontaneous nasalization occurred in some forms, but not in others. Arun notes that the effect of spontaneous nasalization is stronger in Panjabi. Observe in (21a) that the reflex of *[h] in Panjabi is a falling tone on the preceding (or in some cases following) vowel.\(^{13}\) Hindi and Panjabi show parallel developments in the forms in (21b).

Arun (1961:96) further notes that in Hindi the velar nasal in synchronic [ṅk\text{̀}] clusters is often due to spontaneous nasalization:

OIA has a number of words having two forms, one with the nasal and the other without it, e.g. ukhati–un̄khati; makhati–man̄khati, etc. Most probably it was dialectal variation … Modern Hindi/Panjabi forms with nasals derive from nasalizing dialects.

\(^{13}\) I observed in §5.2.4 that the typical reflex of *h is a high tone. The low tone reflex in Panjabi could be due to the fact that *h was phonetically voiced [fi], as it is in present-day Panjabi and Hindi.
Some representative examples are given in (22a). The forms in (22b) show that not all instances of OIA -kh- develop into [ŋk]. Note here that the nasalized vowel in Hindi [mūḥ] and Panjabi [māː] is presumably due to the nasalizing effect of /h/. This laryngeal subsequently developed into low tone in Panjabi (in (22) OIA denotes Old Indo-Aryan and MIA denotes Middle Indo-Aryan, as reconstructed by Arun):

(22)  

<table>
<thead>
<tr>
<th>Sanskrit</th>
<th>Prakrit</th>
<th>Hindi</th>
<th>Panjabi</th>
</tr>
</thead>
<tbody>
<tr>
<td>pakṣa</td>
<td>pakṣa</td>
<td>pāṅkṣa</td>
<td>pāṅkṣa</td>
</tr>
<tr>
<td>kakṣa</td>
<td>kaṅkṣa</td>
<td>kāṅkṣa</td>
<td>kaṅkṣa</td>
</tr>
</tbody>
</table>

b.  

<table>
<thead>
<tr>
<th>OIA</th>
<th>MIA</th>
<th>Hindi</th>
<th>Panjabi</th>
</tr>
</thead>
<tbody>
<tr>
<td>mukha</td>
<td>muha</td>
<td>mūḥ</td>
<td>māː: ‘mouth’</td>
</tr>
<tr>
<td>jekhara</td>
<td>seharao</td>
<td>seh(a)ra:</td>
<td>sēra: ‘chaplet’</td>
</tr>
<tr>
<td>kaphoṇi</td>
<td>kahoṇi</td>
<td>kohni</td>
<td>kūmi: ‘elbow’</td>
</tr>
</tbody>
</table>

While in the forms in (20) and (21) nasalization can conceivably be attributed to high airflow segments, the nasalization in the forms in (22a) appears to be the result of the combination of velar place and voiceless aspiration. The general development observed for intervocalic aspirated stops is that they reduce to /V/, as can be seen in (22b) for some instances of /VkV/. The general change affecting intervocalic unaspirated stops, including /VkV/, is that they were voiced, spirantized, and subsequently deleted in Middle Indo-Aryan.

The status of spontaneous nasalization in Hindi appears to be fairly representative of the cross-linguistic status of this process. First, spontaneous nasalization typically affects vowels after /h/. Second, spontaneous nasalization is generally progressive, although some instances of regressive nasalization are also found. Third, spontaneous nasalization as a diachronic process tends to target a limited number of forms only; in this respect, synchronic and diachronic processes of spontaneous nasalization have the same effect. With regard to Hindi, Ohala (1983) claims that the forms in (20) contain all instances of nasalized vowels in Hindi that are due to spontaneous nasalization. Given their restricted occurrence, it is perhaps not surprising that spontaneously nasalized vowels, in Hindi as well as in other languages, are rather unstable. Regarding Hindi, Ohala (1983) notes that some of the forms in (20) have alternative realizations without nasalized vowels. The facts considered suggest that most processes of spontaneous nasalization are too erratic to leave, or to have left, a firm imprint on the language concerned.

---

14 Bearing in mind the subsequent loss of -h- and the concomitant development of tone in Panjabi.

15 It is dubious whether this is correct, since the list in (20) does not contain most of the examples cited by Arun.

16 In fact, Ohala (1983:78,90) gives both [pʰʊɾ] and [pʰɾʊɾ], but this is probably unintentional.
6.1.2 Discussion

The number of languages with spontaneous nasalization is such that the interaction between laryngeals and nasality merits an explanation. In this regard, the first question that must be asked is whether spontaneous nasalization is in some way phonetically motivated. A number of accounts have been advanced in this respect.

Matisoff (1975:267) observes that spontaneous nasalization is manifested in everyday life when we utter a ponderous ‘hmm’, emit a perplexed ‘huh?’, or when we ‘hum’ along with a song. Or consider the following scenario:

When you arrive home exhausted with two armfuls of groceries, and finally sink into a chair, you might well utter the syllable [h̩] as you sigh with relief.

Matisoff offers an impressionistic interpretation of this phenomenon: when uttering the syllable [h̩], the articulators are in their most relaxed position, with both the velum and the velopharyngeal port opened and the tongue in a neutral, central position for the schwa. According to this view, spontaneous nasalization is therefore essentially caused by ease of articulation.

It is interesting to observe that this interpretation is at odds with the approach to segment inventories in Ní Chiosáin & Padgett (1997). Ní Chiosáin & Padgett claim that the two forces shaping contrastive segment specifications are perceptual distinctness and articulatory markedness. Perceptual distinctness refers to the requirement that for two segments to contrast, there must be a perceptual difference between them. As far as glottal stop is concerned, perceptual distinctness evidently does not favour an underlying nasalization contrast. Articulatory markedness refers to the requirement that segments must be minimally complex in terms of the articulatory gestures of which they are composed. Ní Chiosáin & Padgett argue that articulatory markedness favours a language with a single glottal stop to have oral /薄弱/. Note, however, that [薄弱] requires active raising of the velum, so it is questionable whether an oral glottal stop is articulatorily less complex than its nasalized congener. Consider also the observation that during regular breathing it is “unmarked” for the soft palate to be lowered. Perhaps some languages, such as Lahu, have phonologized this velic lowering to the extent that word-initial (or perhaps utterance-initial) vowels are nasalized. The fact that we also find nasalization in case initial vowels are preceded by laryngeals could then be accounted for by Ohala’s (1972:1168) observation that “[i]t is possible to produce acoustically acceptable versions of [laryngeals] regardless of the state of the soft palate”.

As Matisoff (1975:271) notes, an explanation of spontaneous nasalization that appeals to articulatory inertia can be characterized as a “negative explanation”, in the sense that it explains the occurrence of nasalized laryngeals in terms of something that speakers fail to do (i.e. raise the velum). While this explanation might account for some instances of spontaneous nasalization, there
are also some instances—particularly those that involve an underlying contrast between oral and nasalized laryngeals—which require a positive explanation. This type of account is offered by Ohala & Ohala (1993) (see also Ohala 1975). They observe that segment types which trigger spontaneous nasalization typically involve a high rate of airflow, resulting in a relatively wide glottal opening. This glottal opening, Ohala & Ohala argue, spreads to a following vowel due to coarticulation, where it creates an acoustic effect that is similar to oro-nasal coupling. As a result, such vowels may be reinterpreted as nasalized by listeners, thus precipitating sound change.

The claim that spontaneous nasalization is associated with high-airflow segments is supported by Hindi, where nasalized vowels mostly occur in the vicinity of /h/, but, in some isolated cases at least, also in the context of an aspirated stop, sibilant, or affricate. The question is whether Ohala & Ohala’s account can be extended to include glottal stop. It could perhaps be argued that the release stage of \[g\] produces an effect similar to that of \[h\].

Another question is whether the presence of spontaneous nasalization in a language depends on the presence of “normal”, nasal-induced nasalization. With the possible exception of Lahu, cross-linguistic evidence suggests that it does. A reason for this might be that nasalization must be present in the phonological system of a language in order for a listener to be able to reinterpret the effect of laryngeals as nasalization. This does not take away the fact that spontaneously nasalized vowels are unstable, both synchronically and diachronically. I suggest that this instability is due to the lack of a clear conditioning context. Diachronically, spontaneously nasalized vowels tend to lose their nasality, as in Hindi (where nasality may even shift to another vowel), or are “unpacked” into a sequence of an oral vowel and a following nasal, as in Inor and Bisu. Note that these processes do not normally target nasalized vowels that are nasalized by nasals, presumably because for such vowels the conditioning factor is more robust.

As far as I am aware, no current model of segmental structure provides an adequate characterization of the nasalizing effect of laryngeals. The facts considered suggest that some abstract element is involved that has the general interpretation of “(high) airflow” in laryngeals and of nasalization in vowels. I leave the nature of this element for further research; here I offer a rather more informal interpretation of the process in terms of Element-based Dependency. I suggest that spontaneous nasalization involves the three stages in (23):

---

17 Matisoff observes that spontaneous nasalization is more likely to affect low vowels (see also Ohala 1972). The data considered above suggest that this may hold for /i/ but not (or not always) for /h/, which in some languages, such as Mal and Lisu, appears to target /i/ only.

18 According to Ohala (1993), this would be a typical sound change, in the sense that it is perceptually rather than articulatorily motivated.
The development from stage 1 to stage 2 involves the emergence of vowel nasalization, a phonological change that is the result of reinterpretation of the laryngeal airflow gesture as nasalization; the representation of this change is the main challenge facing a theoretical account. The change from stage 2 to stage 3 involves leftward transfer of nasalization from the vowel to the laryngeal. This process produces an underlingly nasalized laryngeal, and makes it possible to express the generalization that nasalized vowels occur in the environment of a preceding laryngeal.

6.2 Alternations between nasals and laryngeals

Matisoff (1975) maintains that spontaneous nasalization by laryngeals is an illustration of rhinoglottophilia, i.e. the relation between nasality and laryngeal articulations. In this section, I briefly consider some other types of processes which involve a phonological interaction between nasal and laryngeal articulations. While these processes might be argued to fall under the rubric of rhinoglottophilia, we will see that for most of these processes an alternative, though rather abstract, analysis is available.

Alternations between nasals and [h] are found in among others a number of North American languages. An example of such a language is Kitsai, a Caddoan language formerly spoken by a small group now associated with the Wichita tribe. Bucca & Lesser (1969) observe that in Kitsai /n/ is realized as [h] when preceding a voiceless stop, as in (24):

(24)  

<table>
<thead>
<tr>
<th>(23)</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>H/?</td>
<td>L</td>
<td>H/?</td>
<td>H/?</td>
</tr>
<tr>
<td></td>
<td>place</td>
<td>place</td>
<td>place</td>
</tr>
<tr>
<td></td>
<td>[ha, ʔa]</td>
<td>[hā, ?ā]</td>
<td>[hā, ?ā] (←/Hu, ʔa/)</td>
</tr>
</tbody>
</table>

A similar process can be observed in a pattern of verbal inflection in the Algonquian language Cree. Ahekanew (1987) notes that Cree verbs containing a stem-final coronal nasal select the third person endings -k and -kik. In such cases, the nasal surfaces as [h]. A reasonable interpretation of this process is to posit an underlingly aspirated coronal nasal, as in (25):

(25)  

<table>
<thead>
<tr>
<th>(25)</th>
<th>kukuñunā/n+iʔs/akya → kukuñunā[h̥is]akya  ‘stuck in the ground’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ahunā/n+k/i → ahunā[hk]i  ‘hoes’</td>
</tr>
<tr>
<td></td>
<td>kusa/n+iʔatsiu → kusa[h̥]atsiu  ‘house grass’</td>
</tr>
</tbody>
</table>
Given (25), the surface realizations can be accounted for if we assume that the nasal manner component is deleted when /n/ occurs before a voiceless stop, and dependent [h] is deleted elsewhere. Note that this interpretation is abstract to the extent that the underlying form is never phonetically realized. An argument in favour of this scenario is that it mirrors the historical situation: the origin of the aspirated nasal is in all likelihood due to a historical process of nasal devoicing that was triggered by a following voiceless obstruent (see Bloomfield 1946). I briefly discussed this diachronic scenario in §5.2.2.

Another example of a language which has a surface variation between [n] and [h] is Sarcee. In common with other Athapaskan languages, Sarcee signals the perfective form of the verb by voicing of the stem-final consonant. This is illustrated in (26) for stem-final fricatives (all Sarcee data are taken from Cook 1984:232ff.):

(26)      IMPERF  PERF
- dúː - dúː ‘to crawl’
- yúː - yúː ‘to whistle’
- ðôː - ðôː ‘to chew’

This pattern is obscured by alternations involving other stem-final consonants:

(27)      IMPERF  PERF
- ðàːh - ðiːj ‘to stretch’
- zìː - zìː ‘shoot (arrow)’
- zúː - zúː ‘scrape off’

According to Cook (1984), there is synchronic and diachronic evidence which suggests that the underlying stem-final consonant in (27) is /x/. This /x/ is regularly changed to [h] in final position, while its voiced counterpart /y/ is realized as [j] or [w], depending on the quality of the preceding vowel.

---

19 Examples of this process in Navajo and Chipewyan were considered in §4.2.

20 Note in (26) that /l/ patterns as a (sibilant) fricative.
The forms in (27) indicate that the surface alternation in perfectives and imperfectives is not always transparent. The same is true when the stem-final consonant is a nasal, as in (28):

(28) IMPERF PERF
# V in all contexts
-ʔíh -ʔìn- -ʔìn ‘to have’
-ʔíh -ʔìn- -ʔìn ‘to sing’
-ðíh -ðìn- -ðìn ‘to train’

The forms in (28) show that the alternation [h~n] parallels the voicing contrast found in fricatives. This leads Cook (1984) to suggest that the underlying stem-final nasal is a voiceless nasal /Ø/. Note that we are once more dealing with an abstract scenario: /Ø/ is never realized phonetically and nor does it alternate with [h] since, as is shown by the forms in the second column in (28), we always find [n] before a vowel.

On a final point, the alternation in (28) suggests that the underlying nasal patterns as phonologically voiceless. This raises the question how this alternation can be accounted for in terms of Element-based Dependency, where underlying nasals of the kind in (28) are interpreted as aspirated rather than as voiceless. I suggest that the voicing process that is associated with perfective formation involves the addition of dependent |L| in fricatives, and the deletion of dependent |H| in nasals (and perhaps laterals). This difference is shown in (29):

(29) a. H L b. L H
| |...
| |?
|...

Fricative voicing Nasal deaspiration

In (29) we are dealing with two distinct processes: fricative voicing and nasal deaspiration. What unifies these processes is that they produce a voiced output.

Another potential example of rhinoglottophilia concerns postnasal aspiration, a process in which a nasal triggers aspiration of a following voiceless obstruent stop (i.e. N± → N±h). However, while the emergence of aspiration in the context of nasality may create the impression of being “spontaneous”, here, too, an alternative and rather abstract approach is available.

An example of postnasal aspiration can be observed in Swahili. Swahili displays a morphophonemic alternation between nasals and aspirated stops in the prefixation of the nominal class 9/10 marker. The relevant prefix consists of a nasal consonant that is underlingly unspecified for place. I will represent this
nasal as /N/. The forms in (30), taken from Hinnebusch (1975) and Mpiranya (1995), suggest that the phonetic realization of /N/ depends on both the prosodic shape of the root and the manner type of the root-initial consonant:

(30)  a. /N-bwa/ [Ô bwa] ‘dog’
     /N-ge/ [¹ge] ‘scorpion’

  b. /N-buзи/ [“бузи] ‘goat’
     /N-deге/ [¹deге] ‘bird’
     /N-guo/ [¹guо] ‘cloth’

  c. /N-pja/ [ Ôp³ja] ‘new’
     /N-ta/ [Ô³a] ‘wax’
     /N-ti/ [Ô³hi] ‘country’

  d. /N-pepo/ [p³epo] ‘spirits’
     /N-tembo/ [t³embo] ‘elephant’
     /N-kata/ [k³ata] ‘head pad’
     /N-paa/ [p³aa] ‘gazelle’
     /N-kuu/ [k³uu] ‘big’

Consider first those roots that begin with a voiced stop. If such a root is monosyllabic and has a short vowel, as in (30a), /N/ surfaces as a (stressed) homorganic syllabic nasal. This situation differs from that in disyllabic roots and monosyllabic roots with a long vowel or diphthong, as in (30b). In such forms, /N/ is incorporated into the stop, and the resulting sequence is realized as a prenasalized stop. Consider next the realization of /N/ before voiceless stops. The forms in (30c) illustrate that the nasal prefix is realized as syllabic before monosyllabic roots with a short vowel; in such roots, the voiceless stop surfaces as aspirated. The forms in (30d) show that in disyllabic roots and monosyllabic roots with a long vowel, the presence of /N/ is signalled by aspiration of the stop alone.

