Phonological aspects of nasality: An element-based dependency approach
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In this chapter I outline the important aspects of the Element-based Dependency framework. First, in §2.1, I introduce the elements |?|, |H|, and |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 |?|, |H|, and |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 |L| dominates |?|. 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 |?|, |H|, and |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 |?|, |H|, and |L| each correspond to a particular manner distinction, as in (1):

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

Thus, |?|, |H|, and |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 [ʔ], [H], and [L] have complementary acoustic interpretations, given in (2):

(2)  

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>ʔ</td>
<td>: amplitude drop</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>: aperiodicity</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>: periodicity</td>
<td></td>
</tr>
</tbody>
</table>

According to this interpretation, amplitude drop, aperiodicity, and periodicity are the invariant acoustic cues associated with [ʔ], [H], and [L].

In line with the autonomous interpretation hypothesis, I assume that in isolation [ʔ], [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”:

(3)  

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ʔ</td>
<td>: plosive (=prototypical stop)</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>: sibilant (=prototypical fricative)</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>: vowel (=prototypical sonorant)</td>
<td></td>
</tr>
</tbody>
</table>

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 [ʔ] only. In the absence of a place specification [ʔ] is interpreted as /t/, as is shown in (4a). The combination of [ʔ] with [U], [I], and [A] yields the basic stop series /p t k/, as is shown in (4b-d):

1  In consonants [U], [I], 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:

> In 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 [(+)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 [(+)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:
(5) a. O
   |   
   H  H
   |   
   I  I  A

/s/

(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/ → [h] in some dialects of Spanish (see also §1.1), and from the diachronic development *s > h, which is attested in among others Welsh, Ancient Greek, and Hawaiian.

(6) O
   |   
   H

/h/

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. 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 [(+)strident] to the exclusion of other segment types.

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. 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:

(7) Tlingit s’, l’, x’, x’w’, χ’, χ’w’
    Yuchi φ’, s’, f’, l’
    Dakota s’, f’, x’
    Kabardian f’, f’
    Southern Nambiquara s’, 6
    Sui 7

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

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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.

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

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

5 In Element-based Dependency, Southern Nambiquara /b/ can be classified as a “non-buccal sibilant”. The only laryngeally modified non-sibilant in (7) would then be Sui /7/. Contrary to Maddison, 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.\(^6\) 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.

### 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.

\[(8)\]
\[
\begin{array}{cccc}
\text{a. } & \text{N} & \text{b. N} & \text{c. N} & \text{d. N} \\
| & | & | & | \\
L & L & L & L \\
| & | & | & |
\end{array}
\]

\[
\begin{array}{ccc}
\text{U} & \text{I} & \text{A} \\
/\text{a}/ & /\text{i}/ & /\text{a}/ \\
\end{array}
\]

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.

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\(^6\) 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. /ã/, or as approximants, such as /w v r j ʊ/. 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 |ʔ|, the choice depending on the phonological behaviour of the segment. If, for instance, an approximant displays vowel-glide 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 /r/ in these terms, since it can appear as the leftmost member in the onset /r/ in a word like *wreed* /r/ ‘cruel’. A feasible representation of this onset cluster is given in (9), where I assume that /r/ is an underlingly placeless rhotic:

(9)

```
     O
    / H  L \
   / L  H \
  / U  \
```

In (9), the obstruent-like characteristics which are associated with the prosodic position of /r/ are reflected by the the headedness of the obstruent-like manner element |H|. According to Van der Torre (2003:191), the relative distributional freedom of /r/ is due to it being specified for the “consonantal” place element |U|. I consider this interpretation in more detail in chapter 7.

2.2 Complex manner types

In this section, I consider the interpretation of combinations of |ʔ|, |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

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7 This segment is realized as bilabial [β] in southern varieties of Dutch, and as [w] in Surinam Dutch. Note that many Dutch speakers neutralize /r/ to either [v] or [l] before /r/.

8 According to Van der Torre (2003:191), the relative distributional freedom of /r/ 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 $H$:

(10) a. $?$ b. $H$
     |     |
     $H$  $?$

(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 $L$:

(11) a. $H$ b. $L$
     |     |
     $L$  $H$

(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 $L$:

(12) a. $?$ b. $L$
     |     |
     $L$  $?$
(12a) consists of head [ʔ] and dependent [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 [L] and dependent [ʔ]. 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 [ʔ] is the only manner element present is a stop, and, similarly, all manner structures which are headed by [ʔ] are also stop types. However, this is not the case for [H] and [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 [ʔ] dominates [H], as in (13), is interpreted as an affricate:

(13)  O
      |  ?
      |  H

Phonetically, affricates consist of a stop phase followed by a homorganic release stage, resulting in sounds such as [pʰ ts kx]. 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 [+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 /s z ʃ ʒ/, parallel to /ʃ ʒ/, 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 /ts/ and /ʧ/ are represented as follows:

(14) a. O b. O

d | d
d | d
H | H
|   |
I I A

\[\sqrt{ts} / \sqrt{ʧ} /\]

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 |H| dominate place. On the other hand, they express the fact that affricates, by virtue of being |\[├\]|-headed, have at their disposal the type of

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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.11

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

(15) Stops

<table>
<thead>
<tr>
<th></th>
<th>p</th>
<th>t</th>
<th>tʰ</th>
<th>k</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>d</td>
<td>dʰ</td>
<td>q</td>
<td></td>
</tr>
<tr>
<td>b’</td>
<td>d’</td>
<td>qʰ</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Affricates

<table>
<thead>
<tr>
<th></th>
<th>t̠</th>
<th>t̠ˢ</th>
<th>t̠ʰ</th>
<th>t̠ʸ</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>d</td>
<td>dʰ</td>
<td>q</td>
<td></td>
</tr>
<tr>
<td>b’</td>
<td>d’</td>
<td>qʰ</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sibilants

<table>
<thead>
<tr>
<th></th>
<th>s</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>z</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

In addition to plain stops, affricates, and sibilants, !Xu 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, !Xu 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 [tʰ].