Similar to the Kitsai, Cree, and Sarcee facts considered above, I suggest that in Swahili we are dealing with an underlyingly aspirated nasal /N³/. Note again that this interpretation is abstract, since we never find an aspirated nasal at the surface. The only context in which aspiration, i.e. dependent [H], is realized is when it can be associated to a following voiceless stop. This process—postnasal aspiration—can be represented as in (31):

(31) (PFX) O
     [\-----------]
     \     / H ?
      |     |
     ? ... ?
     /N⁺ / [N⁺³]
The pattern of alternation in (30) suggests that the nasal prefix surfaces as syllabic to guarantee that the output of prefixation forms a minimal word. In those cases where the stem already has the required minimal prosodic size, nasal manner is either deleted, as in (30d), or incorporated into the stop, as in (30b). The fact that this incorporation does not take place in case the root-initial stop is aspirated follows naturally from (31): since the dependent position of this stop is already filled by dependent [H], there is no available landing site for nasality.

As was observed, the approach to Swahili nasal prefixation taken here is abstract to the extent that the postulated aspirated nasal never occurs at the surface. Dependent [H] is realized only if it can be associated to a following voiceless stop. [H] is deleted if the root-initial is a voiced stop (presumably because the dependent position of these stops is already occupied by [L]) or any other segment type (presumably because aspiration in Swahili can be contrastive only in stops). As in Cree, there is some historical support for my interpretation of the Swahili facts. The class 9/10 nasal prefix derives from the Proto-Bantu prefix */ni-*. Given this, we may speculate that the high vowel of this prefix underwent devoicing at some point in the history of Swahili, and subsequently merged with the preceding nasal to produce an aspirated /N/. While this scenario requires further research, it is interesting to note that the relation between high vowels, aspiration and nasality can also be found in other Bantu languages, such as Makhulu and Wambo (see §2.3.2).

The final example that I will discuss is a historical process which involves the emergence of a nasal consonant in the environment of a preaspirated stop. The relevant process concerns a diachronic development in the Ponapeic subgroup of Micronesian, which includes Pingelapese, Mokilese, and Ponapean. In these languages, durative aspect is marked by reduplication of the verb. For instance, reduplication of the verb stem /pap-*/ ‘swim’ (derived from Proto-Oceanic *papV-) produces the following results in these languages (cf: Blevins & Garrett 1993:212):

(32) Mokilese /pap+pap/ → [pappap]
Pingelapese /pap+pap/ → [paapap]
Ponapean /pap+pap/ → [pammpap]

As can be seen in (32), reduplication in Ponapean triggers nasal substitution. While this process is not difficult to characterize, it is unclear why /p/ would change to [m] in this environment. Blevins & Garrett (1993:212-5) consider a number of earlier accounts of this process, and conclude that there is no synchronic phonetic motivation for partial geminate nasalization. In order to

21 The fact that the nasal does not surface as syllabic preceding a monosyllabic root with a long vowel can be taken to suggest that minimality is defined at the level of the mora (cf. McCarthy & Prince 1986). In terms of Element-based Dependency, we could say that a monosyllabic root requires a branching nucleus.
account for synchronic nasal substitution, Blevins & Garrett propose a series of
diachronic developments. The first development concerns the emergence of
aspiration in voiceless geminates. This process, they argue, is not phonetically
unnatural, given the observation that a voiceless geminate tends to have a
greater degree of glottal opening than a single voiceless stop. Blevins & Garrett
(1993:219) go on to note that if a voiceless geminate involves a relatively large
glottal opening, then

\[ \text{[h]} \] may produce an effect on vowels that ‘mocks’ that of
nasalization. Because of the open glottis during phonation
accompanying an [h] (or breathy voice), the spectrum of the vowel
will be changed in the following ways: there will be upward
shifting of the formants, especially F1 …, increased bandwidth of
the formants, presence of anti-resonances in the spectrum and an
overall lowering of the amplitude of the vowel … This is identical
to the effect of nasalization on vowels. Articulatory re-
interpretation may occur, i.e., actual nasalization may be produced
on the vowel.

Blevins & Garrett observe that other potential examples of this “articulatory re-
interpretation” are found in the Caucasian languages Bzhedukh and Shapsug,
where vowels following aspirated fricatives are nasalized.22

While the two stages in the diachronic change that led to Ponapean nasal
substitution are phonetically plausible on their own, their combined effect is
phonetically unnatural. From the point of view of synchronic phonology, I
suggest that nasal substitution in Ponapean involves the addition of dominating
[L] to the manner component of the first coda stop, turning the stop into a nasal.

---

22 This scenario could also be responsible for the diachronic development of Proto-Uto-
Aztecan preaspirated stops to Hopi nasal-stop sequences (see Manaster-Ramer 1986).
This is illustrated in (33), where I assume that the \([U]\)-specifications of the two consonants are merged:

\[
\begin{array}{ccc}
C & O & C & O \\
? & + & ? & \rightarrow L & ? \\
U & U & ? & U \\
\end{array}
\]

/...p-p.../ \rightarrow [...mp...]

This synchronic process, while not phonetically motivated, is not difficult to express in phonological terms. We may think of this as an illustration of the fact that phonology is independent from phonetics, in the sense that not all synchronic phonological processes are necessarily phonetically natural.

### 6.3 The interpretation of placeless manner structures

To conclude this chapter, I briefly consider some consequences of the representation of nasalized laryngeals for the Element-based Dependency interpretation of placeless manner structures. Consider again the assumption that elements have a different, but phonetically related, interpretation, depending on their structural context. A case in point is the relation between laryngeals and laryngeal modifications. In their capacity as heads, \[|\] and \[H]\] are interpreted as \[/\] and \[/\], while in their capacity as dependents, they are interpreted as glottalization and aspiration:

\[
\begin{array}{cccc}
a. & O & b. & O & c. & O & d. & O \\
? & H & \ldots & ? & \ldots & H \\
/\text{\textaccentuml{a}{a}/} & /\text{\textaccentuml{a}{a}/} & /\ldots\text{\textaccentuml{a}{a}/} & /\ldots\text{\textaccentuml{a}{a}/} \\
\end{array}
\]

One question that emerges with regard to (34) is whether laryngeals can themselves be laryngeally modified. From a phonetic viewpoint, it is to be expected that the range of laryngeal modifications in laryngeals is severely restricted, since both the laryngeal and the laryngeal modification are produced with the same articulator.

As far as combinations of \[|\] and \[H]\] are concerned, it is reasonable to assume that structures with identical heads and dependents, i.e. glottalized \[|\] and aspirated \[\text{\textaccentuml{a}{a}/}\], are impossible:
I attribute the impossibility of (35a) and (35b) to the OCP. According to this interpretation, the OCP is violated in case there would be complete identity between head and dependent. This is the case only for the structures in (35); that is, while a glottalized or ejective stop like /pʰ/ also has head and dependent /ʔ/, it does not violate the OCP on account of it being also specified for [U].

The question whether the structures in (36) are acceptable is less clear:

(36) a. O b. O

\( /\mathcal{H} / \quad /\mathcal{H} / \)

\( /pʰ/ \quad /h'/\)

(36a) denotes an aspirated glottal stop. As far as I am aware, there are no languages in which this segment type is contrastive. However, since there is neither an articulatory nor a perceptual reason to exclude aspirated glottal stops, there is no a priori reason to rule out (36a). (36b) denotes a glottalized /h/. This segment has been reported to be distinctive in Southern Nambiquara (cf. Price 1976; see also Maddieson 1984, Kroeker 2001), although Maddieson (1984:401) considers the sound to be “obscure”. According to the description in Kroeker, glottalisation is distinctive in both obstruents and sonorants, with the former realized as postglottalized and the latter as preglottalized.\(^23\) The fact that /h'/ is postglottalized suggests that it functions as an obstruent and not as a sonorant. Kroeker (2001:78-9) provides the following obstruent inventory:\(^24\)

(37) p t ð f pʰ tʰ pʰ tʰ s s'

\(k \quad k' \quad k^w \quad k^w' \quad k^h \quad k^{wh} \quad k'\)

\(?\)

Given this inventory, it might perhaps be argued that /h'/ is phonologically velar rather than laryngeal. Kroeker’s description does not contain any evidence bearing on this issue, neither for nor against it. Note, however, that the absence of glottalized /ð/ means that we are dealing with an asymmetric distribution of

\(^23\) Recall that this is in line with the cross-linguistically typical realization of such sounds (see §5.3.1).

\(^24\) The labial fricative is realized as bilabial [ɸ].
glottalization in any case. In line with the sources cited above, I therefore
tentatively conclude that the Nambiquara facts motivate the structure in (36b).
Note, too, that there is some theory-internal support in favour of (36b): given the
assumption that /h/ contains a “sibilant” manner component, and given the fact
that within the class of fricatives there is a preferential association between
sibilant manner and laryngeal modifications (see §2.1.2), we should not rule out
the possibility of glottalized /h/ as a matter of principle.

As argued in §6.1, there are no cooccurrence restrictions on the combination
of laryngeals and dependent [L]. Dependent [L] is also compatible with a
placeless vocalic manner structure. The lack of cooccurrence restrictions here is
unsurprising, given that the interpretation of dependent [L] in these cases is not
laryngeal, but nasal. For the sake of completeness, consider in (38) the Element-

(38)    a.      N
         L L

(b.      O
         L L

Although these structures are marked on account of having dependent structure
in the absence of place, I see no reason why they should be ruled out. Note that,
according to the analysis presented in §6.1, Arabela may be an example of a
language in which (38b) is underlying.

A final comment is in order with regard to the compatibility of laryngeal
manner and distinctive voice. As was noted in §6.1, the hypothesis that
dependent [L] in laryngeals denotes nasalization is based primarily on the cross-
linguistic frequency with which we find laryngeals participating in nasal
harmony. Note, however, that the recognition of nasalized laryngeals predicts
that laryngeals cannot be distinctively voiced. The question whether this is
correct is an empirical issue, of course. To the best of my knowledge, there are
no clear examples of languages which have an underlying distinction between
voiceless /h/ and voiced /ɦ/.25 Distinctively voiced /ɦ/ has been argued to occur
in a number of Wu dialects of Chinese, where it is found in combination with
specific register types (see Duanmu 1990, Kehrein 2002). As Kehrein notes, it is
unclear whether these registers should be analyzed as being derived from /ɦ/, or
vice versa.

At first sight, the impossibility of voiced glottal stop appears to be a
straightforward matter, since glottal closure is incompatible with vocal fold
vibration. However, Ladefoged & Maddieson (1996:76) point out that the sound
transcribed as [ʔ] is in many languages not realized with complete glottal
closure—and incomplete glottal closure is compatible with voicing. The only

25 There are many languages with a single laryngeal fricative that is phonetically realized as
voiced, but that is quite a different matter.
known language where voiced [ʔ] is arguably distinctive is Gimi, a Papuan language of New Guinea. Ladefoged & Maddieson classify the sound as a voiced glottal approximant. If it turns out that voiced /h/ and /ʔ/ are distinctive and contrast with their voiceless counterparts, then I suggest that they can be assigned the following representations:

(39)  

\[
\begin{array}{c|c}
\text{a. } & \text{H} & \text{b. } & \text{ʔ} \\
& \text{L} & & \text{L}
\end{array}
\]

\text{Voiced }/h/ \quad \text{Voiced }/ʔ/ 

Note, however, that this move would imply the possibility of complex placeless manner types. The obvious danger of allowing such structures is that they lead to a proliferation of possible segment types, and thus to a loss of restrictiveness.

6.4 Summary

In this chapter, I have provided evidence in favour of a phonological class of nasalized laryngeals. The evidence for such a class comes primarily from nasalization processes in which laryngeals are targeted by nasalization and, more importantly, from nasalization processes that are triggered by laryngeals themselves. Two such nasalization processes can be distinguished. The first type involves an underlying contrast between an oral and a nasalized laryngeal; this type of contrast is found in, for instance, Seimat. The second type of process involves a single underlyingly nasalized laryngeal; I referred to the nasalization that is triggered by such laryngeals as spontaneous nasalization. Cross-linguistic evidence shows that spontaneous nasalization, while phonetically motivated, typically applies in an erratic manner, affecting some words but leaving others unaffected. Apart from nasalization processes that involve laryngeals, there are also other phonological phenomena that involve interaction between laryngeals and nasals. Some of these, such as the diachronic development of nasals in Ponapean, can be argued to fall under the rubric of spontaneous nasalization, at least from a diachronic perspective. Other processes, such as postnasal aspiration in Swahili, are amenable to an alternative analysis in which aspiration is triggered by an underlyingly aspirated nasal. Underlyingly aspirated nasals can also be posited in Kitsai, Cree and Sarcee, three languages which display a surface alternation between nasals and [h].
Throughout this dissertation, I have proceeded on the assumption that nasals function as a natural class. In this final chapter, I consider a range of data which shows that this is not always the case. We will see that in those cases where nasals display “unnatural” class behaviour, the patterning of specific nasals is, on a superficial level at least, related to differences in their place of articulation.

To put the discussion on a concrete footing, consider some facts from Dutch. First of all, there are good grounds to assume that in Dutch the nasals /m n ŋ/ act as a natural class. This is evidenced for instance in diminutive formation. The forms in (1a) show that in stems with a tense vowel or diphthong, the initial consonant of the diminutive allomorph surfaces as homorganic with a stem-final nasal. The forms in (1b,c) show that the diminutive allomorph surfaces as [-tj] after other sonorants, and as [-ŋ] after obstruents.

(1) | STEM | STEM+DIM |
---|---|---|
| a. raam /ram/ | raampje [rampjə] ‘window’ |
| tuin /tœyn/ | tuintje [tœyntjə] ‘garden’ |
| b. taal /tal/ | taaltje [taltjə] ‘language’ |
| vuur /vyr/ | vuurtje [vyrτjə] ‘fire’ |
| leeuw /lœw/ | leeuwtje [lœwtjə] ‘lion’ |
| trui /troey/ | truitje [troeytjə] ‘jumper’ |
| c. schaap /sxap/ | schaapje [sxaplə] ‘sheep’ |
| voet /vœt/ | voetje [vœtʃə] ‘foot’ |
| boek /bœk/ | boekje [bœkjə] ‘book’ |
| druif /droeyf/ | druifje [droefjə] ‘grape’ |
| vaas /vaz/ | vaasje [vazʃə] ‘vase’ |
| huig /hoeyy/ | huigje [hoeyxjə] ‘uvula’ |

1 The ideas presented in this chapter have been developed together with Erik Jan van der Torre (see Botma & Van der Torre 2001; see also Van der Torre 2003).

2 I assume here that the basic distinction in the Dutch vowel system is between tense and lax vowels (see Van Oostendorp 2000a). The tense series is phonetically long; the lax series is phonetically short.