2.2.2 Non-sibilant fricatives

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

(16)

\[
\begin{array}{c}
\partial \\
H \\
\partial
\end{array}
\]

In traditional feature theory, fricatives are distinguished from stops in terms of \([(+)\text{-}\text{continuant}]\). 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 \(\partial\). This expresses the fact that fricatives, like stops, involve energy reduction. In fricatives, \(\partial\) 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 \(\partial\) is dominated by \(|H|\) and is therefore relatively less prominent.

There are further arguments for assigning fricatives the manner primitive \(\partial\). 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 \(\partial\). 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:

(17)

\[
\begin{array}{c}
\partial \\
\partial
\end{array}
\]

The combination of fricative manner with \(|U|, |I|, \text{ and } |A|\) is interpreted as /\(\partial \theta x/\), 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):

\[
\begin{array}{ccc}
  & O & \\
  | & | & \\
  H & H & H \\
  | & | & \\
  ? & ? & ? \\
  | & | & \\
  U & I & A \\
\end{array}
\]

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 /\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 /\r/ and retroflex /\r/. 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 /\r/ can be classified as [+strident] on acoustic grounds. The sibilant nature of laterals is also supported by the existence of the lateral affricate /\r/. In languages which have sibilant harmony, /\r/, 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 /\r/ 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 [+continuant] distinguishes laterals from rhotics, such that laterals are [–continuant] and rhotics [+continuant] (see Clements 1987, Van de Weijer 1995). Evidence for the non-continuant status of laterals comes from natural class behaviour of stops, nasals, and /\r/. For instance, in Basque stops are deleted before /\r/, which, as Van de Weijer (1995:47) observes, “is a natural class of segments, on the assumption that /\r/ is [–continuant].” There is also distributional evidence for the non-continuant status of /\r/. 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 ŋ]. This, too, is a natural class on the assumption that [l] is [–continuant].

In Element-based Dependency the non-continuant status of /\r/ must be expressed in terms of [\r], 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):

\[(21) \quad \begin{array}{c}
\text{/in+}\text{pokə/} \\
\text{[impoksə] ‘to wrap up’} \\
\text{/in+}\text{qian/} \\
\text{[ingiəŋ] ‘to enter’} \\
\text{/oan+}\text{ntə/} \\
\text{[oənntə] ‘to accept’}
\end{array}\]

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.\(^{12}\) 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-azəŋja] ‘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 |H|; rather, whether or not /l/ has |H| 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 |H|. Clearly, the more restrictive position is to regard /l/ as having |H| only in case of positive phonological evidence.

It should be noted at this point that there are also languages where /l/ appears to lack |H|. 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):

    *td, *lt > ld/li, lt  *rt, *rd > rθ, rœ
    *tk, *tg > lθ  *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 |I|, so that the absence of lenetion 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.\(^{13}\)

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 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 *Keλr* but not *Kerl*\(^{14}\). This asymmetry is generally attributed to the fact that /t/ is more sonorous than /l/. A sonority difference could also be argued to be relevant in languages where /t/ 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 \(|L|-\)headed and laterals as \(|H|-\)headed. Another possibility is to represent rhotics as in (19), and to represent laterals with an additional |?| element; this is motivated by the fact that the amplitude drop associated with |?| 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 /t/ 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):

\[
\begin{align*}
\text{(24) Aitken’s Law} \\
\quad \text{a. All long vowels shorten everywhere except before } /r v z \partial \#/. \\
\quad \text{b. All non-high short vowels lengthen before } /r v z \partial \#/. \\
\end{align*}
\]

Thus, in Aitken’s Law /t/ 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 /t/, like obstruents, devoices in final position, and is realized phonetically as “a fricative and slightly retroflexed [؟].”

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, /t/ functions phonologically as a low glide (see e.g. Giegerich 1999). This could be taken to

\(^{13}\) The same point can be made regarding other types of approximants. As was argued in §2.1.3, these have a variable representation, depending on their phonological behaviour.
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/
     \[\begin{array}{c|c}
              & L \\
            \hline
  H & | \\
  L & A \\
\end{array}\]

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
     \[\begin{array}{c|c}
              & L \\
            \hline
  O & | \\
 \hline
  L & ?/H \\
\end{array}\]

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. O   b. O
     \[\begin{array}{c|c}
              & L \\
            \hline
 \hline
  O & ?/H \\
 \hline
  ?/H & L \\
\end{array}\]
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 \( [\dot{g}] \) 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 \([\pm \text{sonorant}]\). 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:

\[
\begin{array}{ccc}
\text{a.} & \text{O} & \text{b.} & \text{O} \\
\text{\quad |} & \text{\quad |} & \\
\text{?} & \text{H} & \\
\text{\quad |} & \text{\quad |} & \\
\text{L} & \text{L} & \\
\end{array}
\]