3 The realization of <tj> varies between [tj], [tʃ], and [ɕ]; <sʃ> is usually realized as [ʃ] (see also §2.3.2).
In Dutch, /ŋ/ does not occur after tense vowels and diphthongs, so that /m n ŋ/ cannot be compared in this context. However, evidence for the class behaviour of /m n ŋ/ can be found when we consider the pattern of diminutive allomorphy in disyllabic trochaic stems. In case such a stem ends in a nasal, as in (2a), the initial consonant of the suffix surfaces as homorganic with this nasal. Other sonorant-final stems of this type select the allomorph [−tja], as in (2b):4

(2)    STEM          STEM+DIM
      a. bezem /bezəm/    bezempje [ˈbezəmpje] ‘broom’
       harem /hɑrm/     harempje [ˈhɑrempje] ‘harem’
       varken /vɑrkən/   varkentje [ˈvɑrkəntje] ‘pig’
       keuken /kəkən/    keukentje [ˈkəkəntje] ‘kitchen’
       haring /hɑrɪŋ/    harinkje [ˈhɑrɪŋkje] ‘herring’
       koring /koŋɪŋ/    koninkje [ˈkoŋɪŋkje] ‘king’
      b. lepel /lepəl/    lepeltje [ˈlepəltje] ‘spoon’
       vader /ˈvɑdər/    vadertje [ˈvadərtje] ‘father’
       schaduw /ˈsɑdəw/  schaduwtje [ˈsɑdəwtje] ‘shadow’
       auto /ˈɑutər/     autootje [ˈɑutətje] ‘car’

Thus, in disyllabic trochees /m n ŋ/ trigger assimilation of a following suffix-initial stop.

Nevertheless, closer inspection reveals that Dutch nasals do not always display natural class behaviour. For instance, in the formation of compounds we find optional place assimilation of /ŋ/, but not of /m ŋ/, to a following stop:

(3)    STEM+Dim      SW   ‘SW’
       steen+bok      stee[m]bok ‘Capricorn’
       tram+kaart      tra[m]kaart ‘tram ticket’ (*[ŋk]…)
       meng+paneel     me[m]paneel ‘mixing panel’ (*[mp]…)

In this process, /m ŋ/ therefore pattern together to the exclusion of /ŋ/.

In other cases, the distribution of /m/ differs from that of /n ŋ/. An example of this type of asymmetry can be found in the pattern of allomorphy displayed by the agentive suffix. The forms in (4a) show that monosyllabic verbs select the allomorph -er.5 The situation is more complicated in disyllabic trochaic stems; as the forms in (4b) show, here both -er and -aar are found, with the choice of allomorph depending on the type of stem-final consonant:

---

4 Disyllabic trochees with a final obstruent are extremely rare; such forms select [−ja], as in ganneffe ‘crook-DIM’.

5 A more precise formulation is that -er is the unmarked option, given the existence of forms such as dienaar ‘servant’ and diender ‘policeman’. The point to note here is that these forms have specialized meanings, and appear to be possible only in addition to the morphologically unmarked form diener.
The forms in (4b) show that sonorant-final stems select -aar with the exception of /m/, which patterns with obstruents and selects -er. Note that Dutch does not have /y/-final stems of the kind in (4b), which makes it impossible to compare /m/ with /y/ in this context.

A similar phenomenon can be observed in the alternation between Dutch disyllabic trochaic place names and the way in which their inhabitants are referred to (see Booij 1995:73, Van der Torre 2003:126). Here we find -aar after sonorant-final forms, as in (5a). After obstruent-final forms and forms which end in /m/ we find -er, as in (5b):

(5)  a. Place name       Inhabitant   b. Place name       Inhabitant
     Berkel          Berkelaar        Gennep     Gennepер
     Veghel         Veghelaar        Bunnik     Bunniker
     Assen          Assenaar         Lochem     Lochener
     Putten         Puttenaar        Hattum     Hattumer

The few place names ending in /y/ also select -er. The form in (6a) is a rare example of a disyllabic trochee. The same pattern is found in the names of islands, as in (6c):

Van der Torre (2003:126) notes that forms which end in -er take the suffix -naar, often with concomitant loss of the /er/. This can be attributed to a prohibition on the sequence [rar] (see also Smith 1976, Booij 1995).
(6)  

<table>
<thead>
<tr>
<th>Place name</th>
<th>Inhabitant</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Hollandsche Rading</td>
<td>Hollandsche Radinger</td>
</tr>
<tr>
<td>b. Oude Wetering</td>
<td>Oude Weteringer</td>
</tr>
<tr>
<td>c. Terschelling</td>
<td>Terschellinger</td>
</tr>
</tbody>
</table>

It is reasonable to attribute the selection of -er in (6) to the fact that /ŋ/ cannot be followed by any vowel other than /œ/. This is not the only distributional restriction on /ŋ/ in Dutch. As has been noted on a number of occasions (see e.g. Trommelen 1983, Booij 1995), /ŋ/ is disallowed word-initially, as in (7a), and following tense vowels and diphthongs, as in (7b). In intervocalic position /ŋ/ is permitted only when followed by /œ/, as in (7c); this is the only prevocalic context in which /ŋ/ is allowed:

(7)  

a. *[ŋ]ap  
   *[sŋ]ap  

b. *raŋ, *raŋ cf. rang /rɑŋ/ ‘rank’  
   *raŋk, *raŋk cf. rank /rɑŋk/ ‘slender’  

c. *eŋel cf. engel /eŋel/ ‘angel’  
   *zwɑŋər cf. zwanger /zwɑŋər/ ‘pregnant’

The restriction on intervocalic /ŋ/ is psychologically real for speakers of Dutch. In loans and neologisms, such as bingo and Twingo, <ng> is realized as [ŋŋ] or [ŋŋ], never as [ŋ].

The Dutch facts demonstrate that while nasals form a natural class, different nasals may at the same time exhibit asymmetric behaviour. In the remainder of this chapter, I will hypothesize that differences in the phonological behaviour of /m n ŋ/ result from differences in their place of articulation. More specifically, I will claim that each place of articulation is associated with a specific type of markedness effect. Labial place, as expressed by |U|, is the most consonant-like place. This captures the observation that the asymmetric behaviour of /U/ is typical of stop-like articulations, and that |U| has a preference for consonantal positions (onsets and, within onsets, onset heads) in the prosodic organization. Velar place, as expressed by |A|, is the most vowel-like place. This captures the observation that the asymmetric behaviour of /A/ is typical of vowel-like articulations, and that |A| has a preference for vocalic positions (nuclei and codas) in the prosodic organization. Coronal place, as expressed by |I|, is the most unmarked place of articulation for segments in general. As such, the asymmetric behaviour that is displayed by /I/ is characteristic of the markedness effects which are associated with coronals (see e.g. Paradis & Prunet 1991 and McCarthy & Taub 1991).\footnote{In this chapter I will be concerned only with nasal asymmetries. Van der Torre (2003) provides an in-depth discussion of asymmetric behaviour displayed by other sonorants, and concludes that the facts support the basic hypothesis outlined here.}
This chapter is organized as follows. First, in §7.1, I consider a number of instances of asymmetric behaviour involving /m/. Next, in §7.2, I consider some examples of asymmetric behaviour displayed by /ŋ/. Finally, in §7.3, I briefly examine the issue of coronal unmarkedness in relation to /n/.

### 7.1 Consonantal strength

In this section, I discuss a range of cross-linguistic evidence in support of the claim that in those cases where /m/ shows asymmetric behaviour, this behaviour is characteristic of obstruent stops. Since obstruent stops are the most optimal, least marked consonant type, I interpret the asymmetric behaviour of /m/ as an illustration of “consonantal strength”.

Below, two different types of evidence are considered. First, given that stops are best suited to be combined with dependent structure, we expect to find cases in which /m/, but not /n ŋ/, is compatible with a laryngeal modification. Similarly, we expect to find cases in which /m/, but not /n ŋ/, can appear as the leftmost member of a complex onset. I provide some examples of such asymmetries in §§7.1.1 and 7.1.2. The second type of evidence comes from processes in which /m/ displays natural class behaviour with obstruents to the exclusion of /n ŋ/. I examine some examples of such processes in §7.1.3. In §7.1.4, I briefly consider how the observed asymmetries can be interpreted in terms of Element-based Dependency.

#### 7.1.1 Laryngeal modifications

One argument for taking stops to be the unmarked consonant type is that stops are best suited to be combined with a laryngeal modification (see also §2.1). This is supported by the observation that the consonant inventory of a given language has the maximum range of laryngeal contrasts in its stop series (see Maddieson 1984). If /m/ displays consonantal strength, we expect to find evidence which shows that, of /m n ŋ/, /m/ is best compatible with a laryngeal modification. Inspection of UPSID (Maddieson 1984) reveals that there is some support for this expectation. As regards voiceless nasals for instance, Maddieson (1984:60) observes “a preferential association between bilabial place and voicelessness”.

However, when it comes to the distribution of laryngeal modifications across /m n ŋ/, the most striking asymmetry is observed for /ŋ/, which is least suited to be combined with a laryngeal modification.

The table in (8) gives an overview of the distribution of voicelessness across /m n ŋ/ (and, where present, across other nasals) for each of the languages in

---

8 This statement is based on the number of bilabial voiceless nasals nasals as compared to the complete number of voiceless nasals in the corpus.
UPSID with voiceless nasals.\(^9\) For each of these languages, I also give the inventory of plain nasals. Recall here the observation that the presence of a laryngeally modified nasal implies the presence of the corresponding plain nasal (see §5.1).

\[(8) \begin{array}{cccc|c}
\varepsilon & \emptyset & \ddot{\imath} & \text{Other} & \text{Plain nasals} \\
\hline
\text{Sedang} & \checkmark & \checkmark & \checkmark & ! & m \, n \, p \, \eta \\
\text{Sui} & \checkmark & \checkmark & \checkmark & ! & m \, n \, p \, \eta \\
\text{Burmese} & \checkmark & \checkmark & \checkmark & - & m \, n \, p \, \eta \\
\text{Hopii} & \checkmark & \checkmark & \checkmark & - & m \, n \, p \, \eta^w \\
\text{Aleut} & \checkmark & \checkmark & \checkmark & - & m \, n \, \eta \\
\text{Yao} & \checkmark & \checkmark & \checkmark & ! & m \, n \, p \, \eta \\
\text{Mazahua} & \checkmark & \checkmark & \checkmark & - & m \, n \, \eta \\
\text{Lakki} & \checkmark & \checkmark & \checkmark & - & m \, n \, \eta \, \eta^w \, \eta^j \\
\text{Iai} & \checkmark & \checkmark & \checkmark & - & m \, n \, \eta \, \eta^j \\
\text{Klamath} & \checkmark & \checkmark & \checkmark & - & m \, n \\
\text{Otom} & \checkmark & \checkmark & \checkmark & - & m \, n \\
\end{array} \]

In (8) we observe that 4 out of 11 languages have /\varepsilon \emptyset \ddot{\imath}/ (=36.4%).\(^{10}\) This percentage is surprisingly low, given that we normally expect a particular laryngeal modification to be evenly distributed across all places of articulation. Significantly, all languages in UPSID with voiceless nasals minimally have /\varepsilon/.

This would suggest that a contrast in nasals in terms of voicelessness must be minimally present in /m/. I have found only two languages which have voiceless nasals but lack /\varepsilon/, Icelandic (e.g. Árnason 1980) and Tee (Ladefoged 1991); both languages have /\emptyset/ only.\(^{11}\) As far as I am aware, there are no languages in which a contrast in voicelessness is restricted to /\eta/.

Consider next the distribution of breathy voice across /m \, n \, \eta/. UPSID contains a mere two languages with breathy voiced nasals, Hindi and Zhu'hõasi.

---

\(^9\) It will be recalled that I reject a phonological category of voiceless nasals (see §5.2); however, this does not affect the point at issue.

\(^{10}\) Maddieson (1984) describes Iai as lacking /\emptyset/, but this appears to be incorrect. Tryon (1968), Maddieson’s source for Iai, includes /\emptyset/ in the consonant inventory of Iai, and gives several (near-) minimal pairs which indicate that the sound is distinctive. Note, too, that the sounds which Maddieson describes as /\eta^w \varepsilon \ddot{\imath}/ are described by Tryon as /\eta^w \varepsilon^w/. This notation might reflect a velarized realization; note that segments such as /p^v/ are often described as velarized in Oceanic languages.

\(^{11}\) I assume for the sake of the argument that Icelandic <hn> functions as a single segment (see §5.4.2 for discussion of this issue). In Element-based Dependency, all laryngeally modified nasals in (8) involve complex subsyllabic constituents. Note that if Icelandic <hn> is analyzed as a cluster, an explanation is still required for the fact that /hn/ is possible, whereas /hm/ is not.
Here, too, we find the expected type of asymmetry; note in (9) the absence of a breathy voiced /ŋ/.

(9)  

<table>
<thead>
<tr>
<th>Hindi</th>
<th>Other Plain nasals</th>
</tr>
</thead>
<tbody>
<tr>
<td>ŋ̄</td>
<td>ŋ̄</td>
</tr>
<tr>
<td>Zhu’hôasi !Xû</td>
<td>ŋ̄</td>
</tr>
</tbody>
</table>

Hindi and Zhu’hôasi !Xû minimally have /ŋ̄/. This supports the hypothesis that /m/ displays consonantal strength. The number of languages in UPSID with distinctive breathy voiced nasals is extremely small; however, I have found no other languages with a series of breathy voiced nasals that does not minimally include /m/.

The consonantal strength of /m/ also emerges when we consider the distribution of glottalization across /m n ŋ̄/. The table in (10) gives an overview of the distribution of glottalization across the nasal series of each of the languages in UPSID with glottalized nasals:

(10)  

<table>
<thead>
<tr>
<th>Language</th>
<th>m’</th>
<th>n’</th>
<th>ŋ̄</th>
<th>Other Plain nasals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedang</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>ŋ̄</td>
</tr>
<tr>
<td>Sui</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>ŋ̄</td>
</tr>
<tr>
<td>Gbeya</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>m n ŋ̄</td>
</tr>
<tr>
<td>Haida</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>ŋ̄</td>
</tr>
<tr>
<td>Tolowa</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>m n</td>
</tr>
<tr>
<td>Nez Perce</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>m n</td>
</tr>
<tr>
<td>Klamath</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>m n</td>
</tr>
<tr>
<td>Otomi</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>m n</td>
</tr>
<tr>
<td>Nootka</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>m n</td>
</tr>
<tr>
<td>Kwak’wala</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>m n</td>
</tr>
<tr>
<td>Acoma</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>m n</td>
</tr>
<tr>
<td>Wappo</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>m n</td>
</tr>
<tr>
<td>Mazahua</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>ŋ̄</td>
</tr>
<tr>
<td>Zhu’hôasi !Xû</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>ŋ̄</td>
</tr>
<tr>
<td>Southern Nambiquara</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>ŋ̄</td>
</tr>
<tr>
<td>Yuchi</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>ŋ̄</td>
</tr>
</tbody>
</table>

In (10) we observe that the typical pattern for a language is to have /m’ n’/, but not /ŋ̄/; this is the case in 10 of the 16 languages (=62.5%). Observe that 2 of the 16 languages, i.e. Southern Nambiquara and Yuchi, lack /m’/ (=12.5%). It is

---

12 I argued in §5.2 that breathy voiced nasals and voiceless nasals form a single phonological category of “aspirated nasals”; this does not affect the point at issue.

13 A comment is in order regarding Mazahua, which Maddieson describes as having /m’ ŋ̄/ (and /Æ !/). Since Mazahua also has /p’/ rather than /ŋ̄/, the palatal nasal series might be analyzed as being specified for /A/ only. This possibility requires further research.
interesting to observe, however, that Southern Nambiquara and Yuchi lack non-coronal sonorants altogether. Hence, we may attribute the absence of /m/ to the universal markedness implication that a laryngeal contrast in a particular nasal implies the presence of the corresponding plain nasal. Given this implication, the distribution of glottalization in Southern Nambiquara and Yuchi does not weaken the consonantal strength hypothesis. Similar to Tee and Icelandic, Southern Nambiquara and Yuchi exhibit a preferential association between phonation and coronal place. I assume that in these languages we are dealing with an instantiation of coronal unmarkedness; I return to this issue in §7.3.

The distribution of laryngeal modifications across /m n η/ supports the hypothesis that /m/ displays consonantal strength. Inspection of UPSID suggests that in those languages in which the set of laryngeally modified nasals does not include /m/, the modification is a property of coronal sonorants, and thus includes /n/. More generally, the typological facts encountered suggest that a symmetric distribution of a laryngeal modification across /m n η/ is the exception rather than the norm. This observation has potential diachronic implications. For instance, in his reconstruction of Proto-Mal, Filbeck (1978) finds evidence for *m’ but not *n’ and *η’, although he postulates the latter two for reasons of pattern congruity. While this assumption is reasonable enough, typological evidence suggests that it is by no means a necessary one, particularly as far as *η’ is concerned.

The facts encountered also suggest that of /m n η/, /η/ is least compatible with a laryngeal modification. It appears to be a universal implication that a particular laryngeal contrast in /η/ is possible only if this contrast is also present in /m n/. The markedness of laryngeally modified /η/ can also be observed in diachronic processes. For instance, in some of the languages of the Wambo family of Bantu, word-initial sequences of a nasal and a voiceless stop have developed into aspirated nasals (cf. Baucom 1972). In some of these languages, such as Ndonga, this process has affected *mp and *nt, but not *nk. In other languages, such as Kwaluudhi, we find the reflexes /E Ø N/. The different Wambo developments are summarized below, based on Baucom (1972:5) (in (11) PW is short for Proto-Wambo):

(11) | PW | Kafima | Kwambi | Ndonga | Kwanyama | Kwaluudhi |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>mp</td>
<td>mp</td>
<td>Æp</td>
<td>Æp</td>
<td>Æ</td>
<td>Æ</td>
</tr>
<tr>
<td>nt</td>
<td>nt</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
</tr>
<tr>
<td>ηk</td>
<td>ηk</td>
<td>l k</td>
<td>ηk</td>
<td>l</td>
<td>η</td>
</tr>
</tbody>
</table>

Comparative evidence suggests that nasal devoicing in Kwaluudhi applied to all nasals, and that after subsequent loss of the voiceless stop, /l/, but not /Æ/ or /Ø/, lost its laryngeal modification. This brings the asymmetric development of Kwaluudhi /l/ in line with that of *ηb in Proto-Mal and Proto-Thai, as discussed in §5.2.3.1.
Whereas the distribution of laryngeal modifications across /m n η/ offers a clear-cut illustration of asymmetric nasal behaviour, no nasal asymmetries are observed when we consider the distribution of secondary place. Inspection of UPSID does not reveal any preferential association between primary place and palatalization or velarization, neither for nasals nor for any other manner type. As regards labialization, 6 of the 9 languages in UPSID with distinctive labialized nasals contain /ηη/ only. However, this relation seems to depend primarily on place, since in these languages distinctive labialization is a property of all velars. This suggests that the relative cross-linguistic frequency of /ηη/ is not due a nasal asymmetry.

In a similar vein, it might be suggested that the distribution of laryngeal modifications across /m n η/ is not due to a nasal asymmetry, but involves a more general asymmetry which depends on place. However, inspection of UPSID suggests that this is not the case. Rather, the distribution of laryngeal modifications appears to depend on the type of manner and the type of laryngeal contrast involved. For instance, as far as stops are concerned, labial place is relatively dispreferred in plain and glottalized stops, velar place is relatively dispreferred in voiced stops, while aspirated stops, both voiceless and voiced, generally have the same range of place contrasts as their plain counterparts. In voiced glottalized stops, on the other hand, velar place is dispreferred. An antagonistic relation between velar place and a laryngeal modification can also be observed in approximants, provided /w/ is classified as having primary labial place: the UPSID sample contains 25 instances of laryngeally modified /w/ (14 instances of /E/ and 11 instances of /ηη/), 20 instances of /j/ (13 instances of /Q/ and 7 of /–/), but no laryngeally modified velar approximants. Hence, it might be suggested that the asymmetric distribution of laryngeal modifications across /m n η/ is typical of sonorants (or, more generally, of voiced segments), although further research is required to substantiate this hypothesis.

The preceding discussion raises the question why we find nasal asymmetries in relation to laryngeal modifications, but not in relation to secondary place. I suggest that this is due to the fact that manner is relevant in relation to the former, but not in relation to the latter. In supralaryngeal consonants, whether oral or nasal, primary and secondary place both involve modifications in the oral

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14 The number of palatalized velars in UPSID is slightly lower than that of palatalized labials and coronals. According to Maddieson (1984:38), a plausible explanation for this asymmetry is that “historically velars in ‘palatalizing context’ tend to shift their place of articulation and become palatal or palato-alveolar”.

15 These are Awiya, Iraqw, Guarani, Lakkia, Wantoat, and Hopi.

16 It is reasonable to view the preferential association between labialization and velar place as the consonantal equivalent of the preferential association between roundness and backness in vowels.

17 Note that velar approximants are cross-linguistically rare in any case, particularly if—as is assumed here—/w/ is regarded as having primary labial place.
cavity. As a result, we expect any asymmetry to be the result of a relation—
either positive or negative—between primary and secondary place, regardless of
the manner type of the consonant. The situation is different with respect to
manner. Since manner types such as stops and sonorants differ in terms of their
glottal configuration, any asymmetries in the distribution of laryngeal contrasts
could be argued to be related to both manner and place.

7.1.2 Segment phonotactics

Additional support for the consonantal strength of /m/ comes from an
investigation of distributional asymmetries involving /m/. These suggest that the
distribution of /m/ is, in some languages at least, characteristic of obstruents
rather than of sonorants.

Consider first of all the observation that /m/, parallel to obstruent stops, can
in some languages appear as the first member of a consonant cluster. In Polish,
for instance, we find complex onsets beginning with /m/ but not /n/ (cf. Rowicka
1999:312):

(12)  mgiełka ‘mist-DIM’ (*#ng…)
     mnożyć ‘to multiply’ (*#nm…)
     mleko ‘milk’ (*#nl…)
     mody ‘young’ (*#nI…)
     mrugać ‘to wink’ (*#nr…)

The reverse situation is found when we consider the second member of initial
clusters. Consider for instance Russian, which has stop-nasal clusters whose
second member is /n/ but not /m/ (see e.g. Halle 1959). Note, too, that the
existence of /mn/ clusters suggests that /m/ patterns with stops, since both can
occur as the leftmost member of an initial onset:

(13)  [kn]i ga ‘book’ (*#km…)
      [gn]yezd o ‘nest’ (*#gm…)
      [dn]o ‘bottom’ (*#dm…)
      [mn]ogo ‘many’ (*#nm…)

A similar distributional asymmetry is found in Dutch, German, and Old English,
where we find #kn but not *#km.\footnote{The development of English #kn was discussed in §5.3.2.}

So far I have considered sequences which in traditional terms are treated as
clusters. However, asymmetries between the distribution of /m/ and /n n/ are
also observed in sequences which are usually interpreted as involving complex
segments. For instance, Smalley (1976) describes Hmong, a Miao-Yao language
which is spoken in Cambodia, northern Thailand, and southern China, as having
an underlying contrast between stops, nasals, and prenasalized stops, with each displaying an additional contrast in terms of aspiration. Hmong also has a series of laterally released stops, the distribution of which depends on dialect. Hmong Daw has plain and aspirated nasals, and has an additional aspirated labial nasal with lateral release. Hmong Njua has an additional coronal prenasal with lateral release. The consonantal inventory of Hmong is given in (14), based on Smalley (1976:69). In (14), segments in single brackets occur in Hmong Daw only, and the segment in double brackets occurs in Hmong Njua only; Smalley notes that /ŋ/ is marginal in both dialects:

<table>
<thead>
<tr>
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<td>ml</td>
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<td>mlʰ</td>
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</table>

The maximum range of contrasts is therefore found in labials, both stops and nasals. A similar asymmetry between /m/ and /n ə/ is found in other Miao-Yao dialects (see §5.2.1).

The consonantal strength of /m/ is also evidenced by phenomena in which /m/ is exempted from an otherwise general distributional restriction on nasals. A case in point can be found in English. On the assumption that coronals are underspecified for place, Yip (1991) observes that English consonant clusters are limited to at most one place specification. There are very few exceptions to this generalization, and these all seem to involve /m/, as in *Camden, stigma, damsels*, and *flimsy*.

Yet another illustration of consonantal strength comes from processes in which /m/ resists an otherwise general process of nasal place assimilation. An example of this type of asymmetry can be seen in Nyanja, a Bantu language of Mozambique. Herbert (1986:160) observes that in Nyanja, prefixation of the class 9/10 marker /n-?/ results in a homorganic nasal-consonant cluster, whereas prefixation of the class 3 nominal prefix /m-?/ does not. According to Herbert, the prefix /n-?/ (or perhaps /N-?/) is fused with a root-initial consonant to produce a prenasalized stop or fricative, while the prefix /m-?/ is realized as a syllabic nasal:
(15) a. /n-bale/ [ˈbale] ‘plate’ b. /m-peni/ [ˈpini] ‘knife’
   /n-zeru/ [ˈzeru] ‘skill’ /m-zeru/ [ˈzere] ‘line’
   /n-saru/ [ˈsaru] ‘cloth’ /m-seru/ [ˈseru] ‘cleared path’
   /n-kuni/ [ˈkuni] ‘firewood’ /m-kazi/ [ˈkazi] ‘woman’

The prefixes in (15a,b) are historically derived from Proto-Bantu *ni and *mu, which, in Nyanja as well as in many other Bantu languages, have lost the vowels. The prefix nasal in (15a) can be analyzed as /n-/ as has been done here, or as underlyingly unspecified for place. In either case, we are dealing with an asymmetry which can be attributed to the consonantal strength of /m/.

As a final illustration of the consonantal strength of /m/, consider the following facts from Campidanian Sardinian. Bolognesi (1998:26-8) observes that in the Sestu dialect, intervocalic post-tonic /n/ is realized as nasalization on the preceding vowel, as is illustrated by the forms in (16a). The forms in (16b) indicate that in the same environment /m/ is retained:\textsuperscript{19}

(16) a. /pɔni/ [ˈpɔi] ‘put-IMP’
   /pɔnendi/ [ˈpɔndi] ‘put-GER’
   b. /dɔmu/ [ˈdɔmu] ‘house’
   /tomata/ [ˈtomata] ‘tomato’

The nasalization context is more general in central dialects of Campidanian. In these dialects, intervocalic /n/ is realized as nasalization on a preceding vowel irrespective of the location of stress. Here, too, intervocalic /m/ is retained, as can be seen in (17):

(17) \textbf{Central dialects} \hspace{1cm} \textbf{Other dialects}

\begin{tabular}{ll}
[femìa] & [femìna] \hspace{1cm} ‘woman’
[kõilu] & [kõnilu] \hspace{1cm} ‘rabbit’
\end{tabular}

Bolognesi further notes that the Sarrabus dialect of Campidanian is like that of Sestu, but differs from it in two respects: deletion of /n/ with concomitant regressive vowel nasalization occurs in any postvocalic position, and the deleted /n/ has a glottal reflex. The latter observation underscores the componential structure of nasal manner, which, as outlined in §2.3, consists of a combination of the “vowel-like” element [L] and the “stop-like” element [ʔ].

(18) \textbf{Sestu dialect} \hspace{1cm} \textbf{Sarrabus dialect}

\begin{tabular}{ll}
[kanˈsɔːdʒi] & [kanˈsɔːði] \hspace{1cm} ‘song’
[səˈnuʃi] & [səˈnuʃi] \hspace{1cm} ‘the walnut’
\end{tabular}

\textsuperscript{19} According to Trigo (1993), a similar asymmetry can be observed in Lusitanian Portuguese.
I interpret these facts to mean that Campidanian Sardinian has an asymmetric two-nasal system /m n/. The difference between /m/ and /n/ becomes apparent in foot-internal position (and, in some dialects of Campidanian Sardinian, in any intervocalic position), a context in which segments are prone to undergo lenition. The fact that /n/ is realized as nasalization (through deletion of its manner component) or as [ʔ] (through deletion of the manner element |L|) while /m/ remains unaffected, suggests that the latter is sufficiently strong to withstand lenition.

7.1.3 Obstruent class behaviour

Another type of evidence for the consonantal strength of /m/ comes from processes in which /m/, to the exclusion of /n n/ 129 , exhibits natural class behaviour with obstruent stops. In this section, I consider some examples of this type of class behaviour.20

Consider first the following facts from Connemara Irish. Connemara Irish exhibits a morphologically conditioned alternation between /n/ and [r], in such a way that /n/ is realized as [r] in the context of a preceding stop, as in (19a), and as [n] in the context of a preceding fricative, as in (19b) (cf. Bloch-Rozmej 1998:239):21

(19) a. an tsneachte [o tʰ[ɛ̃kta] ‘of the snow’
an tsnáthaid [o trəd] ‘the needle’
sa tsnámh [sə trə:v] ‘into the deep’
b. sneachta [ʃn[ɛ̃kta] ‘snow’
snámh [sNəv] ‘deep’
snáthaid [ʃNəd] ‘needle’

Note that an analysis in which /n/ is underlying is supported by the fact that surface forms that contain [r] are realized with a following nasalized vowel. The rightward transfer of nasalization corroborates the observation that nasalized vowels are less marked than nasalized approximants (see §§3.1 and 3.3). For present purposes, the point to note is that /m/ patterns with stops in the [n–r] alternation, as is evidenced by the forms in (20):

20 It has been claimed on a number of occasions that in Goidelic Celtic lenition /m/ patterns with obstruents, given that /m/, like obstruents but unlike sonorants, lenites to a voiced fricative (see for instance Anderson 1975, Davenport 1995). As was argued in §3.3, my interpretation of these facts is different: I claim that the outcome of nasal lenition, in Goidelic as well as in other languages, has sonorant status. According to this interpretation, Goidelic lenition does not qualify as an example of natural class behaviour of /m/ and obstruents.

21 In (19), “N” represents non-lenited /n/.
Note, too, that a further similarity between stops and /m/ is that both can occur as the leftmost member of a consonant cluster, similar to what was observed in §7.1.2 for Polish and Russian.

Another example of natural class behaviour of stops and /m/ is found in Hindi. As Bharati (1994:57) observes, English loans in Hindi are incorporated with a prothetic vowel if they contain an initial cluster /sp sk sm/, as in (21a). There is free variation between a prothetic and an epenthetic vowel if the initial cluster is /sn sl/, as in (21b). (21c) shows that an initial cluster /sr/ is consistently realized with an epenthetic vowel:

(21) a. English  Hindi  
       English  Hindi  
  special ispesal  slow  si-lo islo  shrewd suruud  
  school iskuul  snake  sinek~isnek  
  smile ismaail

The observation that /m/, in contradistinction to other sonorants, consistently patterns with stops supports the consonantal strength of /m/.

A final illustration of class behaviour of stops and /m/ concerns the observation that in Arabic roots we find cooccurrence restrictions on /n l r/ and /m b f/ (see, among others, Ferguson 1975, Yip 1988, and McCarthy 1994). This suggests that we are dealing with a restriction in terms of place, given that /n l r/ are coronal and /m b f/ are labial. However, the fact that /n/ can occur together with coronal obstruents such as /t/ and /s/ indicates that these cooccurrence restrictions also reflect natural class behaviour of /m/ with obstruents.

7.1.4 Discussion

In the preceding sections, a number of different types of evidence for the consonantal strength of /m/ were provided. In this section, I will briefly consider some avenues of approach as regards the interpretation of this evidence.

Given that the difference between /m n ɳ/ is, superficially at least, one of place, it is plausible to interpret the consonantal strength of /m/ as due to it being specified for [U]. This is the position taken in Van der Torre (2003:55,140), who argues that [U] is “the most consonantal place element” of [U], [I], and [A]. In his discussion of nasals, Van der Torre pays particular attention to distributional asymmetries involving /m n ɳ/, which he accounts for in terms of Optimality Theoretic constraint rankings. One of the constraints which Van der Torre uses is ONSETCONDITIONSONORANT, a representational constraint which sanctions only
those sonorant onset clusters whose leftmost member is labial (cf. Van der Torre 2003:140). The Element-based Dependency interpretation of this constraint is given in (22):

\begin{equation}
(22) \quad \begin{array}{c}
O \\
| \\
| \\
L \quad L \\
| \\
| \\
U \quad \text{place}
\end{array}
\end{equation}

That is, the leftmost sonorant in a complex onset which contains two place-specified manner structures must be specified for [U].