Given that these structures are headed by \( [\dot{g}] \) 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.\(^{14}\) On the one hand, the fact that they are headed by \( [\dot{g}] \) 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 /\( h\)l/ (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 categorical 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. */m̩b/~/m̩p/) nor in terms of the order of the nasal and the oral parts (e.g. */m̩b/~/n̩p/). 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 prepalosion 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 \[ \text{[L]} \] 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 \[ \text{[?]} \] and dependent \[ \text{[L]} \], 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):

\[
\begin{align*}
\text{(31)} & \quad \text{a. } \text{[\text{F\text{ara}p]}'} \quad \text{‘wine-NOM-SG’} & \quad \text{b. } \text{[\text{A\text{z}]}} \quad \text{‘few’} \\
& \text{[\text{F\text{ara}b\text{\text{i}]}]} \quad \text{‘wine-ACC-SG’} & \quad \text{[\text{E\text{v}]}} \quad \text{‘house, home’} \\
& \text{[\text{F\text{ara\text{p}l\text{ar}]}]} \quad \text{‘wine-NOM-PL’}
\end{align*}
\]

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):

\[
\begin{align*}
\text{(32)} & \quad \text{a. } \begin{array}{c}
\text{C} \\
\text{?} & \text{L}
\end{array} & \quad \begin{array}{c}
\text{C} \\
\text{H}
\end{array} \\
& \quad \text{Voiced stop} & \quad \text{Voiced fricative}
\end{align*}
\]

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

bilabial, 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

---

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. /ũ/) and nasal contours (e.g. /ʰb ʰp/).
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 \( /g/ \). Since this structure involves a combination of sonorancy and stopness, I will refer to it as a “sonorant stop”.

\[(33)\]
\[
\begin{array}{c}
L \\
\mid \\
? \\
\end{array}
\]

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):

\[(34)\]  
\[
/\text{ba}+\text{an}/ \quad [\text{ba}\gamma\text{an} \sim \text{ba}\upsilon\text{an} \sim \text{ba}\eta\text{an}] \quad \text{‘to return a favour’}  
/\text{tc}'\text{au}+\text{au}/ \quad [\text{tc}'\gamma\text{au} \sim \text{tc}'\upsilon\text{au} \sim \text{tc}'\eta\text{au}] \quad \text{‘proud’}  
/\text{m}'\text{en}+\text{au}/ \quad [\text{m}'\gamma\text{en} \sim \text{m}'\upsilon\text{en} \sim \text{m}'\eta\text{en}] \quad \text{‘winter coat’}  
/\text{p}\text{en}+\text{ou}/ \quad [\text{p}\gamma\text{en} \sim \text{p}\upsilon\text{en} \sim \text{p}\eta\text{en}] \quad \text{‘lotus root’}
\]

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

\[(35)\]
\[
\begin{array}{c}
O \\
\mid \\
L \\
\mid \\
? \\
\mid \\
A
\end{array}
\quad [\eta\sim\upsilon\sim\gamma]
\]

\[16\] 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)

<table>
<thead>
<tr>
<th>Rotokas A</th>
<th>Rotokas B</th>
</tr>
</thead>
<tbody>
<tr>
<td>p t k</td>
<td>p t k</td>
</tr>
<tr>
<td>m n η</td>
<td>b<del>β</del>m d<del>r</del>l<del>n g</del>γ~η</td>
</tr>
</tbody>
</table>

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)  a. Rotokas A  b. Rotokas B

| O   | O   |
| L   | L   |
| ?   | ?   |
| U   | U   |
| [m] | [b~β~m] |

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:

(38) /p t (k) ?\n    b g s h

Everett (1986:316) observes that /b g/ are optionally realized as [m ŋ] 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}{c|c}
\text{Obstruent stop} & \text{Sonorant stop} \\
O & O \\
\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. 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 /k/.  
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. m> ’where’ (*mí) b. bála ‘sheep’ (*bfla)
    nfu ’person’ (* núu)    leyi ’pot’ (*ĺeyi)
    njëfña ’bitter’ (*njëåna)    wála ‘strong’ (*wfla)

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
    [mip] ’badger’ (*[mipl]) [bpl] ’swollen’ (*[bpl])
    [nî0] ’lose’ (*[nîl]) [dit] ’coal’ (*[dît])
    [tnô] ’follow’ (*[tnô]) [sîgë] ‘Yapara rapids’ (*[sîgë])

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) O
    L    L
    ?

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.\textsuperscript{19} 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 \(|\text{U}|, |\text{I}|, \text{and } |\text{A}|\) is interpreted as /\text{g}/, as in (43):

\begin{align*}
\text{a. } & \text{O} & \text{b. } & \text{O} & \text{c. } & \text{O} \\
& | & | & | \\
& L & L & L \\
& | & | & | \\
& ? & ? & ? \\
& | & | & | \\
& \text{U} & \text{I} & \text{A} \\
\end{align*}

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.\textsuperscript{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):

\begin{align*}
\text{19} & \text{ 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.} \\
\text{20} & \text{ Some other dialects of Dutch, such as the dialect of West Brabant, display nasal effacement in preconsonantal context, creating surface minimal pairs like [l\text{\text{"a}}p] \text{‘lamp’} \sim [l\text{\text{"a}}p] \text{‘rag’} \text{ (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 } |\text{L}|.}
\end{align*}
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:

(45) STEM      PRES-1SG

/stɔp/      [stɔptə]      ‘stop’
/stɔɾf/      [stɔɾfa]      ‘dust’
/plas/      [plas]      ‘pee’
/kraːb/      [kraːbdə]      ‘scratch’
/ˌverv/      [ˌvervə]      ‘paint’
/ˈreiz/      [ˈreizə]      ‘travel’
/ˈstem/      [ˈstemə]      ‘vote’
/rɔl/        [rɔldə]      ‘roll’
/ski/        [skida]      ‘ski’

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 underlyingly voiceless obstruents, and as [-də] elsewhere:

(46) STEM     PAST-SG

/stɔp/      [stɔptə]      ‘stop’
/stɔɾf/      [stɔɾfa]      ‘dust’
/plas/      [plas]      ‘pee’
/kraːb/      [kraːbdə]      ‘scratch’
/ˌverv/      [ˌvervə]      ‘paint’
/ˈreiz/      [ˈreizə]      ‘travel’
/ˈstem/      [ˈstemə]      ‘vote’
/rɔl/        [rɔldə]      ‘roll’
/ski/        [skida]      ‘ski’

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 underlyingly 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.\textsuperscript{21}

There are a number of problems with this account. Firstly, the fact that it relies on a binary-valued feature \([\pm \text{voice}]\) fails to express the markedness of the voiced obstruent series. Secondly, the redundancy rule which inserts \([+\text{voice}]\) 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 \([-\text{da}]\) 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.\textsuperscript{22}

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):

\[
\begin{array}{c}
\circ C \\
\circ U \\
/p/
\end{array} \quad \begin{array}{c}
\circ C \\
\circ U \\
/b/
\end{array}
\]

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 \([L]\).\textsuperscript{23}

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

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

\textsuperscript{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 \([-\text{voice}]\); this implies, then, that in a unary-valued approach there is no progressive voicing assimilation.

\textsuperscript{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):

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

\[
/m+d/ \rightarrow [md] \]

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, /krəb+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.

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

\[
/b+d/ \rightarrow [bd] \]

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 /stəp+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):

\[\]
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 unanswered the question why we do not find leftward spreading of [L] to the stem-final stop, resulting in the surface form */stbd*. I suggest that leftward spreading of [L] is prohibited because it effects an unwarranted modification of the stem-internal obstruent. That is, the voicing specification of the suffix cannot affect the underlying specification in the stem. 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

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

25 This scenario is amenable to an Optimality Theoretic analysis in which stem faithfulness (i.e. “do not change an underlying stem specification”) outranks affix faithfulness (i.e. “do not change an underlying affix specification”); see Grijzenhout & Krämer 2000 for an account of Dutch obstruent (de-)voicing along these lines. Note, however, that an alternative analysis is required to account for the behaviour of the ordinal suffix */-da/*, which *does* trigger regressive voicing (e.g. */zvan-da/ → */zvd/ ’sixth’). I am grateful to Jeroen van de Weijer for raising this issue.
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’
sinch-pa ‘porcupine-GEN’  kam-ba ‘you-GEN’
saiJ-a-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)  

\[
\begin{array}{c}
\text{C} \\
\hline \\
\text{O} \\
\hline \\
\text{L} \\
\hline \\
\text{L} \\
\hline \\
? \\
\end{array}
\]

\[
/N+±/ \rightarrow [N©]
\]

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’  bê  ‘hand’
ho  ‘to eat (meat)’  hô  ‘to sing’
mu  ‘gaiac (Lignum vitae)’  mü  ‘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)  

/fu+ºde/  [fûºd]  ‘hang something up’
Γºde+n¢/  [”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 [ˈðɛn̚ð]; note in (56) that the triggering nasal is specified for dependent |L|:

(56) \[
\begin{array}{cccc}
N & O \\
\hline
L & L & L \\
\hline
I & A & ? \\
\hline
\end{array}
\]

\[
/e+n/ \rightarrow [\text{ên}]
\]

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{tabular}{cccc}
  p & t & k & q \\
  m & n & f & \eta & \eta \\
\end{tabular}

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:

\begin{quote}
The presence of a nasal at a given place of articulation implies the presence of an obstruent at the same place.
\end{quote}

Thus, nasals are like stops as regards their compatibility with place. Note that this is expressed by making \(\tilde{?}\), in both stops and nasals, dominate the place component.

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

(59)  \textit{O}

\begin{align*}
  & | \\
  & L \\
  & ? \\
  & I \\
  & A \\
\end{align*}

/\(\nu\)/

Of the 317 languages in UPSID, 107 have /\(\nu\)/, but only 41 have the palatal stop /\(\tilde{c}\)/ (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 η/ word-initially but only /m n η/ word-finally (see e.g. Bradley 1979). The same situation is found in the Malayic 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):

(60) nom ~ nop ‘heaven’ suram ~ surap ‘beast’
man ~ mat ‘I’ nætem ~ nætæt ‘of a girl, girls’
ɔŋ ~ ɔk ‘mouth’ ɔtæŋɔŋ ~ ɔtæŋɔk ‘reindeer-DAT-SG’

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:

---

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 Auca. Note, however, that according to the description in Capo (1981), the phoneme inventory of Gbe (a Kwa dialect cluster which includes Ewe), does include /t/ dy/. 

CHAPTER 2

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 |\(\sim\)|.