The constraint in (22) guarantees that /m/, but not /n y/, can occur as the leftmost member of a sonorant onset cluster. The data in (12) above suggests that Polish is an example of a language in which (22) is high-ranked. Van der Torre argues that Dutch is another such language. In Dutch, the high-ranking $\text{ONSETCONDITIONSONORANT}$ sanctions the initial cluster in the word $\text{mnemonisch}$ [mnemonis] 'mnemonic' (the only example of this kind), and it ensures that foreign names such as $\text{Mladic}$ [mladit] are realized with the initial cluster left intact. As regards non-nasal sonorants, (22) accounts for the fact that Dutch permits onsets such as /vl vr/, but not /jl jr/ (cf. Van der Torre 2003:180-3). As Norval Smith (p.c.) notes, support for this asymmetry comes from Sranan. Whereas earlier Sranan allowed /wr/ and /jr/, as in /wrôko/ ‘work’ and /jrêpi/ ‘help’, present-day Sranan only permits /wr/ (with /jrêpi/ > /répi/).

It is dubious whether all instances of consonantal strength are equally amenable to an analysis in terms of place. Consider for instance the observation that /m/ may sometimes display natural class behaviour with obstruents to the exclusion of /n y/ (see §7.1.3). While it is evident that /m/ can be singled out on account of having [U], it is unclear how this fact can be employed to establish a structural parallel between /m/ and obstruent manner. A more feasible approach might be to analyze this asymmetry between /m/ and /n y/ in terms of a difference in manner. For instance, the obstruent-like characteristics of /m/ could be expressed by a switch in the dependency relation between the elements which make up nasal manner, such that in /m/ [r] dominates [L], and in /n y/ [L] dominates [r];

\[\text{An alternative account for this asymmetry is to regard} /n/ \text{as an inherently voiced fricative rather than as an approximant, as was suggested in §2.1.3.}\]
According to this interpretation, obstruent stops and /m/ are both headed by [ʔ], which makes it possible to express natural class behaviour of these two segment types. Note that while /m/ is still identified as a sonorant by virtue of the presence of [L], the headedness of [ʔ] makes /m/ more “consonantal” than /n ŋ/. However, it should be observed that the manner structure in (21a) was also argued to represent inherently voiced stops (see §2.2.4). I leave the question whether—and if so, to which extent—these two interpretations are compatible for further research.

### 7.2 Vocalic strength

In this section, I discuss a range of cross-linguistic evidence in support of the claim that in those cases where /ŋ/ shows asymmetric behaviour, this behaviour is characteristic of vowel-like segments. In §7.1, we already observed that of the nasals /m n ŋ/, /ŋ/ is least suited to be combined with a laryngeal modification. On the assumption that the capacity to support laryngeal modifications reflects relative consonantal strength, we can interpret the relative markedness of such modifications in /ŋ/ to be a sign of consonantal weakness, or—as I will refer to it—as “vocalic strength”.

Below, I will consider two other types of evidence in support of the vocalic strength of /ŋ/. Both types of evidence are based on the assumption that if vocalic strength is equated with vowel-like behaviour, then we expect to find cases in which /ŋ/ patterns with vowels to the exclusion of /m n/. In §7.2.1, I examine some cases in which a vocalic position—a nucleus or a coda—permits /ŋ/ but not /m n/, and some cases in which a consonantal position—an onset—permits /m n/, but not /ŋ/. Next, in §7.2.2, I will briefly consider how the facts encountered can be interpreted in Element-based Dependency.

#### 7.2.1 Prosodically conditioned asymmetries

In this section, I take as my starting point the assumption that the onset position of a syllable is associated with consonantal properties while the nucleus position (and, to a lesser extent, the coda position) are associated with vocalic properties.
General support for this assumption comes from the distribution of consonants and vowels in syllable structure. Consider for instance the observation that many languages restrict the range of possible coda consonants to sonorants. Given that sonorants consist of vocalic material, in the sense that they have a manner structure which contains [L], I interpret this to mean that the coda position is a vocalic position. The same point can be made regarding the nucleus, which in most languages is restricted to vowels.

If /n/ displays vocalic strength, then we expect to find languages in which [n], rather than [m n], is the realization of syllable-final nasals. This can be observed for instance in those dialects of French which lack nasal vowels. As is Ploch (1999) notes, the nasal vowels of Standard French correspond to vowel-nasal sequences in Montpellier French. These nasals surface as homorganic with a following consonant word-internally, as in (24a), and as [n] word-finally, as in (24b):

(24)  a. jambe [ʒambə] ‘leg’  b. un [œ̃] ‘a-MASC’
     menthe [mana] ‘mint’  vin [vɛ̃] ‘wine’
     banque [банкə] ‘bank’  vent [van] ‘wind’

The same pattern is found in Midi French (see e.g. Durand 1988, Rice 1996), as well as in some dialects of European Portuguese (see e.g. Trigo 1988). Note, too, that in the Andalusian dialect of Spanish underlying word-final coronals are realized as velar (see Rice 1996).

Another language in which final nasals are realized as velar is Japanese (see e.g. Itô 1986, Yip 1991). Here we find homorganic nasals word-internally, while in word-final prepausal context we find variation between [n] and [M]. Consider the forms in (25):

     mo[ndai] ‘problem’  ze[ŋ–M] ‘goodness’
     da[ŋ]lo ‘dumping’  a[ŋ–M] ‘idea’

The fact that the realization fluctuates between [n] and [M] can be taken as an argument for nasal lenition (see §3.3). For present purposes, the point to note is that both the vocalic and the consonantal allophones surface as velar, which suggests that [A] is the preferred place element in syllable-final context.

In other languages, we find surface variation between nasalized vowels and sequences of an oral—or, more precisely, a non-distinctively nasalized—vowel followed by [n]. For instance, Smith (1987) notes that Sranan exhibits variation of the kind [aŋ-ə-ãŋ]. In a similar vein, Ohala & Ohala (1993:235) note that

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23 Another type of evidence comes from position-dependent patterns of allophonic variation, for instance the variation between clear and dark /l/ (see e.g. Sproat & Fujimura 1993, Botma & Van der Torre 2000).
word-final nasalized vowels in Acatlan Mixtec and Mbay are usually followed by a light velar closure. This realization is also found in Phlong (cf. Cooke et al. 1976:203). Recall, too, that there are languages which at some point in their history have undergone a process in which nasal vowels develop into sequences of an oral vowel plus /ŋ/. Examples of such languages include Bisu (see §5.2.3.2) and Inor (see §6.1.1).

The emergence of [ŋ] in the context of a preceding nasalized vowel is also observed in foreign accents of languages which have nasalized vowels. Citing Delattre (1965), Herbert (1986:203) observes that in a typical English accent of French, nasalized vowels are realized as sequences of an optionally nasalized vowel followed by a homorganic nasal in word-internal position, and by an optionally nasalized vowel followed by /ŋ/ in word-final position. This observation ties in with one of the main findings of Paradis & Prunet (2000): if a language borrows a word from a language with nasalized vowels, and if that language does not itself have nasalized vowels, then vowel nasality is often “unpacked” into a sequence of an oral vowel followed by /ŋ/. Thus we find, for instance, Swedish <restaurang> corresponding to French restaurant [re'sto'ɾã].

The emergence of syllable-final [ŋ] is not always conditioned by a preceding nasal vowel. Dixon (1980:211) observes that some Pama-Nyungan languages, such as Wik-Meñnh and (some dialects of) Anmatjera, have undergone a diachronic process in which /ŋ/ has been added to final open syllables. Dixon reports a similar process for Uradhi, which displays a synchronic process in which final open syllables are augmented by [k] or [ŋ]. According to Dixon, the nasal variant occurs in case the root itself also contains a nasal. Two examples are given in (26) (cf. Dixon 1980:211):24

(26) /juku/ [jûkû] ‘tree’
/ama/ [amâŋ] ‘man’

Dixon attributes this phenomenon to the requirement that words end in a consonant. The fact that the inserted consonant is [k] or [ŋ] supports the unmarked status of velars in syllable-final position, and thus supports the hypothesis that /A/ is the most vocalic place element.25

In the cases considered so far, [ŋ] can be interpreted as the unmarked consonantal realization of nasality in vocalic context. This scenario is to be

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24 According to the description of Crowley (1983), epenthetic [ʔ] is also attested, and appears to be possible regardless of the phonological context. For a more detailed analysis of Uradhi, see Trigo (1988), Paradis & Prunet (1993), and Rice (1996).

25 The issue is complicated by the observation that in some Australian languages, such as Muk-Thang, [ŋ] is also inserted in word-initial context. Dixon suggests that this is not so much due to a property of [ŋ], but to the unmarked status of non-coronals. This unmarkedness is a characteristic trait of Pama-Nyungan languages, where the majority of consonantal contrasts is made on the basis of subtypes of coronal place.
distinguished from those cases in which the emergence of [ŋ] is due to the spreading of vowel place features. An example of the latter type of process is observed in the now extinct Wieringen dialect of Dutch. In Wieringen Dutch, nasals surface as [ŋ] in the context of a preceding /a/ or /cé/ and a following coronal stop, as in the forms in (27a). In other contexts, the nasal surfaces as homorganic with a following stop, as in the forms in (27b) (cf. Daan 1950, Van Oostendorp 2000b):

(27)  a. mond [mɔŋ] ‘mouth’      b. kind [kɔnt] ‘child’
     hand [hɔŋt] ‘hand’     lamp [lɔmp] ‘lamp’

There is evidence to suggest that this pattern was more widespread in earlier stages of Dutch. Hoeksema (1999:94) observes that in Dutch 17th and 18th-century literature, the speech of “farmers and other people of humble origin” (translation mine) is marked by the same phenomenon. Some examples are given in (28):

(28)    Dutch     Literature forms
        mond [mɔnt]       [mɔŋ]     ‘mouth’
        onder [ɔndɔr]     [ɔndɔr]     ‘beneath’
        ander [ɔndɔr]     [ɔndɔr]     ‘other’
        Frans [frans]     [frans] ‘French’

Van der Torre (2003:104-6) argues that these facts can be accounted for in terms of the constraint $V_{ELAR_{NAS}}(R)$. This constraint requires nasals that are dominated by a rhyme position to be specified for $\lceil A \rceil$. In Wieringen Dutch, $V_{ELAR_{NAS}}(R)$ outranks $D_{EP-}\lceil I \rceil$, the latter a correspondence constraint militating against the insertion of $\lceil I \rceil$. This ranking captures the fact that [ŋ] occurs after low back vowels only, which are themselves specified for $\lceil A \rceil$. To account for the fact that /m/ but not /ñ/ is affected, Van der Torre further hypothesizes that the identity constraint which militates against the deletion of $\lceil U \rceil$, i.e. $I_{DEN T-\lceil U \rceil}$, outranks the identity constraint which militates against the deletion of $\lceil I \rceil$, i.e. $I_{DEN T-\lceil I \rceil}$. Van der Torre argues that this ranking is universal.27

Another illustration of the vocalic strength of /ŋ/ comes from those languages in which syllable-final /ŋ/ is compatible with a greater range of preceding vowels than syllable-final /m n/. An example of this asymmetry is

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26 Van der Torre argues that $V_{ELAR_{NAS}}(R)$ is also high-ranked in Cologne German, Afrikaans, Antwerp Dutch, and some dialects of Limburg Dutch; these dialects display syllable-final alternations between coronal and velar nasals similar to those observed in Wieringen Dutch.

27 Van der Torre also assumes that $I_{DEN T-\lceil I \rceil}$ is universally dominated by $I_{DEN T-\lceil A \rceil}$, the latter requiring that $\lceil A \rceil$ be retained in outputs. This ranking derives the cross-linguistically unmarked status of coronal place.
found in the Bisoid languages Bisu and Pyen. Regarding these languages, Bradley (1985a:240) notes that

the generalization that can be made … is that final /m/ occurs after a small number of vowels, notably /u/ and /a/; while /n/ occurs after a few more, and final /ŋ/ occurs after nearly all.

Like the data considered above, this type of distributional asymmetry suggests that /ŋ/ is less marked in vocalic positions than /m n/.

The unmarked status of /ŋ/ in vocalic positions can also be observed in Mandinka, a Manding language of Guinea-Bissao, Senegal, and the Gambia. According to Tourville (1991), Mandinka permits /m n ñ/ syllable-initially, but only /ŋ/ syllable-finally, where /ŋ/ is the only consonant that is allowed. In distributional terms, /ŋ/ therefore patterns with vowels. Further support for the natural class behaviour of /ŋ/ and vowels in Mandinka comes from the observation that /ŋ/ is the only consonant which can be syllabic and tone-bearing. The Mandinka facts therefore support the hypothesis that of /m n ñ/, /ŋ/ displays vocalic strength.

The hypothesis that /ŋ/ displays vocalic strength leads us to expect not only that /ŋ/ is relatively favoured in vocalic positions, but also that /ŋ/ is relatively disfavoured in consonantal positions. A clear illustration of this can be observed in Indo-European, where initial /ŋ/ is absent.28 In other language families, initial /ŋ/ is allowed; however, it appears to be the case that if a particular language permits /ŋ/ in the onset, it will also permit /ŋ/ in the coda.29 Van der Torre (2003:116-8) discusses a number of apparent counterexamples to this generalization, based on a recent typological overview in Anderson (2003), but concludes that none of these constitutes compelling evidence against the antagonistic relation between /ŋ/ and the onset position.

Aside from synchronic asymmetries, we also expect to find evidence from diachronic processes which shows that initial /ŋ/ is less stable than initial /m n/.

One example of this asymmetry is observed in Sabaki, a Bantu subfamily of East Africa which includes Swahili. As Nurse & Hinnebusch (1993:147) note, Sabaki has retained all instances of Proto-Bantu *m, *n, but only some instances of *ŋ. Most synchronic occurrences of Sabaki /ŋ/ are instead derived from *ŋ through a process of stop deletion, which, Nurse & Hinnebusch conclude, must have been active in an earlier stage of Sabaki.30

---

28 In fact, Indo-European is generally reconstructed as lacking /ŋ/ altogether. Subsequent developments in daughter languages have resulted in the observed asymmetry between syllable-initial and syllable-final context.

29 In a similar vein, it appears to be the case that if a language permits /m/ in codas, it will also permit /m/ in onsets. Neither Van der Torre nor I have found any counterexamples to this generalization.

30 In Bantu linguistics this process of postnasal stop deletion is referred to as Meinhof’s Law.
An additional illustration of the instability of *ŋ concerns the development of *Nv clusters in Sabaki. As is the case for Bantu in general, the development of such clusters in Sabaki is characterized by a host of changes affecting both the nasal and the stop part, including postnasal voicing, nasal devoicing, and postnasal aspiration. Mwani, a Sabaki language of northern Mozambique, shows a development which is different from that of other Sabaki languages. In Mwani, labial and coronal *N± clusters have lost the stop portion, while velar *N± sequences have been lost completely. This is illustrated in (29):

(29)  

<table>
<thead>
<tr>
<th>Proto-Sabaki</th>
<th>Mwani</th>
</tr>
</thead>
<tbody>
<tr>
<td>*mpula</td>
<td>mula</td>
</tr>
<tr>
<td>*munutu</td>
<td>munu</td>
</tr>
<tr>
<td>*ŋkuku</td>
<td>uku</td>
</tr>
</tbody>
</table>

According to Nurse & Hinnebusch (1993:162), Mwani has been influenced by the non-Sabaki languages Ruvu and Kagulu, where *N± clusters have changed into aspirated nasals (cf. Kagulu /ŋuku/ <*ŋuku). If this is correct, this might be taken to suggest that there was an intermediate stage in which Mwani had initial /mŋ nŋŋ/, where /mŋ nŋ/ subsequently developed into /m n/ while /ŋŋ/ was lost. This would be another example of the antagonistic relation between /ŋ/ and laryngeal modifications.