The relation between nasals and stops is also supported by diachronic developments. Consider for instance South Island Maori, where /\(\gamma\)/ and /\(k\)/ have merged to /\(k\)/ (cf. Campbell 1998). This development can be characterized in terms of the loss of |\(L\)| 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)

<table>
<thead>
<tr>
<th>Proto-Chamic</th>
<th>Roglai</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. *masam</td>
<td>masap</td>
</tr>
<tr>
<td>*siam</td>
<td>siap</td>
</tr>
<tr>
<td>*maduän</td>
<td>maduat</td>
</tr>
<tr>
<td>*ikan</td>
<td>?ika:ŋ</td>
</tr>
<tr>
<td>*baŋ</td>
<td>bak</td>
</tr>
<tr>
<td>*daŋ</td>
<td>dak</td>
</tr>
<tr>
<td>*gunam</td>
<td>gunam</td>
</tr>
<tr>
<td>*maŋam</td>
<td>maŋam</td>
</tr>
<tr>
<td>*ʔanän</td>
<td>ʔanan</td>
</tr>
<tr>
<td>*kamuän</td>
<td>kamuän</td>
</tr>
<tr>
<td>*lumɔŋ</td>
<td>lumɔŋ</td>
</tr>
<tr>
<td>*tsanjaŋ</td>
<td>ñšanzaŋ</td>
</tr>
</tbody>
</table>

The development in (62a) suggests an analysis in terms of the deletion of |\(L\)| 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. *\(N\) > *\(CN\) > \(C\). 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 /ptk/ are realized as /m n ñ 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)  

\[
\begin{align*}
\text{Dinka} & \\
\text{Shilluck} & \\
\text{tì:k} & \text{‘woman’} & t\eta & \text{‘woman-DET’} \\
\gamma\dot{\theta}t & \text{‘house’} & \gamma\dot{\theta}n & \text{‘house-DET’} \\
\langle\text{mù}k & \text{‘mouth’} & \text{‘house-DEM’} \\
\text{lù:}\overset{\wedge}{\hat{s}i} & \text{‘stick’} & \text{‘stick-DEM’}
\end{align*}
\]

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)  

\[
\begin{align*}
/m\dot{k}+ni/ & [m\ddot{a}ni] \text{ ‘to eat-INTER’} \\
/h\ddot{a}p+b+ni/ & [n\ddot{om}ni] \text{ ‘high-INTER’} \\
/k’ak’t+ni/ & [k’a\ddot{a}ni] \text{ ‘to pick-INTER’}
\end{align*}
\]

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 /m\dot{k}+ni/ in (65), where I assume that the stop occupies the coda position:\textsuperscript{28}

\[
\begin{align*}
\text{28} \text{This is done for illustrative purposes only. Rhee offers a number of arguments for treating Korean word-final consonants as onsets of empty-headed syllables.}
\end{align*}
\]
If the targeted stop is underlingly specified for dependent [H] or [ʔ], 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 underlingly 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 [−g116/g171]. If, on the other hand, the stem-final consonant is a sonorant, as in (66b), the suffix surfaces as [−otja].

<table>
<thead>
<tr>
<th></th>
<th>STEM</th>
<th>STEM+DIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>/kat/</td>
<td>/katja/</td>
</tr>
<tr>
<td></td>
<td>/tas/</td>
<td>/tasja/</td>
</tr>
<tr>
<td></td>
<td>/slf/</td>
<td>/slfja/</td>
</tr>
<tr>
<td>b.</td>
<td>/kam/</td>
<td>/kamåja/</td>
</tr>
<tr>
<td></td>
<td>/kan/</td>
<td>/kanåja/</td>
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<tr>
<td></td>
<td>/ton/</td>
<td>/tonåja/</td>
</tr>
<tr>
<td></td>
<td>/bol/</td>
<td>/bolåja/</td>
</tr>
<tr>
<td></td>
<td>/stet/</td>
<td>/stetåja/</td>
</tr>
</tbody>
</table>

31 The realization of <tj> varies between [tj], [t]j], [tç], and [ç]; <sj> is usually realized as [j].
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.32 The forms in (67) contain some examples involving /r I n/:33

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

Complex onsets of the kind in (67) are required to be heterorganic. This raises the question why \textit{tr} is permitted, but $^*\text{tl}$ 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.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.35 According to this interpretation, nasals have, as it were,
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” |ʔ|.

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):

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

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 |ʔ|) as well as processes in which a vowel or a glide is changed to a nasal (by insertion of |ʔ|).

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 *ŋ has merged with *. This merger can be expressed in terms of the deletion of |ʔ| from the manner structure of the nasal, yielding a homorganic glide:

\[
\begin{array}{c|c}
\text{O} & \text{O/N} \\
| & | \\
L & L \\
| & | \\
ʔ & \\
\end{array}
\]

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 /h/. Some representative developments are given in (70):

\[
\begin{array}{c|c}
\text{O} & \text{O} \\
| & | \\
L & L \\
| & | \\
ʔ & I \quad A \\
\end{array}
\]

\*n > j
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 */g106/ merged with */g107/. The preceding */g107/ was subsequently lost, after which */g119/ developed into */g110/. This raises the question how the presence of */g110/ in (70c) should be accounted for. Picard argues that this */g110/ is also a reflex of */g106/, 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 |\(\text{?}\)| (note that I assume that */g106/ is specified for |\(\text{I}\)| only):

\[
\begin{array}{ccc}
  & O & O \\
  | & | \\
  L & > & L \\
  | & | \\
  I & ? & I \\
  *j & > & n
\end{array}
\]