The diachronic loss of initial /ŋ/, but not /m n/, can also be observed in a number of Pama-Nyungan languages. For instance, Blevins (2001) notes that word-initial *ŋ was lost before /a/ in Arabana and before /i/ in Baagandji. According to Blevins, this type of loss typically affects segments which have intrinsically weak perceptual cues. These segments include /p g j/ and also /ŋ/, which, Blevins (2001:483) observes, is the “weakest nasal”.

7.2.2 Discussion

The distributional asymmetries considered in the previous section strongly suggest that the behaviour of /ŋ/ is more vowel-like than that of /m n/. In this section, I consider some avenues of approach as regards the interpretation of these asymmetries.

A reasonable assumption is to relate the vocalic strength of /ŋ/ to the fact that it is specified for [A]. This is the position taken in Van der Torre (2003:140), who argues that [A] is “the most vocalic place of articulation”. To this effect, Van der Torre proposes two representational constraints; the Element-based Dependency versions of these constraints are given in (30a,b):
The constraint in (30a) is the representational version of \textit{VELAR}_{NAS}(R), introduced in §7.2.1. It states that /ŋ/ can only occur in case it is dominated by a coda constituent. The constraint in (30b) rules out \textit{[A]}-specified nasals in onset position. Most of the distributional asymmetries involving /ŋ/ can be captured using the constraints in (30), although the specific interaction between these and other constraints requires further research (see Van der Torre 2003 for a more detailed investigation of some of the facts considered above). Consider as an illustration the distribution of /ŋ/ in Dutch. As was observed in (7), /ŋ/ in Dutch is disallowed in word-initial onsets as well as after tense vowels and diphthongs. These restrictions can be accounted for in terms of the constraint in (30a). If it is assumed that /ŋ/ can only follow lax vowels, and that lax vowels must be followed by a consonant within the same syllable (see Van Oostendorp 2000a), then the distribution of /ŋ/ is restricted to the dependent position of the rhyme, as in (30a).

As was also observed in connection with /m/, it is questionable whether all instances of vocalic strength can be accounted by reference to place. This holds in particular with regard to the antagonistic relation between /ŋ/ and laryngeal modifications, which, as was noted in §7.1.1, appears to be the result of the combination of nasal manner and \textit{[A]}-place. A possible avenue of approach here is to represent /ŋ/ in terms of a more vocalic manner structure, for instance by making it \textit{[L]}-headed as compared to /m n/, or perhaps by representing /ŋ/ as lacking place altogether (see §4.2.3 for this suggestion). I leave this issue for further research.

### 7.3 Coronal unmarkedness

In this section, I briefly consider some evidence in support of the claim that in those cases where /n/ exhibits asymmetric behaviour, this behaviour is characteristic of the markedness effects associated with coronals. That is, where the asymmetric behaviour of /m n/ seems in many cases to be specific to these nasals, the asymmetric behaviour of /n/ appears to be typical of coronal place in general. In this section, I illustrate the asymmetric patterning of /n/ by focusing on some distributional differences between /n/ and /m n/ in Dutch.
In Dutch, there are two contexts in which /n/ is permitted, but not /m n/. First, Dutch permits only those obstruent-nasal clusters whose second member is /n/. Here clusters with initial labials are very rare, as are forms with initial velar fricatives; forms with initial velar stops are, on the other hand, quite frequent:31

(31)  a. Stop-/n/

[pn]euma ‘pneuma’
[kn]ie ‘knee’
[kn]oop ‘button’
[kn]al ‘bang’

b. Fricative-/n/

[fn]uiken ‘to thwart’
[sn]e ‘gnu’
[sn]iffelen ‘to snigger’

The possibility of /kn/, but not of /km/, is also found in Russian (cf. (13) above). Note that clusters with /m n/ are ruled out for different reasons: the consonantal strength of /m/ renders it unfit to appear in the dependent position of an onset, while the vocalic strength of /n/ renders it unfit to appear in onsets altogether. The fact that /n/ is tolerated in the dependent position of an onset can be attributed to its unmarked coronal status.

Second, word-final /n/, but not /m n/, can occur after a sequence of a tense vowel and a following /r/, as is illustrated by the forms in (32):

(32)  hoorn [hɔrn] ‘horn’
doorn [dɔrn] ‘thorn’
Baarn [barn] ‘id. (place name)’

In some versions of syllable theory, the position in which /n/ occurs in (31) is termed the syllable “appendix” (see Fudge 1969; see also Booij 1995 in relation to Dutch). While the appendix is typically reserved for coronal obstruents, the Dutch facts indicate that it can also be occupied by coronal sonorants. Hence, we may conclude that the relatively unrestricted distribution of /n/ ties in with the general unmarkedness effects associated with coronal place.

Further evidence for the unmarked status of /n/ comes from deletion and insertion processes. Consider first the observation that in Dutch both /m n/ can occur after /s/. In this context /n/, but not /m/, is usually deleted in casual speech:

(33)  a. lopen /lɔpɔn/ [lopa] ‘to walk’
sokken /sɔkɔn/ [sɔkɔ] ‘socks’
varken /varkɔn/ [varkɔ] ‘pig’

b. bezem /bɛzɔm/ [bezn] ‘broom’ (*[beza])
adem /adɔm/ [adɔm] ‘breath’ (*[adɔ])

31 Disregarding /s/, the distributional status of which is exceptional, Dutch does not tolerate homorganic clusters within the same subsyllabic constituent. This accounts for the absence of initial /m/ clusters.
The distribution of /n/ after /s/ in Dutch bears a resemblance to the distribution of [r] in non-rhotic varieties of English. Parallel to English [r], Dutch [n] is realized in the context of a following vowel, as in (34):

(34)  we / lopan sm/  / s:okan an/  het / varkan et/
   we [ lopan sm]  [ s:okan an]  het[ varkan et]
   we walk around socks on the pig eats
   ‘we take a detour’   ‘(put your) socks on!’   ‘the pig eats’

Some speakers of Dutch also exhibit a process of “intrusive-[n]” formation to avoid vowel hiatus (cf. Booij 1995). This process involves the insertion of [n] in the context of a preceding schwa and a following vowel. Some examples are given in (35):

(35)  hij / vtldo het/  / vtldo hei/ komen  het / xeko is/
   hij [ vtldo -n-at]  [ vtldo -n-i]  het [ xeko -n-is]
   he wanted it   wanted he come the crazy is
   ‘he wanted it’   ‘did he want to come?’   ‘the strange thing is’

The coronal place of the epenthetic consonant again ties in with the cross-linguistically unmarked status of these segments. The reason why [n] is inserted in post-/s/ context rather than, say, [t], can be attributed to the fact that /n/ is deleted in exactly the same context. Given this, [n]-intrusion can be viewed as an instance of hypercorrection.

A final piece of evidence in favour of the unmarkedness of /n/ comes from patterns of Dutch place assimilation. The forms in (36) illustrate that /n/ is the only nasal which assimilates in place to a following obstruent. This occurs in prefixation, as in (36a), and in compounding, as in (36b). The forms in (36c-e) indicate that in these contexts /m n/ are not targeted by place assimilation (cf. Van der Torre 2003:136-7):32

(36)  a. in+pakken         i[mp]akken   ‘to wrap up’
   on+verstandig        o[ny]erstandig ‘unwise’
   in+dienes           i[n]iennen  ‘to hand in’
   on+kunde           o[nk]unde  ‘incompetence’
   b. steen+bok         stee[m]bok ‘Capricorn’
   steen+tijd          stee[n]tijd  ‘stone age’
   steen+kool          stee[nk]ool ‘coal’
   c. om+brengen        o[m]brengen ‘to kill’
   om+draaien          o[md]uwen ‘to push over’
   om+kopen           o[mk]open  ‘to bribe’

---

32 This example of nasal asymmetry was briefly discussed in (3) above.
On a related point, Dutch does not tolerate any morpheme-internal sequences of /n/ and a following heterorganic stop. As is the case in most languages, Dutch morpheme-internal nasal-consonant clusters are predominantly homorganic. The few exceptions to this generalization all involve a combination of /m/ and a following coronal obstruent, as in (37a), or a combination of /ŋ/ and a following coronal obstruent, as in (37b):

(37)  a. labial nasal-coronal obstruent       b. velar nasal-coronal obstruent

<table>
<thead>
<tr>
<th></th>
<th>vreemd</th>
<th>langs</th>
<th>hemd</th>
<th>hengst</th>
<th>gems</th>
<th>angst</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[vremt]</td>
<td>[ランス]</td>
<td>[hєmt]</td>
<td>[ヘンス]</td>
<td>[χєms]</td>
<td>[アングス]</td>
</tr>
<tr>
<td>‘strange’</td>
<td>‘along’</td>
<td>‘shirt’</td>
<td>‘stallion’</td>
<td>‘fear’</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The nasal asymmetries in (35) and (36) suggest that |I| is weaker than |U| and |A|, in the sense that |I| is more prone to undergo deletion in processes of place assimilation. The fact that this asymmetry is the cross-linguistically typical scenario supports the view that, all things being equal, |I| is the unmarked place of articulation.

Like Van der Torre, I assume that nasal asymmetries involving /n/ arise from coronal unmarkedness effects. As Paradis & Prunet (1991) note, support for the unmarkedness of coronals comes from their distributional freedom, their cross-linguistic frequency, their susceptibility to processes of assimilation, and from the observation that coronals are generally the preferred default option and epenthetic filler. The last observation is underscored by the pattern of nasal place specification in languages which have only a single underlying nasal consonant. The UPSID sample contains 7 such languages, i.e. Tlingit, Yuchi, Chipewyan, Wichita, Southern Nambiquara, Mixtec, and Taoripi (cf. Maddieson 1984). The phonetic realization of the nasal in these languages is variable. If the language has nasal-consonant clusters, then place is usually determined by the consonant, as is the case for such clusters in general. If there is no following consonant, then the nasal has variable place. Here Tlingit, Chipewyan, Wichita, Yuchi, and Southern Nambiquara have [n], Mixtec has [ŋ], and Taoripi has [m]. The fact that the majority of languages has [n] can be attributed to coronal being the cross-linguistically unmarked place. Mixtec [ŋ] can be attributed to the fact that this nasal is found in postvocalic position only. More generally, it might be that Mixtec displays a process of nasal harmony in which a series of sonorant stops alternates with a series of nasals. Based on the description in Piggott (1992), Mixtec [ŋ]
be suggested that in one-nasal systems, the choice between [n] and [ŋ] is prosodically conditioned (see Rice 1996 for discussion of this issue). The fact that the nasal of Taoripi is realized as [m] rather than [n] or [ŋ] is unexpected.

7.4 Summary

In this chapter, I have shown that although nasals typically behave as a natural class, many languages display asymmetries in the phonological behaviour of particular nasals. The data considered suggests that these asymmetries, rather than being random, are related to specific markedness effects associated with different places of articulation. In general, the asymmetric behaviour displayed by /m/ is typical of consonant-like articulations, which suggests that [U] is the most consonantal place. The asymmetric behaviour that is displayed by /ŋ/ is typical of vowel-like articulations, which suggests that [A] is the most vocalic place. Finally, the asymmetric behaviour displayed by /n/ is associated with the cross-linguistically unmarked behaviour of coronals, and suggests that [I], in nasals as well as in other segment types, is the unmarked place element.

can be interpreted as a non-distinctive consonantal spell-out of a word-final nasalized vowel, similar to what Ohala & Ohala (1993:235) note with regard to Acatlan Mixtec (see §7.2.1).
In this dissertation, I have provided a phonological characterization of nasals, nasalized segments and processes of nasalization, based on a range of data from a large number of languages. To this end, I have developed the model of Element-based Dependency, a theory of phonological representations that combines insights from Dependency Phonology (see especially Anderson & Ewen 1987, Smith 2000) and Element Theory (see Harris & Lindsey 1995).

Element-based Dependency assumes a restricted number of manner, phonation, and place elements, and a restricted number of ways in which these elements can be combined. Place properties are represented in terms of the elements \(|U|, |I|, \) and \(|A|\). Manner and phonation properties are represented in terms of the elements \(|/\text{g}47|, |H|, \) and \(|L|\); these have the following general interpretation:

\[
\begin{align*}
\text{Articulatory interpretation} & \quad \text{Acoustic interpretation} \\
/\text{g}47 & : \text{complete closure} \quad \text{energy reduction} \\
H & : \text{close approximation} \quad \text{aperiodicity} \\
L & : \text{open approximation} \quad \text{periodicity}
\end{align*}
\]

The articulatory interpretation of \(|/\text{g}47|, |H|, \) and \(|L|\) therefore corresponds to the three-way manner distinction in terms of degree of oral stricture, as is assumed in traditional articulatory phonetics.

In combination with a place specification, \(|/\text{g}47|, |H|, \) and \(|L|\) denote plosive, sibilant, and vocalic manner. This is motivated by the observation that plosives, sibilants, and vowels are the unmarked segmental instantiations of the phonetic properties associated with \(|/\text{g}47|, |H|, \) and \(|L|\).

\[
\begin{align*}
? & : \text{plosive} \quad (=\text{unmarked stop type}) \\
H & : \text{sibilant} \quad (=\text{unmarked fricative type}) \\
L & : \text{vowel} \quad (=\text{unmarked sonorant type})
\end{align*}
\]

Some representative structures are given in (3), where O and N are short for onset and nucleus:
The relatively simple structures of plosives, sibilants, and vowels therefore mirror the relatively unmarked status of these segment types. 

\( |?|, |H|, \) and \( |L| \) may enter into head-dependency relations, resulting in complex manner types. The basic manner structure of a nasal consonant, for instance, consists of a complex manner type in which \( |L| \) dominates \( |?| \):

The structure in (4) expresses the fact that the nasal manner structure is that of a “sonorant stop”. This means that from a phonological perspective nasality is a derived concept. Indeed, I have shown in chapter 4 that nasality is not always present in sonorant stops (see also §2.2.5). In some languages, such as Rotokas and Pirahã, sonorant stops are phonetically realized as voiced oral stops. In other languages, such as Kpelle and Gbe, sonorant stops are realized as nasals only if harmonic nasalization is present.

In (4), the dependency relation that holds between \( |L| \) and \( |?| \) is motivated by the relation between, on the one hand, manner and prosodic interpretation and, on the other hand, manner and place. The presence of the head element \( |L| \) identifies nasals as sonorants for the purposes of prosodic interpretation. For instance, the fact that nasals, as consonants, are relatively unmarked in “vocalic” positions (e.g. nuclei and codas) can be attributed to their being \( |L| \)-headed. Nasals share this \( |L| \)-headed structure with vowels and approximants. Nasals have \( |?| \) as dependent (or “dominated”) manner element. This identifies nasals as stops for the purposes of place selection; the fact that nasals can employ the same range of place contrasts as plosives is due to both segment types having dependent \( |?| \) dominate place.

For some languages, the representation of nasals as “bare” sonorant stop structures is sufficient. In other languages, the phonological behaviour of nasals suggests that they must be represented as sonorant stop structures with an additional dependent element \( |L| \), as in (5):

\[
\begin{array}{lll}
(3) & a. & O & b. & O & c. & N \\
& | & | & | \\
& | & H & L \\
& | & I & A \\
& /p/ & /s/ & /a/ \\
\end{array}
\]
The decision as to whether (4) or (5) is the appropriate representation of a nasal is discussed in chapter 2 (see especially §2.2.5). The most straightforward evidence for the presence of dependent \( |L| \) in nasals comes from those languages in which nasals trigger nasalization (i.e. spreading of dependent \( |L| \) to a sonorant) or voicing (i.e. spreading of dependent \( |L| \) to an obstruent). Examples of these processes are discussed in chapters 3 and 4.