This process of nasalization can be viewed as an instance of fortition, since the addition of |\(\text{?}\)| 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
  -tenke-  < -teḱe-  < *-tek-že  'build-PERF' (o-teka ‘to build’)
  -linke-  'pay-PERF' (o-liva ‘to pay’)
  -vinke-  'pass-PERF' (o-vira ‘to pass’)

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
  *-tatu-  > raru  ‘three’ cf. tharu  ‘id.-CL10’
  *-pili-  > ovira  ‘to pass’ cf. ephiro  ‘path-CL9’

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 [?] 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
    |        |
   L  >  L
    |        |
   I  ?     |
    |  I

*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 Nœ, ~C, N±p, and ~. A special development is found in Evale, a Northern Wambo language, where *N has in all contexts developed into /i/:

\[
\begin{align*}
N+p & > ip \\
N+t & > it \\
N+k & > ik \\
N+v & > iv \\
N+j & > ij \\
N+w & > iw
\end{align*}
\]

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:\(^{36}\)

\[
\begin{array}{llll}
\text{N} & \text{N} \\
\text{L} & \text{L} \\
? & I \\
\end{array}
\]

\( ^{*}n > i \)

According to Baucom, the change in (76) involved an intermediate stage in which the nasal was devoiced, i.e. \(*N > ~ > i\). 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 \(/n^b-/\); 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 /nif]/- 'cut' are given in (77):

(77) /nif]/-n-t-es/ [nif]/’is] ‘he cut it’
/nif]/-nú-n-t-es/ [nt]/’anújs] ‘he got it cut’

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

As a final illustration of nasal vocalization, consider the following facts from Usila Chinatec. As is noted by Skinner (1962), Usila Chinatec /m/ is optionally realized as [û]. The important difference between this process and the processes considered above is that in Usila Chinanteck the vocalic variant surfaces as nasalized. I take this to mean that in Usila Chinanteck 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
    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. |L|, 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)

a. \( V \)  
   \( C \)

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)

a. / gala \( \text{[ika\?]} \) ‘to tie’
   b. / lipas \( \text{[lipah]} \) ‘cockroach’
   c. / awan \( \text{[aw\$]} \) ‘cloud’
   d. / kena \( \text{[kenal]} \) ‘to know’

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 \( [\text{?]}) \) 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 /l/ is realized as [\text{i}] (e.g. [\text{kenui}]), or is lost with compensatory lengthening of the preceding vowel (e.g. [\text{kenui}]) (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 \( |l| \) element of the nasal and the \( |A| \) element of the vowel. Note, too, that nasalization occurs only in case the vowel is low; if the vowel is non-low, final /m n/ are realized as [\text{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 the 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 fails 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 \[?, H, \text{ and } L \] as dependent manner are given in (81):

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

A comment is in order with respect to the interpretation of \[H\] and \[L\] as laryngeal elements. Note in (81) that dependent \[H\] involves a greater degree of glottal aperture than \[L\] while, in their capacity as heads, \[L\] involves a greater degree of supraglottal aperture than \[H\].\footnote{I am grateful to Wolfgang Kehrein for raising this issue.} This suggests, then, that the phonetic relation between head and dependent \[H\] and \[L\] is primarily acoustic.

The phonetic realization of dependent \[?, H, \text{ and } L\] 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 \[H\] 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 \[H\] 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 \[H\]. In Javanese, this \[H\] 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 \[H\] of the aspirated stop is realized on a following sonorant consonant, as in words like clue \[/k\'lu\] and cry \[/k\'ra\] (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 \[?, H, \text{ and } L\] 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

\[42\] I am grateful to Wolfgang Kehrein for raising this issue.
are realized as postglottalized (or ejective) and the sonorants as preglottalized.\textsuperscript{43} 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.\textsuperscript{44} 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 \[?\], \[H\], and \[L\]-headed manner types distinguished in Element-based Dependency. The table in (82) summarizes the compatibility of manner and phonation types:\textsuperscript{45}

\begin{tabular}{|l|c|c|c|c|c|}
\hline
Segment type & Voi & Asp & Glott & BrVoi & Impl \\
\hline
\[?\]-headed (stops) & ✓ & ✓ & ✓ & ✓ & ✓ \\
\[H\]-headed (fricatives) & ✓ & ✓ & ✓ & * & * \\
\[L\]-headed (sonorants) & * & ✓ & ✓ & * & * \\
\hline
\end{tabular}

(82) displays two asymmetries: breathy voice and implosion are compatible only with \[?\]-headed segments, and voicing is restricted to \[?\]-headed and \[L\]-headed segments. I will provide a principled account of both asymmetries below.

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):

\textsuperscript{43} We will see in §5.3 that this difference is typical in prevocalic position.

\textsuperscript{44} In what follows, I ignore the relation between laryngeal segments and laryngeal modifications; this issue is discussed §6.3.

\textsuperscript{45} In (82) Voi denotes voice, Asp aspiration, Glott glottalization, BrVoi breathy voice (i.e. “voiced aspiration”), and Impl implosion (i.e. “voiced glottalization”).
Note again the variable realization of structures that are specified for dependent \(|\). A segment such as /p'/ is in some languages realized as an ejective. Similarly, a segment like /a'/ 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 \(|\). Below, I adopt the convention of transcribing all segments that contain dependent \(|\) with the glottalization diacritic /\.

As was noted, contrastive implosion is compatible only with \(|\)-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):

\[(84)\]
a. O
b. O
c. O
d. N

\[
\begin{array}{cccc}
? & ? & H & ? \\
U & I & I & A \\
/p'/ & /s'/ & /\j'/ & /a'/ \\
\end{array}
\]

(84a) is a bilabial glottalized sonorant stop, which is interpreted phonetically as an implosive [b] or as a voiced glottalized stop, i.e. [b'] or [b^\text{\textasciitilde}]], with optional presence of voiced creak during oral closure. Thus, implosion is interpreted as a combination of inherent voicing and dependent \(|\). Note that this representation is required only in case implosive stops are contrastive, as in !Xù. In languages such as Thai and Swahili, in which voiced stops are phonetically realized as imploled, 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. In such cases, too, there is no need to represent these stops as underlyingly specified for dependent [ʔ]. 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 imploled affricate. This segment type is very rare; the only language in UPSID which contains imploled affricates is !Xū. 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 [ʔ]-headed, the resulting segment is not interpreted as being imploled 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 /ʔ/. I suggest that the sound in question functions phonologically as an inherently voiced fricative with dependent glottalization; that is, /ʔ/ has a manner component in which [H] dominates [L], and a dependent element [ʔ].

### 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):

(85)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>?</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>U</td>
<td>I</td>
<td>A</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>/pʰ/</td>
<td>/sʰ/</td>
<td>/aʰ/</td>
<td>/mʰ/</td>
</tr>
</tbody>
</table>

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 [mʰ bʰ mE nE mE mE nE mE].

---

47 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 $|H|$. 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 $|H|$ in terms of the aspiration symbol $/h/.$

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

(86)  a. O   b. O   c. O

\[
\text{\[?\ H \] \[? \ H \] \[L \ H \] \[L \ L \] \[U \ H \] \[I \]}
\]

(86a) represents an inherently voiced bilabial stop with dependent $|H|$, i.e. $/b^h/$; (86b) is an inherently voiced affricate with dependent $|H|$, i.e. $/\tilde{d}z^h/$. Manner components that lack $|\tilde{r}|$ 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 $|H|$, in more detail in chapter 5.

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 $|\tilde{r}|$-headed and $|H|$-headed manner types, but not with $|L|$-headed manner types. This asymmetry is repeated in (87):
The assumption that voicing is represented in terms of dependent $|L|$ 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 $|L|$ is not limited to voicing, but is extended to include nasalization. More specifically, my claim is that the interpretation of dependent $|L|$ depends on the manner type of the segment to which it is associated. If the segment is a sonorant, then dependent $|L|$ is interpreted as nasalization. If, on the other hand, the segment is an obstruent, then dependent $|L|$ is interpreted as voicing.

Let us consider some consequences of this hypothesis. First of all, a context-sensitive interpretation of dependent $|L|$ resolves the asymmetry in (87), as is shown in (88):

\[
\begin{array}{ccc}
\text{Segment type} & \text{Voice} & \text{Nasalization} \\
\hline
|?-\text{headed} & \text{stops} & \checkmark \\
|H?-\text{headed} & \text{fricatives} & \checkmark \\
|L?-\text{headed} & \text{sonorants} & \ast
\end{array}
\]

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

The dual interpretation of dependent $|L|$ 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 $|L|$ in their manner component. In those cases where sonorant voicing is phonologically relevant, it is by virtue of this $|L|$. This implies that dependent $|L|$ denotes distinctive voicing if the manner type to which it is linked does not itself contain $|L|$, as is the case in structures of the kind in (89):
All structures in (89) have obstruent manner components, so that dependent |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 |L|, dependent |L| is interpreted as nasalization. Some representative manner structures are given in (90):


<table>
<thead>
<tr>
<th>U</th>
<th>L</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>/û/</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(90a) represents the nasalized vowel /û/; (90b) is its non-nuclear counterpart, a typical realization of which is [Ü]. Cohn (1993) observes that [Ü] is contrastive in a number of languages, including Yakut, Koñagi, and Umbundu. (90c) is a voiced nasalized fricative /κ/. 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 /κ/ must be viewed as inherently voiced. Finally, (90d) represents a labial nasal contour, a typical realization of which is [b̪]; 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):

---

48 Schadeberg and Williamson also posit a number of underlyingly 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 |ʔ|, and a dependent element |L|:

(92) a. O
    \[\text{L} \quad \text{L}\]
    \[?\]
    \[U\]
    \(/m/\)

b. O
    \[\text{H} \quad \text{L}\]
    \[?\]
    \[\text{L}\]
    \(/H/\)

\(/?/\)

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|, |ʔ| 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 (ʔ-U:L).49 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 (ʔ-U:L).50

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

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

---

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).
(93) \[ \begin{align*} U & : \text{backness} \\ I & : \text{frontness} \\ A & : \text{lowness} \end{align*} \]

It is also possible to view each element as imposing a partition of the vowel space into two regions. This is illustrated in (94):

(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.\(^{53}\) 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):

(95) \[
\begin{array}{ccc}
\text{a.} & \text{N} & \text{b.} & \text{N} & \text{c.} & \text{N} \\
| & | & | & | & | & | \\
L & L & L & | & | & | \\
U & I & A & /u/ & /i/ & /a/ \\
\end{array}
\]

Combinations of \(|U|, |I|, \text{and} |A|\) 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 [uu] 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 |
| I A | A I |

/ɛ/ /ε/

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):

\[(99)\]

\[
\begin{align*}
\text{U} & : \text{(more) constricted labial cavity (=rounding)} \\
\text{I} & : \text{(more) constricted oral cavity (=ATR)} \\
\text{A} & : \text{(more) constricted pharyngeal cavity (=RTR)}
\end{align*}
\]

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.

\[(100)\]

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

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).