One of the central assumptions of Element-based Dependency is that the phonetic interpretation of elements depends on the structural position in which they occur. A case in point is the element \( |L| \). Generally speaking, i.e. in the absence of a specific phonological context, \( |L| \) has the articulatory correlate of open approximation and the acoustic correlate of periodicity. The specific interpretation of \( |L| \), however, depends on its position in the phonological structure. If \( |L| \) occurs as a manner element (i.e. as a head element), the segment concerned is identified as a sonorant. If, on the other hand, \( |L| \) occurs as a phonation element (i.e. as a dependent element), its interpretation is variable: dependent \( |L| \) is interpreted as nasalization if there is also an \( |L| \) present in the head, and as voicing if there is no \( |L| \) present in the head. The three contexts in which \( |L| \) can occur are given in (6a-c). Observe that each of the structures in (6) is dominated by a subsyllabic constituent and dominates a place specification:

\[
(6) \quad \begin{align*}
&\overset{\text{a.}}{\ | \quad |} &\overset{\text{b.}}{\ | \quad |} &\overset{\text{c.}}{\ | \quad |} \\
&L &\text{“}|L| \text{ present”} &L &\text{“}|L| \text{ absent”} &L \\
&\ldots &\ldots &\ldots &
\end{align*}
\]

Three concrete examples are given in (7). In (7a), dependent \( |L| \) is interpreted as nasalization on account of the presence of another \( |L| \) in the manner component. In (7b) and (7c), dependent \( |L| \) is interpreted as voice, since here there is no \( |L| \) present in the manner component:
A general advantage of a context-sensitive interpretation of elements is that it limits the number of elements that must be assumed, thus minimizing the risk of overgeneration. The use of a restricted number of elements implies in turn that Element-based Dependency representations lack phonetic concreteness. This can be considered an advantage, since some phonological properties, such as sonorancy and nasality, lack a clear phonetic correlate (see §1.1).

With respect to \[L\], a context-sensitive interpretation of elements has a number of more specific advantages. First of all, the variable interpretation of dependent \[L\] as nasalization and voice predicts the non-existence of both distinctly voiced sonorants and distinctively nasalized obstruents (disregarding nasal contours, the representation of which is seen to vary from language to language). The non-existence of such segment types is desirable, since there is no evidence to suggest that obstruent nasalization and sonorant voicing are phonologically relevant.

The dual interpretation of dependent \[L\] also permits an insightful analysis of nasal harmony phenomena, i.e. those processes in which nasality surfaces as a property of not just a single segment (as in an English word like milk [mɪlk]), but a range of segments. In Warao, for instance, nasality spreads rightwards from a nasal consonant to the end of a word, until it is arrested by an obstruent (as in a Warao word like moaupu [mõãûpu] ‘give them to him’)

In one subtype of nasal harmony, nasalization surfaces as a property of all sonorants within the harmonic domain, while leaving obstruents unaffected. An example of a language in which this is the case is Tuyuca. The Tuyuca forms in (8) show that nasality, when present in a word, is a necessary property of all sonorants:

(8) Üfê ñ ‘to illuminate’ mîp ‘badger’
Hôl ‘there’ nît ‘coal’
êml ‘howler monkey’ tŋô ‘Yapara rapids’
Úînl ‘wind’ nôsî ‘bird’

The distribution of nasality in such forms can be straightforwardly accounted for if we assume that dependent \[L\], when present as a harmonic element, is attached to all and only \[L\]-specified manner components. In some Tuyuca-type languages, such as Southern Barasano, Tucano, Yuhup, and Gbe, there are independent arguments to analyze dependent \[L\] as a property of entire syllables.
However, in these languages, too, the harmonic target range is coextensive with the number of |L|-specified manner components within the harmonic domain.

A further advantage of the dual interpretation of |L| as nasalization and voice comes from phonological processes in which both nasalization and voice are relevant. One such process is postnasal voicing, i.e. the phenomenon whereby a voiceless obstruent surfaces as voiced under the influence of a preceding nasal consonant. An example of a language which displays postnasal voicing is the Puyo-Pongo dialect of Quechua. The forms in (9a) illustrate that suffix-initial voiceless stops in Puyo-Pongo Quechua surface as voiced when preceded by a stem-final nasal; the forms in (3b) illustrate that these suffix-initial stops surface as voiceless in other contexts:

(9)  a. /kam-ba// [kamba] ‘you-GEN’
    /wakin-da// [wakinda] ‘the house-OBJ’
 b. /sinik-pa// [sinikpa] ‘porcupine-GEN’
    /wasi-ta// [wasita] ‘the others-OBJ’

On the assumption that the nasal is represented as a nasalized sonorant stop, i.e. as a structure with a dependent element |L|, stop voicing can be expressed in terms of the spreading of this |L| to the dependent position of the stop, where it is interpreted as voicing (in (10) I assume that the nasal-stop cluster forms a coda-onset sequence):

(10)  

\[ \begin{array}{c}
  C \\
  \hline
  L \\
  \hline
  O \\
\end{array} \]

Thus, the interpretation of dependent |L| is determined by the manner components to which it is associated.

Further support for the dual interpretation of dependent |L| comes from processes in which nasals trigger either voicing or nasalization, depending on whether the targeted segment is an obstruent or a sonorant. An illustrative example of this type of process is found in Navajo. The forms in (11) illustrate that perfectives in Navajo are signalled by voicing of stem-final obstruents, as in (11a), and by nasalization of stem-final vowels, as in (11b):

(11)  IMPERF  PERF

a. -ʔaał   -ʔaal  ‘chew, eat’
    -ʔaaʃ -ʔaa3  ‘few go’
    -lōōs -lōōz  ‘lead’
b. -bí -bî ‘swim’
-ʔâ -ʔfl ‘classification compact object’
-ka -kā ‘classification contained object’

This type of process provides further support for a single element, e.g. |L|, specifying both voice and nasalization. A number of Navajo-type phenomena are considered in chapter 4.

Another key assumption of Element-based Dependency is that laryngeal contrasts (as expressed in terms of dependent elements) are dominated by a subsyllabic constituent, i.e. an onset, a nucleus, or a coda, rather than by a segmental root node (see also Kehrein 2002). The Element-based Dependency representation of subsyllabic structure is given in (12):

\[
(12) \quad O, N, C \\
\quad \quad \quad \text{manner} \quad \quad \quad \text{phonation} \\
\quad \quad \quad \quad \quad \quad \text{place}
\]

The organization in (12) expresses the fact that manner and place form the “segmental core”. The phonation component 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.

The general advantage of the organization in (12) is that laryngeal contrasts are assigned to the level in the prosodic hierarchy at which they are minimally contrastive. Assigning aspiration to the level of onsets predicts, for instance, that languages never form a phonological contrast which involves the relative order of nasality and aspiration (e.g. */mʰ/~/m/) or the degree of overlap between nasality and, voicing, and aspiration (e.g. */Eh/~/Em/, */’/~/’m/, etc.). The organization in (12) also accounts for the absence of a contrast between a laryngeal segment and the corresponding laryngeal modification (e.g. */mʰ/~/mh/), at least within the same subsyllabic position. The facts considered in §§5.2 and 5.3 suggest that these predictions are borne out.

Specific advantages of the Element-based Dependency approach are, first, that each laryngeal contrast can be represented in terms of a single dependent element, and, second, that no cooccurrence restrictions are required to account for the fact that some manner types are incompatible with some phonation types. Specifically, the incompatibility of obstruent manner and distinctive nasalization and of sonorant manner and distinctive voice follow naturally from the assumption that dependent |L| has a manner-specific interpretation.

Chapter 5 of this dissertation addresses the representation of laryngeal contrasts in relation to laryngeally modified nasals. The Element-based Dependency model predicts the existence of two such segment types: aspirated
nasals, which are represented in terms of a sonorant stop structure with dependent \( |H| \), and glottalized nasals, which are represented in terms of a sonorant stop structure with dependent \( |?| \). In onset position these segment types have the following structure:

\[
\begin{array}{c}
\text{(13)} \quad \text{a. O} \\
\text{L} \quad \text{H} \\
\text{\ \ \ \ \ \ ?} \\
\text{\ \ \ \ \ ?}
\end{array}
\quad \begin{array}{c}
\text{d. O} \\
\text{L} \quad \text{?} \\
\text{\ \ \ ?} \\
\text{\ \ \ ?}
\end{array}
\]

\text{Aspirated nasal} \quad \text{Glottalized nasal}

Cross-linguistic evidence suggests that the range of phonetic variation in laryngeally modified nasals is considerable. For instance, the variation observed in aspirated nasals includes realizations which may be characterized in phonetic terms as voiceless aspirated and breathy voiced. The point to note here is that the presence or absence of voicing depends on the timing and the degree of the glottal opening gesture, but is not itself phonologically relevant. In a similar vein, the phonetic variation that is observed in glottalized nasals includes pregglottalized, postglottalized, and creaky voiced realizations. From the perspective of phonological contrasts, however, the important observation is that no language makes distinctive use of this variation. This supports the hypothesis that we are dealing with only two phonological segment types, represented in terms of dependent \( |H| \) and \( |?| \). The Element-based Dependency model thus offers a restrictive account of the relation between manner and laryngeal aspects of segmental structure.

The first five chapters of this dissertation provide a fairly self-contained outline of the Element-based Dependency approach to nasality: the main tenets of the Element-based Dependency model are introduced in chapters 1 and 2, the interpretation of dependent \( |L| \) as nasalization and voice is discussed in chapters 3 and 4, and the organization and representation of laryngeal contrasts, with special focus on laryngeally modified nasals, is addressed in chapter 5. The last two chapters address two issues of a more peripheral nature: chapter 6 considers the phonological relation between nasalization and laryngeal segments, and advances a number of arguments for the existence of nasalized laryngeals as a phonological segment type. Chapter 7 briefly examines a number of cases where nasals show “non-natural” class behaviour. It is proposed that this behaviour is the result of different, place-related types of markedness. The issues that are discussed in chapters 6 and 7 raise a number of interesting questions, which deserve more detailed answers than have been given in this dissertation. As such, they represent two possible directions in which subsequent work in Element-based Dependency may proceed.


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Samenvatting (Summary in Dutch)


Element-based Dependency maakt gebruik van een klein aantal elementen waarmee de wijze van articulatie (hieronder aangeduid als “manner”), de plaats van articulatie, en de laryngale kenmerken van fonologische segmenten kunnen worden beschreven, en de interactie tussen fonologische segmenten kan worden verklaard. De plaatskenmerken van fonologische segmenten worden uitgedrukt door (combinaties van) de elementen |U|, |I|, en |A|. De manner en laryngale kenmerken van fonologische segmenten worden beschreven door (combinaties van) de elementen |/?|, |[H]|, en |[L]|. Laatstgenoemde elementen hebben de volgende algemene fonetische interpretatie:

(1)  
Articulatorische interpretatie  Akoestische interpretatie
?
: volledige obstrueer reductie van energie
H
: sterke vernauwing aperiodiciteit
L
: geringe vernauwing periodiciteit

De articulatorische interpretatie van |/?|, |[H]|, en |[L]| is in overeenstemming met het drieledige onderscheid in manner dat kan worden gemaakt op basis van de mate van obstrueer in de mondholte. Dit onderscheid is bekend uit de traditionele articulatorische fonetiek.

In combinatie met een plaatselement worden |/?|, |[H]|, en |[L]| als plosief, sibilant, en vokaal geïnterpreteerd. Plosieven, sibilanten, en vokalen kunnen derhalve worden gezien als de ongemarkeerde segmentele verschijningsvormen van de onder (1) beschreven eigenschappen.

(2)  
|/?| : plosief (=ongemarkeerd stop-type)
[H] : sibilant (=ongemarkeerd fricatief-type)
[L] : vokaal (=ongemarkeerd sonorant-type)
In (3) geef ik een voorbeeld van elk van de bovengenoemde segment-types; in (3) staan O en N voor de onset- en de nucleuspositie van de lettergreep:

(3) 

<table>
<thead>
<tr>
<th></th>
<th>O</th>
<th></th>
<th>b.</th>
<th>O</th>
<th></th>
<th>c.</th>
<th>N</th>
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<td>?</td>
<td>H</td>
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<td>U</td>
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</table>

| /p/ | /s/ | /a/ |

De relatief ongemarkeerde status van plosieven, sibilanten, en vokalen wordt derhalve weerspiegeld door de relatief eenvoudige structuur die deze segmenten hebben.

Wanneer [ʔ], [H], en [L] met elkaar gecombineerd worden, ontstaan complexe mannerstructuren. In zulke structuren gaan elementen dominante relatie met elkaar aan. Een nasale consonant—kortweg nasaal—is een voorbeeld van een segment-type met een complexe mannerstructuur. De basisstructuur van een nasaal bestaat uit een mannerstructuur waarin [ʔ] wordt gedomineerd door [L]:

(4) 

<table>
<thead>
<tr>
<th>O</th>
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<tr>
<td>L</td>
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<tr>
<td>?</td>
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De structuur in (4) toont dat een nasaal kan worden opgevat als een “sonorante stopklank”. Dit betekent dat nasaliteit vanuit fonologisch oogpunt een afgeleid begrip is. Bovendien is een nasaal slechts een van de mogelijke interpretaties van de structuur in (4). Zo beargumenteer ik in hoofdstuk 4 dat er sommige talen zijn, zoals het Rotokas en het Pirahã, waarin (4) wordt gerealiseerd als een stemhebbende orale stopklank (zie tevens §2.2.5). In een aantal andere talen, zoals het Kpelle en het Gbe, worden sonorante stopklanken alleen als nasaal gerealiseerd indien er onderliggend harmonische nasalisatie aanwezig is.


Het gedomineerde element in de mannerstructuur van een nasaal is [ʔ]. De aanwezigheid van [ʔ], in deze structurele positie, heeft tot gevolg dat een nasaal
SAMENVATTING

zich als plosief gedraagt voor wat betreft de selectie van plaatselementen. De observatie dat nasalen gebruik (kunnen) maken van dezelfde plaatscontrasten als plosieven kan zo worden gerelateerd aan het feit dat in zowel plosieve als nasale mannerstructuren het element \( \text{[/]} \) plaats domineert.

In sommige talen is een representatie van nasalen als “kale” sonorante stopklanken toereikend. In andere talen echter suggereert het fonologisch gedrag van nasalen dat de basisstructuur in (4) moet worden uitgebreid met een dependent element \([L]\), als in (5):

\[
\begin{align*}
\text{O} & \quad \text{L} & \quad \text{L} \\
\quad & \quad \text{?}
\end{align*}
\]

De overwegingen die een rol spelen bij de vraag of een nasaal in een bepaalde taal moet worden gerepresenteerd als in (4) of als in (5) worden besproken in hoofdstuk 2 (zie in het bijzonder §2.2.5). De meest in het oog springende aanwijzing voor de aanwezigheid van dependente \([L]\) komt uit talen waarin nasalen nasalisatie of stemhebbendheid in een naburig segment afdwingen. Deze processen kunnen worden geformaliseerd als spreiding van dependente \([L]\) naar respectievelijk een sonorante en een obstruente mannerstructuur. Ik bespreek een aantal van dit soort processen in hoofdstuk 3 en hoofdstuk 4.

Een belangrijk uitgangspunt van het Element-based Dependency model betreft het idee dat de fonetische interpretatie van een element afhankelijk is van de positie waarin dat element zich bevindt. De structuuraanhankelijke interpretatie van elementen wordt treffend geïllustreerd door het element \([L]\). In algemene zin—d.w.z. los van een specifieke context—worden segmenten die voor \([L]\) zijn gespecificeerd in articulatorische zin gekarakteriseerd door geringe vernauwing en in akoestische zin door periodiciteit. De specifieke interpretatie van \([L]\) hangt echter af van de positie van \([L]\) binnen de fonologische structuur. Als \([L]\) zich in de mannerstructuur van een segment bevindt (d.w.z. in het “hoofd”), dan gedraagt het segment zich als een sonorant. Als \([L]\) zich daarentegen in de fonatiestructuur bevindt (d.w.z. in de “dependent”), dan heeft \([L]\) een variabele interpretatie: dependente \([L]\) wordt geïnterpreteerd als nasalisatie indien er tevens een element \([L]\) in het hoofd aanwezig is, en als stemhebbendheid indien er geen element \([L]\) in het hoofd aanwezig is.