\subsection*{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):

\[(101)\]

\[
\begin{align*}
\text{U} & : \text{labial constriction} \\
\text{I} & : \text{coronal constriction} \\
\text{A} & : \text{dorsal constriction}
\end{align*}
\]

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. \[\text{round}\] and \[\text{labial}\], 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/:

<table>
<thead>
<tr>
<th>English</th>
<th>Incorporated word</th>
<th>Sranan</th>
</tr>
</thead>
<tbody>
<tr>
<td>sick</td>
<td>/stik/</td>
<td>siki</td>
</tr>
<tr>
<td>beg</td>
<td>/beg/</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>/lus/</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:

<table>
<thead>
<tr>
<th>English</th>
<th>Incorporated word</th>
<th>Sranan</th>
</tr>
</thead>
<tbody>
<tr>
<td>grab</td>
<td>/græb/</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 \[\text{U}\], \[\text{I}\], and \[\text{A}\] 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 \[\text{I}\]. I suggest that this restriction is related to the presence of the manner element \[\text{H}\]. 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 \[\text{H}\] can dominate \[\text{I}\] 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:

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

(104a) and (104b) involve a combination of labiality and coronality, which suggests that the structures are interpreted as /p t/. These segments are extremely rare and possibly non-existent underlyingly. Ladefoged & Maddieson (1996:344) observe that [p] is an allophone of /k/ in Dagbani; in Abkhaz and Lak it is, for some speakers at least, an allophone of /t/. According to Ladefoged & Maddieson, the only language in which /p/ 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 /w kp gb/ trigger merger of a following /b th/, 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. /\(\phi/\sim/\tilde{\phi}\)/. 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. /\(\nu/\sim/\tilde{\nu}\)/, 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. /\(\chi/\sim/\tilde{\chi}\)/. 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, \(|U|, |I|, \text{ and } |A|\) have the following interpretation:

\[(106)\]

\begin{align*}
U &: \text{ labialization} \\
I &: \text{ palatalization} \\
A &: \text{ velarization}
\end{align*}

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

\[(107)\]

\[
\begin{array}{c}
| \\
\text{?} \\
| \\
U \\
L \\
| \\
I \\
| \\
| \\
/p/ \\
\end{array}
\]

In (107) we are effectively dealing with a cluster of a labial stop /\(p/\) and a non-nuclear front vowel /\(\j/\). This raises the question whether it is legitimate to analyze the combination as a single palatalized stop /\(p/\tilde{\j}/\), or whether it is more properly viewed as a cluster /\(p/\j/\). I suggest that the crucial observation here is that languages never have a phonological contrast between a consonant with
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\textsuperscript{1}~p\textsuperscript{2}/ 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:

\[
\text{(108)} \quad \begin{array}{c}
\text{O} \\
? \\
\text{H} \\
\text{U}
\end{array}
\]

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\textsuperscript{b}/ 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 /p/ and /ph/, at least not within the same subsyllabic position. From the perspective of phonological contrast, this suggests that a single representation /p+ː/ 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 /ː/, then an interpretation of /pː/ as a cluster implies that no segment /p/ 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/, /ː/, and /pː/, and if this language allows no sequences other than /pː/, then a single segment interpretation of /pː/ 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 /pː/ and only (109b,c), where /p/ and /ː/ 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/, /h/, 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. /p+l/, but not of an aspirated stop and a lateral, e.g. */p+h+l/*. 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 /p+l/ and /p+h+l/ in (110):


? H  ? H  H ?
U  U  U
/p/  /ph/  /hp/

(110) a. O  b. O'

? L  O  H
U  H  ? L
I  U  H
/p+l/  /p+h+l/

(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. 56 The projected onset is represented as O’. 57 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 */p~/~ph/ and */p~/~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 */p+-+-p/ 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+j/ within an onset is universally realized as /p/ first and /j/ second. The fact that the order here is fixed can be attributed to the fact that /j/ is more sonorous—i.e. consists of more vocalic elements—than /p/. The combination /p+j/ is in this respect similar to a combination such as /f+u/ which, within the same subsyllabic constituent, is predictably realized as /f/ first and /u/ 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. [p’], 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, \( |?| \)-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:

\[
(112) \quad \begin{array}{ll}
\text{a.} & *O \\
\text{b.} & *O \\
\end{array}
\]

(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—i.e. contain more elements—than dependents, since in structures such as /p+I/ 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 \( |?| \)-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:

\[
(113) \quad \begin{array}{c}
\text{N’’’} \\
\text{O} \\
\text{N’} \\
\text{…} \\
\text{N} \\
\text{C} \\
\text{…} \\
\text{…}
\end{array}
\]

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):

\[
(114) \quad \begin{array}{c}
\text{N’’’} \\
\text{N’} \\
\text{L} \\
\text{O} \\
\text{N’} \\
\text{…} \\
\text{…}
\end{array}
\]
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 [ɬ], [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.