De drie contexten waarin \([L]\) kan voorkomen zijn opgesomd in (6). Merk op dat elk van de structuren in (6) wordt gedomineerd door een lettergreeppospositie (een onset, een nucleus, of een coda) en zelf een plaatselement domineert:
In (7) geef ik drie voorbeelden van fonologische segmenten. In de representatie in (7a) wordt dependente $|L|$ als nasalisatie geïnterpreteerd omdat er eveneens een $|L|$ aanwezig is in de mannerstructuur. In (7b) en (7c) wordt dependente $|L|$ geïnterpreteerd als stemhebbendheid, omdat de mannerstructuur hier geen $|L|$ bevat:

Een algemeen voordeel van een contextgevoelige interpretatie van elementen is dat het aantal benodigde elementen beperkt blijft. Waar traditionele theorieën drie kenmerken nodig hebben—d.w.z. [sonorant], [nasaal], en [stem]—gebruikt het Element-based Dependency model slechts een element, in combinatie met de onafhankelijk gemotiveerde noties van hoofd en dependent. Een voordeel van een beperkt aantal elementen is dat dit het risico beperkt dat de theorie meer structuren voorspelt dan noodzakelijk zijn. Het gebruik van een beperkt aantal elementen brengt wel met zich mee dat de resulterende representaties vanuit fonetisch oogpunt weinig concreet zijn. Dit kan als een voordeel worden gezien aangezien bepaalde fonologische concepten, zoals sonoriteit en nasaliteit, geen duidelijk fonetisch correlaat hebben (zie §1.1).

Wat $|L|$ betreft biedt een contextgevoelige interpretatie van elementen een aantal specifieke voordelen. Ten eerste voorspelt de tweeledige interpretatie van dependente $|L|$ als nasalisatie en stem dat stemhebbende sonoranten en genasaliseerde obstruenten geen fonologische status hebben. De afwezigheid van deze segment-types is wenselijk omdat er geen reden is om aan te nemen dat distinctieve nasalisatie van obstruenten en distinctieve stemhebbendheid van sonoranten fonologisch relevant zijn.

De tweeledige interpretatie van dependente $|L|$ maakt ook een inzichtelijke analyse van nasaalharmonie mogelijk. Nasaalharmonie betreft een proces waarin nasaliteit niet beperkt blijft tot een enkel segment (zoals in een Nederlands woord als *melk*), maar over een aantal segmenten wordt uitgesmeerd. In een taal als het Warao verspreidt nasaliteit zich vanuit een nasaal in de richting van het
woordeinde, totdat de nasalisatie wordt geblokkeerd door een obstruent (zoals in het Warao woord *moapu* [mõãûpu] ‘geef ze aan hem’).

In een bepaald type nasaalharmonie worden alle sonorante segmenten in een woord genasaliseerd, terwijl alle obstruente segmenten zich als onzichtbaar (of “transparant”) ten opzichte van het harmonieproces gedragen. In een dergelijke taal correspondeert het domein van nasaalharmonie niet noodzakelijkerwijs met een aan elkaar grenzende reeks segmenten. Een voorbeeld van een taal met dit type nasaalharmonie is het Tuyuca. De woorden in (8) laten zien dat binnen een harmonisch woord alle sonoranten in het Tuyuca genasaliseerd worden:

(8)  Úfã ‘verlichten’  mõûp ‘das (*Meles taxus*)’
    Hõí ‘daar’  nõû ‘(houts)kool’
    êml ‘brulaaap’  tõõ ’Yapara watervallen’
    Õín ‘wind’  jõsõ ‘vogel’

We kunnen de distributie van nasalisiteit in deze woorden verklaren wanneer we aannemen dat |L|, indien onderliggend aanwezig als harmonisch element, zich hecht aan alle voor |L| gespecifieerde manierstructuren. Dit heeft als resultaat dat alle sonoranten genasaliseerd worden en alle obstruenten transparant zijn.

In sommige Tuyuca-achtige talen, zoals het Southern Barasano, het Tucano, en het Yuhup, zijn er redenen om aan te nemen dat het harmonische element |L| onderliggend aanwezig moet zijn op het niveau van de lettergreep. Voor wat betreft de oppervlakte-distributie van nasalisatie verschillen deze talen echter niet van het Tuyuca: ook in het Southern Barasano, het Tucano, en het Yuhup hecht dependente |L| zich aan elke sonorante manierstructuur binnen het harmonische domein. Ik bespreek de rol van dependente |L| in nasaalharmonie in hoofdstuk 3.

Een verder voordeel van de tweeledige interpretatie van |L| wordt duidelijk wanneer we kijken naar fonologische processen waarin zowel stemhebbendheid als nasalisatie een rol spelen. Dit is het geval bij “postnasal voicing”. Postnasal voicing is een proces waarin een onderliggend stemloze obstruent stemhebbend wordt onder invloed van een voorafgaande nasaal. Postnasal voicing komt in een relatief groot aantal talen voor, waaronder het Puyo-Pongo dialect van het Quechua. De voorbeelden in (9a) illustreren dat een suffix-initiële plosief in het Puyo-Pongo Quechua stemhebbend wordt als deze voorafgegaan wordt door een stam-finale nasaal; de voorbeelden in (9b) laten zien dat suffix-initiële plosieven in andere contexten stemloos blijven:

(9)  a. /kam-pa/ [kamba]  ‘jij-GEN’
     /wakin-ta/ [wakinda]  ‘het huis-OBJ’
    b. /sinik-pa/ [sinikpa]  ‘stekelvarken-GEN’
     /wasi-ta/ [wasita]  ‘de anderen-OBJ’

Wanneer we aannemen dat nasalen in het Puyo-Pongo Quechua bestaan uit sonorante stopklanken met een dependent element |L|, als in (5), dan kunnen we
postnasal voicing uitdrukken door spreiding van \([L]\) naar de dependente positie van de plosief. In deze positie wordt \([L]\) geïnterpreteerd als stemhebbendheid. Dit scenario is afgebeeld in (10), waar wordt aangenomen dat de nasaal en de plosief een coda-onset cluster vormen:

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

\text{Nasaal} \quad \text{Plosief}

Een proces als postnasal voicing illustreert dat de interpretatie van dependente \([L]\) wordt bepaald door de manierstructuur waaraan \([L]\) is bevestigd.

De tweeledige interpretatie van dependente \([L]\) wordt verder ondersteund door het bestaan van processen waarin een nasaal of stemhebbendheid of nasalisatie afdwingt, afhankelijk van de manierstructuur van het geëffectueerde segment. Een voorbeeld van zo’n proces komen we tegen in het Navajo. De vormen in (11) tonen dat perfectief aspect in het Navajo wordt uitgedrukt door middel van het stemhebbend maken van een stam-finale obstruent, als in (11a), en door middel van het nasaliseren van een stam-finale sonorant, als in (11b):

\[
(11) \quad \begin{array}{ll}
\text{IMPERF} & \text{PERF} \\
\text{a.} & -\text{?aal} \\
& -\text{?aal} & \text{‘kauwen, eten’} \\
& -\text{?aa}3 & \text{‘weinigen gaan’} \\
& -\text{l}\text{ôs} & -\text{l}\text{ôz} & \text{‘leiden’} \\
\text{b.} & -\text{b}i & -\text{b}i & \text{‘zwemmen’} \\
& -\text{?â} & -\text{?fl} & \text{‘classificeerder voor compacte objecten’} \\
& -\text{ka} & -\text{kâ} & \text{‘classificeerder voor ingesloten objecten’} \\
\end{array}
\]

Dergelijke alternanties suggereren de aanwezigheid van een enkel fonologisch element, bijvoorbeeld \([L]\), dat zowel stemhebbendheid als nasalisatie uitdrukt, afhankelijk van het maniertype van het segment waaraan \([L]\) bevestigd wordt. Ik bespreek een aantal voorbeelden van Navajo-achtige processen in hoofdstuk 4.

Een andere basisgedachte van het Element-based Dependency model is dat laryngale contrasten zoals stemhebbendheid, aspiratie, en glottalisatie (maar ook nasalisatie) niet door een segmentele positie worden gedomineerd, maar door een lettergroeppositie (d.w.z. door een onset, een nucleus, of een coda). Deze organisatie wordt eveneens voorgesteld in Kehrein (2002). De Element-based Dependency representatie van subsyllabische structuur is weergegeven in (12):
Uit (12) kunnen we opmaken dat manner en plaats samen de segmentele “kern” vormen. De fonatiecomponent, waarin de diverse laryngale contrasten worden gespecificeerd, vormt een dependent van deze kern. (12) weerspiegelt derhalve de observatie dat specificaties voor zowel manner als plaats ongemarkeerd zijn, terwijl een specificatie voor fonatie juist gmarkeerd is.

Een algemeen voordeel van de structuur in (12) is dat laryngale contrasten zich op dat punt in de prosodische structuur bevinden waarop ze minimaal contrastief zijn. Een structuur waarin aspiratie een dependent vormt van de onset voorspelt bijvoorbeeld dat talen nooit gebruik maken van een fonologisch contrast dat is gebaseerd op de relatieve volgorde van nasaliteit en aspiratie (bijv. */m̩/~/m/), of op de mate van overlap tussen nasaliteit, stemhebbendheid, en aspiratie (bijv. */É~É/, */f/~/f/). De structuur in (12) biedt eveneens een verklaring voor de afwezigheid van contrasten tussen een larynaal segment en het corresponderende laryngale contrast binnen dezelfde lettergroeipositie (bijv. */m̩/~/m/, */m/~/m/). De data die worden besproken in §§5.2 en 5.3 zijn in overeenstemming met deze voorspellingen.

Specifieke voordelen van de Element-based Dependency representatie van laryngale contrasten zijn, ten eerste, dat elk van deze contrasten gereserveerd wordt door een enkel element en, ten tweede, dat er geen restricties nodig zijn om bepaalde combinaties van manner en fonatie uit te sluiten. Zo volgen de onverenigbaarheid van obstruent-manner met distinctieve nasalisatie en van sonorant-manner met distinctieve stemhebbendheid beide uit de aanname dat dependent L een mannavankelijk interpretatie heeft.

In hoofdstuk 5 onderzoek ik de representatie van laryngale contrasten in relatie tot laryngaal gemanageerde nasalen. Het Element-based Dependency model voorspelt het bestaan van twee types laryngaal gemanageerde nasalen: geaspireerde nasalen (sonorante stopklanken met een dependent element [H]) en geglottaliseerde nasalen (sonorante stopklanken met een dependent element [ʔ]). In onsetpositie hebben deze nasalen de volgende structuur:

(13) a. O                      b. O
    L   H                     L   ?
    ?                       ?

Geaspireerde nasaal        Geglottaliseerde nasaal
De bestudering van talen met distinctieve laryngaal gemonstreerde nasalen leert dat deze segmenten een veelheid aan fonetische realisaties hebben. Zo omvat de variatie in geaspireerde nasalen realisaties die vanuit fonetisch oogpunt kunnen worden gekenmerkt als stemloos, geaspireerd, en stemhebbend-geaspireerd. Bij deze realisaties is de aan- of afwezigheid van stemhebbendheid afhankelijk van de overlap en de mate van glottale opening. De aan- of afwezigheid van stem is zelf niet contrastief in geaspireerde nasalen.

We vinden tevens een grote mate van fonetische variatie in geglottaliseerde nasalen. Afhankelijk van taal en spreker omvat de realisatie gepreglottaliseerde, gepostglottaliseerde, en “creaky voiced” nasalen. Vanuit fonologisch oogpunt is de cruciale observatie echter dat geen enkele taal op een distinctieve manier gebruik maakt van dit soort variatie. Dit ondersteunt het idee dat we niet meer dan twee fonologische segment-types hoeven te onderscheiden, die worden gekarakteriseerd door de aanwezigheid van dependente [H] en [ʔ]. Element-based Dependency biedt in dit opzicht een restrictie kijk op de relatie tussen manner en fonatie.

De eerste vijf hoofdstukken van dit proefschrift geven een overzicht van de Element-based Dependency benadering van nasaliteit: de basisbeginselen van het theoretische model worden uiteengezet in hoofdstuk 1 en 2, de interpretatie van dependente [L] als nasalisatie en stemhebbendheid worden behandeld in hoofdstuk 3 en 4, en de structuur en de representatie van laryngale contrasten, met speciale aandacht voor nasalen, wordt besproken in hoofdstuk 5. In de laatste twee hoofdstukken komen kort twee andere onderwerpen aan bod. In hoofdstuk 6 ga ik dieper in op de relatie tussen nasaliteit en laryngalen, en geef ik kort enkele argumenten voor de genasaliseerde laryngaal als een mogelijk segment-type. In hoofdstuk 7 bespreek ik kort enkele processen waarin nasalen zich niet als een natuurlijke klasse gedragen. Ik stel voor dat dit soort gedrag, in de meeste gevallen althans, wordt veroorzaakt door verschillende vormen van ongemarkeerdheid die samenhangen met verschillende plaatsen van articulatie. De onderwerpen die in hoofdstuk 6 en 7 aan bod komen roepen interessante vragen op, die gedetailleerder antwoorden behoeven dan in dit proefschrift gegeven worden. Zoodee vertegenwoordigen ze twee mogelijke richtingen waarin verder onderzoek binnen het Element-based Dependency model kan worden gedaan.
Curriculum vitae

Bert Botma was born on 22 September 1972 in Vlaardingen, the Netherlands. After completing his secondary school at the Rijksscholengemeenschap Brielle (Gymnasium α), he did his undergraduate studies at the Department of English at Leiden University. During his studies he spent a year at Edinburgh University, studying English and General Linguistics, and teaching Dutch. After graduating in 1996 (with a specialisation in phonology), he worked for a year as a translator and creative writer at the English Text Company in The Hague. From 1997 to 2001 he was employed at HIL/University of Amsterdam as a PhD researcher. From 2000 onwards he combined his research with a part-time position as lecturer in English linguistics in the Department of English at Leiden University. Since February 2004 he has held a permanent position in the same Department.
Stellingen

Behorende bij het proefschrift

Phonological Aspects of Nasality

van

Bert Botma

1. Nasaliteit is vanuit fonologisch oogpunt een afgeleid begrip (dit proefschrift).
2. Fonologisch gezien zijn distinctieve stemhebbendheid en distinctieve nasalisatie in complementaire distributie (dit proefschrift).
5. Processen die zowel stemhebbendheid als nasalisatie afdwingen spelen zich af op subsyllabisch niveau, niet op syllabisch niveau (dit proefschrift).
6. Het aantal mogelijke distinctieve laryngale contrasten in nasale consonanten is universeel beperkt tot twee (dit proefschrift).
7. In laryngaal gemodificeerde nasalen is de aan- of afwezigheid van stemhebbendheid fonologisch niet relevant (dit proefschrift).
9. Typologische generalisaties zijn onlosmakelijk verbonden met het theoretische raamwerk waarbinnen ze worden gepresenteerd.
10. Met stelling 9 in het achterhoofd: alle talen hebben een onderliggend contrast tussen een serie obstruenten en een serie sonorante consonanten (dit proefschrift).
11. De typografische weergave van de notie *magic licensing* in Government Phonology en de notie *sympathy* in Optimality Theory laat zien dat deze theorieën meer met elkaar gemeen hebben dan fervente aanhangers van beide willen toegeven.

12. De oorverdovende geluidssterkte van muziek in uitgaansgelegenheden maakt het leren van Nederlandse Gebarentaal, zowel voor nu als voor later, een bijzonder nuttige bezigheid.

13. Het antwoord op de vraag of het alfabetiseren van een cd-collectie een vorm van efficiënt of neurotisch gedrag is, wordt veelal geslachtelijk bepaald.

14. Een schaker heeft meer last van de *confirmation bias* dan van de tegenstander.

15. Het is een uitstekend idee om uitsluitend champagne te serveren bij een maaltijd: eenvoudig en heerlijk (vrij naar Paul Bocuse, *La Cuisine du Marché*).